Adaptive Feeding behavior and functional responses in pelagic copepods

Zooplankton may modify their feeding behavior in response to prey availability and presence of predators with implications to populations of both predators and prey. Optimal foraging theory predicts that such responses result in a type II functional response for passive foragers and a type III response for active foragers, with the latter response having a stabilizing effect on prey populations. Here, we test the theoretical predictions and the underlying mechanisms in pelagic copepods that are actively feeding (feeding-current feeders), passively feeding (ambushers), or that can switch between the two feeding modes. In all cases, individual behaviors are consistent with the resulting functional response. Passive ambushing copepods have invariant foraging behavior and a type II functional response, as predicted. When foraging actively, the species with switching capability change its functional response from type II to III and modify its foraging effort in response to prey density and predation risk, also as predicted by theory. The obligate active feeders, however, follow a type II response inconsistent with the theoretical prediction. A survey of the literature similarly finds consistent type II response in ambush feeding copepods, but variable (II or III) responses in active feeders. We examine reasons for why observed behaviors at times deviate from predictions, and discuss the population dynamics and food web implications of the two types of functional responses and their underlying mechanisms.
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
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BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.5 SJR 1.712 SNIP 1.225
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Scopus rating (2015): SJR 2.472 SNIP 1.422 CiteScore 3.93
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.112 SNIP 1.584 CiteScore 3.73
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.256 SNIP 1.587 CiteScore 3.98
ISI indexed (2013): ISI indexed yes
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BFI (2012): BFI-level 2
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Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
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BFI (2009): BFI-level 2
Scopus rating (2009): SJR 2.329 SNIP 1.682
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Scopus rating (2008): SJR 2.381 SNIP 1.615
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Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 2.302 SNIP 1.697
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 2.463 SNIP 1.778
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 2.685 SNIP 2.004
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 2.605 SNIP 1.798
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 2.91 SNIP 1.892
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A global mismatch in the protection of multiple marine biodiversity components and ecosystem services

The global loss of biodiversity threatens unique biota and the functioning and services of ecosystems essential for human wellbeing. To safeguard biodiversity and ecosystem services, designating protected areas is crucial; yet the extent to which the existing placement of protection is aligned to meet these conservation priorities is questionable, especially in the oceans. Here we investigate and compare global patterns of multiple biodiversity components (taxonomic, phylogenetic and functional), ecosystem services and human impacts, with the coverage of marine protected areas across a nested spatial scale. We demonstrate a pronounced spatial mismatch between the existing degree of protection and all the conservation priorities above, highlighting that neither the world's most diverse, nor the most productive ecosystems are currently the most protected ecosystems. Furthermore, we show that global patterns of biodiversity, ecosystem services and human impacts are poorly correlated, hence complicating the identification of generally applicable spatial prioritization schemes. However, a hypothetical "consensus approach" would have been able to address all these conservation priorities far more effectively than the existing degree of protection, which at best is only marginally better than a random expectation. Therefore, a holistic perspective is needed when designating an appropriate degree of protection of marine conservation priorities worldwide.

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Web of Science (2016): Indexed yes
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Breaking resilience for a sustainable future: Thoughts for the anthropocene

Strong resilience of a system usually enables the protection of a status quo. Most resilience studies assume that resilience-building is the central objective of sustainability work. Even though transformation has become a central theme in development and social-ecological debates, questions surrounding the weakening resilience of undesired system states are rarely analyzed. We suggest that resilience studies not only serve to protect systems and feedbacks we want to maintain, but may also help to understand and overcome chronic, undesirable,—and thus wicked—resilience. This contribution focuses on reef fisheries in the Spermonde Island Archipelago in Indonesia, based on social and ecological studies between 2004 and 2016. We identify a number of interlocking wickedly resilient vicious cycles as predominant drivers of the impoverishment of fishing households and the overexploited, polluted and degraded state of the coral reefs that fishers’ livelihoods depend on. We argue that more often than not in the Anthropocene, breaking resilience has a central role in the pursuit of sustainable human-nature relations. Therefore, the link between the resilience and the transformation debates needs to be made more explicitly. Breaking interlocking, wicked resilience at multiple levels is needed to move toward sustainable human-nature relations from the local to the global level. There are lacunae in debate, literature, and research practice as to when, where and how wicked resilience might need to be weakened. A more complete resilience lens is particularly needed under Anthropocene conditions to support the unmaking of chronically resilient, anthropogenic systems.

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understand the specific trophic responses to change in the environment. Furthermore, the use of isotopic niches underlines the utility of stable isotopes in studying the potential impacts of environmental change on feeding ecology.

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BFI (2014): BFI-level 1
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**Evolution of boldness and life-history in response to selective harvesting**
Whether intensive harvesting alters the behavioral repertoire of exploited fishes is currently unknown, but plausible. We extend a fish life-history model to account for boldness as a personality trait that affects foraging intensity, which affects energy intake and risk from predation and fishing gear. We systematically investigate life-history and behavioral trait evolution along the boldness–timidity axis in response to the full range of common selectivity and exploitation patterns in fisheries. In agreement with previous studies, we find that any type of harvesting selects for fast life histories and that merely elevated, yet unselective, fishing mortality favors boldness. We also find that timid-selective fishing (which can be expected in species targeted by active gear types) selects for increased boldness. By contrast, increased timidity is predicted when fishing targets bolder individuals common to passive gears, whether in combination with selection on size or not. Altered behavior caused by intensive harvesting should be commonplace in nature, which can have far-reaching ecological, evolutionary, and managerial impacts. Evolution of timidity is expected to strongly erode catchability, which will negatively affect human well-being and influence the reliability of stock assessments that rely on fishery-dependent data.

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Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.256 SNIP 1.051 CiteScore 2.22
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.443 SNIP 1.379 CiteScore 2.6
Web of Science (2014): Indexed yes
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Web of Science (2013): Indexed yes
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Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
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ISI indexed (2011): ISI indexed yes
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BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.425 SNIP 1.118
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.451 SNIP 1.196
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 1.589 SNIP 1.379
Web of Science (2008): Indexed yes
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Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.558 SNIP 1.553
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 1.744 SNIP 1.542
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 2.097 SNIP 1.622
Scopus rating (2002): SJR 1.909 SNIP 1.457
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 1.769 SNIP 1.46
Web of Science (2001): Indexed yes
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Web of Science (2000): Indexed yes
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Foraging response and acclimation of ambush feeding and feeding-current feeding copepods to toxic dinoflagellates
Copepods exposed to toxic algae in "black box" incubation experiments show highly varied responses, but the mechanisms cannot be revealed from such experiments and the implications to copepod and phytoplankton population dynamics consequently not evaluated. Here, we use direct video observations to examine the response and temporal acclimation (5 d) of two copepods with different foraging behaviors to toxic dinoflagellates. Feeding-current feeding Temora longicornis and ambush feeding Acartia tonsa were offered three strains of toxic Alexandrium tamarense and a nontoxic control Protoceratium reticulatum. We hypothesize (1) that ambush feeders are less affected by toxic algae than feeding-current feeders, (2) that copepods acclimate to the toxic algae, and (3) that phytoplankton cells previously exposed to copepod cues elicit stronger responses. Both copepod species consumed the toxic algae at a reduced rate and there was no difference in their net-response, but the mechanisms differed. T. longicornis responded in strain-specific ways by reducing its feeding activity, by rejecting captured algae, or by regurgitating consumed cells. A. tonsa reduced its consumption rate, jump frequency, and jump distance on all strains of the toxic dinoflagellate, and most so on copepod-cue induced cells. There was limited acclimation to algal toxins, although some behavioral responses relaxed or intensified during the first one to several days. Mortality rates were low and the various responses, thus, all allow the copepods to survive harmful algal blooms. However, the implications to algal population dynamics are species/strains specific, with only prey selection providing the toxic algae with a competitive advantage
Identifying salmon lice transmission characteristics between Faroese salmon farms

Sea lice infestations are an increasing challenge in the ever-growing salmon aquaculture sector and cause large economic losses. The high salmon production in a small area creates a perfect habitat for parasites. Knowledge of how salmon lice planktonic larvae disperse and spread the infection between farms is of vital importance in developing treatment management plans to combat salmon lice infestations. Using a particle tracking model forced by tidal currents, we show that Faroese aquaculture farms form a complex network. In some cases as high as 10% of infectious salmon lice released at one farm site enter a neighboring fjord containing another farm site. Farms were characterized as emitters, receivers or isolated, and we could identify two clusters of farms that were largely isolated from each other. The farm characteristics are a valuable input for the development of management plans for the entire Faroese salmon industry.
Implications of late-in-life density-dependent growth for fishery size-at-entry leading to maximum sustainable yield

Currently applied fisheries models and stock assessments rely on the assumption that density-dependent regulation only affects processes early in life, as described by stock-recruitment relationships. However, many fish stocks also experience density-dependent processes late in life, such as density-dependent adult growth. Theoretical studies have found that, for stocks which experience strong late-in-life density dependence, maximum sustainable yield (MSY) is obtained with a small fishery size-at-entry that also targets juveniles. This goes against common fisheries advice, which dictates that primarily adults should be fished. This study aims to examine whether the strength of density-dependent growth in actual fish stocks is sufficiently strong to reduce optimal fishery size-at-entry to below size-at-maturity. A size-structured model is fitted to three stocks that have shown indications of late-in-life density-dependent growth: North Sea plaice (Pleuronectes platessa), Northeast Atlantic (NEA) mackerel (Scomber scombrus), and Baltic sprat (Sprattus sprattus balticus). For all stocks, the model predicts exploitation at MSY with a large size-at-entry into the fishery, indicating that late-in-life density dependence in fish stocks is generally not strong enough to warrant the targeting of juveniles. This result lends credibility to the practise of predominantly targeting adults in spite of the presence of late-in-life density-dependent growth.
Insect temperature-body size trends common to laboratory, latitudinal and seasonal gradients are not found across altitudes

Body size affects rates of most biological and ecological processes, from individual performance to ecosystem function, and is fundamentally linked to organism fitness. Within species, size at maturity can vary systematically with environmental temperature in the laboratory and across seasons, as well as over latitudinal gradients. Recent meta-analyses have revealed a close match in the magnitude and direction of these size gradients in various arthropod orders, suggesting that these size responses share common drivers. As with increasing latitude, temperature also decreases with increasing altitude. Although the general direction of body size clines along altitudinal gradients has been examined previously, to our knowledge altitude-body size (A-S) clines have never been synthesised quantitatively, nor compared with temperature-size (T-S) responses measured under controlled laboratory conditions. Here we quantitatively examine
variation in intraspecific A-S clines among 121 insect species from 50 different global locations, representing 12 taxonomic orders. While some taxa were better represented in the literature than others, our analysis reveals extensive variation in the magnitude and direction of A-S clines. Following the assumption that temperature on average declines by 1°C per 150 m increase in altitude, order-specific A-S clines in the field appear to deviate from laboratory T-S responses. Specifically, the magnitude of A-S clines and T-S responses are more closely matched in some taxonomic orders (e.g. Diptera) than others (e.g. Orthoptera). These findings contrast with the strong co-variation observed between latitude-size clines and T-S responses, and between laboratory and seasonal T-S responses. The lack of clear size relationships with elevation, and hence temperature, is likely due to the counteracting effects of other major drivers with altitude, including season length and oxygen partial pressure. Switches in voltinism within species across altitude, and the dispersal of individuals across different elevations, may also obscure trends.

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Scopus rating (2016): CiteScore 5.45 SJR 3.165 SNIP 1.776
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 3.059 SNIP 1.673 CiteScore 4.81
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 3.114 SNIP 1.854 CiteScore 4.96
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.691 SNIP 1.791 CiteScore 4.82
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 3.083 SNIP 1.794 CiteScore 5.03
ISI indexed (2012): ISI indexed yes
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BFI (2011): BFI-level 2
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ISI indexed (2011): ISI indexed yes
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Scopus rating (2009): SJR 2.62 SNIP 1.564
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Scopus rating (2008): SJR 2.42 SNIP 1.56
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 2.055 SNIP 1.33
Scopus rating (2006): SJR 2.108 SNIP 1.41
Scopus rating (2005): SJR 1.878 SNIP 1.564
Scopus rating (2004): SJR 1.673 SNIP 1.306
Scopus rating (2003): SJR 1.453 SNIP 1.266
Scopus rating (2002): SJR 1.487 SNIP 1.335
Phytoplankton defence mechanisms: traits and trade-offs: Defensive traits and trade-offs

In aquatic ecosystems, unicellular algae form the basis of the food webs. Theoretical and experimental studies have demonstrated that one of the mechanisms that maintain high diversity of phytoplankton is through predation and the consequent evolution of defence mechanisms. Proposed defence mechanisms in phytoplankton are diverse and include physiological (e.g. toxicity, bioluminescence), morphological (e.g. silica shell, colony formation), and behavioural (e.g. escape response) traits. However, the function of many of the proposed defence mechanisms remains elusive, and the costs and benefits (trade-offs) are often unquantified or undocumented. Here, we provide an overview of suggested phytoplankton defensive traits and review their experimental support. Wherever possible we quantify the trade-offs from experimental evidence and theoretical considerations. In many instances, experimental evidence suggests that defences are costless. However, we argue that (i) some costs materialize only under natural conditions, for example, sinking losses, or dependency on the availability of specific nutrients, and (ii) other costs become evident only under resource-deficient conditions where a rivalry for limiting resources between growth and defence occurs. Based on these findings, we suggest two strategies for quantifying the costs of defence mechanisms in phytoplankton: (i) for the evaluation of defence costs that are realized under natural conditions, a mechanistic understanding of the hypothesized component processes is required; and (ii) the magnitude of the costs (i.e. growth reduction) must be assessed under conditions of resource limitation.
Resting eggs in free living marine and estuarine copepods

Marine free living copepods can survive harsh periods and cope with seasonal fluctuations in environmental conditions using resting eggs (embryonic dormancy). Laboratory experiments show that temperature is the common driver for resting egg production. Hence, we hypothesize (i) that seasonal temperature variation, rather than variation in food abundance is the main driver for the occurrence of the resting eggs strategy in marine and estuarine copepod species; and (ii) that the thermal boundaries of the distribution determine where resting eggs are produced and whether they are produced to cope with warm or cold periods. We compile literature information on the occurrence of resting egg production and relate this to spatio-temporal patterns in sea surface temperature and chlorophyll a concentration obtained from satellite observations. We find that the production of resting eggs has been reported for 42 species of marine free living copepods. Resting eggs are reported in areas with high seasonal variation in sea surface temperature (median range 11°C). Temporal variation in chlorophyll a concentrations, however, seems of less importance. Resting eggs are commonly produced to cope with both warm and cold periods and, depending on the species, they are produced at the upper or lower thermal boundaries of a species’ distribution.
Selection for life-history traits to maximize population growth in an invasive marine species

Species establishing outside their natural range, negatively impacting local ecosystems, are of increasing global concern. They often display life-history features characteristic for r-selected populations with fast growth and high reproduction rates to achieve positive population growth rates (r) in invaded habitats. Here, we demonstrate substantially earlier maturation at a 2 orders of magnitude lower body mass at first reproduction in invasive compared to native populations of the comb jelly Mnemiopsis leidyi. Empirical results are corroborated by a theoretical model for competing life-history traits that predicts maturation at the smallest possible size to optimize r, while individual lifetime reproductive success (R0), optimized in native populations, is near constant over a large range of intermediate maturation sizes. We suggest that high variability in reproductive tactics in native populations is an underappreciated determinant of invasiveness, acting as substrate upon which selection can act during the invasion process.
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Scopus rating (2008): SJR 3.934 SNIP 2.203
Web of Science (2008): Indexed yes
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Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 3.148 SNIP 1.897
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Scopus rating (2001): SJR 2.74 SNIP 1.488
Web of Science (2001): Indexed yes
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Spatio-temporal patterns in coral reef communities of the Spermonde Archipelago, 2012-2014, I: Comprehensive reef monitoring reveals two indices that reflect changes in reef health

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Spatio-temporal patterns in the coral reef communities of the Spermonde Archipelago, 2012–2014, II: Fish assemblages display structured variation related to benthic condition

The Spermonde Archipelago is a complex of ~70 mostly populated islands off Southwest Sulawesi, Indonesia, in the center of the Coral Triangle. The reefs in this area are exposed to a high level of anthropogenic disturbances. Previous studies have shown that variation in the benthos is strongly linked to water quality and distance from the mainland. However, little is known about the fish assemblages of the region and if their community structure also follows a relationship with benthic structure and distance from shore. In this study, we used eight islands of the archipelago, varying in distance from 1 to 55 km relative to the mainland, and 3 years of surveys, to describe benthic and fish assemblages and to examine the spatial and temporal influence of benthic composition on the structure of the fish assemblages. Cluster analysis indicated that distinct groups of fish were associated with distance, while few species were present across the entire range of sites. Relating fish communities to benthic composition using a multivariate generalized linear model confirmed that fish groups relate to structural complexity (rugosity) or differing benthic groups; either algae, reef builders (coral and crustose coralline algae) or invertebrates and rubble. From these relationships we can identify sets of fish species that may be lost given continued degradation of the Spermonde reefs. Lastly, the incorporation of water quality, benthic and fish indices indicates that local coral reefs responded positively after an acute disturbance in 2013 with increases in reef builders and fish diversity over relatively short (1 year) time frames. This study contributes an important, missing component (fish community structure) to the growing literature on the Spermonde Archipelago, a system that features environmental pressures common in the greater Southeast Asian region.

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Sustainable use of marine resources through offshore wind and mussel farm co-location

Marine Spatial Planning (MSP) can offer significant benefits in terms of economic conservation strategies, optimizing spatial planning and minimizing the impact on the environment. In this paper, we focused on the application of multi-criteria evaluation (MCE) technique for co-locating offshore wind farms and open-water mussel cultivation. An index of co-location sustainability (SI) was developed based on the application of MCE technique constructed with physical and biological parameters on the basis of remote-sensing data. The relevant physical factors considered were wind velocity, depth range, concerning the site location for energy production, and sea surface temperature anomaly. The biological variables used were Chlorophyll-a (as a measurement of the productivity) and Particle Organic Carbon (POC) concentration, in order to assess their influence on the probable benefits and complete the requirements of this management framework. This SI can be easily implemented to do a first order selection of the most promising areas to be more specifically studied.
in a second order approach based on local field data.

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Authors: Di Tullio, G. R. (Ekstern), Mariani, P. (Intern), Benassai, G. (Ekstern), Di Luccio, D. (Ekstern), Grieco, L. (Ekstern)
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Swim and fly: escape strategy in neustonic and planktonic copepods

Copepods can respond to predators by powerful escape jumps that in some surface-dwelling forms may propel the copepod out of the water. We studied the kinematics and energetics of submerged and out-of-water jumps of two neustonic pontellid copepods, Anomalocera patersoni and Pontella mediterranea, and one pelagic calanoid copepod, Calanus helgolandicus (euxinus). We show that jumping out of the water does not happen just by inertia gained during the copepod's acceleration underwater, but also requires the force generated by the thoracic limbs when breaking through the water's surface to overcome surface tension, drag and gravity. The timing of this appears to be necessary for success. At the moment of breaking the water interface, the instantaneous velocity of the two pontellids reached 125 cm s⁻¹, while their maximum underwater speed (115 cm s⁻¹) was close to that of similarly sized C. helgolandicus (106 cm s⁻¹). The average specific power produced by the two pontellids during out-of-water jumps (1700-3300 W kg⁻¹ muscle mass) was close to that during submerged jumps (900-1600 W kg⁻¹ muscle mass) and, in turn, similar to that produced during submerged jumps of C. helgolandicus (1300 W kg⁻¹ muscle mass). The pontellids may shake off water adhering to their body by repeated strokes of the limbs during flight, which leads to a slight acceleration in the air. Our observations suggest that out-of-water jumps of pontellids are not dependent on any exceptional ability to perform this behavior but have the same energetic cost and are based on the same kinematic patterns and contractive capabilities of muscles as those of copepods swimming submerged.
The understanding of consistent individual differences in behavior, often termed "personality," for adapting and coping with threats and novel environmental conditions has advanced considerably during the last decade. However, advancements are almost exclusively associated with higher-order animals, whereas studies focusing on smaller aquatic organisms are still rare. Here, we show individual differences in the swimming behavior of Daphnia magna, a clonal freshwater invertebrate, before, during, and after being exposed to a lethal threat, ultraviolet radiation (UVR). We show consistency in swimming velocity among both mothers and daughters of D. magna in a neutral environment, whereas this pattern breaks down when exposed to UVR. Our study also, for the first time, illustrates how the ontogenetic development in swimming and refuge-seeking behavior of young individuals eventually approaches that of adults. Overall, we show that aquatic invertebrates are far from being identical robots, but instead they show considerable individual differences in behavior that can be attributed to both ontogenetic development and individual consistency. Our study also demonstrates, for the first time, that behavioral consistency and repeatability, that is, something resembling "personality," is context and state dependent in this zooplankter taxa.
Analysis of trait-based models in marine ecosystems.

The overarching theme for this thesis is spatial and temporal variations in ecosystems. The focus is on describing mechanisms that are responsible for generating the spatial and temporal patterns. The thesis contains two separate projects, each exploring a possible mechanism for pattern formation. In both projects, the model formulations result in partial integro-differential equations. The first project in the thesis considers temporal patterns in a size structured population. Size structure is relevant for species that go through significant changes through their lifetime. The population's response to regular temporal variations in the environment is investigated by introducing a periodic forcing in the system. This can represent seasonal changes. The effect of an imposed forcing is explored both when the underlying unforced system has a stable equilibrium and when it has stable oscillatory dynamics. The numerical solutions show regular cycles where the period is equal to, or an integer multiple of, the forcing period and where the population can have one or more pulses of reproduction in each cycle. Additionally, the numerical results indicate quasi-periodic or chaotic solutions, period doubling bifurcations and coexisting attractors. The bifurcation structure is similar to results for comparable unstructured population models in the literature. This indicates that size structure does not affect the response to periodic forcing. The next project in the thesis considers spatio-temporal pattern formation in a predator–prey system where animals move towards higher fitness. Reaction-diffusion systems have been used extensively to describe spatio-temporal patterns in a variety of systems. However, animals rarely move entirely at random, as expressed by diffusion. This has lead to models with taxis terms, describing individuals moving in the direction of an attractant. An example is chemotaxis models, where bacteria are attracted to a chemical substance. From an evolutionary perspective, it is expected that animals act as to optimize their fitness. Based on this principle, a predator–prey system with fitness taxis and diffusion is proposed. Here, fitness taxis refer to animals moving towards higher values of fitness, and the specific growth rates of the populations are used as a measure of the fitness values. To determine the conditions for pattern formation, a linear stability analysis is conducted. The analysis reveals that the fitness taxis leads to mechanisms for pattern formation, which are based on the prey gathering together. It turns out, that in some cases the problem is not well-posed and an ultraviolet catastrophe occurs, i.e., perturbations with infinitely short wavelength grow infinitely fast. To prevent this, the population dynamics are revised with a spatial feeding kernel, that defines a spatial range wherein a predator consumes prey. A linear stability analysis for the revised system reveals the ultraviolet catastrophe is avoided and the basic mechanisms for pattern formation are unchanged. Numerical solutions to the revised system are computed to visualize the patterns. The solutions encompass stationary spatial patterns in addition to traveling waves, standing waves and irregular solutions that might be spatio-temporal chaos. The modeling approach of fitness taxis presents a general way to express movement and it is concluded that the model provides a useful framework for describing generic mechanisms for pattern formation.
A predator-2 prey fast-slow dynamical system for rapid predator evolution

We consider adaptive change of diet of a predator population that switches its feeding between two prey populations. We develop a novel 1 fast-3 slow dynamical system to describe the dynamics of the three populations amidst continuous but rapid evolution of the predator's diet choice. The two extremes at which the predator's diet is composed solely of one prey correspond to two branches of the three-branch critical manifold of the fast slow system. By calculating the points at which there is a fast transition between these two feeding choices (i.e., branches of the critical manifold), we prove that the system has a two-parameter family of periodic orbits for sufficiently large separation of the time scales between the evolutionary and ecological dynamics. Using numerical simulations, we show that these periodic orbits exist, and that their phase difference and oscillation patterns persist, when ecological and evolutionary interactions occur on comparable time scales. Our model also exhibits periodic orbits that agree qualitatively with oscillation patterns observed in experimental studies of the coupling between rapid evolution and ecological interactions.
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Assessing impact of bottom trawling and hypoxia on seafloor status of the Baltic Sea

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A trait-based approach to understanding marine communities composition, assembly and diversity
A species occurs and thrives in a community thanks to its capacity to grow, reproduce and feed in its surrounding
environment. Understanding how and why some species thrive in particular areas has often been touched upon by
studying the species composition of communities. Traditionally, communities are characterised by their taxonomic
diversity, such as their species richness or the evenness in their abundances. However, there is growing evidence that it is
not the taxonomic identity of the species per se that control its presence and abundance in a given environment but its
characteristics. Species traits refer to quantitatively or qualitatively measurable characteristics of a species. Characterizing
species by their key traits can permit an understanding of
general mechanisms and unravel the processes affecting coexistence in communities. The aim of this thesis was to apply
the trait-based approach to study the composition of marine communities located in the European Seas and relate their
spatial patterns to environmental and anthropogenic pressures.

The species composition of communities can be constrained by several processes, such as competition and the
environment. Using a trait-based approach, we studied the diversity and the processes influencing the composition of
demersal fish communities in the Baltic Sea. While species richness was sharply decreasing from the saline Kattegat to
the brackish Gdansk Bay, trait richness tended to decrease at a lower rate. We found that the species co-occurring in the
Eastern Baltic Sea were in general more ecologically
similar, in terms of their traits, than expected by random chance alone with a strong influence of the environment and notably the salinity gradient on the distribution and trait composition of the communities. While traits are increasingly used in community ecology, they are often selected and used without a consistent framework. We made use of a theoretical framework that
defines life history strategies as a combination of key traits and their trade-offs to investigate large-scale patterns and
drivers of fish community composition across European Seas. We assembled an extensive number of surveys in the
European seas and collected reproductive traits for more than 300 fish species present in these surveys. Based on their
traits, fish species could be categorized into three strategies that reflect the evolutionary and environmental constraints
acting on the species. The strategies’ prevalence exhibited strong geographical patterns which could be explained by
spatial variability in annual sea surface temperature, temperature seasonality, depth and fishing intensity. Due to their tight
coupling to the environment, notably temperature and fishing, life history strategies could be a suitable tool to monitor and understand community changes in response to natural and anthropogenic stressors, including climate change. Spatial patterns of community mean traits and their relationship with the environment are generally assessed on a single taxonomic group. As a result, it is still unclear whether the relationship found for one taxonomic group can be generalised to other taxonomic groups that compose the ecosystem. Yet, understanding the responses of these different groups to environmental pressures is a prerequisite to conserve and manage ecosystems. We studied the spatial pattern of community traits of three key taxonomic groups in the North Sea: copepods, benthos, and fish. We extracted the community composition of these groups from three scientific surveys covering the entire North Sea and combined them with key life history traits common to all three groups: adult size, offspring size and fecundity. While many of the traits co-varied in space and notably demonstrated a latitudinal gradient, none of the traits had a consistent, either positive or negative, relationship across all taxa. The spatial trait-variability could be explained by taxonspecific habitat condition. Thus, trait responses to environmental gradient cannot be generalized across these marine taxonomic groups, pointing toward potential complex responses of multi-taxa communities to environmental changes.

This thesis highlights the value of using traits to understand why communities are composed of a specific set of species and how the mean traits of these communities varies along environmental and anthropogenic gradient. This thesis stresses the utility of the trait-based approach, due to its generality, to compare communities at different scales, from different regions as well as communities composed of different taxonomic entities. The trait-based approach still has a lot to offer to unravel the processes controlling the composition of communities and species distribution, and its use in marine ecology has yet to be extended to other domains, such as understanding the impacts of functional traits composition on the ecosystem functioning in the marine realm.

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**A trait database for marine copepods**
The trait-based approach is gaining increasing popularity in marine plankton ecology but the field urgently needs more and easier accessible trait data to advance. We compiled trait information on marine pelagic copepods, a major group of zooplankton, from the published literature and from experts and organized the data into a structured database. We collected 9306 records for 14 functional traits. Particular attention was given to body size, feeding mode, egg size, spawning strategy, respiration rate, and myelination (presence of nerve sheathing). Most records were reported at the species level, but some phylogenetically conserved traits, such as myelination, were reported at higher taxonomic levels, allowing the entire diversity of around 10 800 recognized marine copepod species to be covered with a few records. Aside from myelination, data coverage was highest for spawning strategy and body size, while information was more limited for quantitative traits related to reproduction and physiology. The database may be used to investigate relationships between traits, to produce trait biogeographies, or to inform and validate trait-based marine ecosystem models. The data can be downloaded.
Bacterial community composition and potential driving factors in different reef habitats of the Spermonde Archipelago, Indonesia

Coastal eutrophication is a key driver of shifts in bacterial communities on coral reefs. With fringing and patch reefs at varying distances from the coast the Spermonde Archipelago in southern Sulawesi, Indonesia offers ideal conditions to study the effects of coastal eutrophication along a spatially defined gradient. The present study investigated bacterial community composition of three coral reef habitats: the water column, sediments, and mucus of the hard coral genus Fungia, along that cross shelf environmental and water quality gradient. The main research questions were: (1) How do water quality and bacterial community composition change along a coastal shelf gradient? (2) Which water quality parameters influence bacterial community composition? (3) Is there a difference in bacterial community composition among the investigated habitats? For this purpose, a range of key water parameters were measured at eight stations in distances from 2 to 55 km from urban Makassar. This was supplemented by sampling of bacterial communities of important microbial habitats using 454 pyrosequencing. Findings revealed that the population center Makassar had a strong effect on the concentrations of Chlorophyll a, suspended particulate matter (SPM), and transparent exopolymer particles (TEP), which were all significantly elevated at the inshore compared the other seven sites. Shifts in the bacterial communities were specific to each sampled habitat. Two OTUs, belonging to the genera Escherichia/Shigella (Gammaproteobacteria) and Raistonia (Betaproteobacteria), respectively, both dominated the bacterial community composition of the both size fractions of the water column and coral mucus. The sampled reef sediments were more diverse, and no single OTUs was dominant. There was no gradual shift in bacterial classes or OTUs within the sampled habitats. In addition, we observed very distinct communities between the investigated habitats. Our data show strong changes in the bacterial community composition at the inshore site for water column and sediment samples. Alarmingly, there was generally a high prevalence of potentially pathogenic bacteria across the entire gradient.
Behavior is a major determinant of predation risk in zooplankton

Zooplankton exhibit different small-scale motile behaviors related to feeding and mating activities. These different motile behaviors may result in different levels of predation risk, which may partially determine the structure of planktonic communities. Here, we experimentally determined predation mortality associated with (1) feeding activity (ambush feeders vs. feeding-current vs. cruising feeders) and (2) mate-finding behavior (males vs. females). The copepods Oithona nana, O. davisae (ambush feeders), Temora longicornis (feeding-current feeder), and Centropages hamatus (cruising feeder) were used as prey for different predatory copepods. Copepods with “active” feeding behaviors (feeding-current and cruising feeders) showed significantly higher mortality from predation (~2–8 times) than similarly sized copepods with low motility feeding behavior (ambush feeders). Copepod males, which have a more active motile behavior than females (mate-seeking behavior), suffered a higher predation mortality than females in most of the experiments. However, the predation risk for mate-searching behavior in copepods varied depending on feeding behavior with ambush feeders consistently having the greatest difference in predation mortality between genders (~4-8 times higher for males than for females). This gender-specific predation pressure may partially explain field observations of female-biased sex ratios in ambush feeding copepods (e.g., Oithonidae).

Overall, our results demonstrate that small-scale motile behavior is a key trait in zooplankton that significantly affects predation risk and therefore is a main determinant of distribution and composition of zooplankton communities in the ocean.
Bridging food webs, ecosystem metabolism, and biogeochemistry using ecological stoichiometry theory

Although aquatic ecologists and biogeochemists are well aware of the crucial importance of ecosystem functions, i.e., how biota drive biogeochemical processes and vice-versa, linking these fields in conceptual models is still uncommon. Attempts to explain the variability in elemental cycling consequently miss an important biological component and thereby impede a comprehensive understanding of the underlying processes governing energy and matter flow and transformation. The fate of multiple chemical elements in ecosystems is strongly linked by biotic demand and uptake; thus, considering elemental stoichiometry is important for both biogeochemical and ecological research. Nonetheless, assessments of ecological stoichiometry (ES) often focus on the elemental content of biota rather than taking a more holistic view by examining both elemental pools and fluxes (e.g., organismal stoichiometry and ecosystem process rates). ES theory holds the promise to be a unifying concept to link across hierarchical scales of patterns and processes in ecology, but this has not been fully achieved. Therefore, we propose connecting the expertise of aquatic ecologists and biogeochemists with ES theory as a common currency to connect food webs, ecosystem metabolism, and biogeochemistry, as they are inherently concatenated by the transfer of carbon, nitrogen, and phosphorous through biotic and abiotic nutrient transformation and fluxes. Several new studies exist that demonstrate the connections between food web ecology, biogeochemistry, and ecosystem metabolism. In addition to a general introduction into the topic, this paper presents examples of how these fields can be combined with a focus on ES. In this review, a series of concepts have guided the discussion: (1) changing biogeochemistry affects trophic interactions and ecosystem processes by altering the elemental ratios of key species and assemblages; (2) changing trophic dynamics influences the transformation and fluxes of matter across environmental boundaries; (3) changing ecosystem metabolism will alter the chemical diversity of the non-living environment. Finally, we propose that using ES to link nutrient cycling, trophic dynamics, and ecosystem metabolism would allow for a more holistic understanding of ecosystem functions in a changing environment.
Challenges to fisheries management due to stock recovery

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Authors: van Gemert, R. (Intern), Andersen, K. H. (Intern)
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Climate change implications for fisheries and aquaculture

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Authors: Brander, K. (Intern), Cochrane, K. (Ekstern), Barange, M. (Ekstern), Soto, D. (Ekstern)
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Climate-mediated changes in marine ecosystem regulation during El Niño
The degree to which ecosystems are regulated through bottom-up, top-down or direct physical processes represents a long-standing issue in ecology, with important consequences for resource management and conservation. In marine ecosystems, the role of bottom-up and top-down forcing has been shown to vary over spatio-temporal scales, often linked to highly variable and heterogeneously distributed environmental conditions. Ecosystem dynamics in the Northeast Pacific have been suggested to be predominately bottom-up regulated. However, it remains unknown to what extent top-down regulation occurs, or whether the relative importance of bottom-up and top-down forcing may shift in response to climate change. In this study, we investigate the effects and relative importance of bottom-up, top-down and physical forcing during changing climate conditions on ecosystem regulation in the Southern California Current System (SCCS) using a generalized food web model. This statistical approach is based on non-linear threshold models and a long-term data set (~60 year) covering multiple trophic levels from phytoplankton to predatory fish. We found bottom-up control to be the primary mode of ecosystem regulation. However, our results also demonstrate an alternative mode of regulation represented by interacting bottom-up and top-down forcing, analogous to wasp-waist dynamics, but occurring across multiple trophic levels and only during periods of reduced bottom-up forcing (i.e., weak upwelling, low nutrient concentrations and primary production). The shifts in ecosystem regulation are caused by changes in ocean-atmosphere forcing and triggered by highly variable climate conditions associated with El Niño. Furthermore, we show that biota respond differentially to major El Niño events during positive or negative phases of the Pacific Decadal Oscillation (PDO), as well as highlight potential concerns for marine and fisheries management by demonstrating increased sensitivity of pelagic fish to exploitation during El Niño. This article is protected by copyright. All rights reserved.

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Community ecology in 3D: Tensor decomposition reveals spatio-temporal dynamics of large ecological communities

Understanding spatio-temporal dynamics of biotic communities containing large numbers of species is crucial to guide ecosystem management and conservation efforts. However, traditional approaches usually focus on studying community dynamics either in space or in time, often failing to fully account for interlinked spatio-temporal changes. In this study, we demonstrate and promote the use of tensor decomposition for disentangling spatio-temporal community dynamics in long-term monitoring data. Tensor decomposition builds on traditional multivariate statistics (e.g. Principal Component Analysis) but extends it to multiple dimensions. This extension allows for the synchronized study of multiple ecological variables.
measured repeatedly in time and space. We applied this comprehensive approach to explore the spatio-temporal dynamics of 65 demersal fish species in the North Sea, a marine ecosystem strongly altered by human activities and climate change. Our case study demonstrates how tensor decomposition can successfully (i) characterize the main spatio-temporal patterns and trends in species abundances, (ii) identify sub-communities of species that share similar spatial distribution and temporal dynamics, and (iii) reveal external drivers of change. Our results revealed a strong spatial structure in fish assemblages persistent over time and linked to differences in depth, primary production and seasonality. Furthermore, we simultaneously characterized important temporal distribution changes related to the low frequency temperature variability inherent in the Atlantic Multidecadal Oscillation. Finally, we identified six major sub-communities composed of species sharing similar spatial distribution patterns and temporal dynamics. Our case study demonstrates the application and benefits of using tensor decomposition for studying complex community data sets usually derived from large-scale monitoring programs.

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Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
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Computational Fluid Dynamics of Choanoflagellate Filter-Feeding
Choanoflagellates are unicellular aquatic organisms with a single flagellum that drives a feeding current through a funnel-shaped collar filter on which bacteria-sized prey are caught. Using computational fluid dynamics (CFD) we model the beating flagellum and the complex filter flow of the choanoflagellate Diaphanoeca grandis. Our CFD simulations based on the current understanding of the morphology underestimate the experimentally observed clearance rate by more than an order of magnitude: The beating flagellum is simply unable to draw enough water through the fine filter. Our observations motivate us to suggest a radically different filtration mechanism that requires a flagellar vane (sheet), and addition of a wide vane in our CFD model allows us to correctly predict the observed clearance rate.

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Connectivity and Dispersal of Salmon Lice in a Tidal Energetic Island System: Faroe Islands

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Disentangling the counteracting effects of water content and carbon mass on zooplankton growth
Zooplankton vary widely in carbon percentage (carbon mass as a percentage of wet mass), but are often described as either gelatinous or non-gelatinous. Here we update datasets of carbon percentage and growth rate to investigate whether carbon percentage is a continuous trait, and whether its inclusion improves zooplankton growth models. We found that carbon percentage is continuous, but that species are not distributed homogenously along this axis. To assess variability of this trait in situ, we investigated the distribution of biomass across the range of carbon percentage for a zooplankton time series at station L4 off Plymouth, UK. This showed separate biomass peaks for gelatinous and crustacean taxa, however, carbon percentage varied 8-fold within the gelatinous group. Species with high carbon mass had lower carbon percentage, allowing separation of the counteracting effects of these two variables on growth rate. Specific growth rates, g (d -1) were negatively related to carbon percentage and carbon mass, even in the gelatinous taxa alone, suggesting that the trend is not driven by a categorical difference between these groups. The addition of carbon percentage doubled the explanatory power of growth models based on mass alone, demonstrating the benefits of considering carbon percentage as a continuous trait.
Distinctly different behavioral responses of a copepod, Temora longicornis, to different strains of toxic dinoflagellates, *Alexandrium spp*

Zooplankton responses to toxic algae are highly variable, even towards taxonomically closely related species or different strains of the same species. Here, the individual level feeding behavior of a copepod, *Temora longicornis*, was examined which offered 4 similarly sized strains of toxic dinoflagellate *Alexandrium spp.* and a non-toxic control strain of the dinoflagellate *Protoceratium reticulatum*. The strains varied in their cellular toxin concentration and composition and in lytic activity. High-speed video observations revealed four distinctly different strain-specific feeding responses of the copepod during 4 h incubations: (i) the ‘normal’ feeding behavior, in which the feeding appendages were beating almost constantly to produce a feeding current and most (90%) of the captured algae were ingested; (ii) the beating activity of the feeding appendages was reduced by ca. 80% during the initial 60 min of exposure, after which very few algae were captured and ingested; (iii) capture and ingestion rates remained high, but ingested cells were regurgitated; and (iv) the copepod continued beating its appendages and captured cells at a high rate, but after 60 min, most captured cells were rejected. The various prey aversion responses observed may have very different implications to the prey and their ability to form blooms: consumed but regurgitated cells are dead, captured but rejected cells survive and may give the prey a competitive advantage, while reduced feeding activity of the grazer may be equally beneficial to the prey and its competitors. These behaviors were not related to lytic activity or overall paralytic shellfish toxins (PSTs) content and composition and suggest that other cues are responsible for the responses.

**General information**

State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, University of Copenhagen, Alfred Wegener Institut-Helmholtz Zentrum für Polar- und Meeresforschung, East China Sea Fisheries Research Institute, Chinese Academy of Fisheries Sciences
Authors: Xu, J. (Intern), Hansen, P. J. (Ekstern), Nielsen, L. T. (Intern), Krock, B. (Ekstern), Tillmann, U. (Ekstern), Kiørboe, T. (Intern)
Pages: 1-9
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Scopus rating (2016): CiteScore 2.98 SJR 1.04 SNIP 1.243
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.612 SNIP 1.439 CiteScore 3.56
Distinctly different behavioral responses of a copepod, Temora longicornis, to different strains of toxic dinoflagellates, Alexandrium spp.

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Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, East China Sea Fisheries Research Institute, Chinese Academy of Fisheries Sciences, University of Copenhagen
Authors: Xu, J. (Intern), Hansen, P. J. (Ekstern), Nielsen, L. T. (Intern), Kiørboe, T. (Intern)
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Distinctly different behavioral responses of a copepod, Temora longicornis, to different strains of toxic dinoflagellates, Alexandrium spp.

**General information**
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Chinese Academy of Fisheries Sciences, University of Copenhagen
Authors: Xu, J. (Intern), Hansen, P. J. (Ekstern), Nielsen, L. T. (Intern), Kiørboe, T. (Intern)
Dynamics of phytoplankton blooms in turbulent vortex cells

Turbulence and coherent circulation structures, such as submesoscale and mesoscale eddies, convective plumes and Langmuir cells, play a critical role in shaping phytoplankton spatial distribution and population dynamics. We use a framework of advection-reaction-diffusion equations to investigate the effects of turbulent transport on the phytoplankton population growth and its spatial structure in a vertical two-dimensional vortex flow field. In particular, we focus on how turbulent flow velocities and sinking influence phytoplankton growth and biomass aggregation. Our results indicate that conditions in mixing and growth of phytoplankton can drive different vertical spatial structures in the mixed layer, with the depth of the mixed layer being a critical factor to allow coexistence of populations with different sinking speed. With increasing mixed layer depth, positive growth for sinking phytoplankton can be maintained with increasing turbulent flow velocities, allowing the apparently counter-intuitive persistence of fast sinking phytoplankton populations in highly turbulent and deep mixed layers. These dynamics demonstrate the role of considering advective transport within a turbulent vortex and can help to explain observed phytoplankton biomass during winter in the North Atlantic, where the overturn of deep convection has been suggested to play a critical role in phytoplankton survival.
Ecological effects of full and partial protection in the crowded Mediterranean Sea: a regional meta-analysis

Marine protected areas (MPAs) are a cornerstone of marine conservation. Globally, the number and coverage of MPAs are increasing, but MPA implementation lags in many human-dominated regions. In areas with intense competition for space and resources, evaluation of the effects of MPAs is crucial to inform decisions. In the human-dominated Mediterranean Sea, fully protected areas occupy only 0.04% of its surface. We evaluated the impacts of full and partial protection on biomass and density of fish assemblages, some commercially important fishes, and sea urchins in 24 Mediterranean MPAs. We explored the relationships between the level of protection and MPA size, age, and enforcement. Results revealed significant positive effects of protection for fisheries target species and negative effects for urchins as their predators benefited from protection. Full protection provided stronger effects than partial protection. Benefits of full protection for fish biomass were only correlated with the level of MPA enforcement; fish density was higher in older, better enforced, and -interestingly- smaller MPAs. Our finding that even small, well-enforced, fully protected areas can have significant ecological effects is encouraging for "crowded" marine environments. However, more data are needed to evaluate sufficient MPA sizes for protecting populations of species with varying mobility levels.
Effects of fertilizers used in agricultural fields on algal blooms
The increasing occurrence of algal blooms and their negative ecological impacts have led to intensified monitoring activities. This needs the proper identification of the most responsible factor/factors for the bloom formation. However, in natural systems, algal blooms result from a combination of factors and from observation it is difficult to identify the most important one. In the present paper, using a mathematical model we compare the effects of three human induced factors (fertilizer input in agricultural field, eutrophication due to other sources than fertilizers, and overfishing) on the bloom dynamics and DO level. By applying a sophisticated sensitivity analysis technique, we found that the increasing use of fertilizers in agricultural field causes more rapid algal growth and decreases DO level much faster than eutrophication from other sources and overfishing. We also look at the mechanisms how fertilizer input rate affects the algal bloom dynamics and DO level. The model can be helpful for the policy makers in determining the influential factors responsible for the bloom formation.
Effects of high-frequency strobed laser light on Atlantic cod (Gadus morhua) physiology and behavior

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography, Section for Aquaculture, Centre for Ocean Life, SINTEF, Swedish University of Agricultural Sciences
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Event: Abstract from Dansk Havforskermøde, Helsingør, Denmark.
Main Research Area: Technical/natural sciences
Publication: Research - peer-review › Journal article – Annual report year: 2017

Effects of high-frequency strobed laser light on Atlantic cod (Gadus morhua) physiology and behavior

The copepod Calanus glacialis is a key species in the Arctic ecosystem. Increased shipping and oil and gas activities in the Arctic increase the risk of an oil spill. It is therefore important to study the potential consequences of an oil spill on this key species in the Arctic marine ecosystems. As a part of a large joint industry initiative (www.arcticresponsetechnology.org) a first of its kind mesocosm experiment was executed in an Arctic fjord of the Island of Svalbard. Effects of natural attenuation of the oil, in-situ burning and chemical dispersion were studied on grazing, egg production and hatching of the Arctic copepod Calanus glacialis. Eight mesocosms with open top and bottom were deployed in the sea ice in Van Mijenfjorden, Svalbard, in February 2015. Two replicates were used for all treatments. After application, surface ice was allowed to re-establish. Water was collected from the top 2 cm water column in March and just before sea ice break up in May, and was used in two 14-day incubation experiments with C. glacialis collected in Isfjorden.

Effects of oil spill responses on key Arctic zooplankton species

The copepod Calanus glacialis is a key species in the Arctic ecosystem. Increased shipping and oil and gas activities in the Arctic increase the risk of an oil spill. It is therefore important to study the potential consequences of an oil spill on this key species in the Arctic marine ecosystems. As a part of a large joint industry initiative (www.arcticresponsetechnology.org) a first of its kind mesocosm experiment was executed in an Arctic fjord of the Island of Svalbard. Effects of natural attenuation of the oil, in-situ burning and chemical dispersion were studied on grazing, egg production and hatching of the Arctic copepod Calanus glacialis. Eight mesocosms with open top and bottom were deployed in the sea ice in Van Mijenfjorden, Svalbard, in February 2015. Two replicates were used for all treatments. After application, surface ice was allowed to re-establish. Water was collected from the top 2 cm water column in March and just before sea ice break up in May, and was used in two 14-day incubation experiments with C. glacialis collected in Isfjorden.
Copepods were fed during the experiment and eggs and pellets were quantified daily. Egg hatching was determined in the beginning and end of the experiment. There was no significant effect of the oil spill treatments on average cumulated specific pellet production or egg hatching success. However, in May, the average cumulated specific egg production was significantly higher in the dispersed oil treatment compared to the control from day 2 (+169%) until the end of the experiment (+41%).

**General information**
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Section for Marine Ecology and Oceanography
Authors: Pancic, M. (Intern), Köhler, E. (Intern), Paulsen, M. L. (Intern), Toxværd, K. U. (Intern), Le Floch, S. (Ekstern), Hjorth, M. (Ekstern), Nielsen, T. G. (Intern)
Publication date: 2017
Event: Abstract from Dansk Havforsormed, Helsingør, Denmark.
Main Research Area: Technical/natural sciences

Efficiency of fisheries is increasing at the ecosystem level
Managing fisheries presents trade-offs between objectives, for example yields, profits, minimizing ecosystem impact, that have to be weighed against one another. These trade-offs are compounded by interacting species and fisheries at the ecosystem level. Weighing objectives becomes increasingly challenging when managers have to consider opposing objectives from different stakeholders. An alternative to weighing incomparable and conflicting objectives is to focus on win-wins until Pareto efficiency is achieved: a state from which it is impossible to improve with respect to any objective without regressing at least one other. We investigate the ecosystem-level efficiency of fisheries in five large marine ecosystems (LMEs) with respect to yield and an aggregate measure of ecosystem impact using a novel calibration of size-based ecosystem models. We estimate that fishing patterns in three LMEs (North Sea, Barents Sea and Benguela Current) are nearly efficient with respect to long-term yield and ecosystem impact and that efficiency has improved over the last 30 years. In two LMEs (Baltic Sea and North East US Continental Shelf), fishing is inefficient and win-wins remain available. We additionally examine the efficiency of North Sea and Baltic Sea fisheries with respect to economic rent and ecosystem impact, finding both to be inefficient but steadily improving. Our results suggest the following: (i) a broad and encouraging trend towards ecosystem-level efficiency of fisheries; (ii) that ecosystem-scale win-wins, especially with respect to conservation and profits, may still be common; and (iii) single-species assessment approaches may overestimate the availability of win-wins by failing to account for trade-offs across interacting species.

**General information**
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Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, University of Washington, University of California, Santa Barbara
Authors: Jacobsen, N. S. (Intern), Burgess, M. G. (Ekstern), Andersen, K. H. (Intern)
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Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
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Web of Science (2016): Indexed yes
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Scopus rating (2015): SJR 3.668 SNIP 3.034 CiteScore 7.05
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 3.462 SNIP 3.327 CiteScore 7.13
Web of Science (2014): Indexed yes
Estimating uncertainty of data limited stock assessments

Many methods exist to assess the fishing status of data-limited stocks; however, little is known about the accuracy or the uncertainty of such assessments. Here we evaluate a new size-based data-limited stock assessment method by applying it to well-assessed, data-rich fish stocks treated as data-limited. Particular emphasis is put on providing uncertainty estimates of the data-limited assessment. We assess four cod stocks in the North-East Atlantic and compare our estimates of stock status (F/Fmsy) with the official assessments. The estimated stock status of all four cod stocks followed the established stock assessments remarkably well and the official assessments fell well within the uncertainty bounds. The estimation of spawning stock biomass followed the same trends as the official assessment, but not the same levels. We conclude that the data-limited assessment method can be used for stock assessment and that the uncertainty estimates are reliable. Further work is needed to quantify the spawning biomass of the stock.
Feed, breed and be eaten: behavior dependent trade-offs in zooplankton

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: van Someren Gréve, H. (Intern), Almeda, R. (Intern), Kiørboe, T. (Intern)
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Feeding in a viscous world: How microbes catch prey

General information
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Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Nielsen, L. T. (Intern), Kiørboe, T. (Intern)
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Event: Abstract from Dansk Havforskermøde, Helsingør, Denmark.
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Fish and Fisheries: The size - and trait - based approach

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Andersen, K. H. (Intern)
Number of pages: 284
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Fisheries Impact Evaluation Tool (FIT) with Application to Assess the Bottom Fishing Footprint in Western Baltic Sea (ICES Subdivisions 22-24)

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Ecosystem based Marine Management, Section for Monitoring and Data, Centre for Ocean Life, Wageningen IMARES
Authors: Bastardie, F. (Intern), Eigaard, O. R. (Intern), Nielsen, J. R. (Intern), Egekvist, J. (Intern), Hintzen, N. T. (Ekstern)
, van Denderen, P. D. (Intern), Rijnsdorp, A. (Ekstern)
Number of pages: 25
Publication date: 2017

Fish growth in pelagic and benthic food webs across marine ecosystems

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: van Denderen, P. D. (Intern), Andersen, K. H. (Intern)
Publication date: 2017
Main Research Area: Technical/natural sciences
Food-web dynamics under climate change

Climate change affects ecological communities through its impact on the physiological performance of individuals. However, the population dynamics of species well inside their thermal niche is also determined by competitors, prey and predators, in addition to being influenced by temperature changes. We use a trait-based food-web model to examine how the interplay between the direct physiological effects from temperature and the indirect effects due to changing interactions between populations shapes the ecological consequences of climate change for populations and for entire communities. Our simulations illustrate how isolated communities deteriorate as populations go extinct when the environment moves outside the species' thermal niches. High-trophic-level species are most vulnerable, while the ecosystem function of lower trophic levels is less impacted. Open communities can compensate for the loss of ecosystem function by invasions of new species. Individual populations show complex responses largely uncorrelated with the direct impact of temperature change on physiology. Such complex responses are particularly evident during extinction and invasion events of other species, where climatically well-adapted species may be brought to extinction by the changed food-web topology. Our results highlight that the impact of climate change on specific populations is largely unpredictable, and apparently well-adapted species may be severely impacted.
From traits to life-history strategies: Deconstructing fish community composition across European seas

The life history of a species is determined by trade-offs between growth, survival and reproduction to maximize fitness in a given environment. Following a theoretical model, we investigate whether the composition of marine fish communities can be understood in terms of a set of lifehistory strategies and whether the prevalence of the strategies follows specific spatial patterns that can be related to the environment.

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Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Instituto Español de Oceanografía, Thünen Institute of Sea Fisheries, Marine and Freshwater Research Institute
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Scopus rating (2016): CiteScore 6.4 SJR 4.061 SNIP 1.903
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Scopus rating (2015): SJR 4.57 SNIP 2.051 CiteScore 6.67
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Gender-specific feeding rates in planktonic copepods with different feeding behavior

Planktonic copepods have sexually dimorphic behaviors, which can cause differences in feeding efficiency between genders. Copepod feeding rates have been studied extensively but most studies have focused only on females. In this study, we experimentally quantified feeding rates of males and females in copepods with different feeding behavior: ambush feeding (Oithona nana), feeding-current feeding (Temora longicornis) and cruising feeding (Centropages hamatus). We hypothesize that carbon-specific maximum ingestion rates are similar between genders, but that maximum clearance rates are lower for male copepods, particularly in ambush feeders, where the males must sacrifice feeding for mate searching. We conducted gender-specific functional feeding response experiments using prey of different size and motility. In most cases, gender-specific maximum ingestion and clearance rates were largely explained by the difference in size between sexes, independent of the feeding strategy. However, maximum clearance rates of males were approximately two times higher than for females in the ambush feeding copepod O. nana feeding on an optimal motile prey (Oxyrrhis marina), as hypothesized. We conclude that the conflict between mate searching and feeding can cause significant difference in feeding efficiency between copepod genders in ambush feeders but not in feeding-current and cruising feeders.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: van Someren Gréve, H. (Intern), Almeda, R. (Intern), Lindegren, M. (Intern), Kiørboe, T. (Intern)
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Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Plankton Research
Global change in the trophic functioning of marine food webs

The development of fisheries in the oceans, and other human drivers such as climate warming, have led to changes in species abundance, assemblages, trophic interactions, and ultimately in the functioning of marine food webs. Here, using a trophodynamic approach and global databases of catches and life history traits of marine species, we tested the hypothesis that anthropogenic ecological impacts may have led to changes in the global parameters defining the transfers of biomass within the food web. First, we developed two indicators to assess such changes: the Time Cumulated Indicator (TCI) measuring the residence time of biomass within the food web, and the Efficiency Cumulated Indicator (ECI) quantifying the fraction of secondary production reaching the top of the trophic chain. Then, we assessed, at the large marine ecosystem scale, the worldwide change of these two indicators over the 1950-2010 time-periods. Global trends were identified and cluster analyses were used to characterize the variability of trends between ecosystems. Results showed that the most common pattern over the study period is a global decrease in TCI, while the ECI indicator tends to increase. Thus, changes in species assemblages would induce faster and apparently more efficient biomass transfers in marine food webs. Results also suggested that the main driver of change over that period had been the large increase in fishing pressure. The largest changes occurred in ecosystems where ‘fishing down the marine food web’ are most intensive.
Global patterns in marine predatory fish

Large teleost (bony) fish are a dominant group of predators in the oceans and constitute a major source of food and livelihood for humans. These species differ markedly in morphology and feeding habits across oceanic regions; large pelagic species such as tunas and billfish typically occur in the tropics, whereas demersal species of gadoids and flatfish dominate boreal and temperate regions. Despite their importance for fisheries and the structuring of marine ecosystems, the underlying factors determining the global distribution and productivity of these two groups of teleost predators are poorly known. Here, we show how latitudinal differences in predatory fish can essentially be explained by the inflow of energy at the base of the pelagic and benthic food chain. A low productive benthic energy pathway favours large pelagic species, whereas equal productivities support large demersal generalists that outcompete the pelagic specialists. Our findings demonstrate the vulnerability of large teleost predators to ecosystem-wide changes in energy flows and hence provide key insight to predict the responses of these important marine resources under global change.

Global patterns in the productivity of marine fish along parallel pathways of energy

General information
Hydrodynamic properties and distribution of bait downstream of a zooplankton trap

The flow regime around a chemically baited trap is crucial for the trapping process and distribution of bait downstream of traps. We measured the flow field downstream of a trap prototype in flume experiments and mapped the distribution of bait using laser induced fluorescence. The trap produced a downstream wake, where flow recirculated towards the trap, allowing organisms slower than the free stream flow to interact with the trap. The chemical tracer revealed an average gradient with increasing concentrations towards the trap. Finally, we evaluated trap performance in field experiments. Traps with internal light caught on average 3.4 times more zooplankton than traps without light in short-term deployments (1 h). Trapping efficiency could be manipulated by chemical stimuli; a piece of fish (Salmo salar) inside traps deterred 79% of the zooplankton compared to traps without fish. We conclude that the flow regime around a cylindrical trap may facilitate trapping and that combined stimuli modalities may allow higher selectivity. The effective radius of the trap will depend on the surrounding flow and will likely be small when flow-rate exceeds swimming speed of targeted organisms. Finally, we propose applications for selective traps in aquaculture and pest management.
Hydrodynamics of microbial filter feeding

Microbial filter feeders are an important group of grazers, significant to the microbial loop, aquatic food webs, and biogeochemical cycling. Our understanding of microbial filter feeding is poor, and, importantly, it is unknown what force microbial filter feeders must generate to process adequate amounts of water. Also, the trade-off in the filter spacing remains unexplored, despite its simple formulation: A filter too coarse will allow suitably sized prey to pass unintercepted, whereas a filter too fine will cause strong flow resistance. We quantify the feeding flow of the filter-feeding choanoflagellate Diaphanoeca grandis using particle tracking, and demonstrate that the current understanding of microbial filter feeding is inconsistent with computational fluid dynamics (CFD) and analytical estimates. Both approaches underestimate observed filtration rates by more than an order of magnitude; the beating flagellum is simply unable to draw enough water through the fine filter. We find similar discrepancies for other choanoflagellate species, highlighting an apparent paradox. Our observations motivate us to suggest a radically different filtration mechanism that requires a flagellar vane (sheet), something notoriously difficult to visualize but sporadically observed in the related choanocytes (sponges). A CFD model with a flagellar vane correctly predicts the filtration rate of D. grandis, and using a simple model we can account for the filtration rates of other microbial filter feeders. We finally predict how optimum filter mesh size increases with cell size in microbial filter feeders, a prediction that accords very well with observations. We expect our results to be of significance for small-scale biophysics and trait-based ecological modeling.

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Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Department of Mechanical Engineering, Fluid Mechanics, Coastal and Maritime Engineering, Department of Physics, Biophysics and Fluids
Web of Science (2002): Indexed yes
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https://www.ncbi.nlm.nih.gov/pmc/journals/2/

Relations
Activities:
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Impacts of climate change on pelagic fisheries

General information
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Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Section for Marine Living Resources
Authors: Muhling, B. (Ekstern), Lindegren, M. (Intern), Worsøe Clausen, L. (Intern), Hobday, A. (Ekstern)
Number of pages: 1,048
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Publication: Research - peer-review › Book chapter – Annual report year: 2017

Indvandrene

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Section for Oceans and Arctic
Authors: Kiørboe, T. (Intern), Jaspers, C. (Intern)
Pages: 5
Publication date: 2017

Publication information
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Newspaper: Weekendavisen
Ratings:
ISI indexed (2013): ISI indexed no
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ISI indexed (2011): ISI indexed no
Main Research Area: Technical/natural sciences
Publication: Communication › Newspaper article – Annual report year: 2017
Ingestion, growth and gross growth efficiencies of copepod nauplii with different feeding behavior

General information
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Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Torres, R. R. (Intern), Almeda, R. (Intern), van Someren Grève, H. (Intern), Kjærboe, T. (Intern)
Publication date: 2017
Event: Abstract from Dansk Havforskermøde, Helsingør, Denmark.
Main Research Area: Technical/natural sciences
Publication: Research › Conference abstract for conference – Annual report year: 2017

Interactive effects of prey refuge and additional food for predator in a diffusive predator-prey system

Additional food for predators has been considered as one of the best established techniques in integrated pest management and biological conservation programs. In natural systems, there are several other factors, e.g., prey refuge, affect the success of pest control. In this paper, we analyze a predator-prey system with prey refuge and additional food for predator apart from the focal prey in the presence of diffusion. Our main aim is to study the interactive effects of prey refuge and additional food on the system dynamics and especially on the controllability of prey (pest). Different types of Turing patterns such as stripes, spots, holes, and mixtures of them are obtained. It is found that the supply of additional food to the predator is unable to control the prey (pest) population when prey refuge is high. Moreover, when both prey refuge and additional food are low, spatial distribution of prey becomes complex and once again prey control becomes difficult. However, the joint effect of reduction in prey refuge and the presence of appropriate amount of additional food can control prey (pest) population from the system.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Indian Statistical Institute
Authors: Chakraborty, S. (Intern), Tiwari, P. K. (Ekstern), Sasmal, S. (Ekstern), Biswas, S. (Ekstern), Bhattacharya, S. (Ekstern), Chattopadhyay, J. (Ekstern)
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Web of Science (2015): Indexed yes
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Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.096 SNIP 1.985 CiteScore 2.73
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.919 SNIP 1.856 CiteScore 2.22
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.871 SNIP 1.549 CiteScore 2.06
Marine fish traits follow fast-slow continuum along coastal-offshore gradient

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Instituto Español de Oceanografía, Marine Research Institute, University of Hamburg, Johann Heinrich von Thünen-Institute, University of Hamburg
Authors: Beukhof, E. (Intern), Frelat, R. (Ekstern), Pécuchet, L. (Intern), Fock, H. (Ekstern), Punzón, A. (Ekstern), Sólmundsson, J. (Ekstern), Moellmann, C. (Ekstern), Lindegren, M. (Intern)
Publication date: 2017
Main Research Area: Technical/natural sciences
Electronic versions:

Publishers version
Publication: Research › Conference abstract for conference – Annual report year: 2017

Marine fish traits follow fast-slow continuum along coastal-offshore gradient

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Instituto Español de Oceanografía, Marine Research Institute, University of Hamburg, Johann Heinrich von Thünen-Institute, University of Hamburg
Authors: Beukhof, E. (Intern), Frelat, R. (Ekstern), Pécuchet, L. (Intern), Fock, H. (Ekstern), Punzón, A. (Ekstern), Sólmundsson, J. (Ekstern), Moellmann, C. (Ekstern), Lindegren, M. (Intern)
Publication date: 2017
Main Research Area: Technical/natural sciences
Electronic versions:

Publishers version
Publication: Research › Poster – Annual report year: 2017
Mating, feeding and not being eaten: sex-specific trade-offs in copepods

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: van Someren Gréve, H. (Intern), Almeda, R. (Intern), Kiørboe, T. (Intern)
Publication date: 2017
Event: Abstract from ASLO Aquatic Sciences Meeting 2017, Honolulu, United States.
Main Research Area: Technical/natural sciences
Publication: Research › Conference abstract for conference – Annual report year: 2017

Metapopulation theory identifies biogeographical patterns among core and satellite marine bacteria scaling from tens to thousands of kilometers: Applied metapopulation theory for marine microbes

Metapopulation theory developed in terrestrial ecology provides applicable frameworks for interpreting the role of local and regional processes in shaping species distribution patterns. Yet, empirical testing of metapopulation models on microbial communities is essentially lacking. We determined regional bacterioplankton dynamics from monthly transect sampling in the Baltic Sea Proper using 16S rRNA gene sequencing. A strong positive trend was found between local relative abundance and occupancy of populations. Notably, the occupancy-frequency distributions were significantly bimodal with a satellite mode of rare endemic populations and a core mode of abundant cosmopolitan populations (e.g. Synechococcus, SAR11 and SAR86 clade members). Temporal changes in population distributions supported several theoretical frameworks. Still, bimodality was found among bacterioplankton communities across the entire Baltic Sea, and was also frequent in globally distributed datasets. Datasets spanning waters with widely different physicochemical characteristics or environmental gradients typically lacked significant bimodal patterns. When such datasets were divided into subsets with coherent environmental conditions, bimodal patterns emerged, highlighting the importance of positive feedbacks between local abundance and occupancy within specific biomes. Thus, metapopulation theory applied to microbial biogeography can provide novel insights into the mechanisms governing shifts in biodiversity resulting from natural or anthropogenically induced changes in the environment.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Linnaeus University, Lund University, Swedish University of Agricultural Sciences, KTH - Royal Institute of Technology, Umea University
Authors: Lindh, M. V. (Ekstern), Sjöstedt, J. (Intern), Ekstam, B. (Ekstern), Casini, M. (Ekstern), Lundin, D. (Ekstern), Hugerth, L. W. (Ekstern), Hu, Y. O. O. (Ekstern), Andersson, A. F. (Ekstern), Andersson, A. (Ekstern), Legrand, C. (Ekstern), Pinhassi, J. (Ekstern)
Pages: 1222-1236
Publication date: 2017
Main Research Area: Technical/natural sciences

Publication information
Journal: Environmental Microbiology
Volume: 19
Issue number: 3
ISSN (Print): 1462-2912
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 5.02 SJR 2.221 SNIP 1.406
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.999 SNIP 1.584 CiteScore 5.61
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.85 SNIP 1.616 CiteScore 5.6
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 3.246 SNIP 1.843 CiteScore 6.37
ISI indexed (2013): ISI indexed yes
Unicellular eukaryotes make up the base of the ocean food web and exist as a continuum in trophic strategy from pure heterotrophy (phagotrophic zooplankton) to pure photoautotrophy (‘phytoplankton’), with a dominance of mixotrophic organisms combining both strategies. Here we formulate a trait-based model for mixotrophy with three key resource-harvesting traits: photosynthesis, phagotrophy and inorganic nutrient uptake, which predicts the trophic strategy of species throughout the seasonal cycle. Assuming that simple carbohydrates from photosynthesis fuel respiration, and feeding primarily provides building blocks for growth, the model reproduces the observed light-dependent ingestion rates and species-specific growth rates with and without prey from the laboratory. The combination of traits yielding the highest growth rate suggests high investments in photosynthesis, and inorganic nutrient uptake in the spring and increased phagotrophy during the summer, reflecting general seasonal succession patterns of temperate waters. Our trait-based model presents a simple and general approach for the inclusion of mixotrophy, succession and evolution in ecosystem models. The ISME Journal advance online publication, 2 August 2016; doi:10.1038/ismej.2016.92.
Modelling Jellyfish in marine ecosystems

General information
Motile behavior and predation risk in planktonic copepods: Behavior dependent predation risk

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Technical University of Denmark
Authors: van Someren Gréve, H. (Intern), Almeda, R. (Intern), Kiørboe, T. (Intern)
Publication date: 2017
Main Research Area: Technical/natural sciences

Publication Information
Journal: Limnology and Oceanography
Volume: 62
Issue number: 5
ISSN (Print): 0024-3590
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.5 SJR 1.712 SNIP 1.225
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.472 SNIP 1.422 CiteScore 3.93
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.112 SNIP 1.584 CiteScore 3.73
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.256 SNIP 1.587 CiteScore 3.98
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.456 SNIP 1.5 CiteScore 3.81
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 2.374 SNIP 1.445 CiteScore 3.59
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.38 SNIP 1.425
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 2.329 SNIP 1.682
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 2.381 SNIP 1.615
On the missing link in ecology: improving communication between modellers and experimentalists

Collaboration between modellers and experimentalists is essential in ecological research, however, different obstacles linking both camps often hinder scientific progress. In this commentary, we discuss several issues of the current state of affairs in this research loop. Backed by an online survey amongst fellow ecologists, modellers and experimentalists alike, we identify two major areas that need to be mended. Firstly, differences in language and jargon lead to a lack of exchange of ideas and to unrealistic mutual expectations. And secondly, constraint data sharing, accessibility and quality limit the usage of empirical data and thereby the impact of ecological studies. We discuss ways to advance collaboration; how to improve communication and the design of experiments; and the sharing of data. We hope to start a much-needed conversation between modellers and experimentalists, to further future research collaboration and to increase the impact of single ecological studies alike.

General information
State: Published
Organisations: Centre for Ocean Life, National Institute of Aquatic Resources, Lund University, University of Bergen
Authors: Heuschele, J. (Ekstern), Ekvall, M. T. (Ekstern), Mariani, P. (Intern), Lindemann, C. (Ekstern)
Pages: 1071-1077
Publication date: 2017
Main Research Area: Technical/natural sciences

Publication Information
Journal: Oikos
Volume: 126
Issue number: 8
ISSN (Print): 0030-1299
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.68 SJR 2.313 SNIP 1.348
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Ontogenetic body-mass scaling of nitrogen excretion relates to body surface area in diverse pelagic invertebrates

Many physiological and ecological processes depend on body size and the supply of limiting nutrients. Hence, it is important to derive quantitative predictions based on a mechanistic understanding of the influence of body size on metabolic rate and on the ratios of consumed to excreted elements. Among diverse pelagic invertebrates that change shape during ontogeny, recent analysis has demonstrated a significant positive correlation between the body-mass allometry of respiration rates (measured as the ontogenetic body mass-scaling exponent bR) and the allometry of body surface area (bA, as predicted from body-shape changes using a Euclidean model). As many pelagic invertebrates use a large portion of their external body surface for both resource uptake and waste excretion, we predicted that body-mass scaling exponents for rates of excretion of soluble N (bN) should also then relate to the degree of body-shape change during growth. We tested this hypothesis using literature data on bN for 39 species of pelagic invertebrates across five different phyla, and find strong support: bN is significantly positively correlated with predicted bA, whilst also co-varying with bR. Intraspecific differences between bN and bR values reveal ontogenetic shifts in the ratio of O2-consumed to N-excreted. We suggest that a variety of factors, including adaptive developmental shifts in the relative anabolism and catabolism of proteins and lipids, may cause these shifts in consumption-excretion ratios. Diverse pelagic invertebrates that dominate vast open water ecosystems falsify the predictions of general metabolic scaling theories built upon resource-transport networks, but support predictions of surface-area dependent theory.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Queen Mary University of London, Juniata College Huntingdon, University of Liverpool
Photoregulation in a kleptochloroplastidic dinoflagellate, Dinophysis acuta

**General information**
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Tallinn University of Technology, University of Copenhagen, University of Technology
Authors: Hansen, P. J. (Ekstern), Ojamäe, K. (Ekstern), Berge, T. (Intern), Trampe, E. C. (Ekstern), Nielsen, L. T. (Intern), Lips, I. (Ekstern), Kühl, M. (Forskerdatabase)
Publication date: 2017
Event: Abstract from Dansk Havforskermøde, Helsingør, Denmark.
Main Research Area: Technical/natural sciences
Publication: Research - peer-review › Journal article – Annual report year: 2016

Plankton and fisheries

**General information**
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Brander, K. (Intern)
Number of pages: 704
Publication date: 2017
Host publication information
Title of host publication: Marine Plankton: A practical guide to ecology, methodology, and taxonomy
Publisher: Oxford University Press
Editors: Castellani, C., Edwards, M.
ISBN (Print): 9780199233267
Chapter: 8
Main Research Area: Technical/natural sciences
Publication: Research - peer-review › Book chapter – Annual report year: 2017

Plankton biogeography: An exploration of patterns, drivers, functions, and predictability

**General information**
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Section for Marine Ecology and Oceanography
Authors: Brun, P. G. (Intern), Payne, M. (Intern), Kjærboe, T. (Intern)
Number of pages: 196
Publication date: 2017
Publication information
Publisher: DTU Aqua. National Institute of Aquatic Resources
Main Research Area: Technical/natural sciences
Publication: Research › Ph.D. thesis – Annual report year: 2017
**Predator persistence through variability of resource productivity in Tritrophic systems**

The trophic structure of species communities depends on the energy transfer between trophic levels. Primary productivity varies strongly through time, challenging the persistence of species at higher trophic levels. Yet resource variability has mostly been studied in systems with only one or two trophic levels. We test the effect of variability in resource productivity in a tritrophic model system including a resource, a size-structured consumer, and a size-specific predator. The model complies with fundamental principles of mass conservation and the body-size dependence of individual-level energetics and predator-prey interactions. Surprisingly, we find that resource variability may promote predator persistence. The positive effect of variability on the predator arises through periods with starvation mortality of juvenile prey, which reduces the intraspecific competition in the prey population. With increasing variability in productivity and starvation mortality in the juvenile prey, the prey availability increases in the size range preferred by the predator. The positive effect of prey mortality on the trophic transfer efficiency depends on the biologically realistic consideration of body size-dependent and food-dependent functions for growth and reproduction in our model. Our findings show that variability may promote the trophic transfer efficiency, indicating that environmental variability may sustain species at higher trophic levels in natural ecosystems.

**General information**

State: Published  
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, University of Amsterdam  
Authors: Soudijn, F. H. (Intern), de Roos, A. M. (Ekstern)  
Pages: 844-853  
Publication date: 2017  
Main Research Area: Technical/natural sciences

**Publication information**

Journal: American Naturalist  
Volume: 190  
Issue number: 6  
ISSN (Print): 0003-0147  
Ratings:  
BFI (2018): BFI-level 2  
Web of Science (2018): Indexed yes  
BFI (2017): BFI-level 2  
Web of Science (2017): Indexed yes  
BFI (2016): BFI-level 2  
Scopus rating (2016): CiteScore 3.63 SJR 2.672 SNIP 1.419  
Web of Science (2016): Indexed yes  
BFI (2015): BFI-level 2  
Scopus rating (2015): SJR 2.814 SNIP 1.365 CiteScore 3.52  
BFI (2014): BFI-level 2  
Scopus rating (2014): SJR 3.267 SNIP 1.613 CiteScore 4.22  
Web of Science (2014): Indexed yes  
BFI (2013): BFI-level 2  
Scopus rating (2013): SJR 3.173 SNIP 1.643 CiteScore 4.52  
ISI indexed (2013): ISI indexed yes  
BFI (2012): BFI-level 2  
Scopus rating (2012): SJR 3.416 SNIP 1.657 CiteScore 4.68  
ISI indexed (2012): ISI indexed yes  
BFI (2011): BFI-level 2  
Scopus rating (2011): SJR 3.867 SNIP 1.673 CiteScore 4.72  
ISI indexed (2011): ISI indexed yes  
BFI (2010): BFI-level 2  
Scopus rating (2010): SJR 4.219 SNIP 1.761  
BFI (2009): BFI-level 2  
Scopus rating (2009): SJR 3.973 SNIP 1.762  
BFI (2008): BFI-level 2  
Scopus rating (2008): SJR 4.022 SNIP 1.737  
Scopus rating (2007): SJR 4.269 SNIP 1.892
Predicting the consequences of species loss using size-structured biodiversity approaches: Consequences of biodiversity loss

Understanding the consequences of species loss in complex ecological communities is one of the great challenges in current biodiversity research. For a long time, this topic has been addressed by traditional biodiversity experiments. Most of these approaches treat species as trait-free, taxonomic units characterizing communities only by species number without accounting for species traits. However, extinctions do not occur at random as there is a clear correlation between extinction risk and species traits. In this review, we assume that large species will be most threatened by extinction and use novel allometric and size-spectrum concepts that include body mass as a primary species trait at the levels of populations and individuals, respectively, to re-assess three classic debates on the relationships between biodiversity and (i) food-web structural complexity, (ii) community dynamic stability, and (iii) ecosystem functioning. Contrasting current expectations, size-structured approaches suggest that the loss of large species, that typically exploit most resource species, may lead to future food webs that are less interwoven and more structured by chains of interactions and compartments. The disruption of natural body-mass distributions maintaining food-web stability may trigger avalanches of secondary extinctions and strong trophic cascades with expected knock-on effects on the functionality of the ecosystems. Therefore, we argue that it is crucial to take into account body size as a species trait when analysing the consequences of biodiversity loss for natural ecosystems. Applying size-structured approaches provides an integrative ecological concept that enables a better understanding of each species’ unique role across communities and the causes and consequences of biodiversity loss.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, German Centre for Integrative Biodiversity Research, University of Tasmania, Linköping University, Centre National de la Recherche Scientifique, University of Copenhagen, Leibniz-Institute of Freshwater Ecology and Inland Fisheries (IGB), Berlin, Åbo Academy University, Imperial College London, Université Montpellier, Universite Pierre et Marie Curie, University of Hamburg
Authors: Brose, U. (Ekstern), Blanchard, J. L. (Ekstern), Eklöf, A. (Ekstern), Galiana, N. (Ekstern), Hartvig, M. (Intern), R. Hirt, M. (Ekstern), Kalinkat, G. (Ekstern), Nordström, M. C. (Ekstern), O’Gorman, E. J. (Ekstern), Rall, B. C. (Ekstern), Schneider, F. D. (Ekstern), Thébault, E. (Ekstern), Jacob, U. (Ekstern)
Pages: 684-697
Publication date: 2017
Main Research Area: Technical/natural sciences

Publication information
Journal: Biological Reviews
Volume: 92
Issue number: 2
ISSN (Print): 1464-7931
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
Productivity and recovery of forage fish under climate change and fishing: North Sea sandeel as a case study

Forage fish occupy a central position in marine food-webs worldwide by mediating the transfer of energy and organic matter from lower to higher trophic levels. The lesser sandeel (Ammodytes marinus) is one of the ecologically and economically most important forage fish species in the North-east Atlantic, acting as a key prey for predatory fish and sea birds, as well as supporting a large commercial fishery. In this case study, we investigate the underlying factors affecting recruitment and how these in turn affect productivity of the North Sea sandeel using long-term data and modelling. Our results demonstrate how sandeel productivity in the central North Sea (Dogger Bank) depends on a combination of external and internal regulatory factors, including fishing and climate effects, as well as density dependence and food availability of the preferred zooplankton prey (Calanus finmarchicus and Temora longicornis). Furthermore, our model scenarios suggest that while fishing largely contributed to the abrupt stock decline during the late 1990s and the following period of low biomass, a complete recovery of the stock to the highly productive levels of the early 1980s would only be possible through changes in the surrounding ecosystem, involving lower temperatures and improved feeding conditions. To that end, we stress the need for ecosystem-based management accounting for multiple internal and external factors occurring within the broader context of the ecosystem in which forage fish species, such as sandeel, play an important and integral part.
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<td><strong>State:</strong> Accepted/In press</td>
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<tr>
<td><strong>Organisations:</strong> National Institute of Aquatic Resources, Centre for Ocean Life, Section for Marine Living Resources, Section for Oceans and Arctic, Section for Ecosystem based Marine Management, International Council for the Exploration of the Sea</td>
</tr>
<tr>
<td><strong>Authors:</strong> Lindegren, M. (Intern), van Deurs, M. (Intern), MacKenzie, B. (Intern), Worsøe Clausen, L. (Intern), Christensen, A. (Intern), Rindorf, A. (Intern)</td>
</tr>
<tr>
<td><strong>Publication date:</strong> 2017</td>
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<td><strong>Main Research Area:</strong> Technical/natural sciences</td>
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<tr>
<td><strong>Journal:</strong> Fisheries Oceanography</td>
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<td><strong>ISSN (Print):</strong> 1054-6006</td>
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<td><strong>Ratings:</strong></td>
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<td>BFI (2011): BFI-level 2</td>
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<td>Scopus rating (2011): CiteScore 2.42</td>
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<td>ISI indexed (2011): ISI indexed yes</td>
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<td>Web of Science (2011): Indexed yes</td>
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<td>Scopus rating (2006): SJR 0.704 SNIP 0.987</td>
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<td>Scopus rating (2005): SJR 0.139 SNIP 0.231</td>
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<td>Web of Science (2003): Indexed yes</td>
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<td>Web of Science (2002): Indexed yes</td>
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<tr>
<td><strong>Original language:</strong> English</td>
</tr>
<tr>
<td><strong>DOIs:</strong> 10.1111/fog.12246</td>
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Publication: Research - peer-review › Journal article – Annual report year: 2017
Seasonal body size reductions with warming covary with major body size gradients in arthropod species

Major biological and biogeographical rules link body size variation with latitude or environmental temperature, and these rules are often studied in isolation. Within multivoltine species, seasonal temperature variation can cause substantial changes in adult body size, as subsequent generations experience different developmental conditions. Yet, unlike other size patterns, these common seasonal temperature–size gradients have never been collectively analysed. We undertake the largest analysis to date of seasonal temperature-size gradients in multivoltine arthropods, including 102 aquatic and terrestrial species from 71 global locations. Adult size declines in warmer seasons in 86% of the species examined. Aquatic species show approximately 2.5-fold greater reduction in size per °C of warming than terrestrial species, supporting the hypothesis that greater oxygen limitation in water than in air forces aquatic species to exhibit greater plasticity in body size with temperature. Total percentage change in size over the annual cycle appears relatively constant with annual temperature range but varies between environments, such that the overall size reduction in aquatic-developing species (approx. 31%) is almost threefold greater than in terrestrial species (approx. 11%). For the first time, we show that strong correlations exist between seasonal temperature–size gradients, laboratory responses and latitudinal–size clines, suggesting that these patterns share common drivers.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Queen Mary University of London, University of Liverpool
Authors: Horne, C. R. (Ekstern), Hirst, A. G. (Intern), Atkinson, D. (Ekstern)
Publication date: 2017
Main Research Area: Technical/natural sciences

Publication information
Journal: Proceedings of the Royal Society B: Biological Sciences
Volume: 284
Issue number: 1851
Article number: 20170238
ISSN (Print): 0962-8452
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.89 SJR 2.541 SNIP 1.474
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.948 SNIP 1.535 CiteScore 4.08
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.916 SNIP 1.673 CiteScore 4.18
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 3.091 SNIP 1.762 CiteScore 5.08
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.947 SNIP 1.881 CiteScore 4.99
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 3.234 SNIP 1.789 CiteScore 5.02
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.894 SNIP 1.61
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 2.581 SNIP 1.389
Seasonal succession in zooplankton feeding traits reveals trophic trait coupling

The seasonal forcing of pelagic communities invokes a succession of the dominant phytoplankton and zooplankton species. Here, we characterize the seasonal succession of the plankton traits and their interactions using observations and model simulations of the plankton community in the western English Channel. We focus on activity traits that characterize the defensive and feeding abilities of zooplankton and distinguish between low risk, low return ambush feeders and high risk, high return feeding-current feeders. While the phytoplankton succession depends on traits related to nutrient acquisition and photosynthesis, it also depends on grazing which couples feeding and motility traits across trophic guilds. Despite interannual variations in the species dominating the protist plankton community, the seasonal trait distribution reveals robust and repeatable seasonal patterns, changing between non-motile cells flourishing in spring and motile community dominating during summer. The zooplankton community is dominated by active feeding-current feeders with peak biomass in the late spring declining during summer. The model reveals how zooplankton grazing reinforces protist plankton seasonal succession and shows how the physical environment controls the vertical structure of plankton communities, where ambush feeders exhibit a preference for greater depths during summer. We characterize the seasonal succession as trophic trait coupling and conjecture that this coupling leads to a trophic trait cascade where successive trophic levels alternate in their expression of activity traits further up in the food chain.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Section for Marine Ecology and Oceanography
Authors: Kenitz, K. (Intern), Visser, A. (Intern), Mariani, P. (Intern), Andersen, K. H. (Intern)
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Publication date: 2017
Main Research Area: Technical/natural sciences

Publications information
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Web of Science (2018): Indexed yes
Seasonal succession in zooplankton feeding traits reveals trophic trait coupling

General information
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Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Section for Marine Ecology and Oceanography
Authors: Kenitz, K. (Intern), Visser, A. (Intern), Mariani, P. (Intern), Andersen, K. H. (Intern)
Publication date: 2017
Event: Abstract from Dansk Havforskermøde, Helsingør, Denmark.
Main Research Area: Technical/natural sciences

Shifts in coastal sediment oxygenation cause pronounced changes in microbial community composition and associated metabolism

A key characteristic of eutrophication in coastal seas is the expansion of hypoxic bottom waters, often referred to as ‘dead zones’. One proposed remediation strategy for coastal dead zones in the Baltic Sea is to mix the water column using pump stations, circulating oxygenated water to the sea bottom. Although microbial metabolism in the sediment surface is recognized as key in regulating bulk chemical fluxes, it remains unknown how the microbial community and its metabolic processes are influenced by shifts in oxygen availability. Here, coastal Baltic Sea sediments sampled from oxic and anoxic sites, plus an intermediate area subjected to episodic oxygenation, were experimentally exposed to oxygen shifts. Chemical, 16S rRNA gene, metagenomic, and metatranscriptomic analyses were conducted to investigate changes in chemistry fluxes, microbial community structure, and metabolic functions in the sediment surface. Compared to anoxic controls, oxygenation of anoxic sediment resulted in a proliferation of bacterial populations in the facultative anaerobic genus Sulfurovum that are capable of oxidizing toxic sulfide. Furthermore, the oxygenated sediment had higher amounts of RNA transcripts annotated as sqr, fccB, and dsrA involved in sulfide oxidation. In addition, the importance of cryptic sulfur cycling was highlighted by the oxidative genes listed above as well as dsVA, trtB, dmsA, and ddHAB that encode reductive processes being identified in anoxic and intermediate sediments turned oxic. In particular, the intermediate site sediments responded differently upon oxygenation compared to the anoxic and oxic site sediments. This included a microbial community composition with more habitat generalists, lower amounts of RNA transcripts attributed to methane oxidation, and a reduced rate of organic matter degradation. These novel data emphasize that genetic expression analyses has the power to identify key molecular mechanisms that regulate microbial community responses upon oxygenation of dead zones. Moreover, these results highlight that microbial responses, and therefore ultimately remediation efforts, depend largely on the oxygenation history of sites. Furthermore, it was shown that re-oxygenation efforts to remediate dead zones could ultimately be facilitated by in situ microbial molecular mechanisms involved in removal of toxic H2S and the potent greenhouse gas methane.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Linnaeus University, Lund University
Authors: Broman, E. (Ekstern), Sjöstedt, J. (Intern), Pinhassi, J. (Ekstern), Dopson, M. (Ekstern)
Number of pages: 1
Pages: 96
Publication date: 2017
Main Research Area: Technical/natural sciences

Publication information
Journal: Microbiome
Volume: 5
Issue number: 1
ISSN (Print): 2049-2618
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 10.6 SJR 6.225 SNIP 2.321
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 5.709 SNIP 1.839 CiteScore 8.85
BFI (2014): BFI-level 1
Starvation tolerance of neritic copepods with different overwintering and feeding strategies

Swimming and feeding of mixotrophic biflagellates

Many unicellular flagellates are mixotrophic and access resources through both photosynthesis and prey capture. Their fitness depends on those processes as well as on swimming and predator avoidance. How does the flagellar arrangement and beat pattern of the flagellate affect swimming speed, predation risk due to flow-sensing predators, and prey capture? Here, we describe measured flows around two species of mixotrophic, biflagellated haptophytes with qualitatively different flagellar arrangements and beat patterns. We model the near cell flows using two symmetrically arranged point forces with variable position next to a no-slip sphere. Utilizing the observations and the model we find that puller force arrangements favour feeding, whereas equatorial force arrangements favour fast and quiet swimming. We determine the capture rates of both passive and motile prey, and we show that the flow facilitates transport of captured prey along the haptonema structure. We argue that prey capture alone cannot fulfil the energy needs of the observed species, and that the mixotrophic life strategy is essential for survival.
Temporal and spatial differences between taxonomic and trait biodiversity in a large marine ecosystem: Causes and consequences

Biodiversity is a multifaceted concept, yet most biodiversity studies have taken a taxonomic approach, implying that all species are equally important. However, species do not contribute equally to ecosystem processes and differ markedly in their responses to changing environments. This recognition has led to the exploration of other components of biodiversity, notably the diversity of ecologically important traits. Recent studies taking into account both taxonomic and trait diversity have revealed that the two biodiversity components may exhibit pronounced temporal and spatial differences. These apparent incongruences indicate that the two components may respond differently to environmental drivers and that changes in one component might not affect the other. Such incongruences may provide insight into the structuring of communities through community assembly processes, and the resilience of ecosystems to change. Here we examine temporal and spatial patterns and drivers of multiple marine biodiversity indicators using the North Sea fish community as a case study. Based on long-term spatially resolved survey data on fish species occurrences and biomasses from 1983 to 2014 and an extensive trait dataset we: (i) investigate temporal and spatial incongruences between taxonomy and trait-based indicators of both richness and evenness; (ii) examine the underlying environmental drivers and, (iii) interpret the results in the context of assembly rules acting on community composition. Our study shows that taxonomy and trait-based biodiversity indicators differ in time and space and that these differences are correlated to natural and anthropogenic drivers, notably temperature, depth and substrate richness. Our findings show that trait-based biodiversity indicators add information regarding community composition and ecosystem structure compared to and in conjunction with taxonomy-based indicators. These results emphasize the importance of examining and monitoring multiple indicators of biodiversity in ecological studies as well as for conservation and ecosystem-based management purposes.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Section for Oceans and Arctic, University of Copenhagen
Authors: Dencker, T. S. (Intern), Pécuchet, L. (Intern), Beukhof, E. (Intern), Richardson, K. (Ekstern), Payne, M. R. (Intern), Lindegren, M. (Intern)
Publication date: 2017
Main Research Area: Technical/natural sciences

Publication information
Journal: P L o S One
Volume: 12
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Article number: e0189731
ISSN (Print): 1932-6203
The constraints of high density production of the calanoid copepod Acartia tonsa Dana
Copepods are excellent live feed for marine fish larvae in aquaculture. Culturing copepods at high density is important to increase the total egg yield, but this is still a main challenge. To address this, we conducted experiments to test factors affecting the egg harvest potential of the well studied and aquaculture relevant calanoid Acartia tonsa. A simple model was developed to evaluate the influence of individual egg production, egg predation, crowding effects and tank design on the egg harvest. At high densities from 500 to 3500 ind L−1, there was no difference in food ingestion and egg cannibalism. However, the copepods showed lower food consumption and egg cannibalism compared to the ecologically relevant densities of 20–100 ind L−1. Model calculations demonstrate that maximum egg harvest is the result of a subtle balance between water mixing and tank depth: a shallow, non-mixed tank will allow the eggs to settle and escape cannibalism but at the same time prevent the algal food staying suspended, and full utilization of the egg production potential depends on
the fine tuning of these parameters
The importance of benthic-pelagic coupling for marine ecosystem functioning in a changing world

Benthic-pelagic coupling is manifested as the exchange of energy, mass, or nutrients between benthic and pelagic habitats. It plays a prominent role in aquatic ecosystems and it is crucial to functions from nutrient cycling to energy transfer in food webs. Coastal and estuarine ecosystem structure and function is strongly affected by anthropogenic pressures, however there are large gaps in our understanding of the responses of inorganic nutrient and organic matter fluxes between benthic habitats and the water column. We illustrate the varied nature of physical and biological benthic-pelagic coupling processes and their potential sensitivity to three anthropogenic pressures - climate change, nutrient loading, and fishing - using the Baltic Sea as a case study, and summarize current knowledge on the exchange of inorganic nutrients and organic material between habitats. Traditionally measured benthic-pelagic coupling processes (e.g. nutrient exchange and sedimentation of organic material) are to some extent quantifiable but the magnitude and variability of biological processes are rarely assessed, preventing quantitative comparisons. Changing oxygen conditions will continue to have widespread effects on the processes that govern inorganic and organic matter exchange among habitats while climate change and nutrient load reductions may have large effects on organic matter sedimentation. Many biological processes (predation, bioturbation) are expected to be sensitive to anthropogenic drivers but the outcomes for ecosystem function are largely unknown. We emphasize how improved empirical and experimental understanding of benthic-pelagic coupling processes and their variability are necessary to inform models that can quantify the feedbacks among processes and ecosystem responses to a changing world. This article is protected by copyright. All rights reserved.
The Sub-Polar Gyre Index - a community data set for application in fisheries and environment research

Scientific interest in the sub-polar gyre of the North Atlantic Ocean has increased in recent years. The sub-polar gyre has contracted and weakened, and changes in circulation pathways have been linked to changes in marine ecosystem productivity. To aid fisheries and environmental scientists, we present here a time series of the Sub-Polar Gyre Index (SPG-I) based on monthly mean maps of sea surface height. The established definition of the SPG-I is applied, and the first EOF (empirical orthogonal function) and PC (principal component) are presented. Sensitivity to the spatial domain and
time series length are explored but found not to be important factors in terms of the SPG-I's interpretation. Our time series compares well with indices presented previously. The SPG-I time series is freely available online (http://dx.doi.org/10.7489/1806-1), and we invite the community to access, apply, and publish studies using this index time series.

**General information**

State: Published  
Organisations: Centre for Ocean Life, National Institute of Aquatic Resources, Marine Scotland Science 
Authors: Berx, B. (Ekstern), Payne, M. (Intern) 
Pages: 259-266 
Publication date: 2017 
Main Research Area: Technical/natural sciences

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Journal: Earth System Science Data 
Volume: 9 
Issue number: 1 
ISSN (Print): 1866-3508 
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Web of Science (2017): Indexed yes 
Scopus rating (2016): CiteScore 7.28 SJR 4.647 SNIP 2.504 
Web of Science (2016): Indexed yes 
Scopus rating (2015): SJR 5.282 SNIP 2.822 CiteScore 7.07 
Web of Science (2015): Indexed yes 
Scopus rating (2014): SJR 4.471 SNIP 2.559 CiteScore 6.19 
ISI indexed (2013): ISI indexed no 
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Original language: English 
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Publication: Research - peer-review › Journal article – Annual report year: 2017

**Trait-based approaches to ocean life**

**General information**

State: Published  
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life 
Authors: Kiørboe, T. (Intern) 
Publication date: 2017 
Event: Abstract from Dansk Havforskermøde, Helsingør, Denmark. 
Main Research Area: Technical/natural sciences 
Publication: Research › Conference abstract for conference – Annual report year: 2017

**Trait-based model of mixotrophy in plankton**

**General information**

State: Published  
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, University of Copenhagen 
Authors: Andersen, K. H. (Intern), Berge, T. (Ekstern), Chakraborty, S. (Intern), Hansen, P. J. (Ekstern) 
Publication date: 2017 
Event: Abstract from Dansk Havforskermøde, Helsingør, Denmark. 
Main Research Area: Technical/natural sciences 
Publication: Research › Conference abstract for conference – Annual report year: 2017
Trophic impact of Atlantic bluefin tuna migrations in the North Sea
Large highly migratory predators can have major impacts on local marine ecosystems by reducing prey populations and leading to trophic cascades that affect the entire fish community. These trophic interactions are typically non-linear and can alter both the migratory behaviour of the predator and the stability of the fish community. The impact of a migrating top-predator is investigated here for Atlantic bluefin tuna in the North Sea. Bluefin tuna has been absent from the region for half-century, but recent years have seen recovery of migrations and a return of bluefin tuna in the area. We use a size spectrum model to analyse the trophic impact of the returning tuna on the entire fish community, under scenarios with varying levels of tuna consumption and fishing mortality on the prey. We show that with high level of prey fishing mortality in the North Sea, the effect of a tuna re-colonization results in only limited trophic cascades. However, high tuna consumption or changes in fishing mortality may result in a sudden recruitment failure of small-pelagic fish due to cascading effects on the fish community. In present-day conditions, the level of tuna consumption that triggers recruitment failure is lower at increasing fishing mortalities on their prey, providing indications for the future sustainable management of both small-pelagics and bluefin tuna in the area.

General information
State: Published
Organisations: Centre for Ocean Life, National Institute of Aquatic Resources, Section for Oceans and Arctic
Authors: Mariani, P. (Intern), Andersen, K. H. (Intern), Lindegren, M. (Intern), MacKenzie, B. (Intern)
Pages: 1552-1560
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Main Research Area: Technical/natural sciences

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Journal: ICES Journal of Marine Science
Volume: 74
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Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.63
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 2.18
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 2.62
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 2.46
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 2.35
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 2.32
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Web of Science (2009): Indexed yes
Trophic strategies of unicellular plankton

Unicellular plankton employ trophic strategies ranging from pure photoautotrophs over mixotrophy to obligate heterotrophs (phagotrophs), with cell sizes from 10–8 to 1 μg C. A full understanding of how trophic strategy and cell size depend on resource environment and predation is lacking. To this end, we develop and calibrate a trait-based model for unicellular planktonic organisms characterized by four traits: cell size and investments in phototrophy, nutrient uptake, and phagotrophy. We use the model to predict how optimal trophic strategies depend on cell size under various environmental conditions, including seasonal succession. We identify two mixotrophic strategies: generalist mixotrophs investing in all three investment traits and obligate mixotrophs investing only in phototrophy and phagotrophy. We formulate two conjectures: (1) most cells are limited by organic carbon; however, small unicellulars are colimited by organic carbon and nutrients, and only large photoautotrophs and smaller mixotrophs are nutrient limited; (2) trophic strategy is bottom-up selected by the environment, while optimal size is top-down selected by predation. The focus on cell size and trophic strategies facilitates general insights into the strategies of a broad class of organisms in the size range from micrometers to millimeters that dominate the primary and secondary production of the world’s oceans.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Chakraborty, S. (Intern), Nielsen, L. T. (Intern), Andersen, K. H. (Intern)
Publication date: 2017
Event: Abstract from Dansk Havforskermøde, Helsingør, Denmark.
Main Research Area: Technical/natural sciences
Publication: Research – Conference abstract for conference – Annual report year: 2017

Journal: American Naturalist
Volume: 189
Issue number: 4
ISSN (Print): 0003-0147
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
Fisheries can double the production of protein and revenue by abandoning current single-species management. This provocative prediction is the implication of the work in PNAS by Szuwalski et al. (1). Using the East China Sea as a case, they show how an indiscriminate fishery can support unexpectedly large catches by removing predators from the ecosystem. Such ecosystem engineering stands in stark contrast to reigning management paradigms that do not allow fishing down predators to increase the productivity of their prey.

The theoretical support for such a feat of ecosystem engineering is well developed (2, 3). Trusting the Chinese catch statistics, Szuwalski et al. (1) provide empirical evidence that theory may be turned into practice. But their work is more than “just another fisheries paper;” it underscores highly controversial issues about the unavoidable trade-offs in managing fisheries and ecosystems. If we narrowly consider food security, maximizing fisheries catch from the ecosystem is a “no-brainer,” but from a conservation point of view, the loss of biodiversity in the East China Sea may seem like Aquacalypse come true (4). Can we really double fisheries’ production by turning the oceans into mega-scale mariculture operations? Is it what we want?
When in life does density dependence occur in fish populations?

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Section for Marine Living Resources, Section for Marine Ecology and Oceanography
Authors: Andersen, K. H. (Intern), Jacobsen, N. S. (Intern), Jansen, T. (Intern), Beyer, J. E. (Intern)
Pages: 656-667
Publication date: 2017
Main Research Area: Technical/natural sciences

Publication information
Journal: Fish and Fisheries
Volume: 18
Issue number: 4
ISSN (Print): 1467-2960
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 7.7 SJR 3.606 SNIP 3.245
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 3.668 SNIP 3.034 CiteScore 7.05
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 3.462 SNIP 3.327 CiteScore 7.13
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 3.488 SNIP 3.12 CiteScore 6.19
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 3.565 SNIP 2.852 CiteScore 6.14
Zooplankton motile behavior: traits and trade-offs in planktonic copepods

Research on planktonic copepod ecology is vital to understand the factors controlling marine food web dynamics since copepods are the major components of zooplankton communities and the main link between trophic levels in marine environments. Despite their taxonomic diversity, copepods share certain phenotypic characteristics, or “traits”, that are essential in determining trophic interactions and fitness. One important characteristic that decisively influences organism interactions is behavior. Copepods display two distinct behavioral strategies in terms of motility: “active” (feeding-current and cruising feeding) or “passive” (ambush feeding). Differences in motile behavior between strategies imply different consequences for encounter rates with prey, sex partners, and potential predators. This thesis aims to provide a mechanistic understanding of how the different behavioral strategies in zooplankton result in different trade-offs between efficient feeding, mate finding, and predation risk. We experimentally quantified i) swimming behavior, ii) feeding rates on different prey, iii) escape capability and iv) predation risk in various copepod life stages and genders with different motile and feeding behavior. We found that an active feeding behavior resulted in high feeding efficiency on both motile and immotile prey, but also high predation mortality from rheotactic predators. In contrast, ambush feeding was inefficient for non-motile prey (one of order of magnitude lower than for active feeders), but least risky in term of predation risk (up to eight times lower than for active feeders). Strict ambush feeders, which depend on the fluid disturbance generated to perceive the prey, are therefore more constrained in terms of prey availability than other feeding strategies. Hence, a high feeding efficiency is traded off against a high predation risk in zooplankton. We show that differences in predation rates and feeding efficiency between copepod genders are dependent on the feeding behavior. In ambush feeders (Oithona spp), where feeding and mate finding are conflicting activities, males have to sacrifice feeding time to search for females and display high-velocity mate-searching behavior. Consequently, males showed a lower feeding efficiency and significantly higher predation mortality than females. On contrast, in active feeders both sexes moved more during feeding and showed small differences between genders in feeding efficiency and predation risk. Finally, we also found that foraging activity decreased with increasing food availability, especially in active feeding strategies, resulting in a decrease in predation risk. Therefore, changes in behavior depending on food availability have implications on zooplankton predation risk (“bottom-up behavioral cascades”) in marine plankton food webs. Our overall conclusion is that behavior is a key trait in copepods that plays a decisive role in the trade-off between feeding, mate finding, and survival. The optimality of each behavioral strategy is determined by the environmental conditions particularly by prey availability, prey type, and predation pressure. Copepod behavior is therefore a determining factor of grazing impact, distribution and composition of zooplankton in the marine environment.
Accumulation, transformation and breakdown of DSP toxins from the toxic dinoflagellate Dinophysis acuta in blue mussels, Mytilus edulis

Okadaic acid (OA), dinophysistoxins (DTX) and pectenotoxins (PTX) produced by the dinoflagellates Dinophysis spp. can accumulate in shellfish and cause diarrhetic shellfish poisoning upon human consumption. Shellfish toxicity is a result of algal abundance and toxicity as well as accumulation and depuration kinetics in mussels. We mass-cultured Dinophysis acuta containing OA, DTX-1b and PTX-2 and fed it to the blue mussel, Mytilus edulis under controlled laboratory conditions for a week to study toxin accumulation and transformation. Contents of OA and DTX-1b in mussels increased linearly with incubation time, and the net toxin accumulation was 66% and 71% for OA and DTX-1b, respectively. Large proportions (~50%) of both these toxins were transformed to fatty acid esters. Most PTX-2 was transformed to PTX-2 seco-acid and net accumulation was initially high, but decreased progressively throughout the experiment, likely due to esterification and loss of detectability. We also quantified depuration during the subsequent four days and found half-life times of 5-6 days for OA and DTX-1b. Measurements of dissolved toxins revealed that depuration was achieved through excreting rather than metabolizing toxins. This is the first study to construct a full mass balance of DSP toxins during both accumulation and depuration, and we demonstrate rapid toxin accumulation in mussels at realistic in situ levels of Dinophysis. Applying the observed accumulation and depuration kinetics, we model mussel toxicity, and demonstrate that a concentration of only 75 Dinophysis cells l-1 is enough to make 60 mm long mussels exceed the regulatory threshold for OA equivalents.
A dark hole in our understanding of marine ecosystems and their services: Perspectives from the mesopelagic community

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography, Research Secretariat, Centre for Ocean Life, AZTI-Tecnalia, National Oceanography Centre, University of the Azores
Authors: St. John, M. (Intern), Borja, A. (Ekstern), Chust, G. (Ekstern), Grigorov, I. (Intern), Mariani, P. (Intern), Martin, A. P. (Ekstern), Santos, R. S. (Ekstern)
Publication date: 2016
Main Research Area: Technical/natural sciences

Publication information
Journal: Frontiers in Marine Science
Volume: 3
Article number: 31
Ratings:
BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.53 SJR 0.173 SNIP 0.109
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.145 SNIP 0.05
BFI (2014): BFI-level 1
BFI (2013): BFI-level 1
ISI indexed (2013): ISI indexed no
Original language: English
A diffusion approximation based on renewal processes with applications to strongly biased run–tumble motion

We consider organisms which use a renewal strategy such as run–tumble when moving in space, for example to perform chemotaxis in chemical gradients. We derive a diffusion approximation for the motion, applying a central limit theorem due to Anscombe for renewal-reward processes; this theorem has not previously been applied in this context. Our results extend previous work, which has established the mean drift but not the diffusivity. For a classical model of tumble rates applied to chemotaxis, we find that the resulting chemotactic drift saturates to the swimming velocity of the organism when the chemical gradients grow increasingly steep. The dispersal becomes anisotropic in steep gradients, with larger dispersal across the gradient than along the gradient. In contrast to one-dimensional settings, strong bias increases dispersal. We next include Brownian rotation in the model and find that, in limit of high chemotactic sensitivity, the chemotactic drift is 64 % of the swimming velocity, independent of the magnitude of the Brownian rotation. We finally derive characteristic timescales of the motion that can be used to assess whether the diffusion limit is justified in a given situation. The proposed technique for obtaining diffusion approximations is conceptually and computationally simple, and applicable also when statistics of the motion is obtained empirically or through Monte Carlo simulation of the motion.

General information

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Organisations: National Institute of Aquatic Resources, Section for Marine Living Resources, Centre for Ocean Life
Authors: Thygesen, U. H. (Intern)
Pages: 556-579
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Main Research Area: Technical/natural sciences

Publication information

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Volume: 78
Issue number: 3
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Ratings:

BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 1.4 SJR 0.684 SNIP 0.833
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 0.768 SNIP 0.76 CiteScore 1.34
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 0.668 SNIP 0.728 CiteScore 1.32
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 0.787 SNIP 0.984 CiteScore 1.68
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 0.953 SNIP 1.195 CiteScore 2.06
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 0.95 SNIP 1.112 CiteScore 1.95
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 0.93 SNIP 1.113
Adult and offspring size in the ocean: a database of size metrics and conversion factors

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, University of Copenhagen, University of Hawaii, University of Göttingen, Linnaeus University
Authors: Neuheimer, A. B. (Intern), Hartvig, M. (Intern), Heuschele, J. (Intern), Hylander, S. (Intern), Kiørboe, T. (Intern), Olsson, K. H. (Intern), Sainmont, J. (Intern), Andersen, K. H. (Intern)
Pages: 1083
Publication date: 2016
Main Research Area: Technical/natural sciences

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Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 4.8 SJR 3.255 SNIP 1.76
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 3.934 SNIP 1.931 CiteScore 5.24
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 3.694 SNIP 1.987 CiteScore 5.09
A global synthesis of seasonal temperature-size responses in copepods: Seasonal temperature-size responses in copepods

Aim
Body size is a master trait with significant ecological importance. Seasonal changes in body size within diverse ectothermic species can result from different environmental conditions experienced during ontogeny in subsequent generations. Whilst intraspecific changes in adult size have been well studied under controlled experimental conditions and across geographical ranges, comprehensive analyses of temporal changes are lacking, and there remains considerable unexplained variation in body size responses within aquatic taxa. Using planktonic copepods as an exemplar taxon, we quantify variation in adult body mass within seasonally varying marine and freshwater environments. We describe how size variation relates to temperature, food concentration (chlorophyll-a) and life-history characteristics, including feeding strategy. Location: Global.

Methods
Using a meta-analytic approach we extract quantitative data from published literature on seasonal size responses of copepods. We analyse competing models to determine the best predictors of these responses, and compare the relative importance of temperature and chlorophyll-a concentration in explaining variation in body size.

Results
We quantify 140 seasonal size responses from 33 different global locations, representing 48 planktonic copepod species from four taxonomic orders. We find that temperature ($r^2 = 0.50$), rather than food ($r^2 = 0.22$), is the dominant explanatory variable of changes in adult body size across seasons. A striking outcome is that calanoid copepods, which utilize feeding currents to capture prey, exhibit a four-fold greater reduction in adult body mass per degrees C (-3.66%) compared with cyclopoid copepods (-0.91%), which are ambush feeders. By contrast, species body size or reproductive strategy did not explain variation in the seasonal temperature-size response.

Main conclusions
Our findings lead us to suggest that feeding strategies may play a significant role in dictating the magnitude of seasonal temperature-size responses in copepods, with potential implications for other ectotherms with
diverse feeding methods. Seasonal temperature-size responses were typically much more variable than responses in laboratory studies that provided excess food, suggesting that field conditions modify the temperature-size response.

**General information**
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Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Queen Mary University of London, University of Liverpool
Pages: 988-999
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Main Research Area: Technical/natural sciences

**Publication information**
Journal: Global Ecology and Biogeography
Volume: 25
Issue number: 8
ISSN (Print): 1466-822X
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 6.4 SJR 4.061 SNIP 1.903
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 4.57 SNIP 2.051 CiteScore 6.67
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 4.433 SNIP 2.386 CiteScore 6.92
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 4.171 SNIP 2.543 CiteScore 7.38
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 4.266 SNIP 2.236 CiteScore 6.56
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 3.808 SNIP 1.995 CiteScore 5.68
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 3.947 SNIP 2.187
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 4.134 SNIP 2.188
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 3.598 SNIP 2.045
Scopus rating (2007): SJR 2.723 SNIP 1.561
Scopus rating (2006): SJR 2.381 SNIP 1.697
Scopus rating (2005): SJR 2.36 SNIP 1.659
Scopus rating (2004): SJR 2.068 SNIP 1.323
Scopus rating (2003): SJR 1.411 SNIP 1.091
Scopus rating (2002): SJR 0.898 SNIP 0.997
Scopus rating (2001): SJR 1.195 SNIP 1.082
Scopus rating (2000): SJR 0.906 SNIP 0.878
Scopus rating (1999): SJR 0.553 SNIP 0.582
Original language: English

Electronic versions:
Postprint
DOIs:
10.1111/geb.12460
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Source-ID: 2304198511
Publication: Research - peer-review › Journal article – Annual report year: 2016

An indicator for ecosystem externalities in fishing

Ecosystem externalities arise when one use of an ecosystem affects its other uses through the production functions of the ecosystem. We use simulations with a size-spectrum ecosystem model to investigate the ecosystem externality created by fishing of multiple species. The model is based upon general ecological principles and is calibrated to the North Sea. Two fleets are considered: a “forage fish” fleet targeting species that mature at small sizes and a “large fish” fleet targeting large piscivorous species. Based on the marginal analysis of the present value of the rent, we develop a benefit indicator that explicitly divides the consequences of fishing into internal and external benefits. This analysis demonstrates that the forage fish fleet has a notable economic impact on the large fish fleet, but the reverse is not true. The impact can be either negative or positive, which entails that for optimal economic exploitation, the forage fishery has to be adjusted according to the large fish fishery. With the present large fish fishery in the North Sea, the two fisheries are well adjusted; however, the present combined exploitation level is too high to achieve optimal economic rents.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, University of Southern Denmark
Authors: Ravn-Jonsen, L. (Ekstern), Andersen, K. H. (Intern), Vestergaard, N. (Ekstern)
Pages: 400-425
Publication date: 2016
Main Research Area: Technical/natural sciences

Publication information
Journal: Natural Resource Modeling
Volume: 29
Issue number: 3
ISSN (Print): 0890-8575
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.64 SJR 0.286 SNIP 0.466
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.416 SNIP 0.655 CiteScore 1.16
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.684 SNIP 0.898 CiteScore 1.23
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.49 SNIP 0.561 CiteScore 0.86
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.438 SNIP 0.805 CiteScore 0.82
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.314 SNIP 0.32 CiteScore 0.57
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Anoxia-mediated release of dissolved organic matter from Baltic coastal sediments stimulate further hypoxia

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography, Centre for Ocean Life
Authors: Reader, H. (Intern), Stedmon, C. (Intern), Kowalczuk, P. (Ekstern), Magnuson, Å. (Intern)
Publication date: 2016
Main Research Area: Technical/natural sciences
Publication: Research - peer-review › Journal article – Annual report year: 2016

Assessing the role of environmental factors on Baltic cod recruitment, a complex adaptive system emergent property

General information
State: Published
Organisations: Section for Marine Ecology and Oceanography, National Institute of Aquatic Resources, Centre for Ocean Life, Institute of Oceanology of the Polish Academy of Sciences
Authors: Krekoukiotis, D. (Intern), Palacz, A. P. (Intern), St John, M. A. (Intern)
Publication date: 2016
Main Research Area: Technical/natural sciences
Publication information
Journal: Frontiers in Marine Science
Volume: 3
Article number: 126
Ratings:
BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.53 SJR 0.173 SNIP 0.109
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.145 SNIP 0.05
BFI (2014): BFI-level 1
BFI (2013): BFI-level 1
ISI indexed (2013): ISI indexed no
Original language: English
Electronic versions:
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DOIs:
10.3389/fmars.2016.00126
Source: FindIt
Source-ID: 2306800861
Assumptions behind size-based ecosystem models are realistic: Comment

A recent publication about balanced harvesting (Froese et al., ICES Journal of Marine Science; doi:10.1093/icesjms/fsv122) contains several erroneous statements about size-spectrum models. We refute the statements by showing that the assumptions pertaining to size-spectrum models discussed by Froese et al. are realistic and consistent. We further show that the assumption about density-dependence being described by a stock recruitment relationship is responsible for determining whether a peak in the cohort biomass of a population occurs late or early in life. Finally, we argue that there is indeed a constructive role for a wide suite of ecosystem models to evaluate fishing strategies in an ecosystem context.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Section for Ecosystem based Marine Management, University of Tasmania, Commonwealth Scientific and Industrial Research Organisation, Wageningen IMARES
Authors: Andersen, K. H. (Intern), Blanchard, J. L. (Ekstern), Fulton, E. A. (Ekstern), Gislason, H. (Intern), Jacobsen, N. S. (Intern), van Kooten, T. (Ekstern)
Pages: 1651-1655
Publication date: 2016
Main Research Area: Technical/natural sciences

Publication information
Journal: ICES Journal of Marine Science
Volume: 73
Issue number: 6
ISSN (Print): 1054-3139
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.63
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 2.18
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 2.62
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 2.46
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 2.35
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 2.32
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Web of Science (2010): Indexed yes
A trait database for marine copepods

The trait-based approach is gaining increasing popularity in marine plankton ecology but the field urgently needs more and easier accessible trait data to advance. We compiled trait information on marine pelagic copepods, a major group of zooplankton, from the published literature and from experts, and organised the data into a structured database. We collected 9345 records for 14 functional traits. Particular attention was given to body size, feeding mode, egg size, spawning strategy, respiration rate and myelination (presence of nerve sheathing). Most records were reported on the species level, but some phylogenetically conserved traits, such as myelination, were reported on higher taxonomic levels, allowing the entire diversity of around 10 800 recognized marine copepod species to be covered with few records. Besides myelination, data coverage was highest for spawning strategy and body size while information was more limited for quantitative traits related to reproduction and physiology. The database may be used to investigate relationships between traits, to produce trait biogeographies, or to inform and validate trait-based marine ecosystem models. The data can be downloaded from PANGAEA, doi:10.1594/PANGAEA.862968.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Brun, P. G. (Intern), Payne, M. R. (Intern), Kiørboe, T. (Intern)
Pages: 1-33
Publication date: 2016
Main Research Area: Technical/natural sciences

Publication information
Journal: Earth System Science Data Discussions
ISSN (Print): 1866-3591
Ratings:
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Original language: English
Marine Copepods, Zooplankton, Traits, Body Size, Egg Size, Feeding Mode, Spawning Strategy, Respiration Rate, Myelination
Electronic versions:
essd_2016_30.pdf
DOIs:
10.5194/essd-2016-30
Source: FindIt
Source-ID: 2306809783
Publication: Research - peer-review › Journal article – Annual report year: 2016
Carbon export by vertically migrating zooplankton: Optimal vertical migration and carbon export

Through diel vertical migration (DVM), zooplankton add an active transport to the otherwise passive sinking of detrital material that constitutes the biological pump. This active transport has proven difficult to quantify. We present a model that estimates both the temporal and depth characteristic of optimal DVM behavior based on a trade-off between feeding opportunity and predation risk; factors that vary with latitude, time of year, and the size of the migrating animal. This behavioral component, coupled to a nutrient-phytoplankton-zooplankton (NPZ) productivity model provides estimates of the active transport of carbon by different size fractions of the migrating zooplankton population as function of time and space. The approach is motivated by the difficulty in incorporating behavioral aspects of carbon transport into large scale carbon budgets of the world's oceans. The results show that despite their lower abundance, large zooplankton (length circa 1–2 mm) migrate deeper and transport approximately twice as much carbon as do the smaller zooplankton (length circa 0.2–0.3 mm). In mid-latitudes (~30°N to ~45°N), where pronounced spring blooms are observed, up to 20% more carbon is transported than at either equatorial or boreal latitudes. We estimate that the amount of carbon transported below the mixed layer by migrating zooplankton in the North Atlantic Ocean constitutes 27% (16–30%) of the total export flux associated with the biological pump in that region.
### General information

**State:** Published  
**Organisations:** National Institute of Aquatic Resources, Centre for Ocean Life, Section for Marine Ecology and Oceanography  
**Authors:** Hansen, A. N. (Intern), Visser, A. W. (Intern)  
**Pages:** 701-710  
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**Main Research Area:** Technical/natural sciences

### Publication information

**Journal:** Limnology and Oceanography  
**Volume:** 61  
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**Ratings:**  
- BFI (2018): BFI-level 2  
- Web of Science (2018): Indexed yes  
- BFI (2017): BFI-level 2  
- Web of Science (2017): Indexed yes  
- BFI (2016): BFI-level 2  
- Web of Science (2016): Indexed yes  
- Scopus rating (2016): CiteScore 3.5 SJR 1.712 SNIP 1.225  
- Web of Science (2016): Indexed yes  
- BFI (2015): BFI-level 2  
- Scopus rating (2015): SJR 2.472 SNIP 1.422 CiteScore 3.93  
- Web of Science (2015): Indexed yes  
- BFI (2014): BFI-level 2  
- Scopus rating (2014): SJR 2.112 SNIP 1.584 CiteScore 3.73  
- BFI (2013): BFI-level 2  
- Scopus rating (2013): SJR 2.256 SNIP 1.587 CiteScore 3.98  
- ISI indexed (2013): ISI indexed yes  
- Web of Science (2013): Indexed yes  
- BFI (2012): BFI-level 2  
- Scopus rating (2012): SJR 2.456 SNIP 1.5 CiteScore 3.81  
- ISI indexed (2012): ISI indexed yes  
- Web of Science (2012): Indexed yes  
- BFI (2011): BFI-level 2  
- Scopus rating (2011): SJR 2.374 SNIP 1.445 CiteScore 3.59  
- ISI indexed (2011): ISI indexed yes  
- Web of Science (2011): Indexed yes  
- BFI (2010): BFI-level 2  
- Scopus rating (2010): SJR 2.38 SNIP 1.425  
- Web of Science (2010): Indexed yes  
- BFI (2009): BFI-level 2  
- Scopus rating (2009): SJR 2.329 SNIP 1.682  
- Web of Science (2009): Indexed yes  
- BFI (2008): BFI-level 2  
- Scopus rating (2008): SJR 2.381 SNIP 1.615  
- Web of Science (2008): Indexed yes  
- Scopus rating (2007): SJR 2.361 SNIP 1.682  
- Web of Science (2007): Indexed yes  
- Scopus rating (2006): SJR 2.38 SNIP 1.641  
- Web of Science (2006): Indexed yes  
- Scopus rating (2005): SJR 2.302 SNIP 1.697  
- Web of Science (2005): Indexed yes  
- Scopus rating (2004): SJR 2.463 SNIP 1.778  
- Web of Science (2004): Indexed yes
Comparing model predictions for ecosystem-based management

Ecosystem modeling is becoming an integral part of fisheries management, but there is a need to identify differences between predictions derived from models employed for scientific and management purposes. Here, we compared two
models: a biomass-based food-web model (Ecopath with Ecosim (EwE)) and a size-structured fish community model. The models were compared with respect to predicted ecological consequences of fishing to identify commonalities and differences in model predictions for the California Current fish community. We compared the models regarding direct and indirect responses to fishing on one or more species. The size-based model predicted a higher fishing mortality needed to reach maximum sustainable yield than EwE for most species. The size-based model also predicted stronger top-down effects of predator removals than EwE.

In contrast, EwE predicted stronger bottom-up effects of forage fisheries removal. In both cases, the differences are due to the presumed degree of trophic overlap between juveniles of large-bodied fish and adult stages of forage fish. These differences highlight how each model’s emphasis on distinct details of ecological processes affects its predictions, underscoring the importance of incorporating knowledge of model assumptions and limitation, possibly through using model ensembles, when providing model-based scientific advice to policy makers.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, University of Washington
Authors: Jacobsen, N. S. (Intern), Essington, T. E. (Ekstern), Andersen, K. H. (Intern)
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Main Research Area: Technical/natural sciences

Publication information
Journal: Canadian Journal of Fisheries and Aquatic Sciences
Volume: 73
Issue number: 4
ISSN (Print): 0706-652X
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 2.56 SJR 1.322 SNIP 1.163
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.256 SNIP 1.051 CiteScore 2.22
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.443 SNIP 1.379 CiteScore 2.6
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.421 SNIP 1.081 CiteScore 2.25
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.324 SNIP 1.196 CiteScore 2.29
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.423 SNIP 1.09 CiteScore 2.13
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.425 SNIP 1.118
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.451 SNIP 1.196
As an introduction to the following Themed Section on the significance of planktonic organisms to the functioning of marine ecosystems and global biogeochemical cycles we discuss the ramifications size imparts on the biology of plankton. We provide examples of how the characteristics of these microscopic organisms shape plankton population dynamics, distributions, and ecosystem functions. Key features of the marine environment place constraints on the ecology and evolution of plankton. Understanding these constraints is critical in developing a mechanistic understanding and predictive capacity of how planktonic ecosystems function, render their capacities in terms of biogeochemical cycling and trophic transfer, and how planktonic communities might respond to changing climate conditions.
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.025 SNIP 0.796 CiteScore 1.77
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.095 SNIP 1.255 CiteScore 2.24
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.289 SNIP 1.109 CiteScore 2.39
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.557 SNIP 1.101 CiteScore 2.43
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.158 SNIP 1.045 CiteScore 1.99
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.186 SNIP 0.98
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.922 SNIP 1.046
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.174 SNIP 1.037
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.31 SNIP 1.225
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.19 SNIP 1.118
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.116 SNIP 1.068
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 1.035 SNIP 1.101
Scopus rating (2003): SJR 1.315 SNIP 1.299
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 1.239 SNIP 1.068
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 1.234 SNIP 1
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 1.226 SNIP 1.049
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 1.598 SNIP 1.191
Original language: English
MARINE, OCEANOGRAPHY, COMMUNITY STRUCTURE, ACARTIA-TONSA, SEX-RATIOS, OCEAN, ZOOPLANKTON, PHYTOPLANKTON, GROWTH, SIZE, POPULATION, PREDATION, Plankton Ecology, Scales, Biogeochemistry, Motility, Behavior
Electronic versions:
Publisher version
DOIs:
10.1093/plankt/fbw049
Source: FindIt
Source-ID: 2343156064
Publication: Research - peer-review › Journal article – Annual report year: 2016
Differences in density-dependence drive dual offspring size strategies in fish

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Ecosystem based Marine Management, Centre for Ocean Life
Authors: Olsson, K. H. (Intern), Gislason, H. (Intern), Andersen, K. H. (Intern)
Pages: 118-127
Publication date: 2016
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Theoretical Biology
Volume: 407
ISSN (Print): 0022-5193
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.918 SNIP 0.932 CiteScore 2.16
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.084 SNIP 1.017 CiteScore 2.21
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.07 SNIP 1.048 CiteScore 2.25
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.04 SNIP 1.044 CiteScore 2.44
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.939 SNIP 1.04 CiteScore 2.5
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.802 SNIP 1.031 CiteScore 2.44
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.069 SNIP 0.978
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.134 SNIP 1.081
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 0.87 SNIP 1.088
Scopus rating (2007): SJR 1.269 SNIP 1.104
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.108 SNIP 1.054
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.089 SNIP 0.924
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 1.032 SNIP 0.911
Documentation on key drivers and physiological tolerance limits for resident and invasive species: Report: BIO-C3 Deliverable, D1.2

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography, Section for Marine Living Resources, Centre for Ocean Life, University of Tartu, University of Hamburg
Number of pages: 100
Publication date: 2016

Publication information
Original language: English
Main Research Area: Technical/natural sciences
Electronic versions:
Publishers version
DOIs:
10.3289/BIO-C3_D2.2
Links:
http://oceanrep.geomar.de/32927/
Publication: Research › Report – Annual report year: 2016

Dynamics of a physiologically structured population in a time-varying environment
Physiologically structured population models have become a valuable tool to model the dynamics of populations. In a stationary environment such models can exhibit equilibrium solutions as well as periodic solutions. However, for many organisms the environment is not stationary, but varies more or less regularly. In order to understand the interaction between an external environmental forcing and the internal dynamics in a population, we examine the response of a physiologically structured population model to a periodic variation in the food resource. We explore the addition of forcing in two cases: (A) where the population dynamics is in equilibrium in a stationary environment, and (B) where the population dynamics exhibits a periodic solution in a stationary environment. When forcing is applied in case A, the solutions are mainly periodic. In case B the forcing signal interacts with the oscillations of the unforced system, and both periodic and irregular (quasi-periodic or chaotic) solutions occur. In both cases the periodic solutions include one and multiple period cycles, and each cycle can have several reproduction pulses.

General information
State: Published
Organisations: Department of Applied Mathematics and Computer Science , Dynamical Systems, National Institute of Aquatic Resources, Centre for Ocean Life, Section for Marine Living Resources
Authors: Heilmann, I. L. T. (Intern), Starke, J. (Intern), Andersen, K. H. (Intern), Thygesen, U. H. (Intern), Sørensen, M. P. (Intern)
Pages: 54-61
Publication date: 2016
Main Research Area: Technical/natural sciences
Effects of oil spill responses on key Arctic zooplankton species

The copepod Calanus glacialis is a key species in the Arctic ecosystem. Increased shipping and oil and gas activities in the Arctic increase the risk of an oil spill. It is therefore important to study the potential consequences of an oil spill on this key species in the Arctic marine ecosystems. As a part of a large joint industry initiative (www.arcticresponsetechnology.org) a first of its kind mesocosm experiment was executed in an Arctic fjord of the Island of Svalbard. Effects of natural attenuation of the oil, in-situ burning and chemical dispersion were studied on grazing, egg production and hatching of the Arctic copepod Calanus glacialis. Eight mesocosms with open top and bottom were deployed in the sea ice in Van Mijenfjorden, Svalbard, in February 2015. Two replicates were used for all treatments. After application, surface ice was allowed to re-establish. Water was collected from the top 2 cm water column in March and just before sea ice break up in May, and was used in two 14-day incubation experiments with C. glacialis collected in Isfjorden. Copepods were fed during the experiment and eggs and pellets were quantified daily. Egg hatching was determined in the beginning and end of the experiment. There was no significant effect of the oil spill treatments on average cumulated specific pellet production or egg hatching success. However in May, the average cumulated specific egg production was significantly higher in the dispersed oil treatment compared to the control from day 2 (+ 169 %) until the end of the experiment (+ 41 %).
**Effects of oil spill responses on key Arctic zooplankton species**

Increased shipping and oil and gas activities in the Arctic increase the risk of an oil spill. Oil compounds can have toxic impact on Arctic marine ecosystems, but impacts from response technologies on ice associated ecology have not been studied extensively. The copepod Calanus glacialis is a key species in the Arctic marine ecosystem. It plays a central role in energy transfer between primary producers and higher trophic levels of the Arctic food chain. It is therefore relevant to study potential consequences of an oil spill on this ecological important species. As a part of a large joint industry initiative (www.arcticresponsetechnology.org) a first of its kind mesocosm experiment was executed in an Arctic fjord of the Island of Svalbard. Effects of natural attenuation of the oil, in-situ burning and chemical dispersion were studied on grazing, egg production and hatching of the Arctic copepod Calanus glacialis. Eight mesocosms with open top and bottom were deployed in the sea ice in Van Mijenfjorden, Svalbard, in February 2015. Two replicates were used for all treatments. After application, surface ice was allowed to re-establish. Water was collected from the top 2 cm water column in March and just before sea ice break up in May, and was used in two 14-day incubation experiments with C. glacialis collected in Isfjorden. Copepods were fed during the experiment and eggs and pellets were quantified daily. Egg hatching was determined in the beginning and end of the experiment. There was no significant effect of the oil spill treatments on average cumulated specific pellet production or egg hatching success. However in May, the average cumulated specific egg production was significantly higher in the oil-dispersant mixture treatment compared to the control from day 2 (+ 169 %) until the end of the experiment (+ 41 %). To correlate observed effects and toxicity, and to examine potential pollutant transfer, the chemical content of incubation water, exposed females and produced eggs was further analysed for chemical residue. These results will be presented on the SETAC 2016 conference.

**Environmental Impacts—Marine Ecosystems**

This chapter presents a review of what is known about the impacts of climate change on the biota (plankton, benthos, fish, seabirds and marine mammals) of the North Sea. Examples show how the changing North Sea environment is affecting biological processes and organisation at all scales, including the physiology, reproduction, growth, survival, behaviour and transport of individuals; the distribution, dynamics and evolution of populations; and the trophic structure and coupling of ecosystems. These complex responses can be detected because there are detailed long-term biological and environmental records for the North Sea; written records go back 500 years and archaeological records many thousands of years. The information presented here shows that the composition and productivity of the North Sea marine ecosystem is clearly affected by climate change and that this will have consequences for sustainable levels of harvesting and other ecosystem services in the future. Multi-variate ocean climate indicators that can be used to monitor and warn of changes in composition and productivity are now being developed for the North Sea.
Fish stock assessment under data limitations developing a new method based on a size-structured theoretical ecology framework

Fish stock assessment is an integral part of every fisheries management system. Modern assessment methods require data about the fishery and the stock, such as catches, survey estimates, aging information and life history parameters, all of which is difficult and expensive to gather. However, the majority of global fish catches come from species that lack an official assessment due to lack of data. That is true especially for small scale fisheries and fisheries in developing countries. New methods are in need that require little amount of easily attainable data and provide scientific advice for fish stocks that are not assessed. The goal of the thesis is to develop a new data-limited stock assessment method that is: rooted in theoretical ecology, requires only information about the size composition of the catch or surveys (i.e. aging is not required), and does not require time-series. The method provides estimates of fishing mortality and the FMSY reference point, it is tested and validated, and is implemented as software package making it easy to use by stakeholders of different levels. The basis of the method is a size-based theoretical ecology framework that describes exploited fish stocks. The model parameters correspond to Beverton-Holt life history invariants, which reduces the number of parameters and allows data-limited assessments to borrow information from data-rich stocks. The mathematical formulation of the single species population dynamics is used in a maximum-likelihood optimisation framework to estimate model parameters. The data-limited method estimates at the same time the fishing mortality rate and the biological reference point FMSY. Minimum data requirements consist of a single size frequency distribution from the commercial catch or a scientific survey. If the total catch is known, important quantities about the stock (e.g. biomass of spawners, recruitment) can be quantified. The method is tested using simulated data and validated using a subset of available data from data-rich fish stocks. The implementation of the method as a software package in the R programming language is publicly available.

Fluid dynamic constraints on resource acquisition in small pelagic organisms

Physicists have long examined the fluid dynamics of swimming at low Reynolds number, but the main scope has rarely been to understand the behavior and ecology of microorganisms. However, many ecological questions about the functioning of small aquatic organisms can only be addressed by the application of formal fluid physics. Here, I examine resource acquisition mechanisms in small aquatic organisms, ranging from uptake of dissolved molecules to feeding on suspended particulate prey, and examine how organism behaviors and morphologies may be shaped by the often non-intuitive small-scale fluid physics.
Foraging mode and prey size spectra of suspension-feeding copepods and other zooplankton
Prey size spectra of suspension-feeding zooplankton may be predicted from foraging mode and a mechanistic understanding of prey perception and capture. I examine this for suspension-feeding copepods where 2 foraging modes can be distinguished: ambush feeding and active (i.e. cruising and feeding-current) feeding. Prey perception mechanisms differ between the 2 foraging modes. I use simple arguments to predict that the ambush strategy targets larger prey and has a narrower prey size spectrum than the cruising and feeding-current feeding strategies. I compile data from the literature that confirm the prediction. I also make qualitative predictions of food size spectra in zooplankton with other prey perception mechanisms that accord with observations.
From traits to life history strategies: deconstructing fish community composition across European Seas

General information
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Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Section for Marine Ecology and Oceanography, Thünen Institute of Sea Fisheries
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Global patterns in the feeding ecology of large marine fish

General information
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Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Section for Marine Ecology and Oceanography
Authors: van Denderen, P. D. (Intern), Lindegren, M. (Intern), MacKenzie, B. (Intern), Watson, R. A. (Ekstern), Andersen, K. H. (Intern)
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Høj funktionel rigdom trods få arter i Østersøen

General information
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Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Törnroos, A. (Intern)
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Journal: Aktuel naturvidenskab
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How much crude oil can zooplankton ingest? Estimating the quantity of dispersed crude oil defecated by planktonic copepods
We investigated and quantified defecation rates of crude oil by 3 species of marine planktonic copepods (Temora turbinata, Acartia tonsa, and Parvocalanus crassirostris) and a natural copepod assemblage after exposure to mechanically or chemically dispersed crude oil. Between 88 and 100% of the analyzed fecal pellets from three species of copepods and a natural copepod assemblage exposed for 48 h to physically or chemically dispersed light crude oil contained crude oil droplets. Crude oil droplets inside fecal pellets were smaller (median diameter: 2.4-3.5 μm) than droplets in the physically and chemically dispersed oil emulsions (median diameter: 6.6 and 8.0 μm, respectively). This
suggests that copepods can reject large crude oil droplets or that crude oil droplets are broken into smaller oil droplets before or during ingestion. Depending on the species and experimental treatments, crude oil defecation rates ranged from 5.3 to 245 ng-oil copepod(-1) d(-1), which represent a mean weight-specific defecation rate of 0.026 μg-oil μg-C copepod(-1) d(-1). Considering a dispersed crude oil concentration commonly found in the water column after oil spills (1 μL L(-1)) and copepod abundances in high productive coastal areas, copepods may defecate similar to 1.3-2.6 mg-oil m(-3) d(-1), which would represent similar to 0.15%-0.30% of the total dispersed oil per day. Our results indicate that ingestion and subsequent defecation of crude oil by planktonic copepods has a small influence on the overall mass of oil spills in the short term, but may be quantitatively important in the flux of oil from surface water to sediments and in the transfer of low-solubility, toxic petroleum hydrocarbons into food webs after crude oil spills in the sea. (C) 2015 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).
Influence of UVB radiation on the lethal and sublethal toxicity of dispersed crude oil to planktonic copepod nauplii

Toxic effects of petroleum to marine zooplankton have been generally investigated using dissolved petroleum hydrocarbons and in the absence of sunlight. In this study, we determined the influence of natural ultraviolet B (UVB) radiation on the lethal and sublethal toxicity of dispersed crude oil to naupliar stages of the planktonic copepods Acartia tonsa, Temora turbinata and Pseudodiaptomus pelagicus. Low concentrations of dispersed crude oil (1 μL L(–1)) caused a significant reduction in survival, growth and swimming activity of copepod nauplii after 48 h of exposure. UVB radiation increased toxicity of dispersed crude oil by 1.3-3.8 times, depending on the experiment and measured variables. Ingestion of crude oil droplets may increase photoenhanced toxicity of crude oil to copepod nauplii by enhancing photosensitization. Photoenhanced sublethal toxicity was significantly higher when T. turbinata nauplii were exposed to dispersant-treated oil than crude oil alone, suggesting that chemical dispersion of crude oil may promote photoenhanced toxicity to marine zooplankton. Our results demonstrate that acute exposure to concentrations of dispersed crude oil and dispersant (Corexit 9500) commonly found in the sea after oil spills are highly toxic to copepod nauplii and that natural levels of UVB radiation substantially increase the toxicity of crude oil to these planktonic organisms. Overall, this study emphasizes the importance of considering sunlight in petroleum toxicological studies and models to better estimate the impact of crude oil spills on marine zooplankton.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, University of Texas
Authors: Almeda, R. (Intern), Harvey, T. E. (Ekstern), Connelly, T. L. (Ekstern), Baca, S. (Ekstern), Buskey, E. J. (Ekstern)
Number of pages: 13
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Journal: Chemosphere
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Web of Science (2018): Indexed yes
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Web of Science (2017): Indexed yes
Local environmental conditions shape generalist but not specialist components of microbial metacommunities in the Baltic Sea

Marine microbes exhibit biogeographical patterns linked with fluxes of matter and energy. Yet, knowledge of the mechanisms shaping bacterioplankton community assembly across temporal scales remains poor. We examined bacterioplankton 16S rRNA gene fragments obtained from Baltic Sea transects to determine phylogenetic relatedness and assembly processes coupled with niche breadth. Communities were phylogenetically more related over time than expected by chance, albeit with considerable temporal variation. Hence, habitat filtering, i.e., local environmental conditions, rather than competition structured bacterioplankton communities in summer but not in spring or autumn. Species sorting (SS) was the dominant assembly process, but temporal and taxonomical variation in mechanisms was observed. For May communities, Cyanobacteria, Actinobacteria, Alpha- and Betaproteobacteria exhibited SS while Bacteroidetes and Verrucomicrobia were assembled by SS and mass effect. Concomitantly, Gammaproteobacteria were assembled by the neutral model and patch dynamics. Temporal variation in habitat filtering and dispersal highlights the impact of seasonally driven reorganization of microbial communities. Typically abundant Baltic Sea populations such as the NS3a marine group (Bacteroidetes) and the SAR86 and SAR11 clade had the highest niche breadth. The verrucomicrobial Spartobacteria population also exhibited high niche breadth. Surprisingly, variation in bacterioplankton community composition was regulated by environmental factors for generalist taxa but not specialists. Our results suggest that generalists such as NS3a, SAR86, and SAR11 are reorganized to a greater extent by changes in the environment compared to specialists and contribute more strongly to determining overall biogeographical patterns of marine bacterial communities.

General information
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Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Linnaeus University, Lund University, Swedish University of Agricultural Sciences, Umeå University
Authors: Lindh, M. V. (Ekstern), Sjöstedt, J. (Intern), Casini, M. (Ekstern), Andersson, A. (Ekstern), Legrand, C. (Ekstern), Pinhassi, J. (Ekstern)
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Scopus rating (2016): CiteScore 4.16 SJR 1.731 SNIP 1.172
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BFI (2015): BFI-level 1
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Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.861 SNIP 1.16 CiteScore 3.76
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.751 SNIP 0.951 CiteScore 3.56
ISI indexed (2013): ISI indexed no
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BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.415 SNIP 0.725 CiteScore 2.78
ISI indexed (2012): ISI indexed no
Scopus rating (2011): SJR 0.626 SNIP 0.187
Web of Science (2011): Indexed yes
Marine ecosystem connectivity mediated by migrant–resident interactions and the concomitant cross-system flux of lipids

General information
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Organisations: National Institute of Aquatic Resources, Section for Marine Living Resources, Centre for Ocean Life, National Food Institute, Research Group for Bioactives – Analysis and Application, Section for Marine Ecology and Oceanography, Lund University, University of Bergen
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Scopus rating (2016): SJR 1.579 SNIP 1.048 CiteScore 2.86
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.686 SNIP 0.939 CiteScore 2.66
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.37 SNIP 0.886 CiteScore 2.37
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.876 SNIP 0.725 CiteScore 1.66
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.58 SNIP 0.518
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Maximizing fisheries yields while maintaining community structure

General information
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Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Wageningen IMARES, University of Bergen
Authors: Kolding, J. (Ekstern), Jacobsen, N. S. (Intern), Andersen, K. H. (Intern), van Zwieten, P. A. (Ekstern)
Pages: 644–655
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Scopus rating (2016): CiteScore 2.56 SJR 1.322 SNIP 1.163
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.256 SNIP 1.051 CiteScore 2.22
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.443 SNIP 1.379 CiteScore 2.6
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.421 SNIP 1.081 CiteScore 2.25
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.324 SNIP 1.196 CiteScore 2.29
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.423 SNIP 1.09 CiteScore 2.13
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.425 SNIP 1.118
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.451 SNIP 1.196
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 1.589 SNIP 1.379
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.621 SNIP 1.236
Web of Science (2007): Indexed yes
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Oil spills and dispersants can cause the initiation of red tides

**General information**
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Almeda, R. (Intern), Buskey, E. (Ekstern)
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Patterns and drivers of fish community assembly in a large marine ecosystem
The presence and survival of the species in a community depend on their abilities to maximize fitness in a given environment. The study of the processes that control survival and co-existence, termed ‘assembly rules’, follows various mechanisms, primarily related to biotic or abiotic factors. To determine assembly rules, ecological similarities of co-occurring species are often investigated. This can be evaluated using trait-based indices summarizing the species’ niches in a given community. In order to investigate the underlying processes shaping community assembly in marine ecosystems, we investigated the patterns and drivers of fish community composition in the Baltic Sea, a semi-enclosed sea characterized by a pronounced environmental gradient. Our results showed a marked decline in species- and functional richness, largely explained by decreasing salinities. In addition, habitat complexity and oxygen were found to be significant drivers. Furthermore, we showed that the trait composition of the fish community in the western Baltic Sea is more similar than expected by random chance alone. This implies that environmental filtering, acting along the salinity gradient, is the dominant factor shaping community composition. However, community composition in the eastern part, an area beyond the steep decline in salinity, was characterized by fewer species with largely different trait characteristics, indicating that community assembly is also affected by biotic interactions. Our results add to the knowledge base of key abiotic drivers impacting marine fish communities and their vulnerability to environmental changes, a key concern for fisheries and marine ecosystem management.

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Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Pécuchet, L. (Intern), Törnroos, A. (Intern), Lindegren, M. (Intern)
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Main Research Area: Technical/natural sciences

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Journal: Marine Ecology - Progress Series
Volume: 546
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Photoregulation in a Kleptochloroplastidic Dinoflagellate, Dinophysis acuta

Some phagotrophic organisms can retain chloroplasts of their photosynthetic prey as so-called kleptochloroplasts and maintain their function for shorter or longer periods of time. Here we show for the first time that the dinoflagellate Dinophysis acuta takes control over "third-hand" chloroplasts obtained from its ciliate prey Mesodinium spp. that originally ingested the cryptophyte chloroplasts. With its kleptochloroplasts, D. acuta can synthesize photosynthetic as well as photoprotective pigments under long-term starvation in the light. Variable chlorophyll fluorescence measurements showed that the kleptochloroplasts were fully functional during 1 month of prey starvation, while the chlorophyll a-specific inorganic carbon uptake decreased within days of prey starvation under an irradiance of 100 µmol photons m(-2) s(-1). While acute cells can regulate their pigmentation and function of kleptochloroplasts they apparently lose the ability to maintain high inorganic carbon fixation rates.
Plankton community composition and vertical migration during polar night in Kongsfjorden

The polar night in the Arctic is characterized by up to six months of darkness, low temperatures and limited food availability. Biological data on species composition and abundance during this period are scarce due to the logistical challenges posed when sampling these regions. Here, we characterize the plankton community composition during the polar night using water samplers and zooplankton net samples (50, 64, 200, 1500 lm), supplemented by acoustics (ADCPs, 300 kHz), to address a previously unresolved question–which species of zooplankton perform diel vertical migration...
migration during the polar night? The protist community (smallest plankton fraction) was mainly represented by ciliates (Strombidiida). In the larger zooplankton fractions (50, 64, 200 μm) the species composition was represented primarily by copepod nauplii and small copepods (e.g., Microcalanus spp., Pseudocalanus spp. and Oithona similis). In the largest zooplankton fraction (>1500 μm), the euphausiid, Thysanopoea inermis, was the most abundant species followed by the chaetognath Parasagitta elegans. Classical DVM was not observed throughout the darkest parts of the polar night (November–mid-January), although, subtle vertical migration patterns were detected in the acoustic data. With the occurrence of a more distinct day–night cycle (i.e., end of January), acoustical DVM signals were observed, paralleled by a classical DVM pattern in February in the largest fractions of zooplankton net samples. We suggest that Thysanoessa spp. are main responsible for the acoustical migration patterns throughout the polar night, although, chaetognaths and copepods may be co-responsible.

General information
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Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography, Centre for Ocean Life, University Centre in Svalbard, UiT The Arctic University of Norway, Scottish Association for Marine Science, Akvaplan-niva AS
Authors: Grenvald, J. C. (Intern), Callesen, T. A. (Intern), Daase, M. (Ekstern), Hobbs, L. (Ekstern), Darnis, G. (Ekstern), Renaud, P. E. (Ekstern), Cottier, F. (Ekstern), Nielsen, T. G. (Intern), Berge, J. (Ekstern)
Pages: 1879-1895
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BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
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Scopus rating (2016): CiteScore 1.72 SJR 0.866 SNIP 0.761
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.985 SNIP 0.751 CiteScore 1.62
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.931 SNIP 0.81 CiteScore 1.75
Web of Science (2014): Indexed yes
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Scopus rating (2013): SJR 1.109 SNIP 1.054 CiteScore 2.07
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.029 SNIP 0.891 CiteScore 1.89
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.857 SNIP 0.925 CiteScore 1.77
Prey perception in feeding-current feeding copepods: Reply to comment

We reply to the comments of Paffenhöfer and Jiang (2016) who argue that remote chemical prey perception is necessary for feeding-current feeding copepods to fulfill their nutritional requirements in a dilute ocean, that remote chemical prey detection may only be observed at very low prey concentrations, and that chemical prey perception is feasible if prey cells release dissolved organic material in short-lasting but intense bursts. We demonstrate that mechanoreception at a very short range is sufficient to sustain a living, even in a dilute ocean. Further, if chemoreception requires that prey cells have short intense leakage burst, only a very small fraction of prey cells would be available to the copepod at any instance in time and, thus would be inefficient at low prey concentration. Finally, we report a few new observations of prey capture in two species of copepods, Temora longicornis and Centropages hamatus, offered a 45-μm sized dinoflagellate at very low concentration. The observed short prey detection distances, up to a few prey cell radii, are consistent with mechanoreception and we argue briefly that near-field mechanoreception is the most likely and common prey perception mechanism in calanoid copepods.

General information

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Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Consejo Nacional de Investigaciones Científicas y Tecnicas, Pierre and Marie Curie University - University of Paris VI, University of Gothenburg, Consejo Superior de Investigaciones Científicas y Tecnicas
Authors: Kiørboe, T. (Intern), Goncalves, R. J. (Ekstern), Florian Couespel, D. (Ekstern), van Someren Gréve, H. (Intern), Saiz, E. (Ekstern), Tiselius, P. (Intern)
Pages: 1169-1171
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Journal: Limnology and Oceanography
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Records of five bryozoan species from offshore gas platforms rare for the Dutch North Sea

General information
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Authors: Beukhof, E. D. (Intern), Coolen, J. W. P. (Ekstern), van der Weide, B. E. (Ekstern), Cuperus, J. (Ekstern), de Blauwe, H. (Ekstern), Lust, J. (Ekstern)
Publication date: 2016
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Remaining questions in the case for balanced harvesting
Balanced harvesting – harvesting all species and sizes in an ecosystem in proportion to their productivity – is a fisheries management strategy that has been suggested recently to increase yields, while reducing overall ecosystem impact. However, some aspects of balanced harvesting are controversial, including its call for extensive harvesting of juveniles and forage fish. Balanced harvesting also calls for targeting species and size-classes that are not currently marketable, possibly at a significant economic cost. Some have argued that this cost is outweighed by the ecological benefits of maintaining the ecosystem size and trophic structures and by the benefits of extra yield for food security. There is broad consensus that balanced harvesting would require major changes to fishery management institutions and consumer behaviour, and it is unclear to what extent it is physically possible with current technologies. For this reason, we argue that steps to implement balanced harvesting are difficult to justify until the case for it is more clearly resolved. We outline some of the pivotal questions that must be answered to make a convincing case for or against balanced harvesting, many of which can be answered.
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Reproductive traits (Fecundity, egg diameter, parental care) of marine European fish

General information
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Publication information
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Resilience and stability of a pelagic marine ecosystem
The accelerating loss of biodiversity and ecosystem services worldwide has accentuated a long-standing debate on the role of diversity in stabilizing ecological communities and has given rise to a field of research on biodiversity and ecosystem functioning (BEF). Although broad consensus has been reached regarding the positive BEF relationship, a number of important challenges remain unanswered. These primarily concern the underlying mechanisms by which diversity increases resilience and community stability, particularly the relative importance of statistical averaging and functional complementarity. Our understanding of these mechanisms relies heavily on theoretical and experimental studies, yet the degree to which theory adequately explains the dynamics and stability of natural ecosystems is largely unknown, especially in marine ecosystems. Using modelling and a unique 60-year dataset covering multiple trophic levels, we show that the pronounced multi-decadal variability of the Southern California Current System (SCCS) does not represent fundamental changes in ecosystem functioning, but a linear response to key environmental drivers channelled through bottom-up and physical control. Furthermore, we show strong temporal asynchrony between key species or functional groups within multiple trophic levels caused by opposite responses to these drivers. We argue that functional complementarity is the primary mechanism reducing community variability and promoting resilience and stability in the SCCS.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, University of California, San Diego
Authors: Lindegren, M. (Intern), Checkley, D. M. (Ekstern), Ohman, M. D. (Ekstern), Koslow, J. A. (Ekstern), Goericke, R. (Ekstern)
Number of pages: 9
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Scopus rating (2016): CiteScore 3.89 SJR 2.541 SNIP 1.474
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.948 SNIP 1.535 CiteScore 4.08
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.916 SNIP 1.673 CiteScore 4.18
Web of Science (2014): Indexed yes
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BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.947 SNIP 1.881 CiteScore 4.99
ISI indexed (2012): ISI indexed yes
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BFI (2011): BFI-level 2
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ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
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Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 2.581 SNIP 1.389
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 2.364 SNIP 1.372
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 2.475 SNIP 1.447
Scopus rating (2006): SJR 2.925 SNIP 1.713
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 2.633 SNIP 1.52
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 2.872 SNIP 1.699
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 2.891 SNIP 1.561
Scopus rating (2002): SJR 3.005 SNIP 1.5
Scopus rating (2001): SJR 2.688 SNIP 1.32
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 2.458 SNIP 1.359
Scopus rating (1999): SJR 2.434 SNIP 1.726
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Role of zooplankton dynamics for Southern Ocean phytoplankton biomass and global biogeochemical cycles

Global ocean biogeochemistry models currently employed in climate change projections use highly simplified representations of pelagic food webs. These food webs do not necessarily include critical pathways by which ecosystems interact with ocean biogeochemistry and climate. Here we present a global biogeochemical model which incorporates ecosystem dynamics based on the representation of ten plankton functional types (PFTs): six types of phytoplankton, three types of zooplankton, and heterotrophic procaryotes. We improved the representation of zooplankton dynamics in our model through (a) the explicit inclusion of large, slow-growing macrozooplankton (e.g. krill), and (b) the introduction of trophic cascades among the three zooplankton types. We use the model to quantitatively assess the relative roles of iron vs. grazing in determining phytoplankton biomass in the Southern Ocean high-nutrient low-chlorophyll (HNLC) region during summer. When model simulations do not include macrozooplankton grazing explicitly, they systematically overestimate Southern Ocean chlorophyll biomass during the summer, even when there is no iron deposition from dust. When model simulations include a slow-growing macrozooplankton and trophic cascades among three zooplankton types, the high-chlorophyll summer bias in the Southern Ocean HNLC region largely disappears. Our model results suggest that the observed low phytoplankton biomass in the Southern Ocean during summer is primarily explained by the dynamics of the Southern Ocean zooplankton community, despite iron limitation of phytoplankton community growth rates. This result has implications for the representation of global biogeochemical cycles in models as zooplankton faecal pellets sink rapidly and partly control the carbon export to the intermediate and deep ocean.

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Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, University of East Anglia, Université Lille Nord de France, Laboratoire des Sciences de Climat et de l’Environnement, Bournemouth University, University of Essex, Macquarie University, Queen Mary University of London, Institute of Marine Research, Sorbonne Universités, Plymouth Marine Laboratory, Memorial University of Newfoundland, ETH Zurich, Université Pierre et Marie Curie
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Scopus rating (2016): CiteScore 4.25 SJR 2.328 SNIP 1.305
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 2.453 SNIP 1.324 CiteScore 4.04
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 2.194 SNIP 1.363 CiteScore 4.03
Web of Science (2014): Indexed yes
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ISI indexed (2013): ISI indexed yes
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Scaling laws in phytoplankton nutrient uptake affinity

Nutrient uptake affinity affects the competitive ability of microbial organisms at low nutrient concentrations. From the theory of diffusion limitation it follows that uptake affinity scales linearly with the cell radius. This is in conflict with some observations suggesting that uptake affinity scales to a quantity that is closer to the square of the radius, i.e. to cell surface area. We show that this apparent conflict can be resolved by nutrient uptake theory. Pure diffusion limitation assumes that the cell is a perfect sink which means that it is able to absorb all encountered nutrients instantaneously. Here we provide empirical evidence that the perfect sink strategy is not common in phytoplankton. Although small cells are indeed favored by a large surface to volume ratio, we show that they are punished by higher relative investment cost in order to fully benefit from the larger surface to volume ratio. We show that there are two reasons for this. First, because the small cells need a higher transporter density in order to maximize their affinity, and second because the relative cost of a transporter is higher for a small than for a large cell. We suggest that this might explain why observed uptake affinities do not scale linearly with the cell radius.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography, Centre for Ocean Life, University of Bergen
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Publication date: 2016
Main Research Area: Technical/natural sciences

Publication information
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DOI: 10.3389/fmars.2016.00026
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Selection for high reproduction rates during establishment of non-indigenous species: A case study of a successful marine invader

General information
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Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography, Centre for Ocean Life
Authors: Jaspers, C. (Intern), Marty, L. (Intern), Kierboe, T. (Intern)
Publication date: 2016
Event: Abstract from International Jellyfish Blooms Symposium, Barcelona, Spain.
Main Research Area: Technical/natural sciences
Publication: Research › Conference abstract for conference – Annual report year: 2016

Selective silicate-directed motility in diatoms
Diatoms are highly abundant unicellular algae that often dominate pelagic as well as benthic primary production in the oceans and inland waters. Being strictly dependent on silica to build their biomineralized cell walls, marine diatoms precipitate $240 \times 10^{12}$ mol Si per year, which makes them the major sink in the global Si cycle. Dissolved silicic acid (dSi) availability frequently limits diatom productivity and influences species composition of communities. We show that benthic diatoms selectively perceive and behaviourally react to gradients of dSi. Cell speed increases under dSi-limited conditions in a chemokinetic response and, if gradients of this resource are present, increased directionality of cell movement promotes chemotaxis. The ability to exploit local and short-lived dSi hotspots using a specific search behaviour likely contributes to micro-scale patch dynamics in biofilm communities. On a global scale this behaviour might affect sediment-water dSi fluxes and biogeochemical cycling.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Friedrich-Schiller-Universität Jena, Lund University, Universiteit Gent
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Number of pages: 7
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Main Research Area: Technical/natural sciences

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Shape shifting predicts ontogenetic changes in metabolic scaling in diverse aquatic invertebrates

Metabolism fuels all biological activities, and thus understanding its variation is fundamentally important. Much of this variation is related to body size, which is commonly believed to follow a 3/4-power scaling law. However, during ontogeny, many kinds of animals and plants show marked shifts in metabolic scaling that deviate from 3/4-power scaling predicted by general models. Here, we show that in diverse aquatic invertebrates, ontogenetic shifts in the scaling of routine metabolic rate from near isometry (bR = scaling exponent approx. 1) to negative allometry (bR < 1), or the reverse, are associated with significant changes in body shape (indexed by bL = the scaling exponent of the relationship between body mass and body length). The observed inverse correlations between bR and bL are predicted by metabolic scaling theory that emphasizes resource/waste fluxes across external body surfaces, but contradict theory that emphasizes resource transport through internal networks. Geometric estimates of the scaling of surface area (SA) with body mass (bA) further show that ontogenetic shifts in bR and bA are positively correlated. These results support new metabolic scaling theory based on SA influences that may be applied to ontogenetic shifts in bR shown by many kinds of animals and plants.
Fishers and scientists have known for over 100 years that the status of fish stocks can be greatly influenced by prevailing climatic conditions. Based on historical sea surface temperature data, the North Sea has been identified as one of 20 ‘hot spots’ of climate change globally and projections for the next 100 years suggest that the region will continue to warm. The consequences of this rapid temperature rise are already being seen in shifts in species distribution and variability in stock...
This chapter reviews current evidence for climate change effects on fisheries in the North Sea—one of the most important fishing grounds in the world—as well as available projections for North Sea fisheries in the future. Discussion focuses on biological, operational and wider market concerns, as well as on possible economic consequences. It is clear that fish communities and the fisheries that target them will be very different in 50 or 100 years’ time and that management and governance will need to adapt accordingly.

**Solid phase extraction and metabolic profiling of exudates from living copepods**

Copepods are ubiquitous in aquatic habitats. They exude bioactive compounds that mediate mate finding or induce defensive traits in prey organisms. However, little is known about the chemical nature of the copepod exometabolome that contributes to the chemical landscape in pelagic habitats. Here we describe the development of a closed loop solid phase extraction setup that allows for extraction of exuded metabolites from live copepods. We captured exudates from male and female Temora longicornis and analyzed the content with high resolution LC-MS. Chemometric methods revealed 87 compounds that constitute a specific chemical pattern either qualitatively or quantitatively indicating copepod presence. The majority of the compounds were present in both female and male exudates, but nine compounds were mainly or exclusively present in female exudates and hence potential pheromone candidates. Copepodamide G, known to induce defensive responses in phytoplankton, was among the ten compounds of highest relative abundance in both male and female extracts. The presence of copepodamide G shows that the method can be used to capture and analyze chemical signals from living source organisms. We conclude that solid phase extraction in combination with metabolic profiling of exudates is a useful tool to develop our understanding of the chemical interplay between pelagic organisms.
Spatial structuration of life history traits: congruence between multiple taxa and environmental drivers in the North Sea

**General information**
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Spatio-temporal changes in life-history traits of the North Sea fish community under climate change and fishing

**General information**
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Beukhof, E. (Intern), Dencker, T. S. (Intern), Pécuchet, L. (Intern), Lindegren, M. (Intern)
Publication date: 2016
Main Research Area: Technical/natural sciences

The global susceptibility of coastal forage fish to competition by large jellyfish

Competition between large jellyfish and forage fish for zooplankton prey is both a possible cause of jellyfish increases and a concern for the management of marine ecosystems and fisheries. Identifying principal factors affecting this competition is therefore important for marine management, but the lack of both good quality data and a robust theoretical framework have prevented general global analyses. Here, we present a general mechanistic food web model that considers fundamental differences in feeding modes and predation pressure between fish and jellyfish. The model predicts forage fish dominance at low primary production, and a shift towards jellyfish with increasing productivity, turbidity and fishing. We present an index of global ecosystem susceptibility to shifts in fish–jellyfish dominance that compares well with data on jellyfish distributions and trends. The results are a step towards better understanding the processes that govern jellyfish
occurrences globally and highlight the advantage of considering feeding traits in ecosystem models.

**General information**

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Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Schnedler-Meyer, N. A. (Intern), Mariani, P. (Intern), Kiørboe, T. (Intern)
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- Scopus rating (2016): CiteScore 3.89 SJR 2.541 SNIP 1.474
- Web of Science (2016): Indexed yes
- BFI (2015): BFI-level 2
- Scopus rating (2015): SJR 2.948 SNIP 1.535 CiteScore 4.08
- Web of Science (2015): Indexed yes
- BFI (2014): BFI-level 2
- Scopus rating (2014): SJR 2.916 SNIP 1.673 CiteScore 4.18
- Web of Science (2014): Indexed yes
- BFI (2013): BFI-level 2
- Scopus rating (2013): SJR 3.091 SNIP 1.762 CiteScore 5.08
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- Scopus rating (2012): SJR 2.947 SNIP 1.881 CiteScore 4.99
- ISI indexed (2012): ISI indexed yes
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- BFI (2010): BFI-level 2
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- Web of Science (2010): Indexed yes
- BFI (2009): BFI-level 2
- Scopus rating (2009): SJR 2.581 SNIP 1.389
- Web of Science (2009): Indexed yes
- BFI (2008): BFI-level 2
- Scopus rating (2008): SJR 2.364 SNIP 1.372
- Web of Science (2008): Indexed yes
- Scopus rating (2007): SJR 2.475 SNIP 1.447
- Web of Science (2007): Indexed yes
- Scopus rating (2006): SJR 2.925 SNIP 1.713
- Web of Science (2006): Indexed yes
- Scopus rating (2005): SJR 2.633 SNIP 1.52
- Web of Science (2005): Indexed yes
- Scopus rating (2004): SJR 2.872 SNIP 1.699
- Web of Science (2004): Indexed yes
The migration game in habitat network: the case of tuna

Long-distance migration is a widespread process evolved independently in several animal groups in terrestrial and marine ecosystems. Many factors contribute to the migration process and of primary importance are intra-specific competition and seasonality in the resource distribution. Adaptive migration in direction of increasing fitness should lead to the ideal free distribution (IFD) which is the evolutionary stable strategy of the habitat selection game. We introduce a migration game which focuses on migrating dynamics leading to the IFD for age-structured populations and in time varying habitats, where dispersal is costly. The model predicts migration dynamics between these habitats and the corresponding population distribution.

When applied to Atlantic bluefin tunas, it predicts their biomass is located in the spawning areas which have also the largest diversity in the age-structure. Distant feeding areas are occupied on a seasonal base and often by larger individuals, in agreement with empirical observations. Moreover, we show that only a selected number of migratory routes emerge as those effectively used by tunas.
The predictive skill of species distribution models for plankton in a changing climate

Statistical species distribution models (SDMs) are increasingly used to project spatial relocations of marine taxa under future climate change scenarios. However, tests of their predictive skill in the real-world are rare. Here, we use data from the Continuous Plankton Recorder program, one of the longest running and most extensive marine biological monitoring programs, to investigate the reliability of predicted plankton distributions. We apply three commonly used SDMs to 20 representative plankton species, including copepods, diatoms, and dinoflagellates, all found in the North Atlantic and adjacent seas. We fit the models to decadal subsets of the full (1958–2012) dataset, and then use them to predict both forward and backward in time, comparing the model predictions against the corresponding observations. The probability of correctly predicting presence was low, peaking at 0.5 for copepods, and model skill typically did not outperform a null model assuming distributions to be constant in time. The predicted prevalence increasingly differed from the observed prevalence for predictions with more distance in time from their training dataset. More detailed investigations based on four focal species revealed that strong spatial variations in skill exist, with the least skill at the edges of the distributions, where prevalence is lowest. Furthermore, the scores of traditional single-value model performance metrics were contrasting and some implied overoptimistic conclusions about model skill. Plankton may be particularly challenging to model, due to its short life span and the dispersive effects of constant water movements on all spatial scales, however there are few other studies against which to compare these results. We conclude that rigorous model validation, including comparison against null models, is essential to assess the robustness of projections of marine planktonic species under climate change.
The sex specific metabolic footprint of Oithona davisae

In pelagic copepods, the group representing the highest animal abundances on earth, males and females have distinct morphological and behavioural differences. In several species female pheromones are known to facilitate the mate finding process, and copepod exudates induce changes in physiology and behaviour in several phytoplankton species. Here we tested whether the sexual dimorphism in morphology and behaviour is mirrored in the exudate composition of males and females. We find differences in the exudate composition, with females seemingly producing more compounds. While we were able to remove the sex pheromones from the water by filtration through reverse phase solid phase extraction columns, we were not able to recover the active pheromone from the solid phase.

General information
The theoretical foundations for size spectrum models of fish communities

Size spectrum models have emerged from 40 years of basic research on how body size determines individual physiology and structures marine communities. They are based on commonly accepted assumptions and have a low parameter set, which make them easy to deploy for strategic ecosystem oriented impact assessment of fisheries. We describe the fundamental concepts in size-based models about food encounter and the bioenergetics budget of individuals. Within the general framework three model types have emerged that differs in their degree of complexity: the food-web, the trait-based and the community model. We demonstrate the differences between the models through examples of their response to fishing and their dynamic behavior. We review implementations of size spectrum models and describe important variations concerning the functional response, whether growth is food-dependent or fixed, and the density-dependence imposed on the system. Finally we discuss challenges and promising directions.
Toxic phytoplankton as a keystone species in aquatic ecosystems: stable coexistence to biodiversity

**General information**

State: Published  
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, University of Oldenburg, Indian Institute of Technology Ropar  
Authors: Chakraborty, S. (Intern), Ramesh, A. (Ekstern), Dutta, P. S. (Ekstern)  
Pages: 735-746  
Publication date: 2016  
Main Research Area: Technical/natural sciences

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Web of Science (2017): Indexed Yes  
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Trade-offs in zooplankton feeding behaviour

General information

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Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Almeda, R. (Intern), van Someren Gréve, H. (Intern), Kiørboe, T. (Intern)
Publication date: 2016
Main Research Area: Technical/natural sciences
Publication: Research - peer-review › Journal article – Annual report year: 2015

Trait biogeography of marine copepods - an analysis across scales

Functional traits, rather than taxonomic identity, determine the fitness of individuals in their environment: traits of marine organisms are therefore expected to vary across the global ocean as a function of the environment. Here, we quantify such spatial and seasonal variations based on extensive empirical data and present the first global biogeography of key traits (body size, feeding mode, relative offspring size and myelination) for pelagic copepods, the major group of marine zooplankton. We identify strong patterns with latitude, season and between ocean basins that are partially (c. 50%) explained by key environmental drivers. Body size, for example decreases with temperature, confirming the temperature-
size rule, but surprisingly also with productivity, possibly driven by food-chain length and size-selective predation. Patterns unrelated to environmental predictors may originate from phylogenetic clustering. Our maps can be used as a test-bed for trait-based mechanistic models and to inspire next-generation biogeochemical models.

**General information**

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Organisations: National Institute of Aquatic Resources, Centre for Ocean Life  
Authors: Brun, P. G. (Intern), Payne, M. R. (Intern), Kjærboe, T. (Intern)  
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Web of Science (2015): Indexed yes  
BFI (2014): BFI-level 2  
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Web of Science (2014): Indexed yes  
BFI (2013): BFI-level 2  
Scopus rating (2013): SJR 7.933 SNIP 3.489 CiteScore 11.4  
ISI indexed (2013): ISI indexed yes  
Web of Science (2013): Indexed yes  
BFI (2012): BFI-level 2  
Scopus rating (2012): SJR 9.224 SNIP 3.613 CiteScore 11.25  
ISI indexed (2012): ISI indexed yes  
Web of Science (2012): Indexed yes  
BFI (2011): BFI-level 2  
Scopus rating (2011): SJR 9.279 SNIP 3.358 CiteScore 10.43  
ISI indexed (2011): ISI indexed yes  
Web of Science (2011): Indexed yes  
BFI (2010): BFI-level 2  
BFI (2009): BFI-level 2  
Scopus rating (2009): SJR 7.774 SNIP 3.257  
BFI (2008): BFI-level 2  
Scopus rating (2008): SJR 8 SNIP 3.155  
Web of Science (2008): Indexed yes  
Scopus rating (2007): SJR 7.859 SNIP 3.017  
Scopus rating (2006): SJR 6.092 SNIP 2.526  
Scopus rating (2005): SJR 4.386 SNIP 1.92  
Scopus rating (2004): SJR 3.683 SNIP 1.756  
Scopus rating (2003): SJR 3.673 SNIP 1.745  
Scopus rating (2002): SJR 2.701 SNIP 1.285  
Scopus rating (2001): SJR 1.794 SNIP 0.862
Oceans are exposed to anthropogenic climate change shifting marine systems toward potential instabilities. The physical, biological and social implications of such shifts can be assessed within individual scientific disciplines, but can only be fully understood by combining knowledge and expertise across disciplines. For climate change related problems these research directions have been well-established since the publication of the first IPCC report in 1990, however it is not well-documented to what extent these directions are reflected in published research. Focusing on the Nordic region, we evaluated the development of climate change related marine science by quantifying trends in number of publications, disciplinarity, and scientific focus of 1362 research articles published between 1990 and 2011. Our analysis showed a faster increase in publications within climate change related marine science than in general marine science indicating a growing prioritisation of research with a climate change focus. The composition of scientific disciplines producing climate change related publications, which initially was dominated by physical sciences, shifted toward a distribution with almost even representation of physical and biological sciences with social sciences constituting a minor constant proportion. These trends suggest that the predominantly model-based directions of the IPCC have favoured the more quantitatively oriented natural sciences rather than the qualitative traditions of social sciences. In addition, despite being an often declared prerequisite to successful climate science, we found surprisingly limited progress in implementing interdisciplinary research indicating that further initiatives nurturing scientific interactions are required.
Uncertainties in projecting climate-change impacts in marine ecosystems

Projections of the impacts of climate change on marine ecosystems are a key prerequisite for the planning of adaptation strategies, yet they are inevitably associated with uncertainty. Identifying, quantifying, and communicating this uncertainty is key to both evaluating the risk associated with a projection and building confidence in its robustness. We review how uncertainties in such projections are handled in marine science. We employ an approach developed in climate modelling by breaking uncertainty down into (i) structural (model) uncertainty, (ii) initialization and internal variability uncertainty, (iii) parametric uncertainty, and (iv) scenario uncertainty. For each uncertainty type, we then examine the current state-of-the-art in assessing and quantifying its relative importance. We consider whether the marine scientific community has addressed these types of uncertainty sufficiently and highlight the opportunities and challenges associated with doing a better job. We find that even within a relatively small field such as marine science, there are substantial differences between subdisciplines in the degree of attention given to each type of uncertainty. We find that initialization uncertainty is rarely treated explicitly and reducing this type of uncertainty may deliver gains on the seasonal-to-decadal time-scale. We conclude that all parts of marine science could benefit from a greater exchange of ideas, particularly
concerning such a universal problem such as the treatment of uncertainty. Finally, marine science should strive to reach
the point where scenario
uncertainty is the dominant uncertainty in our projections

**General information**

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Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Section for Marine Ecology and
Oceanography, Plymouth Marine Laboratory, University of British Columbia, North Pacific Marine Science Organization,
IFREMER, Dalhousie University, National Oceanographic and Atmospheric Administration, Dragonfly Data Science,
University of Washington, Universidade de Lisboa

Authors: Payne, M. (Intern), Barange, M. (Ekstern), Cheung, W. W. L. (Ekstern), MacKenzie, B. (Intern), Batchelder, H. P.
(Ekstern), Cormon, X. (Ekstern), Eddy, T. D. (Ekstern), Fernandes, J. A. (Ekstern), Hollowed, A. B. (Ekstern), Jones, M. C.
(Ekstern), Link, J. S. (Ekstern), Neubauer, P. (Ekstern), Ortiz, I. (Ekstern), Queirós, A. M. (Ekstern), Paula, J. R. (Ekstern)

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Web of Science (2016): Indexed yes

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Web of Science (2015): Indexed yes

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ISI indexed (2012): ISI indexed yes

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Web of Science (2011): Indexed yes

BFI (2010): BFI-level 1

Web of Science (2010): Indexed yes

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Using marine reserves to manage impact of bottom trawl fisheries requires consideration of benthic food-web interactions

Marine protected areas (MPAs) are widely used to protect exploited fish species as well as to conserve marine habitats and their biodiversity. They have become a popular management tool also for bottom trawl fisheries, a common fishing technique on continental shelves worldwide. The effects of bottom trawling go far beyond the impact on target species, as trawls also affect other components of the benthic ecosystem and the seabed itself. This means that for bottom trawl fisheries, MPAs can potentially be used not only to conserve target species but also to reduce impact of these side-effects of the fishery. However, predicting the protective effects of MPAs is complicated because the side-effects of trawling potentially alter the food-web interactions between target and non-target species. These changes in predatory and competitive interactions among fish and benthic invertebrates may have important ramifications for MPAs as tools to manage or mitigate the effects of bottom trawling. Yet, in current theory regarding the functioning of MPAs in relation to bottom trawl fisheries, such predatory and competitive interactions between species are generally not taken into account. In this paper, we discuss how food-web interactions that are potentially affected by bottom trawling may alter the effectiveness of MPAs to protect (i) biodiversity and marine habitats, (ii) fish populations, (iii) fisheries yield and (iv) trophic structure of the community. We make the case that in order to be applicable for bottom trawl fisheries, guidelines for the implementation of MPAs must consider their potential food-web effects, at the risk of failing management.
Adult and offspring size in the ocean over 17 orders of magnitude follows two life history strategies

Explaining variability in offspring vs. adult size among groups is a necessary step to determine the evolutionary and environmental constraints shaping variability in life history strategies. This is of particular interest for life in the ocean where a diversity of offspring development strategies is observed along with variability in physical and biological forcing factors in space and time. We compiled adult and offspring size for 407 pelagic marine species covering more than 17 orders of magnitude in body mass including Cephalopoda, Cnidaria, Crustaceans, Ctenophora, Elasmobranchii, Mammalia, Sagittoidea, and Teleost. We find marine life following one of two distinct strategies, with offspring size being either proportional to adult size (e.g., Crustaceans, Elasmobranchii, and Mammalia) or invariant with adult size (e.g., Cephalopoda, Cnidaria, Sagittoidea, Teleosts, and possibly Ctenophora). We discuss where these two strategies occur and how these patterns (along with the relative size of the offspring) may be shaped by physical and biological constraints in the organism’s environment. This adaptive environment along with the evolutionary history of the different groups shape...
observed life history strategies and possible group-specific responses to changing environmental conditions (e.g.,
production and distribution).

**General information**
State: Published
Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography, Centre for Ocean
Life, Section for Ocean Ecology and Climate, Section for Ecosystem based Marine Management
Authors: Neuheimer, A. (Intern), Hartvig, M. (Intern), Heuschele, J. (Intern), Hylander, S. (Intern), Kiørboe, T. (Intern),
Olsson, K. H. (Intern), Sainmont, J. (Intern), Andersen, K. H. (Intern)
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Web of Science (2016): Indexed yes
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Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 3.694 SNIP 1.987 CiteScore 5.09
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
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ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 4.041 SNIP 2.107 CiteScore 5.38
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 4.242 SNIP 1.934 CiteScore 5.03
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 4.001 SNIP 2.048
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 3.766 SNIP 1.942
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 4.274 SNIP 2.109
Web of Science (2008): Indexed yes
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Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 4.388 SNIP 2.256
Scopus rating (2005): SJR 3.662 SNIP 2.207
Scopus rating (2004): SJR 3.799 SNIP 2.34
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 3.398 SNIP 2.229
Advective loss of overwintering Calanus finmarchicus from the Faroe-Shetland Channel

The flow of deep water from the Norwegian Sea to the North Atlantic via the Faroe-Shetland Channel is one of the critical bottlenecks in the meridional overturn circulation. It is also a flow that potentially carries with it a large number of the overwintering copepod, Calanus finmarchicus, a regionally important secondary producer. Using a high resolution hydrodynamic model, MIKE 3 FM, we simulate the overflow of deep water and estimate the associated loss rate of C. finmarchicus as a function of the water depth strata within which they reside. We estimate a net advective loss from the Norwegian Sea population of 80 +/- 10 kt carbon bound in lipids of C finmarchicus biomass per year, a number that constitutes about 50% of the total overwintering population. Estimates of water mass characteristics and particle tracking suggest that the fate of individuals transported in the overflowing water is to be entrained into warmer waters of the North Atlantic Basin, a habitat that appears to be unsuitable for successful overwintering. (C) 2015 Elsevier Ltd. All rights reserved.

General information
State: Published
Organisations: Centre for Ocean Life, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
Authors: Rullyanto, A. (Intern), Jonasdottir, S. H. (Intern), Visser, A. W. (Intern)
Pages: 76-82
Publication date: 2015
Main Research Area: Technical/natural sciences

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Scopus rating (2016): CiteScore 2.76 SJR 1.45 SNIP 1.119
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.369 SNIP 1.174 CiteScore 2.77
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.557 SNIP 1.279 CiteScore 2.67
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 2.077 SNIP 1.314 CiteScore 3.11
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 2.024 SNIP 1.165 CiteScore 2.81
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
A marine eutrophication impacts assessment method in LCIA coupling coastal ecosystems exposure to nitrogen and species sensitivity to hypoxia

Characterisation modelling in Life Cycle Impact Assessment (LCIA) aims at quantifying potential impacts of anthropogenic emissions. It delivers substance-specific Characterisation Factors (CF) expressing ecosystem responses to marginal increments in emitted quantities. Nitrogen (N) emissions from e.g. agriculture and industry enrich coastal marine ecosystems. Excessive algal growth and dissolved oxygen (DO) depletion typify the resulting marine eutrophication. LCIA modelling frameworks typically encompass fate, exposure and effect in the environment. The present novel method couples relevant marine biological processes of ecosystem’s N exposure (Exposure Factor, XF) with the sensitivity of select species to hypoxia (Effect Factor, EF). The XF converts N-inputs into a sinking carbon flux from planktonic primary production and DO consumed by bacterial respiration in bottom waters, whereas EF builds on probabilistic Species Sensitivity Distribution (SSD) methodologies to quantify potential species losses from hypoxia. Results show 2 orders of magnitude global spatial differentiation on a Large Marine Ecosystems (LME) spatial resolution. Adding an N-fate model completes CFs for anthropogenic N-forms, thus producing comparative environmental sustainability indicators of human activities as applied in Life Cycle Assessment (LCA) of product systems.

General information
State: Published
Organisations: Department of Management Engineering, Quantitative Sustainability Assessment, National Institute of Aquatic Resources, Centre for Ocean Life
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Publication date: 2015
Event: Abstract from ASLO Aquatic Sciences Meeting 2015, Granada, Spain.
Main Research Area: Technical/natural sciences

Bibliographical note
Oral presentation

Relations
An effective algorithm for approximating adaptive behavior in seasonal environments

Behavior affects most aspects of ecological processes and rates, and yet modeling frameworks which efficiently predict and incorporate behavioral responses into ecosystem models remain elusive. Behavioral algorithms based on life-time optimization, adaptive dynamics or game theory are unsuited for large global models because of their high computational demand. We compare an easily integrated, computationally efficient behavioral algorithm known as Gilliam’s rule against the solution from a life-history optimization. The approximation takes into account only the current conditions to optimize behavior; the so-called "myopic approximation", "short sighted", or "static optimization". We explore the performance of the myopic approximation with diel vertical migration (DVM) as an example of a daily routine, a behavior with seasonal dependence that trades off predation risk with foraging opportunities in aquatic environments. The myopic approximation proves to be a robust replacement for the life-history optimization, deviating only up to 25% in regions of strong seasonality. The myopic approximation has additional advantages in that it can readily accommodate density dependence and inter-annual variations, aspects that can only be accessed in dynamic programming approaches with escalating computational costs. Furthermore, the explanatory power of the myopic approximation is notably higher than when behavior is not implemented, highlighting the importance for adaptive DVM behavior in ecological models where techniques such as dynamic programming are simply too computational demanding to be implemented.
A new compact, cost-efficient concept for underwater range-gated imaging: the UTOFIA project

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography, Centre for Ocean Life, AZTI-Tecnalia
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Number of pages: 1
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Bibliographical note
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Publication: Research › Poster – Annual report year: 2015

An Indicator for ecosystem externalities in fishing
Ecosystem externalities arise when one use of an ecosystem affects its other uses through the production functions of the ecosystem. We use simulations from a size-spectrum ecosystem model to investigate the ecosystem externally created by fishing of multiple species. The model is based upon general ecological principles and is calibrated to the North Sea. Two fleets are considered: a “forage fish” fleet targeting species that mature at small sizes and a “large fish” fleet targeting large piscivorous species.
Based on the marginal analysis of the present value of the rent, we develop a benefit indicator that explicitly divides the consequences of fishing into internal and external benefits. This analysis demonstrates that the forage fish fleet has a notable economic impact on the large fish fleet, but the reverse is not true. The impact can be either negative or positive, which entails that for optimal economic exploitation, the forage fishery has to be adjusted according to the large fish fishery. With the present large fish fishery in the North Sea, the two fisheries are well adjusted; however, the present combined exploration level is too high to achieve optimal economic rents.
Assessing stock status instead of fishing mortality reduces the need for information on growth
Behavior-dependent senescence in pelagic copepods

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Section for Marine Living Resources
Authors: Kiørboe, T. (Intern), Ceballos, S. (Intern), Thygesen, U. H. (Intern)
Pages: 651-653
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Main Research Area: Technical/natural sciences

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Behaviour-dependent predation risk in marine planktonic copepods

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: van Someren Gréve, H. (Intern), Almeda, R. (Intern), Kiørboe, T. (Intern)
Publication date: 2015
Event: Abstract from ASLO Aquatic Sciences Meeting 2015, Granada, Spain.
Main Research Area: Technical/natural sciences
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Beyond ocean connectivity: embracing advances on early life stages and adult connectivity to assessment and management challenges

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Marine Living Resources, Centre for Ocean Life
Authors: Deurs, M. V. (Intern), Lindegren, M. (Intern), Persson, A. (Ekstern), Jacobsen, C. (Ekstern), Nilsson, A. (Ekstern)
Publication date: 2015
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Biogeographic changes in fish diversity driven by changes in climate and exploitation

General information
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Can we understand and predict the distributional shifts of pelagic fish?

General information
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Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Payne, M. (Intern)
Number of pages: 1
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Carbon content of Mnemiopsis leidyi eggs and specific egg production rates in northern Europe

General information
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Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Marine Biological Laboratory
Authors: Jaspers, C. (Intern), Costello, J. H. (Ekstern), Colin, S. P. (Ekstern)
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Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.095 SNIP 1.255 CiteScore 2.24
Web of Science (2014): Indexed yes
Climate and fishing steer ecosystem regeneration to uncertain economic futures

Overfishing of large predatory fish populations has resulted in lasting restructurings of entire marine food webs worldwide, with serious socio-economic consequences. Fortunately, some degraded ecosystems show signs of recovery. A key challenge for ecosystem management is to anticipate the degree to which recovery is possible. By applying a statistical food-web model, using the Baltic Sea as a case study, we show that under current temperature and salinity conditions, complete recovery of this heavily altered ecosystem will be impossible. Instead, the ecosystem regenerates towards a new ecological baseline. This new baseline is characterized by lower and more variable biomass of cod, the commercially most important fish stock in the Baltic Sea, even under very low exploitation pressure. Furthermore, a socio-economic assessment shows that this signal is amplified at the level of societal costs, owing to increased uncertainty in biomass and reduced consumer surplus. Specifically, the combined economic losses amount to approximately 120 million € per year, which equals half of today's maximum economic yield for the Baltic cod fishery. Our analyses suggest that shifts in ecological and economic baselines can lead to higher economic uncertainty and costs for exploited ecosystems, in particular, under climate change.
Concentrations of sunscreens and antioxidant pigments in Arctic Calanus spp. in relation to ice cover, ultraviolet radiation, and the phytoplankton spring bloom: MAAs and astaxanthin in copepods

Arctic zooplankton ascend to shallow depths during spring to graze on the yearly occurring phytoplankton bloom. However, in surface waters they are exposed to detrimental ultraviolet radiation (UVR) levels. Here, we quantified concentrations of substances known to have UVR-protective functions, namely mycosporine-like amino acids (MAAs) and the carotenoid astaxanthin, from March to May in Calanus finmarchicus, Calanus glacialis and Calanus hyperboreus. Ice cover was 100% in the beginning of March, started to break up during April and was gone by the end of May. UVR-exposure in the water column was tightly linked to the ice conditions and water UVR-transparency was up to 6 m (depth where 1% radiation remains). Concentrations of MAAs in C. finmarchicus and C. glacialis increased sharply during ice break-up and peaked concurrently with maximum chlorophyll a (Chl a) levels. MAA-concentrations in C. hyperboreus increased later in accordance with its later arrival to the surface. The concentration of astaxanthin increased in all three species over time but there was no synchrony with ice conditions or the phytoplankton bloom. Even though only the upper 6 m of the water column was affected by UV-radiation, MAAs in the copepods were tightly correlated to the UV-threat. Hence, changes in ice cover are projected to have a large impact on the UVR-exposure of zooplankton emphasizing the importance of the timing of zooplankton ascent from deep waters in relation to the phytoplankton bloom and the ice break-up.
Connecting the seas of Norden: Commentary

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography, Centre for Ocean Life, Bergen Marine Research Cluster, Stockholm University, Åbo Academy University, Lund University, University of Oslo, University of Bergen, University of Helsinki, University of Akureyri
Controlling factors in fish early life history and how they combine to influence trophic links across the North Atlantic Ocean.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Section for Marine Ecology and Oceanography, University of Hawaii
Authors: Neuheimer, A. (Intern), Payne, M. (Intern), MacKenzie, B. (Intern)
Number of pages: 1
Publication date: 2015
Event: Abstract from ICES Annual Science Conference 2015, Copenhagen, Denmark.
Main Research Area: Technical/natural sciences
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Publication: Research › Conference abstract for conference – Annual report year: 2015

Ecological niches of open ocean phytoplankton taxa
We characterize the realized ecological niches of 133 phytoplankton taxa in the open ocean based on observations from the MAREDAT initiative and a statistical species distribution model (MaxEnt). The models find that the physical conditions (mixed layer depth, temperature, light) govern large-scale patterns in phytoplankton biogeography over nutrient
availability. Strongest differences in the realized niche centers were found between diatoms and coccolithophores. Diatoms (87 species) occur in habitats with significantly lower temperatures, light intensity and salinity, with deeper mixed layers, and with higher nitrate and silicate concentrations than coccolithophores (40 species). However, we could not statistically separate the realized niches of coccolithophores from those of diazotrophs (two genera) and picophytoplankton (two genera). Phaeocystis (two species) niches only clearly differed from diatom niches for temperature. While the realized niches of diatoms cover the majority of niche space, the niches of picophytoplankton and coccolithophores spread across an intermediate fraction and diazotroph and colonial Phaeocystis niches only occur within a relatively confined range of environmental conditions in the open ocean. Our estimates of the realized niches roughly match the predictions of Reynolds' C-S-R model for the global ocean, namely that taxa classified as nutrient stress tolerant have niches at lower nutrient and higher irradiance conditions than light stress tolerant taxa. Yet, there is considerable within-class variability in niche centers, and many taxa occupy broad niches, suggesting that more complex approaches may be necessary to capture all aspects of phytoplankton ecology.
Environmental context and trophic trait plasticity in a key species, the tellinid clam Macoma balthica L.

Species show varying levels of plasticity regarding morphology, physiology and behaviour in relation to their immediate environment, and several trait characteristics are habitat-dependent. Determining when and how the environmental context changes trait expression is of key importance for understanding the role of individual species for ecosystem functioning. The tellinid clam Macoma balthica can vary its feeding behaviour, shifting between deposit- and suspension-feeding. In order to study the context-dependency of this trophic plasticity in adult clams, we conducted an experiment assessing food uptake by using stable isotope signatures (delta C-13 and delta N-15). We transplanted individuals between and within two shallow bays differing in exposure (exposed sheltered) and sediment characteristics. Our results show that isotope signatures of clams differed between the two habitats and that clams in the exposed site showed stable isotope values linked to a diet of suspended particulate organic material, while values of individuals in the sheltered site corresponded to an uptake of sediment-bound organic material. Clams transplanted between these two environmental settings were gradually showing differing isotopic signatures from clams at their original habitat, over time mirroring the changes in clams in the site to which they were transferred. The shift in carbon and nitrogen stable isotopes of the clams provides insights into the context-dependent intraspecific feeding plasticity of this zoobenthic key species. The causes for this shift were coupled to contrasts in the hydrodynamic and biotic setting, implying that feeding plasticity may explain adaptation of organisms to changes in their surroundings. (C) 2015 Elsevier B.V. All rights reserved.
Environmental determinates of blue whiting (Micromesistius poutassou) spawning distribution

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Ecosystem based Marine Management, Centre for Ocean Life, Section for Marine Ecology and Oceanography
Authors: Miesner, A. K. (Intern), Payne, M. (Intern)
Publication date: 2015
Event: Abstract from ICES Annual Science Conference 2015, Copenhagen, Denmark.
Main Research Area: Technical/natural sciences

Bibliographical note
ICES C.M. 2015/
Publication: Research › Conference abstract for conference – Annual report year: 2016

Environmental effects on sprat (Sprattus sprattus) physiology and growth at the distribution frontier: A bioenergetic modelling approach

Sprat, Sprattus sprattus, is a small pelagic fish species with a wide distribution along the European continental shelf, the Mediterranean Sea, the Black Sea and the Baltic Sea. The Baltic Sea is the coldest area of the species distribution range. Even here, sprat is still numerous and holds a key role in the ecosystem. However, the population is sensitive to small changes in environmental conditions. In this paper, we set up a bioenergetic model of Baltic sprat and evaluate how variability and seasonal changes in the physical environment affects the physiology and growth of individual sprat. The model is dynamic and seasonally resolved. It is parameterised based on sprat from the Bornholm Basin. Our model results suggest that the optimal temperature for sprat growth is 17.5 °C, which is only observed in the Central Baltic Sea in the top water layer during a short period in summer. During 41/2 winter months individual sprat do not grow and utilize stored energy from the previous growth season. We analysed the maximum attainable individual body size as a function of temperature. The model predicted reduced maximum body sizes with increasing temperature. The model can be used for studying climate change scenarios on individual growth, egg production and condition of Baltic sprat.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, University of Hamburg, Danish Meteorological Institute, Johann Heinrich von Thünen-Institute
Authors: Frisk, C. (Intern), Andersen, K. H. (Intern), Temming, A. (Ekstern), Herrmann, J. (Ekstern), Madsen, K. S. (Ekstern), Kraus, G. (Ekstern)
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Scopus rating (2016): CiteScore 2.43 SJR 0.941 SNIP 1.089
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.087 SNIP 1.112 CiteScore 2.43
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BFI (2014): BFI-level 2
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Web of Science (2014): Indexed yes
Environmental filtering drives functional diversity of fish assemblages in a temperate system.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Pécuchet, L. (Intern), Törnroos, A. (Intern), Lindegren, M. (Intern)
Publication date: 2015
Event: Abstract from ICES Annual Science Conference 2015, Copenhagen, Denmark.
Main Research Area: Technical/natural sciences
Publication: Research - peer-review › Journal article – Annual report year: 2015

Environmental filtering drives functional diversity of fish assemblages in a temperate system.
Equal temperature-size responses of the sexes are widespread within arthropod species

Sexual size dimorphism (SSD) is often affected by environmental conditions, but the effect of temperature on SSD in ectotherms still requires rigorous investigation. We compared the plastic responses of size-at-maturity to temperature between males and females within 85 diverse arthropod species, in which individuals of both sexes were reared through ontogeny under identical conditions with excess food. We find that the sexes show similar relative (proportional) temperature-body size (T-S) responses on average. The high degree of similarity occurs despite an analysis that includes a wide range of animal body sizes, variation in degree of SSD and differences in the sign of the T-S response. We find no support for Rensch's rule, which predicts greater variation in male size, or indeed the reverse, greater female size variation. SSD shows no systematic temperature dependence in any of the 17 arthropod orders examined, five of which (Diptera, Orthoptera, Lepidoptera, Coleoptera and Calanoida) include more than six thermal responses. We suggest that the same proportional T-S response may generally have equivalent fitness costs and benefits in both sexes. This contrasts with effects of juvenile density, and food quantity/quality, which commonly result in greater size plasticity in females, suggesting these variables have different adaptive effects on SSD.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Pécuchet, L. (Intern), Törnroos, A. (Intern), Lindegren, M. (Intern)
Publication date: 2015
Event: Abstract from International Symposium on "Effects of Climate Change on the World's Oceans", Santos, Brazil.
Main Research Area: Technical/natural sciences
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General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, University of Liverpool, Queen Mary University of London
Authors: Hirst, A. G. (Intern), Horne, C. (Ekstern), Atkinson, D. (Ekstern)
Publication date: 2015
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Web of Science (2018): Indexed yes
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Web of Science (2017): Indexed yes
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Scopus rating (2016): CiteScore 3.89 SJR 2.541 SNIP 1.474
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.948 SNIP 1.535 CiteScore 4.08
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.916 SNIP 1.673 CiteScore 4.18
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 3.091 SNIP 1.762 CiteScore 5.08
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.947 SNIP 1.881 CiteScore 4.99
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 3.234 SNIP 1.789 CiteScore 5.02
Feeding currents facilitate a mixotrophic way of life

Mixotrophy is common, if not dominant, among eukaryotic flagellates, and these organisms have to both acquire inorganic nutrients and capture particulate food. Diffusion limitation favors small cell size for nutrient acquisition, whereas large cell size facilitates prey interception because of viscosity, and hence intermediately sized mixotrophic dinoflagellates are simultaneously constrained by diffusion and viscosity. Advection may help relax both constraints. We use high-speed video microscopy to describe prey interception and capture, and micro particle image velocimetry (micro-PIV) to quantify the flow fields produced by free-swimming dinoflagellates. We provide the first complete flow fields of free-swimming interception feeders, and demonstrate the use of feeding currents. These are directed toward the prey capture area, the position varying between the seven dinoflagellate species studied, and we argue that this efficiently allows the grazer to approach small-sized prey despite viscosity. Measured flow fields predict the magnitude of observed clearance rates. The fluid deformation created by swimming dinoflagellates may be detected by evasive prey, but the magnitude of flow deformation in the feeding current varies widely between species and depends on the position of the transverse flagellum. We also use the near-cell flow fields to calculate nutrient transport to swimming cells and find that feeding currents may enhance nutrient uptake by ≈75% compared with that by diffusion alone. We argue that all phagotrophic microorganisms must have developed adaptations to counter viscosity in order to allow prey interception, and conclude that the flow fields created by the beating flagella in dinoflagellates are key to the success of these mixotrophic organisms

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Nielsen, L. T. (Intern), Kiørboe, T. (Intern)
Pages: 2117-2127
Publication date: 2015
Main Research Area: Technical/natural sciences
Fisheries-induced neutral and adaptive evolution in exploited fish populations and consequences for their adaptive potential

Fishing may induce neutral and adaptive evolution affecting life-history traits, and molecular evidence has shown that neutral genetic diversity has declined in some exploited populations. Here, we theoretically study the interplay between neutral and adaptive evolution caused by fishing. An individual-based eco-genetic model is devised that includes neutral and functional loci in a realistic ecological setting. In line with theoretical expectations, we find that fishing induces evolution towards slow growth, early maturation at small size and higher reproductive investment. We show, first, that the choice of genetic model (based on either quantitative genetics or gametic inheritance) influences the evolutionary recovery of traits after fishing ceases. Second, we analyse the influence of three factors possibly involved in the lack of evolutionary recovery: the strength of selection, the effect of genetic drift and the loss of adaptive potential. We find that evolutionary recovery is hampered by an association of weak selection differentials with reduced additive genetic variances. Third, the contribution of fisheries-induced selection to the erosion of functional genetic diversity clearly dominates that of genetic drift only for the traits related to maturation. Together, our results highlight the importance of taking into account population genetic variability in predictions of eco-evolutionary dynamics.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, IFREMER, International Institute for Applied Systems Analysis
Authors: Marty, L. (Intern), Dieckmann, U. (Ekstern), Ernande, B. (Ekstern)
Pages: 47-63
Publication date: 2015
Main Research Area: Technical/natural sciences

Publication information
Journal: Evolutionary Applications
Volume: 8
Issue number: 1
ISSN (Print): 1752-4563
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 4.96 SJR 2.299 SNIP 1.478
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 2.666 SNIP 1.392 CiteScore 4.27
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 2.356 SNIP 1.402 CiteScore 4.23
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 2.478 SNIP 1.432 CiteScore 4.48
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
Four types of interference competition and their impacts on the ecology and evolution of size-structured populations and communities

We investigate how four types of interference competition - which alternatively affect foraging, metabolism, survival, and reproduction - impact the ecology and evolution of size-structured populations. Even though all four types of interference competition reduce population biomass, interference competition at intermediate intensity sometimes significantly increases the abundance of adult individuals and the population's reproduction rate. We find that foraging and metabolic interference evolutionarily favor smaller maturation size when interference is weak and larger maturation size when interference is strong. The evolutionary response to survival interference and reproductive interference is always larger maturation size. We also investigate how the four types of interference competition impact the evolutionary dynamics and resultant diversity and trophic structure of size-structured communities. Like other types of trait-mediated competition, all four types of interference competition can induce disruptive selection and thus promote initial diversification. Even though foraging interference and reproductive interference are more potent in promoting initial diversification, they catalyze the formation of diverse communities with complex trophic structure only at high levels of interference intensity. By contrast, survival interference does so already at intermediate levels, while reproductive interference can only support relatively smaller communities with simpler trophic structure. Taken together, our results show how the type and intensity of interference competition jointly affect coexistence patterns in structured population models.

General information
State: Published
Organisations: Department of Applied Mathematics and Computer Science, National Institute of Aquatic Resources, Centre for Ocean Life, Umeå University, International Institute for Applied Systems Analysis
Authors: Zhang, L. (Intern), Andersen, K. H. (Intern), Dieckmann, U. (Ekstern), Brännström, Å. K. (Ekstern)
Pages: 280-290
Publication date: 2015
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Theoretical Biology
Volume: 380
ISSN (Print): 0022-5193
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.918 SNIP 0.932 CiteScore 2.16
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.084 SNIP 1.017 CiteScore 2.21
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.07 SNIP 1.048 CiteScore 2.25
Web of Science (2014): Indexed yes
How does Calanus helgolandicus maintain its population in a variable environment? Analysis of a 25-year time series from the English Channel

Calanus helgolandicus is a key copepod of the NE Atlantic and fringing shelves, with a distribution that is expanding northwards with oceanic warming. The Plymouth L4 site has warmed over the past 25-years, and experiences large variations in the timing and availability of food for C. helgolandicus. Here we examine the degree to which these changes translate into variation in reproductive output and subsequently C. helgolandicus population size. Egg production rates (eggs female-1 day-1) were maximal in the spring to early-summer period of diatom blooms and high ciliate abundance, rather than during the equally large autumn blooms of autotrophic dinoflagellates. Egg hatch success was lower in spring however, with a greater proportion of naupliar deformities then also. Both the timing and the mean summer abundance of C. helgolandicus (CI-CVI) reflected those of spring total reproductive output. However this relationship was driven by inter-annual variability in female abundance and not that of egg production per female, which ranged only two-fold. Winter abundance of C. helgolandicus at L4 was much more variable than abundance in other seasons, and reflected conditions from the previous growing season. However, these low winter abundances had no clear carry-over signal to the following season's population size. Overall, the C. helgolandicus population appears to be surprisingly resilient at this dynamic, inshore site, showing no long-term phenology shift and only a four-fold variation in mean abundance between years. This dampening effect may reflect a series of mortality sources, associated with the timing of stratification in the early part of the season, likely affecting egg sinking and loss, plus intense, density-dependent mortality of early stages in mid-summer likely through predation
Impacts of the local environment on recruitment – a comparative study of North Sea and Baltic Sea fish stocks

While the impact of environmental forcing on recruitment variability in marine populations remains largely elusive, studies spanning large spatial areas and many stocks are able to identify patterns common to different regions and species. In this study, we investigate the effects of the environment on the residuals of a Ricker stock-recruitment (SR) model, used as a proxy of prerecruits' survival, of 18 assessed stocks in the Baltic and North Seas. A probabilistic principal components (PCs) analysis permits the identification of groups of stocks with shared variability in the prerecruits' survival, most notably a group of pelagics in the Baltic Sea and a group composed of gadoids and herring in the North Sea. The first two PCs generally grouped the stocks according to their localizations: the North Sea, the Kattegat-Western Baltic, and the Baltic Sea. This suggests the importance of the local environmental variability on the recruitment strength. Hence, the prerecruits' survival variability is studied according to geographically disaggregated and potentially impacting abiotic or biotic variables. Time series (1990-2009) of nine environmental variables consistent with the spawning locations and season for each stock were extracted from a physical-biogeochemical model to evaluate their ability to explain the survival of prerecruits. Environmental variables explained >70% of the survival variability for eight stocks. The variables water current, salinity, temperature, and biomass of other fish stocks are regularly significant in the models. This study shows the importance of the local environment on the dynamics of SR. The results provide evidence of the necessity of including environmental variables in stock assessment for a realistic and efficient management of fisheries.
Improving the reliability of fishery predictions under climate change

The increasing number of publications assessing impacts of climate change on marine ecosystems and fisheries attests to rising scientific and public interest. A selection of recent papers, dealing more with biological than social and economic aspects, is reviewed here, with particular attention to the reliability of projections of climate impacts on future fishery yields. The 2014 Intergovernmental Panel on Climate Change (IPCC) report expresses high confidence in projections that mid- and high-latitude fish catch potential will increase by 2050 and medium confidence that low-latitude catch potential will decline. These levels of confidence seem unwarranted, since many processes are either absent from or poorly represented in the models used, data are sparse and, unlike terrestrial crop projections, there are no controlled experiments. This review discusses methodological issues that affect our understanding of climate impacts, such as how to improve coupled models from physics to fish and how to strengthen confidence in analysis of time series.
Ingestion of dispersed crude oil by zooplankton

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Almeda, R. (Intern), Connelly, T. L. (Ekstern), Hyatt, C. (Ekstern), Villarreal, T. (Ekstern), Buskey, E. (Ekstern)
Publication date: 2015
Event: Abstract from ASLO Aquatic Sciences Meeting 2015, Granada, Spain.
Main Research Area: Technical/natural sciences
Publication: Research › Conference abstract for conference – Annual report year: 2016

Interrelations between senescence, life-history traits, and behavior in planktonic copepods

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Department of Applied Mathematics and Computer Science, Section for Marine Living Resources, Spanish Institute of Oceanography
Authors: Kiørboe, T. (Intern), Ceballos, S. (Intern), Thygesen, U. H. (Intern)
Pages: 2225-2235
Publication date: 2015
Main Research Area: Technical/natural sciences
Publication: Journal article – Annual report year: 2015
Limits to the reliability of size-based fishing status estimation for data-poor stocks

For stocks which are considered “data-poor” no knowledge exist about growth, mortality or recruitment. The only available information is from catches. Here we examine the ability to assess the level of exploitation of a data-poor stock based only on information of the size of individuals in catches. The model is a formulation of the classic Beverton–Holt theory in terms of size where stock parameters describing growth, natural mortality, recruitment, etc. are determined from life-history invariants. A simulation study was used to compare the reliability of assessments performed under different information availability scenarios, from data-limited, where none of the parameters are known beforehand, to different degrees of information availability cases where one or more parameters are known. If no parameters are known it is possible to correctly assess whether the fishing mortality is below Fmsy in more than 60% of the cases, and almost always correctly assess whether a stock is subject to overfishing. Adding information about age, i.e., assuming that growth rate and asymptotic size are known, does not improve the estimation. Only knowledge of the ratio between mortality and growth led to a considerable improvement in the assessment. Overall, the simulation study demonstrates that it may be possible to classify a data-poor stock as undergoing over- or under-fishing, while the exact status, i.e., how much the fishing mortality is above or below Fmsy, can only be assessed with a substantial uncertainty. Limitations of the approach are discussed.
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<td>SJR 0.611</td>
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<td>BFI-level 1</td>
<td>SJR 0.546</td>
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Original language: English
DOIs: 10.1016/j.fishres.2014.10.007
Long-term functional trends in Baltic Sea coastal macrofauna and fish

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Swedish University of Agricultural Sciences, Åbo Academy University, Hafok AB
Authors: Törnroos, A. (Intern), Olsson, J. (Ekstern), Gårdmark, A. (Ekstern), Pébuchet, L. (Intern), Blomqvist, M. (Ekstern), Lindegren, M. (Intern), Bonsdorff, E. (Ekstern)
Number of pages: 2
Publication date: 2015
Event: Abstract from ICES Annual Science Conference 2015, Copenhagen, Denmark.
Main Research Area: Technical/natural sciences
Electronic versions:
Publishers_version

Bibliographical note
ICES ASC 2015/Q:10
Source: PublicationPreSubmission
Source-ID: 119461435
Publication: Research › Conference abstract for conference – Annual report year: 2015

Making and using predictions of species distributions to improve survey design

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Payne, M. (Intern)
Publication date: 2015
Event: Abstract from ICES Annual Science Conference 2015, Copenhagen, Denmark.
Main Research Area: Technical/natural sciences
Electronic versions:
Publishers_version

Bibliographical note
ICES CM 2015/C:08
Publication: Research › Conference abstract for conference – Annual report year: 2015

Marine Microplastics - Method development for detection of plastic particles from sea water

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography, Centre for Ocean Life
Authors: Lenz, R. (Intern), Enders, K. (Intern)
Publication date: 2015
Event: Abstract from 18. Danske Havforskermøde, Copenhagen, Denmark.
Main Research Area: Technical/natural sciences
Publication: Research › Conference abstract for conference – Annual report year: 2015

Mating success and sexual selection in a pelagic copepod, Temora longicornis: Evidence from paternity analyses

Knowledge about mating patterns is essential for understanding and explaining rates of reproduction and genetic potential of copepods populations. The aim of this study was to examine (1) the occurrence of multiple paternity in Temora longicornis, (2) the effect of multiple paternity (if present) on the females reproductive output, and (3) whether mating is random or some individuals have a higher than average chance of fertilizing or being fertilized (super individuals). We show that multiple paternity is common in this copepod species, that females benefit from multiple matings by increased offspring production, and that a relatively small fraction of the males and females in a population account for most of the offspring production. In both males and females, mating is nonrandom. Superior individuals with a higher than average matings success were identified both among females and among males.

General information
State: Published
Maximum sustainable yield from fisheries: food production, resource rent and conservation

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, University of Southern Denmark
Authors: Andersen, K. H. (Intern), Brander, K. (Intern), Ravn-Jonsen, L. (Ekstern)
Number of pages: 1
Publication date: 2015

Host publication information
Title of host publication: Book of Abstracts. DTU's Sustain Conference 2015
Place of publication: Lyngby
Publisher: Technical University of Denmark (DTU)
Article number: F10
Main Research Area: Technical/natural sciences
Conference: DTU Sustain Conference 2015, Lyngby, Denmark, 17/12/2015 - 17/12/2015
Electronic versions:
F10_DTU_Sustain_2015.pdf
Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2015

Measuring evolutionary adaptation of phytoplankton with local field observations

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Brun, P. G. (Intern), Kiørboe, T. (Intern), Payne, M. (Intern)
Pages: E5223-E5224
Publication date: 2015
Main Research Area: Technical/natural sciences

Publication information
Journal: Proceedings of the National Academy of Sciences
Volume: 112
Issue number: 38
ISSN (Print): 0027-8424
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Modelled niche centres and niche breadths of open ocean phytoplankton taxa

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Section for Marine Ecology and Oceanography, ETH Zurich, Xiamen University
Publication date: 2015

Publication information
Original language: English
Main Research Area: Technical/natural sciences
DOIs: 10.1594/PANGAEA.858006
Links: https://doi.pangaea.de/10.1594/PANGAEA.858006
Publication: Research › Dataset – Annual report year: 2017

Modelling emergent trophic strategies in plankton
Plankton are typically divided into phytoplankton and zooplankton in marine ecosystem models. Yet, most protists in the photic zone engage in some degree of phagotrophy, and it has been suggested that trophic strategy is really a continuum between pure phototrophs (phytoplankton) and pure phagotrophs (unicellular zooplankton). Such a continuum of trophic strategies is well represented by trait-based modelling techniques. A key model ingredient is the size of individual cells, as size constrains affinities for nutrient uptake, photosynthesis and active encounter with other cells. We outline a general trait-based model of a unicellular planktonic organism where size is a central trait and where nutrient uptake, photosynthesis and phagotrophy are determined by investments into these functions and by the physical constraints imposed by organism size. This framework provides simple predictions of how trophic strategy correlates with size.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Section for Marine Ecology and Oceanography, University of Copenhagen, University of Bergen
Authors: Andersen, K. H. (Intern), Aksnes, D. L. (Ekstern), Berge, T. (Ekstern), Fiksen, Ø. (Ekstern), Visser, A. (Intern)
Pages: 862-868
Publication date: 2015
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Plankton Research
Volume: 37
Issue number: 5
ISSN (Print): 0142-7873
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
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Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Web of Science (2016): Indexed yes
Scopus rating (2016): CiteScore 1.92 SJR 1.098 SNIP 0.848
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2015): SJR 1.025 SNIP 0.796 CiteScore 1.77
Web of Science (2015): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2014): SJR 1.095 SNIP 1.255 CiteScore 2.24
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.289 SNIP 1.109 CiteScore 2.39
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
Modelling survival and connectivity of Mnemiopsis leidyi in the south-western North Sea and Scheldt estuaries

Three different models were applied to study the reproduction, survival and dispersal of Mnemiopsis leidyi in the Scheldt estuaries and the southern North Sea: a high-resolution particle tracking model with passive particles, a low-resolution particle tracking model with a reproduction model coupled to a biogeochemical model, and a dynamic energy budget (DEB) model. The results of the models, each with its strengths and weaknesses, suggest the following conceptual situation: (i) the estuaries possess enough retention capability to keep an overwintering population, and enough exchange with coastal waters of the North Sea to seed offshore populations; (ii) M. leidyi can survive in the North Sea, and be transported over considerable distances, thus facilitating connectivity between coastal embayments; (iii) under current climatic conditions, M. leidyi may not be able to reproduce in large numbers in coastal and offshore waters of the North Sea, but this may change with global warming; however, this result is subject to substantial uncertainty. Further quantitative observational work is needed on the effects of temperature, salinity and food availability on reproduction and on mortality at different life stages to improve models such as used here.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Cefas, Royal Netherlands Institute for Sea Research - NIOZ, Deltares
Authors: van der Molen, J. (Ekstern), van Beek, J. (Ekstern), Augustine, S. (Intern), Vansteenbrugge, L. (Ekstern), van Walraven, L. (Ekstern), Langenberg, V. (Ekstern), van der Veer, H. W. (Ekstern), Hostens, K. (Ekstern), Pitois, S.
Novel insight into the role of heterotrophic dinoflagellates in the fate of crude oil spills in the sea

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Almeda, R. (Intern), Connelly, T. L. (Ekstern), Buskey, E. (Ekstern)
Publication: 2015
Event: Abstract from Gulf of Mexico Oil Spill & Ecosystem Conference, Houston, United States.
Main Research Area: Technical/natural sciences
Publication: Research › Conference abstract for conference – Annual report year: 2016

Perceiving the algae: How feeding-current feeding copepods detect their nonmotile prey: Prey Detection in Copepods

Feeding-current feeding copepods detect and capture prey individually, but the mechanism by which nonmotile prey is detected has been unclear. Early reports that copepods detect phytoplankton prey at distances of one body length or more led to the hypothesis that solutes leaking from the prey would be carried to the copepod by the sheared feeding current and arrive prior to the prey, thus allowing the copepod to adjust the feeding current to bring the prey within reach of the feeding appendages. Many subsequent studies have been interpreted assuming this mechanism, which appears currently to be the main accepted view. Here, we review the observations available in the literature and add our own data to show that in most cases the prey, whether phytoplankton cells or inert particles, has to be within a few prey radii from the setae of the feeding appendages to elicit a capture response. We further demonstrate that (1) long-range chemical detection is incompatible with known algal leakage rates and reasonable assumptions of sensitivity, (2) that near-field chemical detection is constrained by diffusion across the boundary layer of the sensor and takes longer than observed near-contact times, and (3) that most reported detection distances are well predicted by models of fluid mechanical signal generation and detection. We conclude that near-field mechanoreception is the common prey detection mode in pelagic copepods. Prey detection distances are thus governed mainly by the reach of the feeding appendages, in contrast to the strong prey size-dependency implied by remote chemical prey detection.
Quiet swimming at low Reynolds number

The stresslet provides a simple model of the flow created by a small, freely swimming and neutrally buoyant aquatic organism and shows that the far field fluid disturbance created by such an organism in general decays as one over distance squared. Here we discuss a quieter swimming mode that eliminates the stresslet component of the flow and leads to a faster spatial decay of the fluid disturbance described by a force quadrupole that decays as one over distance cubed. Motivated by recent experimental results on fluid disturbances due to small aquatic organisms, we demonstrate that a three-Stokeslet model of a swimming organism which uses breast stroke type kinematics is an example of such a quiet swimmer. We show that the fluid disturbance in both the near field and the far field is significantly reduced by appropriately arranging the propulsion apparatus, and we find that the far field power laws are valid surprisingly close to the organism. Finally, we discuss point force models as a general framework for hypothesis generation and experimental exploration of fluid mediated predator-prey interactions in the planktonic world.
Quirky patterns in time-series of estimates of recruitment could be artefacts

The accessibility of databases of global or regional stock assessment outputs is leading to an increase in meta-analysis of the dynamics of fish stocks. In most of these analyses, each of the time-series is generally assumed to be directly comparable. However, the approach to stock assessment employed, and the associated modelling assumptions, can have an important influence on the characteristics of each time-series. We explore this idea by investigating recruitment time-series with three different recruitment parameterizations: a stock–recruitment model, a random-walk time-series model, and non-parametric “free” estimation of recruitment. We show that the recruitment time-series is sensitive to model assumptions and this can impact reference points in management, the perception of variability in recruitment and thus undermine meta-analyses. The assumption of the direct comparability of recruitment time-series in databases is therefore not consistent across or within species and stocks. Caution is therefore required as perhaps the characteristics of the time-series of stock dynamics may be determined by the model used to generate them, rather than underlying ecological phenomena. This is especially true when information about cohort abundance is noisy or lacking.
Reproduction rates under variable food conditions and starvation in Mnemiopsis leidyi: significance for the invasion success of a ctenophore

The ctenophore Mnemiopsis leidyi is characterized by high growth rates and a large reproductive capacity. However, reproductive dynamics are not yet well understood. Here, we present laboratory data on food-dependent egg production in M. leidyi and egg hatching time and success. Further, we report on the reproduction of laboratory-reared and field-caught animals during starvation. Our results show that the half-saturation zooplankton prey concentration for egg production is reached at food levels of 12–23 µgC L⁻¹, which is below the average summer food concentration encountered in invaded areas of northern Europe. Furthermore, starved animals continue to produce eggs for up to 12 days after cessation of feeding with high overall hatching success of 65–90%. These life history traits allow M. leidyi to thrive and reproduce in environments with varying food conditions and give it a competitive advantage under unfavourable conditions. This may explain why recurrent population blooms are observed and sustained in localized areas in invaded northern Europe, where water exchange is limited and zooplankton food resources are quickly depleted by M. leidyi. We suggest that these reproductive life history traits are key to its invasion success.

General information

State: Published
Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography, Danish Shellfish Centre, Centre for Ocean Life, University of Gothenburg
Authors: Jaspers, C. (Intern), Møller, L. F. (Intern), Kiørboe, T. (Intern)
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Main Research Area: Technical/natural sciences

Publication information

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Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.92 SJR 1.098 SNIP 0.848
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.025 SNIP 0.796 CiteScore 1.77
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.095 SNIP 1.255 CiteScore 2.24
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.289 SNIP 1.109 CiteScore 2.39
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.557 SNIP 1.101 CiteScore 2.43
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.158 SNIP 1.045 CiteScore 1.99
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.186 SNIP 0.98
Revealing the role of predator interference in a predator-prey system with disease in prey population

Predation on a species subjected to an infectious disease can affect both the infection level and the population dynamics. There is an ongoing debate about the act of managing disease in natural populations through predation. Recent theoretical and empirical evidence shows that predation on infected populations can have both positive and negative influences on disease in prey populations. Here, we present a predator-prey system where the prey population is subjected to an infectious disease to explore the impact of predator on disease dynamics. Specifically, we investigate how the interference among predators affects the dynamics and structure of the predator-prey community. We perform a detailed numerical bifurcation analysis and find an unusually large variety of complex dynamics, such as, bistability, torus and chaos, in the presence of predators. We show that, depending on the strength of interference among predators, predators enhance or control disease outbreaks and population persistence. Moreover, the presence of multistable regimes makes the system very sensitive to perturbations and facilitates a number of regime shifts. Since, the habitat structure and the choice of predators deeply influence the interference among predators, thus before applying predators to control disease in prey populations or applying predator control strategy for wildlife management, it is essential to carefully investigate how these predators interact with each other in that specific habitat; otherwise it may lead to ecological disaster.
RevFisk – et projekt som kvantificerer stenrevs betydning for fisk

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Ecosystem based Marine Management, Section for Freshwater Fisheries Ecology, Section for Marine Living Resources, Section for Marine Ecology and Oceanography, Centre for Ocean Life, Aarhus University, DHI Denmark
Publication date: 2015
Event: Poster session presented at 18. Danske Havforskermøde, Copenhagen, Denmark.
Main Research Area: Technical/natural sciences
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Review of environmental factors influencing distributions of selected Baltic species: Report: BIO-C3 Deliverable, D1.1 . EU Bonusproject BIO-C3

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Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Number of pages: 75
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Main Research Area: Technical/natural sciences
Electronic versions:
DOIs: 10.3289/BIO-C3_D1.1
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Publication: Research › Report – Annual report year: 2016

Role of crude oil ingestion by zooplankton in the fate of crude oil spills in the sea

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Almeda, R. (Intern), Connelly, T. L. (Ekstern), Buskey, E. (Ekstern)
Publication date: 2015
Main Research Area: Technical/natural sciences
Publication: Research › Conference abstract for conference – Annual report year: 2016

Similar effects of bottom trawling and natural disturbance on composition and function of benthic communities across habitats

Bottom trawl fishing has widespread impacts on benthic habitats and communities. The benthic response to trawling seems to be smaller or absent in areas exposed to high natural disturbance, leading to the hypothesis that natural and trawl disturbance affect benthic communities in a similar way. However, systematic tests of this hypothesis at large spatial scales and with data from sites spanning a large range of natural disturbance do not exist. Here, we examine the effects of trawl and natural (tidal-bed shear stress) disturbance on benthic communities over gradients of commercial bottom trawling effort in 8 areas in the North and Irish Seas. Using a trait-based approach, that classified species by life-history strategies or by characteristics that provide a proxy for their role in community function, we found support for the hypothesis that trawl and natural disturbance affect benthic communities in similar ways. Both sources of disturbance caused declines in long-living, hard-bodied (exoskeleton) and suspension-feeding organisms. Given these similar impacts, there was no detectable trawling effect on communities exposed to high natural disturbance. Conversely, in 3 out of 5 areas with low bed shear stress, responses to trawling were detected and resulted in community compositions comparable with those in areas subject to high natural disturbance, with communities being composed of either small-sized, deposit-feeding animals or mobile scavengers and predators. The findings highlight that knowledge of the interacting effects of
trawl and natural disturbance will help to identify areas that are more or less resilient to trawling and support the
development of management plans that account for the environmental effects of fishing.
Size structures sensory hierarchy in ocean life

Life in the ocean is shaped by the trade-off between a need to encounter other organisms for feeding or mating, and to avoid encounters with predators. Avoiding or achieving encounters necessitates an efficient means of collecting the maximum possible information from the surroundings through the use of remote sensing. In this study, we explore how sensing mode and range depend on body size. We reveal a hierarchy of sensing modes (chemosensing, mechanosensing, vision, hearing, and echolocation) where body size determines the available battery of sensing modes and where larger body size means a longer sensing range. The size-dependent hierarchy and the transitions between primary sensory modes are explained on the grounds of limiting factors set by physiology and the physical laws governing signal generation, transmission and reception. We characterize the governing mechanisms and theoretically predict the body size limits for various sensory modes, which align very well with size ranges found in literature. The treatise of all ocean life, from unicellular organisms to whales, demonstrates how body size determines available sensing modes, and thereby acts as a major structuring factor of aquatic life.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Department of Physics, Biophysics and Fluids, Centre for Ocean Life, Section for Marine Ecology and Oceanography
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Main Research Area: Technical/natural sciences

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Journal: Proceedings of the Royal Society B: Biological Sciences
Volume: 282
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BFI (2018): BFI-level 2
BFI (2017): BFI-level 2
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.89 SJR 2.541 SNIP 1.474
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.948 SNIP 1.535 CiteScore 4.08
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.916 SNIP 1.673 CiteScore 4.18
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 3.091 SNIP 1.762 CiteScore 5.08
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.947 SNIP 1.881 CiteScore 4.99
ISI indexed (2012): ISI indexed yes
The production of toxins by some species of phytoplankton is known to have several economic, ecological, and human health impacts. However, the role of toxins on the spatial distribution of phytoplankton is not well understood. In the present study, the spatial dynamics of a nutrient-phytoplankton system with toxic effect on phytoplankton is investigated. We analyze the linear stability of the system and obtain the condition for Turing instability. In the presence of toxic effect, we find that the distribution of nutrient and phytoplankton becomes inhomogeneous in space and results in different patterns, like stripes, spots, and the mixture of them depending on the toxicity level. We also observe that the distribution of nutrient and phytoplankton shows spatiotemporal oscillation for certain toxicity level. (C) 2015 Elsevier Inc. All rights reserved.
Spatial linkages in the early life history of north eastern Atlantic herring populations across the north of the British Isles

General Information
State: Published
Strengthening confidence in climate change impact science

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, University of British Columbia, Instituto Mediterráneo de Estudios Avanzados, National Center for Ecological Analysis and Synthesis, University of Queensland, University of North Carolina, Scottish Association for Marine Science, Friedrich-Alexander University Erlangen-Nuremberg, Edith Cowan University, University of Plymouth, Commonwealth Scientific and Industrial Research Organisation, University of the Sunshine Coast, Farallon Institute for Advanced Ecosystem Research
Authors: O'Connor, M. I. (Ekstern), Holding, J. M. (Ekstern), Kappel, C. V. (Ekstern), Duarte, C. M. (Ekstern), Brander, K. (Intern), Brown, C. J. (Ekstern), Bruno, J. F. (Ekstern), Buckely, L. (Ekstern), Burrows, M. T. (Ekstern), Halpern, B. S. (Ekstern), Kiessling, W. (Ekstern), Moore, P. (Ekstern), Pandolfi, J. M. (Ekstern), Parmesan, C. (Ekstern), Poloczanska, E. S. (Ekstern), Schoeman, D. S. (Ekstern), Sydeman, W. J. (Ekstern), Richardson, A. J. (Ekstern)
Pages: 64-76
Publication date: 2015
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Journal: Global Ecology and Biogeography
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Scopus rating (2016): CiteScore 6.4 SJR 4.061 SNIP 1.903
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 4.57 SNIP 2.051 CiteScore 6.67
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 4.433 SNIP 2.386 CiteScore 6.92
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 4.171 SNIP 2.543 CiteScore 7.38
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 4.266 SNIP 2.236 CiteScore 6.56
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 3.808 SNIP 1.995 CiteScore 5.68
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 2
Synoptic-scale analysis of mechanisms driving surface chlorophyll dynamics in the North Atlantic

Several hypotheses have been proposed for the onset of the spring phytoplankton bloom in the North Atlantic. Our main objective is to examine which bottom-up processes can best predict the annual increase in surface phytoplankton concentration in the North Atlantic by applying novel phenology algorithms to ocean colour data. We construct indicator fields and time series which, in various combinations, provide models consistent with the principle dynamics previously proposed. Using a multimodel inference approach, we investigate the evidence supporting these models and how it varies in space. We show that, in terms of bottom-up processes alone, there is a dominant physical mechanism, namely mixed-layer shoaling, that best predicts the interannual variation in the initial increase in surface chlorophyll across large sectors of the North Atlantic. We further show that different regions are governed by different physical phenomena and that wind-driven mixing is a common component, with either heat flux or light as triggers. We believe these findings to be relevant to the ongoing discussion on North Atlantic bloom onset.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography, Centre for Ocean Life, Faroe Marine Research Institute, Nansen Environmental and Remote Sensing Center
Authors: Ferreira, A. S. (Intern), Hatun, H. (Ekstern), Counillon, F. (Ekstern), Payne, M. (Intern), Visser, A. (Intern)
Pages: 3641-3653
Publication date: 2015
Main Research Area: Technical/natural sciences

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Scopus rating (2016): CiteScore 4.25 SJR 2.328 SNIP 1.305
Web of Science (2016): Indexed yes
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Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 2.194 SNIP 1.363 CiteScore 4.03
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 2.468 SNIP 1.425 CiteScore 4.21
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 2.366 SNIP 1.312 CiteScore 3.92
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 2.524 SNIP 1.178 CiteScore 3.86
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 2.36 SNIP 1.108
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.951 SNIP 1.197
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.848 SNIP 1.234
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.465 SNIP 1.113
Scopus rating (2006): SJR 0.997 SNIP 0.688
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 0.293 SNIP 1.043
Web of Science (2005): Indexed yes
Original language: English
ECOLOGY, GEOSCIENCES, SPRING PHYTOPLANKTON BLOOMS, CRITICAL DEPTH HYPOTHESIS, ANNUAL CYCLES, GLOBAL OCEAN, CALANUS-FINMARCHICUS, SEA, MODEL, VARIABILITY, STRATIFICATION, CONVECTION
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Taxonomic and functional diversity patterns of fish assemblages in the European Seas

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Pécuchet, L. (Intern), Hidalgo, M. (Ekstern), Lindegren, M. (Intern)
Publication date: 2015
Event: Poster session presented at ICES Annual Science Conference 2015, Copenhagen, Denmark.
Main Research Area: Technical/natural sciences
Publication: Research › Poster – Annual report year: 2015
Temperature-size responses match latitudinal-size clines in arthropods, revealing critical differences between aquatic and terrestrial species

Two major intraspecific patterns of adult size variation are plastic temperature-size (T-S) responses and latitude-size (L-S) clines. Yet, the degree to which these co-vary and share explanatory mechanisms has not been systematically evaluated. We present the largest quantitative comparison of these gradients to date, and find that their direction and magnitude co-vary among 12 arthropod orders ($r^2 = 0.72$). Body size in aquatic species generally reduces with both warming and decreasing latitude, whereas terrestrial species have much reduced and even opposite gradients. These patterns support the prediction that oxygen limitation is a major controlling factor in water, but not in air. Furthermore, voltinism explains much of the variation in T-S and L-S patterns in terrestrial but not aquatic species. While body size decreases with warming and with decreasing latitude in multivoltine terrestrial arthropods, size increases on average in univoltine species, consistent with predictions from size vs. season-length trade-offs
The Baltic ATLANTIS model: Implementing a holistic framework to evaluate ecosystem wide responses to changes in climate and anthropogenic forcing

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography, Section for Ecosystem based Marine Management, Section for Marine Living Resources, Section for Monitoring and Data, Centre for Ocean Life, Aarhus University
Authors: Palacz, A. (Intern), Nielsen, J. R. (Intern), Christensen, A. (Intern), Gislason, H. (Intern), Bastardie, F. (Intern), Geitner, K. (Intern), Maar, M. (Ekstern), Lindegren, M. (Intern), Hufnagl, M. (Intern), Fulton, E. (Ekstern)
Number of pages: 1
Publication date: 2015
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Main Research Area: Technical/natural sciences
Links:
http://www.marine-vectors.eu/Core_pages/The_Baltic_ATLANTIS_model_a_holistic_framework_to
Publication: Research › Poster – Annual report year: 2015

The effect of zooplankton on the efficiency of the biological carbon pump

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Koski, M. (Intern), Pankoke, L. M. (Ekstern)
Publication date: 2015
Event: Abstract from 18. Danske Havforskermøde, Copenhagen, Denmark.
Main Research Area: Technical/natural sciences
Publication: Research › Conference abstract for conference – Annual report year: 2015

The influence of generalist predators in spatially extended predator-prey systems
The presence of generalist predators is known to have important ecological impacts in several fields. They have wide applicability in the field of biological control. However, their role in the spatial distribution of predator and prey populations is still not clear. In this paper, the spatial dynamics of a predator-prey system is investigated by considering two different types of generalist predators. In one case, it is considered that the predator population has an additional food source and can survive in the absence of the prey population. In the other case, the predator population is involved in intraguild predation, i.e., the source of the additional food of the predator coincides with the food source of the prey population and thus both prey and predator populations compete for the same resource. The conditions for linear stability and Turing instability are analyzed for both the cases. In the presence of generalist predators, the system shows different pattern formations and spatiotemporal chaos which has important implications for ecosystem functioning not only in terms of their predictability, but also in influencing species persistence and ecosystem stability in response to abrupt environmental changes. This study establishes the importance of the consideration of spatial dynamics while determining optimal strategies for biological control through generalist predators

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, University of Oldenburg
The predictive potential of ecological niche models for plankton in the North Atlantic

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Brun, P. G. (Intern), Kiørboe, T. (Intern), Licandro, P. (Ekstern)
Event: Abstract from International Symposium on "Effects of Climate Change on the Word's Oceans", Santos, Brazil.
Main Research Area: Technical/natural sciences

Bibliographical note
Best Early Career Scientist Presentations
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DOI: 10.1016/j.ecocom.2015.06.003
The role of deep convection on the dynamics of the North Atlantic phytoplankton community

In recent years observations of a significant winter phytoplankton stock and blooms in the absence of stratification have challenged the classical picture of phytoplankton dynamics in the North Atlantic. To explain phytoplankton winter survival, it has been suggested that deep convection can sustain low primary production by frequently returning plankton cells to the euphotic zone. For this mechanism to work the convective vertical velocities have to superimpose the sinking rate of phytoplankton cells and cell photosynthesis has to compensate for respiratory and other losses. In this thesis different modeling approaches are used to investigate several aspects of the bio-physical interplay between deep convection and phytoplankton growth. Simple water column models for phytoplankton have suggested that phytoplankton cannot grow in highly turbulent deep mixed layers, conditions typical for deep convective regimes. To investigate this discrepancy between observations and model studies, a modeling approach commonly used in population models was applied to a spatial grid, where the advective flow was explicit represented. The result shows that indeed phytoplankton can persist in highly turbulent deep waters and suggests that it is the convective overturning within the mixed layer, that enables cell to thrive under these conditions.

To investigate the role of acclimation during winter and during the onset of the spring bloom, an adaptive Individual-Based-Model (IBM) was developed, allowing to test the phyto-convection hypothesis in relation to individual physiological rates. The model in-cooperates an adaptive parameterization for respiration and a mechanistic sinking model, both of which have been suggested as important contributors to phytoplankton losses during the winter. While cell sinking was found to be only of lesser importance, respiration had a large impact on phytoplankton survival during during winter and especially during the onset of stratification. In difference to the non-hydrostatic model coupled to the IBM, ecosystem models are hydrostatic and are therefore not able to capture convective motion as such. Due to the coupling of deep convection and phytoplankton winter survival in the north Atlantic this can lead to an underestimate of winter phytoplankton biomass. As a first step to improve the winter phytoplankton representation, a simple parameterization assuming average mixed layer light levels throughout the whole mixed layer, was implemented into an ecosystem model and validated with a non-hydrostatic convection model. The new parameterization improved the model fit to observational data substantially. The increased standing stock during winter led to higher carbon export, in particular during the onset of thermal stratification in spring. The finding of this thesis have important implication for our understanding of carbon sequestration during winter and for the role of the North Atlantic as a carbon sink, in particular in a scenario of climate change.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography, Centre for Ocean Life
Authors: Lindemann, C. (Intern), St. John, M. (Intern), Mariani, P. (Intern)
Number of pages: 152
Publication date: 2015

Trade-offs between objectives for ecosystem management of fisheries

The strategic objectives for fisheries, enshrined in international conventions, is to maintain or restore stocks to produce maximum sustainable yield (MSY) and implement the ecosystem approach requiring that interactions between species be taken into account and conservation constraints be respected. While the yield and conservation aims are to some extent compatible when a fishery for a single species is considered, species interactions entail that MSY for a species depends on the species with which it interacts and the yield and conservation objectives therefore conflict when an ecosystem approach to fisheries management is required. We apply a conceptual size- and trait-based model to clarify and resolve these issues, by determining the fishing pattern that maximizes the total yield of an entire fish community in terms of catch weight or economic rent under acceptable conservation constraints. Our results indicate that the eradication of large, predatory fish species results in a potential maximum catch atleast twice as high as if conservation constraints are imposed. However, such a large catch could only be achieved at a cost of foregone rent; maximum rent extracts less than half of the potential maximum catch weight. When a conservation constraint is applied, catch can be maximized at negligible cost in foregone rent, compared with maximizing rent. Maximization of rent is the objective that comes closest to respecting conservation concerns.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Technical University of Denmark
Authors: Andersen, K. H. (Intern), Brander, K. (Intern), Ravn-Jonsen, L. (Intern)
Pages: 1390-1396
Understanding diversity shifts by characterising the community

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Fredricson, J. (Ekstern), Payne, M. (Intern)
Number of pages: 2
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Event: Abstract from ICES Annual Science Conference 2015, Copenhagen, Denmark.
Main Research Area: Technical/natural sciences
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Understanding observed copepod distributions with a trait data base

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Brun, P. G. (Intern), Kiørboe, T. (Intern), Payne, M. (Intern)
Publication date: 2015
Event: Poster session presented at Trait-based Approaches to Ocean Life, Waterville Valley, New Hampshire, United States.
Main Research Area: Technical/natural sciences
Publication: Research › Poster – Annual report year: 2015

What are the major global threats and impacts in marine environments? Investigating the contours of a shared perception among marine scientists from the bottom-up

Marine scientists broadly agree on which major processes influence the sustainability of marine environments worldwide. Recent studies argue that such shared perceptions crucially shape scientific agendas and are subject to a confirmation bias. Based on these findings a more explicit engagement with scientists' (shared) perceptions of global change in marine environments is called for. This paper takes stock of the shared understanding in marine science of the most pertinent, worldwide threats and impacts that currently affect marine environments. Using results from an email survey among leading academics in marine science this article explores if a shared research agenda in relation to global change in marine environments exists. The analysis demonstrates that marine scientists across disciplines are largely in agreement on some common features of global marine change. Nevertheless, the analysis also highlights where natural and social scientists diverge in their assessment. The article ends discussing what these findings imply for further improvement of interdisciplinary marine science

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Ecosystem based Marine Management, Section for Marine Ecology and Oceanography, Section for Marine Living Resources, Centre for Ocean Life, University of the Faroe Islands, Wageningen IMARES, University of Oslo, University of Iceland, University of Helsinki, Åbo Academy University, Stockholm Business School, University of Bergen
Pages: 197-201
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Main Research Area: Technical/natural sciences
Publication information
Journal: Marine Policy
Volume: 60
When bigger is better - a theoretical and empirical examination of factors contributing to selection on offspring size in fish

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Ecosystem based Marine Management, Centre for Ocean Life
Zooplankton Hydrodynamics: An investigation into the physics of aquatic interactions

Zooplankton are hugely abundant organisms found in all aquatic environments and form an important part of the marine ecosystems. Most zooplankton swim in order to find food and mates, and to avoid predators. In spite of its advantages, swimming comes with trade-offs, it costs energy and creates flow disturbances that may attract predators. The first part of this thesis attempts to quantify the trade-offs associated with the swimming behaviour of diverse zooplankton.

We measured the swimming kinematics and flow fields around the 'jumping' copepod Acartia tonsa at various stages of its life cycle, and found qualitative differences in flow structures, energy expenditure, and swimming efficiency, between the early and later stages. The spatial decay rate of flow disturbances was faster in the later stages, suggesting that those may be less vulnerable to predation. Broadening the scope, we then measured flows around a wide range of zooplankton which use a variety of swimming modes such as hovering, cruising, jumping, and breast stroke swimming. We found that the spatial decay rate of the flow velocity is dictated by the swimming mode. The modes used for swimming only, such as jumping and breast stroke swimming, had much faster spatial decay as compared to the other modes, resulting in 'quiet' swimming.

This motivated us to examine breast stroke swimming in more detail, for which flow velocity decayed spatially as one over distance cubed. We employed a simple model using three point forces to represent the forces acting on the swimmer. Our analysis showed a configuration-dependent spatial decay of flow velocity. Arranging the propulsive forces close to the equator resulted in changing the far field velocity decay from one over distance squared to one over distance cubed, comparing well with the experimental observations. To further investigate periodic swimming using breast stroke, we measured detailed swimming dynamics and induced flows for the cladoceran Podon intermedius. We estimated the propulsive forces acting on P. intermedius, which showed that the fast spatial decay in the induced flows was not explained by the three point force model. We speculate that this is due to inertial effects in the flow, which seem to play an important role in the swimming of larger zooplankton. We also developed a simple model to mimic the dynamics of periodic swimming, which showed that non-linear drag terms are needed in the model to correctly capture the observed dynamics.

The second part of this thesis examines how size dictates transitions in life strategies, and thus acts as a structuring factor in marine life. To this end, we reviewed data on size-based scaling laws for resource acquisition, motility, sensing, and offspring size for all pelagic marine life, from bacteria to whales. We also reviewed and developed theoretical arguments for the observed scaling laws and for the characteristic sizes at which transitions from one strategy to another take place. Based on our findings, we divided life in the ocean into seven major realms based on trophic strategy, physiology, and life history strategy.

Finally, we delve deeper into size based structuring of sensory strategies in the ocean. Survival in the open ocean requires effective collection of information from the surroundings via the use of various sensory modes. We studied how sensing modes and their respective ranges depend on body size. We investigated the physiological constraints on sense organs, together with the physics of signal generation, transmission, and reception. Our analysis revealed a hierarchy of sensing modes - with increasing size, a larger battery of sensory modes becomes available and the sensing range increases. Our theoretical predictions of lower and upper size limits for various senses aligned well with the size ranges found in the literature. Although the scaling analyses and the size limits are only first order estimates, this work forms the first comprehensive analysis of the size based structuring of sensory modes used by marine life.
A cascade of warming impacts brings bluefin tuna to Greenland waters

Rising ocean temperatures are causing marine fish species to shift spatial distributions and ranges, and are altering predator-prey dynamics in food webs. Most documented cases of species shifts so far involve relatively small species at lower trophic levels, and consider individual species in ecological isolation from others. Here we show that a large highly migratory top predator fish species has entered a high latitude sub-polar area. Bluefin tuna, Thunnus thynnus Linnaeus 1758, were captured in waters east of Greenland (65°N) in August 2012 during exploratory fishing for Atlantic mackerel, Scomber scombrus Linnaeus 1758. The bluefin tuna were captured in a single net-haul in 9-11°C water together with 6 tonnes of mackerel, which is a preferred prey species and itself a new immigrant to the area. Regional temperatures in August 2012 were historically high and contributed to a warming trend since 1985, when temperatures began to rise. The presence of bluefin tuna in this region is likely due to a combination of warm temperatures that are physiologically more tolerable and immigration of an important prey species into the region. We conclude that a cascade of climate change impacts is restructuring the food web in east Greenland waters.

General information

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Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography, Centre for Ocean Life, Section for Marine Living Resources, Danish Meteorological Institute, Greenland Institute of Natural Resources
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bluefin tuna, climate, food web, Greenland, mackerel, predator-prey, temperature, trophic cascade

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Accuracy and precision in the calculation of phenology metrics
Phytoplankton phenology (the timing of seasonal events) is a commonly used indicator for evaluating responses of marine ecosystems to climate change. However, phenological metrics are vulnerable to observation-(bloom amplitude, missing data, and observational noise) and analysis-related (temporal resolution, preprocessing technique, and phenology metric)
processes. Here we consider the impact of these processes on the robustness of four phenology metrics (timing of maximum, 5% above median, maximum growth rate, and 15% of cumulative distribution). We apply a simulation-testing approach, where a phenology metric is first determined from a noise- and gap-free time series, and again once it has been modified. We show that precision is a greater concern than accuracy for many of these metrics, an important point that has been hereto overlooked in the literature. The variability in precision between phenology metrics is substantial, but it can be improved by the use of preprocessing techniques (e.g., gap-filling or smoothing). Furthermore, there are important differences in the inherent variability of the metrics that may be crucial in the interpretation of studies based upon them. Of the considered metrics, the 15% of cumulative distribution metric best satisfies the precision criteria. However, the 5% above median metric is comparable in terms of precision and exhibits more inherent variability. We emphasize that the choice of phenology metric should be determined by the specific nature of the question being asked. We believe these findings to be useful to the current discussion on phenology metrics of phytoplankton dynamics.

**General information**
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Web of Science (2010): Indexed yes
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A comparison of multispecies models with potential use for strategic fisheries management

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Authors: Jacobsen, N. S. (Intern)
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A demonstration of an integrated ecosystem assessment and advice for Baltic Sea fish stocks

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A life-history evaluation of the impact of maternal effects on recruitment and fisheries reference points
Fishing causes dramatic changes in the age and size structure of fish stocks. In particular, the targeting of the largest and oldest individuals in a stock changes the age and size distribution of that stock. A large female produces a higher quantity of eggs than a young female because of its larger size, but recent laboratory evidence further indicates that large females also produce eggs of higher quality, a phenomenon known as maternal effects. However, most traditional management models assume that all female fish contribute equally per unit biomass to future recruitment. Here we investigate whether
this assumption is valid by calculating the impact of maternal effects both before and after accounting for density-dependent effects. We find that the contribution of large individuals to reproduction is much more pronounced for unfished than for fished stocks. Fisheries reference points are largely unaffected by maternal effects. Our results indicate that the incorporation of maternal effects into impact assessments of fisheries is not expected to change advice substantially. Important exceptions are stocks whose demography is very vulnerable to fishing (and which therefore have low fishing reference points) for which maternal effects are relevant and necessary to consider.

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Web of Science (2015): Indexed yes
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Scopus rating (2014): SJR 1.443 SNIP 1.379 CiteScore 2.6
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ISI indexed (2012): ISI indexed yes
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Scopus rating (2011): SJR 1.423 SNIP 1.09 CiteScore 2.13
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BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.425 SNIP 1.118
Web of Science (2010): Indexed yes
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Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 1.589 SNIP 1.379
Web of Science (2008): Indexed yes
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A metacommunity perspective on source-sink dynamics and management: the Baltic Sea as a case study

The degree to which metapopulation processes influence fish stock dynamics is a largely unresolved issue in marine science and management, especially for highly mobile species such as Atlantic cod (Gadus morhua) and herring (Clupea harengus). The Baltic Sea comprises a heterogeneous oceanographic environment that structures the spatial and temporal distribution of the dominant species cod, herring, and sprat (Sprattus sprattus). Despite local differences, the stocks are traditionally managed as homogeneous units. Here, we present a metacommunity-perspective on source–sink dynamics of Baltic Sea fish stocks by using a spatially disaggregated statistical food web model. The model is fitted to area-specific time series of multiple abiotic and biotic variables using state-space methods. Our analysis reveals pronounced net fluxes between areas, indicative of source–sink dynamics, as well as area-specific differences in species interactions (i.e., density dependence, competition, and predator–prey) and the degree of fishing and climate impact on survival and recruitment. Furthermore, model simulations show that decreasing exploitation pressure in the source area for cod (without reallocating fishing effort) produces an increase in neighboring sink habitats, but a decline of prey species in response to increased predation. Our approach provides valuable insight concerning metacommunity-structuring of marine fish and may serve as an important tool for implementing sustainable management strategies under the ecosystem approach to marine and fisheries management.

Read More: http://www.esajournals.org/doi/abs/10.1890/13-0566.1
Analysis of self-overlap reveals trade-offs in plankton swimming trajectories

Movement is a fundamental behaviour of organisms that not only brings about beneficial encounters with resources and mates, but also at the same time exposes the organism to dangerous encounters with predators. The movement patterns adopted by organisms should reflect a balance between these contrasting processes. This trade-off can be hypothesized as being evident in the behaviour of plankton, which inhabit a dilute three-dimensional environment with few refuges or orienting landmarks. We present an analysis of the swimming path geometries based on a volumetric Monte Carlo sampling approach, which is particularly adept at revealing such trade-offs by measuring the self-overlap of the trajectories. Application of this method to experimentally measured trajectories reveals that swimming patterns in copepods are shaped to efficiently explore volumes at small scales, while achieving a large overlap at larger scales. Regularities in the observed trajectories make the transition between these two regimes always sharper than in randomized trajectories or as predicted by random walk theory. Thus, real trajectories present a stronger separation between exploration for food and exposure to predators. The specific scale and features of this transition depend on species, gender and local environmental conditions, pointing at adaptation to state and stage-dependent evolutionary trade-offs. © 2014 The Author(s) Published by the Royal Society. All rights reserved.
A resolution to the blue whiting (Micromesistius poutassou) population paradox?

We provide the strongest evidence to date supporting the existence of two independent blue whiting (Micromesistius poutassou (Risso, 1827)) populations in the North Atlantic. In spite of extensive data collected in conjunction with the fishery, the population structure of blue whiting is poorly understood. On one hand, genetic, morphometric, otolith and drift...
modelling studies point towards the existence of two populations, but, on the other hand, observations of adult
distributions point towards a single population. A paradox therefore arises in attempting to reconcile these two sets of
information. Here we analyse 1100 observations of blue whiting larvae from the Continuous Plankton Recorder (CPR)
from 1948-2005 using modern statistical techniques. We show a clear spatial separation between a northern spawning
area, in the Rockall Trough, and a southern one, off the Porcupine Seabight. We further show a difference in the timing of
spawning between these sites of at least a month, and meaningful differences in interannual variability. The results
therefore support the two-population hypothesis. Furthermore, we resolve the paradox by showing that the acoustic
observations cited in support of the single-population model are not capable of resolving both populations, as they occur
too late in the year and do not extend sufficiently far south to cover the southern population: the confusion is the result of a
simple observational artefact. We conclude that blue whiting in the North Atlantic comprises two populations.

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Web of Science (2015): Indexed yes
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Scopus rating (2013): SJR 1.74 SNIP 1.147 CiteScore 3.94
ISI indexed (2013): ISI indexed yes
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Scopus rating (2012): SJR 1.945 SNIP 1.142 CiteScore 4.15
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BFI (2011): BFI-level 1
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ISI indexed (2011): ISI indexed yes
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BFI (2010): BFI-level 1
Scopus rating (2010): SJR 2.631 SNIP 1.161
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 2.473 SNIP 0.985
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 2.323 SNIP 0.96
A Sustainability Index of potential co-location of offshore wind farms and open water aquaculture

This paper presents the definition of a Sustainability Index for the co-location in marine areas of offshore wind farms and aquaculture plans. The development of the index is focused on the application of MCE technique based on physical constraints and biological parameters that are directly linked to the primary production. The relevant physical factors considered are wind velocity and depth range (which directly governs the choice of the site for energy production and for offshore technology), the relevant biological parameters are SST, SST anomaly and CHL-a concentration (as a measurement of the productivity). The further development of the technique, already used in open water aquaculture localization, consists in converting raw data into sustainability scores, which have been combined using additive models, in order to define the overall sustainability. The study area used to implement the computation of the Sustainability Index (SI) was identified in the Danish portion of the Baltic Sea and in the western part of the Danish North Sea. Results on the spatial distribution of the SI underline different responses as a function of the physical and biological main influencing parameters.

General information
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Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Section for Ecosystem based Marine Management, University of Naples "Parthenope"
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Scopus rating (2016): CiteScore 2.23 SJR 0.887 SNIP 1.123
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.783 SNIP 1.002 CiteScore 1.92
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.883 SNIP 1.306 CiteScore 2.05
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.719 SNIP 1.394 CiteScore 1.84
A synthesis of the distribution of Mnemiopsis leidyi in European waters

General information
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Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Section for Marine Ecology and Oceanography, IFREMER, Alfred Wegener Institute, Aarhus University, Université Montpellier, University of Toulon, Institute of Biology of the Southern Seas, CSIC, Université de La Rochelle, Thünen Institute of Sea Fisheries, University Museum of Bergen, National Research Council of Italy, Alfred Wegener Institute for Polar and Marine Research, Leibniz-Institute for Baltic Sea Research, Sorbonne Universités, Institute of Fisheries, Marine Ecology, Istanbul University, Cefas, Institute for Agricultural and Fisheries Research, Marine Biology and Ecology Department, Royal Netherlands Institute for Sea Research - NIOZ, Delftiares, GEOMAR - Helmholtz Centre for Ocean Research Kiel, University of Gothenburg, Aix Marseille Universite, University of Southern Denmark
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Bioavailability and radiocarbon age of fluvial dissolved organic matter (DOM) from a northern peatland-dominated catchment: effect of land-use change
The radiocarbon age and biodegradability of dissolved organic matter (DOM) from a northern peat-dominated river system was studied and the effects of land-use were compared. Samples were obtained from streams and ditches comprising sub-catchments of the Kiiminki River, Northern Finland. Sample sites included areas of natural mire, areas subjected to
moderate disturbance (ditching to enhance forestry), and areas subjected to serious land use change (agriculture and peat excavation). The study employed a 55 day bioassay that measured the biodegradation potential of surface-water DOM. We identified release of modern (mean 6-13 year old) DOM from natural sites, and material aged up to 1,553 years from disturbed sites. The proportion of biodegradable DOC ranged from 4.1 to 17.9 %, and bacterial DOC removal was modelled using twin-pool and reactivity-continuum (beta distribution) approaches. Bacterial growth efficiency ranged from 0.11 to 0.26 between areas of different land use, and these relatively low values reflect the humic-rich DOM released from boreal peatland. Despite the range of land-use types studied, including intensive peatland excavation areas, there was no detectable relationship between the biological lability of DOM and its radiocarbon age.

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BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.182 SNIP 1.309 CiteScore 2.54
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.272 SNIP 1.61 CiteScore 3.15
Web of Science (2014): Indexed yes
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Scopus rating (2013): SJR 1.193 SNIP 1.288 CiteScore 2.71
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.106 SNIP 1.15 CiteScore 2.33
ISI indexed (2012): ISI indexed yes
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BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.892 SNIP 1.184 CiteScore 2.08
ISI indexed (2011): ISI indexed yes
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Scopus rating (2010): SJR 0.758 SNIP 0.612
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.956 SNIP 1.042
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.659 SNIP 0.896
Scopus rating (2007): SJR 0.988 SNIP 1.066
Scopus rating (2006): SJR 0.822 SNIP 0.973
Scopus rating (2005): SJR 0.991 SNIP 1.435
Scopus rating (2004): SJR 0.761 SNIP 0.947
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 0.535 SNIP 0.893
Biogeographic classification of the Caspian Sea

Like other inland seas, the Caspian Sea (CS) has been influenced by climate change and anthropogenic disturbance during recent decades, yet the scientific understanding of this water body remains poor. In this study, an eco-geographical classification of the CS based on physical information derived from space and in-situ data is developed and tested against a set of biological observations. We used a two-step classification procedure, consisting of (i) a data reduction with self-organizing maps (SOMs) and (ii) a synthesis of the most relevant features into a reduced number of marine ecoregions using the Hierarchical Agglomerative Clustering (HAC) method. From an initial set of 12 potential physical variables, 6 independent variables were selected for the classification algorithm, i.e., sea surface temperature (SST), bathymetry, sea ice, seasonal variation of sea surface salinity (DSSS), total suspended matter (TSM) and its seasonal variation (DTSM).

The classification results reveal a robust separation between the northern and the middle/southern basins as well as a separation of the shallow near-shore waters from those off-shore. The observed patterns in ecoregions can be attributed to differences in climate and geochemical factors such as distance from river, water depth and currents. A comparison of the annual and monthly mean Chl a concentrations between the different ecoregions shows significant differences (Kruskal–Wallis rank test, $P < 0.05$). In particular, we found differences in phytoplankton phenology, with differences in the date of bloom initiation, its duration and amplitude between ecoregions. A first qualitative evaluation of differences in community composition based on recorded presence-absence patterns of 27 different species of plankton, fish and benthic invertebrate also confirms the relevance of the ecoregions as proxies for habitats with common biological characteristics.

General information

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Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Gorgan University of Agricultural Sciences and Natural Resources, ETH Zurich
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Web of Science (2016): Indexed yes
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Scopus rating (2013): SJR 2.468 SNIP 1.425 CiteScore 4.21
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Body shape shifting during growth permits tests that distinguish between competing geometric theories of metabolic scaling

Metabolism fuels all of life’s activities, from biochemical reactions to ecological interactions. According to two intensely debated theories, body size affects metabolism via geometrical influences on the transport of resources and wastes. However, these theories differ crucially in whether the size dependence of metabolism is derived from material transport across external surfaces, or through internal resource-transport networks. We show that when body shape changes during growth, these models make opposing predictions. These models are tested using pelagic invertebrates, because these animals exhibit highly variable intraspecific scaling relationships for metabolic rate and body shape. Metabolic scaling slopes of diverse integument-breathing species were significantly positively correlated with degree of body flattening or elongation during ontogeny, as expected from surface area theory, but contradicting the negative correlations predicted by resource-transport network models. This finding explains strong deviations from predictions of widely adopted theory, and underpins a new explanation for mass-invariant metabolic scaling during ontogeny in animals and plants.
Bridging the gap between marine biogeochemical and fisheries sciences; configuring the zooplankton link
Exploring climate and anthropogenic impacts on marine ecosystems requires an understanding of how trophic components interact. However, integrative end-to-end ecosystem studies (experimental and/or modelling) are rare. Experimental investigations often concentrate on a particular group or individual species within a trophic level, while
tropho-dynamic field studies typically employ either a bottom-up approach concentrating on the phytoplankton community or a top-down approach concentrating on the fish community. Likewise the emphasis within modelling studies is usually placed upon phytoplankton-dominated biogeochemistry or on aspects of fisheries regulation. In consequence the roles of zooplankton communities (protists and metazoans) linking phytoplankton and fish communities are typically under-represented if not (especially in fisheries models) ignored. Where represented in ecosystem models, zooplankton are usually incorporated in an extremely simplistic fashion, using empirical descriptions merging various interacting physiological functions governing zooplankton growth and development, and thence ignoring physiological feedback mechanisms. Here we demonstrate, within a modelled plankton food-web system, how trophic dynamics are sensitive to small changes in parameter values describing zooplankton vital rates and thus the importance of using appropriate zooplankton descriptors. Through a comprehensive review, we reveal the mismatch between empirical understanding and modelling activities identifying important issues that warrant further experimental and modelling investigation. These include: food selectivity, kinetics of prey consumption and interactions with assimilation and growth, form of voided material, mortality rates at different age-stages relative to prior nutrient history. In particular there is a need for dynamic data series in which predator and prey of known nutrient history are studied interacting under varied pH and temperature regimes.

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Capital versus income breeding in a seasonal environment

The allocation of resources between growth, storage, and reproduction is a key trade-off in the life-history strategies of organisms. A central dichotomy is between capital breeders and income breeders. Capital breeders build reserves that allow them to spawn at a later time independently of food availability, while income breeders allocate ingested food directly to reproduction. Motivated by copepod studies, we use an analytical model to compare the fitness of income with capital breeding in a deterministic seasonal environment. We analyze how the fitness of breeding strategies depend on feeding season duration and size at maturity. Small capital breeders perform better in short feeding seasons but fall behind larger individuals when the length of the feeding season increases. Income breeding favors smaller individuals as their short generation time allows for multiple generations within a year and thereby achieve a high annual growth rate, outcompeting capital breeders in long feeding seasons. Therefore, we expect to find a dominance of small income breeders in temperate waters, while large capital breeders should dominate high latitudes where the spring is short and intense. This pattern is evident in nature, particularly in organisms with a generation time of a year or less.

General information

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Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography, Centre for Ocean Life, Akvaplan-niva AS
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Changes in the C, N, and P cycles by the predicted salps-krill shift in the southern ocean

The metabolic carbon requirements and excretion rates of three major zooplankton groups in the Southern Ocean were studied in February 2009. The research was conducted in the framework of the ATOS research project as part of the Spanish contribution to the International Polar Year. The objective was to ascertain the possible consequences of the predicted zooplankton shift from krill to salps in the Southern Ocean for the cycling of biogenic carbon and the concentration and stoichiometry of dissolved inorganic nutrients. The carbon respiratory demands and NH4-N and PO4-P excretion rates of <5 mm size copepods, krill and salps were estimated by incubation experiments. The carbon-specific metabolic rates and N:P metabolic quotients of salps were higher than those of krill (furcilia spp. and adults) and copepods, and as expected there was a significant negative relation between average individual zooplankton biomass and their metabolic rates, each metabolic process showing a particular response that lead to different metabolic N:P ratios.

The predicted change from krill to salps in the Southern Ocean would encompass not only the substitution of a pivotal group for Antarctic food webs (krill) by one with an indifferent trophic role (salps). In a zooplankton community dominated by salps the respiratory carbon demand by zooplankton will significantly increase, and therefore the proportion of primary
production that should be allocated to compensate for the global respiratory C-losses of zooplankton. At the same time, the higher production by salps of larger, faster sinking fecal pellets will increase the sequestration rate of biogenic carbon. Similarly, the higher N and P excretion rates of zooplankton and the changes in the N:P stoichiometry of the metabolic products will modify the concentration and proportion of N and P in the nutrient pool, inducing quantitative and qualitative changes on primary producers that will translate to the whole Southern Ocean ecosystem.

Comparative ecology of widely distributed pelagic fish species in the North Atlantic: Implications for modelling climate and fisheries impacts

This paper reviews the current knowledge on the ecology of widely distributed pelagic fish stocks in the North Atlantic basin with emphasis on their role in the food web and the factors determining their relationship with the environment. We consider herring (Clupea harengus), mackerel (Scomber scombrus), capelin (Mallotus villosus), blue whiting (Micromesistius poutassou), and horse mackerel (Trachurus trachurus), which have distributions extending beyond the continental shelf and predominantly occur on both sides of the North Atlantic. We also include albacore (Thunnus alalunga), bluefin tuna (Thunnus thynnus), swordfish (Xiphias gladius), and blue marlin (Makaira nigricans), which, by contrast, show large-scale migrations at the basin scale. We focus on the links between life history processes and the environment, horizontal and vertical distribution, spatial structure and trophic role. Many of these species carry out extensive migrations from spawning grounds to nursery and feeding areas. Large oceanographic features such as the North Atlantic subpolar gyre play an important role in determining spatial distributions and driving variations in stock size. Given the large biomasses of especially the smaller species considered here, these stocks can exert significant top-down pressures on the food web and are important in supporting higher trophic levels. The review reveals commonalities and differences between the ecology of widely distributed pelagic fish in the NE and NW Atlantic basins, identifies knowledge gaps and modelling needs that the EURO-BASIN project attempts to address. © 2014 Elsevier Ltd. All rights reserved.
Inland waters transport large amounts of dissolved organic matter (DOM) from terrestrial environments to the oceans, but DOM also reacts en route, with substantial water column losses by mineralization and sedimentation. For DOM transformations along the aquatic continuum, lakes play an important role as they retain waters in the landscape allowing for more time to alter DOM. We know DOM losses are significant at the global scale, yet little is known about how the reactivity of DOM varies across landscapes and climates. DOM reactivity is inherently linked to its chemical composition.

We used fluorescence spectroscopy to explore DOM quality from 560 lakes distributed across Sweden and encompassed a wide climatic gradient typical of the boreal ecozone. Six fluorescence components were identified using parallel factor analysis (PARAFAC). The intensity and relative abundance of these components were analyzed in relation to lake chemistry, catchment, and climate characteristics. Land cover, particularly the percentage of water in the catchment, was a primary factor explaining variability in PARAFAC components. Likewise, lake water retention time influenced DOM quality. These results suggest that processes occurring in upstream water bodies, in addition to the lake itself, have a dominant influence on DOM quality. PARAFAC components with longer emission wavelengths, or red-shifted components, were most reactive. In contrast, protein-like components were most persistent within lakes. Generalized characteristics of PARAFAC components based on emission wavelength could ease future interpretation of fluorescence spectra. An important secondary influence on DOM quality was mean annual temperature, which ranged between -6.2 and +7.5 °C. These results suggest that DOM reactivity depends more heavily on the duration of time taken to pass through the landscape, rather than temperature. Projected increases in runoff in the boreal region may force lake DOM toward a higher overall amount and proportion of humic-like substances.
Dealing with the presence of the ciliate Euplotes sp. in cultures of the copepod Acartia tonsa

Ciliates in live feed cultures can be a pest that lower production yields. This could dramatically affect the management and success of copepod cultures. In this study, we investigated the effect of the ciliate Euplotes sp. on egg production, specific egg production and egg hatching success of Acartia tonsa fed with Rhodomonas salina. We found that at a concentration of 2 cells ml⁻¹, Euplotes sp. had no effect on the production and hatching success of eggs but increased/decreased the mortality/quality of non-subitaneous eggs. Euplotes sp. had a good fatty acid profile containing high proportion of unsaturated fatty acids, but the amount of fatty acids compared to their carbon weight was very low and, therefore, it was considered as a poor food source. We propose a short-term interruption of food supply to copepod cultures in order to mitigate bloom formation of ciliates. This will force copepods to feed on them actively as prey and therefore decrease their long-term negative effects. © 2013 Springer Science+Business Media Dordrecht.
Den bedste forskning ligger på grænsen mellem discipliner

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Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Department of Physics, Biophysics and Fluids
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**Distributional shifts of species in the North Atlantic: the rule or the exception?**
This work addresses recent shifts in the distribution of marine pelagic fish in the northern North Atlantic and attempts to set them in the context of climate variability, climate change, population dynamics and migration processes. Shifts in the distribution of North-east Atlantic mackerel, and the associated political dispute over fishing rights, has drawn much attention in recent years. However, a closer examination of spatial distributions of pelagic fish in this region suggests that such shifts are not by any means unique: several other examples, both well- and less-well-known, are presented and discussed here. These examples are then used to illustrate the potential importance of various mechanisms that can control the distribution of these species, such as climate variability and change, and population and migration dynamics. A set of simple analytical approaches is demonstrated that can be used to assess the relative importance of each of these mechanisms. Finally, these observations are drawn together to reveal a picture of a dynamic ecosystem in a constant state of flux and to emphasis the necessity

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Authors: Payne, M. (Intern)
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**Does copepod size determine food consumption of particulate feeding fish?**
The climate-induced reduction in the mean copepod size, mainly driven by a decrease in the abundance of the large Calanus finmarchicus around 1987, has been linked to the low survival of fish larvae in the North Sea. However, to what extent this sort of reduction in copepod size has any influence on adult particulate feeding fish is unknown. In the present study, we investigated the hypothesis that the availability of the large copepods determines food consumption and growth conditions of lesser sandeel (Ammodytes marinus) in the North Sea. Analysis of stomach content suggested that food consumption is higher for fish feeding on large copepods, and additional calculations revealed how handling time limitation may provide part of the explanation for this relationship. Comparing stomach data and zooplankton samples indicated that lesser sandeel actively target large copepods when these are available. Finally, we observed that the length of lesser sandeel began to decrease in the late 1980s, simultaneously with the C. finmarchicus decline

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Organisations: National Institute of Aquatic Resources, Section for Marine Living Resources, Centre for Ocean Life, Section for Ecosystem based Marine Management
Authors: Deurs, M. V. (Intern), Koski, M. (Intern), Rindorf, A. (Intern)
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Does the ‘snot’ of the oceans matter? Engaging with the public on gelatinous zooplankton. Lessons learned from The Danish Eel Expedition 2014
Dynamic Energy Budget theory: a means to develop competences in sustainable use of biological systems

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Eels in culture, fisheries and science in Denmark

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Effects of temperature on life history set the sensitivity to fishing in Atlantic cod Gadus morhua

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Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Wang, H. (Ekstern), Botsford, L. W. (Ekstern), White, J. W. (Ekstern), Fogarty, M. J. (Ekstern), Juanes, F. (Ekstern), Hastings, A. (Ekstern), Holland, M. D. (Ekstern), Brander, K. (Intern)
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Calanus hyperboreus is a key species in the Arctic regions because of its abundance and role in the Arctic food web. Exploitation of the off shore oil reserves along Western Greenland is expected in the near future, and it is important to evaluate the acute and chronic effects of oil emissions to the ecosystem. In this study C. hyperboreus females were exposed to concentrations of 0, 0.1, 1, 10 and 100 nM pyrene and saturated concentrations measured to ~300 nM. Daily quantification of egg and faecal pellet production showed significant decreases in the pellet production, while the egg production was unaffected. The hatching success was also unaffected, although the total reproductive output was reduced with increased pyrene concentrations. Accumulation of pyrene in the copepods was higher in feeding than starving females and only trace amounts of the phase I metabolite 1-hydroxypyrene, were found. Lowered reproductive output,
reduced grazing, and reduced ability to metabolize pyrene suggest that oil contamination may constitute a risk to C. hyperboreus recruitment, energy transfer in the food web and transfer of pyrene to higher trophic levels
Evaluating targets and trade-offs among fisheries and conservation objectives using a multispecies size spectrum model

Marine environmental management policies seek to ensure that fishing impacts on fished populations and other components of the ecosystem are sustainable, to simultaneously meet objectives for fisheries and conservation. For example, in Europe, targets for (i) biodiversity, (ii) food web structure as indicated by the proportion of large fish and (iii) fishing mortality rates for exploited species that lead to maximum sustainable yield, FMSY, are being proposed to support implementation of the Marine Strategy Framework Directive. Efforts to reconcile any trade-offs among objectives need to be informed by knowledge on the consequences of alternate management actions. We develop, calibrate and apply a multispecies size spectrum model of the North Sea fish community to assess the response of populations and the community to fishing. The model predicts species’ size distributions, abundance, productivity and interactions and therefore provides a single framework for evaluating trade-offs between population status, community and food web structure, biodiversity and fisheries yield. We show that the model can replicate realistic fish population and community structure and past responses to fishing. We assess whether meeting management targets for exploited North Sea populations (fishing species at FMSY) will be sufficient to meet proposed targets for biodiversity and food web indicators under two management scenarios (status quo and FMSY). The recovery in biodiversity indicators is 60% greater when fishing populations at FMSY than if status quo (2010) fishing rates are maintained. The probability of achieving a food web target was 60% under both scenarios in spite of major community restructuring revealed by other indicators of community size structure. Synthesis and applications. Our model can be applied to evaluate indicator targets and trade-offs among fisheries and conservation objectives. There is a significant probability that reductions in fishing mortality below FMSY would be needed in Europe if managers make a binding commitment to a proposed large fish indicator target, with concomitant reductions in fisheries yield.
Fishing out collective memory of migratory schools

Animals form groups for many reasons but there are costs and benefit associated with group formation. One of the benefits is collective memory. In groups on the move, social interactions play a crucial role in the cohesion and the ability to make consensus decisions. When migrating from spawning to feeding areas fish schools need to retain a collective memory of the destination site over thousand of kilometers and changes in group formation or individual preference can produce sudden changes in migration pathways. We propose a modelling framework, based on stochastic adaptive networks, that can reproduce this collective behaviour. We assume that three factors control group formation and school migration behaviour: the intensity of social interaction, the relative number of informed individuals and the preference that each individual has for the particular migration area. We treat these factors independently and relate the individuals’ preferences to the experience and memory for certain migration sites. We demonstrate that removal of knowledgable individuals or alteration of individual preference can produce rapid changes in group formation and collective behavior. For example, intensive fishing targeting the migratory species and also their preferred prey can reduce both terms to a point at which migration to the destination sites is suddenly stopped. The conceptual approaches represented by our modelling framework may therefore be able to explain large-scale changes in fish migration and spatial distribution.
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Fiskeynge er fremtidens nyttårstorsk

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Issue number: 3
Fitness costs and benefits of ultraviolet radiation exposure in marine pelagic copepods

Life-history theory predicts that organisms should allocate energy throughout their life such that they maximize their fitness. Copepod zooplankton are known to accumulate sunscreens (so-called mycosporine-like amino acids, MAAs) and antioxidant carotenoids to mitigate negative effects of ultraviolet radiation (UVR), but it is not well known how this affects their fitness. We followed cohorts of the marine copepod Acartia tonsa and assessed how fitness was affected by UVR exposure and a diet rich in UVR-protective sunscreens. Several fitness components including somatic growth, egg quality and nauplii production (larvae) were negatively affected by UVR, whereas other components such as size at maturity, survival and length of life were not. Nauplii production through low egg quality was the most influential life-history parameter that changed in response to UVR. There was interaction between fitness costs and food source. If copepods were fed a diet rich in UVR-screening MAAs, they were able to maintain and even increase their fitness even though they were exposed to otherwise detrimental radiation. Levels of UVR-protective carotenoids were low in the studied species and a meta-analysis revealed that marine copepods in general have much lower - by an order of magnitude - levels of carotenoids than freshwater species, while levels of MAAs are similar between the two habitats. We conclude that allocation to different fitness components to some extent is plastic although egg quality is by far the most influential factor, and this is an example of how environmental variability affects overall fitness. Fitness costs associated with UVR exposure in the absence of UVR-screening MAAs were present. Other costs such as costs for accumulating MAAs were not detected, and if present, they were outweighed by a stimulated fitness in combined UVR and MAA treatments challenging the common model that inducible defences (such as accumulation of MAAs) should come with a cost. Low levels of carotenoids in marine systems suggest high predation pressures on pigmented specimens. Accumulation of nonpigmented MAAs could hence be a key adaptation for surface-dwelling marine zooplankton to maintain or even increase their fitness when exposed to detrimental radiation.
Flow disturbances generated by feeding and swimming zooplankton

Interactions between planktonic organisms, such as detection of prey, predators, and mates, are often mediated by fluid signals. Consequently, many plankton predators perceive their prey from the fluid disturbances that it generates when it feeds and swims. Zooplankton should therefore seek to minimize the fluid disturbance that they produce. By means of particle image velocimetry, we describe the fluid disturbances produced by feeding and swimming in zooplankton with diverse propulsion mechanisms and ranging from 10-µm flagellates to greater than millimeter-sized copepods. We show that zooplankton, in which feeding and swimming are separate processes, produce flow disturbances during swimming with a much faster spatial attenuation (velocity $u$ varies with distance $r$ as $u \propto r^{-3}$ to $r^{-4}$) than that produced by zooplankton for which feeding and propulsion are the same process ($u \propto r^{-1}$ to $r^{-2}$). As a result, the spatial extension of the fluid disturbance produced by swimmers is an order of magnitude smaller than that produced by feeders at similar Reynolds numbers. The 'quiet' propulsion of swimmers is achieved either through swimming erratically by short-lasting power strokes, generating viscous vortex rings, or by "breast-stroke swimming." Both produce rapidly attenuating flows. The more "noisy" swimming of those that are constrained by a need to simultaneously feed is due to constantly beating flagella or appendages that are positioned either anteriorly or posteriorly on the (cell) body. These patterns transcend differences in size and taxonomy and have thus evolved multiple times, suggesting a strong selective pressure to minimize predation risk.
Forecasting fish stock dynamics under climate change: Baltic herring (Clupea harengus) as a case study

Climate change and anthropogenic disturbances may affect marine populations and ecosystems through multiple pathways. In this study we present a framework in which we integrate existing models and knowledge on basic regulatory processes to investigate the potential impact of future scenarios of fisheries exploitation and climate change on the temporal dynamics of the central Baltic herring stock. Alternative scenarios of increasing sea surface temperature and decreasing salinity of the Baltic Sea from a global climate model were combined with two alternative fishing scenarios, and their direct and ecosystem-mediated effects (i.e., through predation by cod and competition with sprat) on the herring population were evaluated for the period 2010-2050. Gradual increase in temperature has a positive impact on the long-term productivity of the herring stock, but it has the potential to enhance the recovery of the herring stock only in combination with sustainable fisheries management (i.e., Fmsy). Conversely, projections of herring spawning stock biomass (SSB) were generally low under elevated fishing mortality levels (Fhigh), comparable with those experienced by the stock during the 1990s. Under the combined effects of long-term warming and high fishing mortality uncertainty in herring SSB projections was higher and increasing for the duration of the forecasts, suggesting a synergistic effect of fishery exploitation and climate forcing on fish populations dynamics. Our study shows that simulations of long-term fish dynamics can be an informative tool to derive expectations of the potential long-term impact of alternative future scenarios of exploitation and climate change.

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Organisations: Centre for Ocean Life, National Institute of Aquatic Resources, Lund University, National Marine Fisheries Research Institute, University of Gothenburg
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The use of modelling approaches in marine science, and in particular fisheries science, is explored. We highlight that the choice of model used for an analysis should account for the question being posed or the context of the management...
problem. We examine a model-classification scheme based on Richard Levins’ 1966 work suggesting that models can only achieve two of three desirable model attributes: realism, precision, and generality. Model creation, therefore, requires trading-off of one of these attributes in favour of the other two: however, this is often in conflict with the desires of end-users (i.e. mangers or policy developers). The combination of attributes leads to models that are considered to have empirical, mechanistic, or analytical characteristics, but not a combination of them. In fisheries science, many examples can be found of models with these characteristics. However, we suggest that models or techniques are often employed without consideration of their limitations, such as projecting into unknown space without generalism, or fitting empirical models and inferring causality. We suggest that the idea of trade-offs and limitations in modelling be considered as an essential first step in assessing the utility of a model in the context of knowledge for decision-making in management.
How can we distinguish between competing explanations of year class strength?

**General information**
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Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography, Centre for Ocean Life
Authors: Ferreira, A. S. (Intern), MacKenzie, B. (Intern), Butenschön, M. (Ekstern), Payne, M. (Intern)
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Main Research Area: Technical/natural sciences
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How important is diversity for capturing environmental-change responses in ecosystem models?

Marine ecosystem models used to investigate how global change affects ocean ecosystems and their functioning typically omit pelagic plankton diversity. Diversity, however, may affect functions such as primary production and their sensitivity to environmental changes. Here we use a global ocean ecosystem model that explicitly resolves phytoplankton diversity by defining subtypes within four phytoplankton functional types (PFTs). We investigate the model's ability to capture diversity effects on primary production under environmental change. An idealized scenario with a sudden reduction in vertical mixing causes diversity and primary-production changes that turn out to be largely independent of the number of coexisting phytoplankton subtypes. The way diversity is represented in the model provides a small number of niches with respect to nutrient use in accordance with the PFTs defined in the model. Increasing the number of phytoplankton subtypes increases the resolution within the niches. Diversity effects such as niche complementarity operate between, but not within PFTs, and are constrained by the variety of traits and trade-offs resolved in the model. The number and nature of the niches formulated in the model, for example via trade-offs or different PFTs, thus determines the diversity effects on ecosystem functioning captured in ocean ecosystem models.

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Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Massachusetts Institute of Technology, GEOMAR - Helmholtz Centre for Ocean Research Kiel
Authors: Prowe, F. (Intern), Pahlow, M. (Ekstern), Dutkiewicz, S. (Ekstern), Oschlies, A. (Ekstern)
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Within its life cycle, a copepod goes through drastic changes in size, shape and swimming mode. In particular, there is a stark difference between the early (nauplius) and later (copepodid) stages. Copepods inhabit an intermediate Reynolds number regime (between similar to 1 and 100) where both viscosity and inertia are potentially important, and the Reynolds number changes by an order of magnitude during growth. Thus we expect the life stage related changes experienced by a copepod to result in hydrodynamic and energetic differences, ultimately affecting the fitness. To quantify these differences, we measured the swimming kinematics and fluid flow around jumping Acartia tonsa at different stages of its life cycle, using particle image velocimetry and particle tracking velocimetry. We found that the flow structures around nauplii and copepodids are topologically different, with one and two vortex rings, respectively. Our measurements suggest that copepodids cover a larger distance compared to their body size in each jump and are also hydrodynamically quieter, as
the flow disturbance they create attenuates faster with distance. Also, copepodids are energetically more efficient than nauplii, presumably due to the change in hydrodynamic regime accompanied with a well-adapted body form and swimming stroke.

**General information**

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**Organisations:** Department of Physics, Biophysics and Fluids, National Institute of Aquatic Resources, Centre for Ocean Life

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- Scopus rating (2005): SJR 1.591 SNIP 1.309
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Inter- and intra-specific diurnal habitat selection of zooplankton during the spring bloom observed by Video Plankton Recorder

Diel vertical migration (DVM) is a common behavior adopted by zooplankton species. DVM is a prominent adaptation for avoiding visual predation during daylight hours and still being able to feed on surface phytoplankton blooms during night. Here, we report on a DVM study using a Video Plankton Recorder (VPR), a tool that allows mapping of vertical zooplankton distributions with a far greater spatial resolution than conventional zooplankton nets. The study took place over a full day–night cycle in Disko Bay, Greenland, during the peak of the phytoplankton spring bloom. The sampling revealed a large abundance of copepods performing DVM (up during night and down during day). Migration behavior was expressed differently among the abundant groups with either a strong DVM (euphausiids), an absence of DVM (i.e., permanently deep; ostracods) or a marked DVM, driven by strong surface avoidance during the day and more variable depth preferences at night (Calanus spp.). The precise individual depth position provided by the VPR allowed us to conclude that the escape from surface waters during daytime reduces feeding opportunities but also lowers the risk of predation (by reducing the light exposure) and thereby is likely to influence both state (hunger, weight and stage) and survival. The results suggest that the copepods select day and night time habitats with similar light levels (~10−9 μmol photon s−1 m−2). Furthermore, Calanus spp. displayed state-dependent behavior, with DVM most apparent for smaller individuals, and a deeper residence depth for the larger individuals.
Krill diversity and population structure along the sub-Arctic Godthåbsfjord, SW Greenland

In June 2010 four krill species were collected in Godthaëbsfjord, SW Greenland, namely Thysanoessa raschii, T. inermis, T. longicaudata and Meganyctiphanes norvegica. A transect from offshore Fyllas Bank to the inner Godthaëbsfjord revealed a zonation of the species in relation to hydrography. Offshore, in the Atlantic-influenced water, the Atlantic T. longicaudata dominated. All individuals of T. longicaudata found offshore were carrying spermatophores. Within the fjord T. raschii and T. inermis were present in high numbers but the former dominated. The boreal M. norvegica were only present in the inner part of the fjord. Presence of only 1-year-old individuals and no fertilized females suggests the population is sustained by advection of M. norvegica from offshore waters. Krill community
abundance and biomass were lowest offshore and peaked in the innermost part of Godtha˚bsfjord. Thysanoessa inermis matured after 2 years, while T. raschii matured after 1 and 2 years, respectively, depending on temperature. The present study suggests that a warmer future will favour Atlantic species and result in a more diverse self-sustainable krill community in the Godtha˚bsfjord.

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Low fertilization rates in a pelagic copepod caused by sexual selection?

We studied female fertilization status in North Sea summer populations and laboratory cultures of the marine copepod Temora longicornis and found fractions of fertilized females in both field and laboratory populations that were much smaller (<50%) than predicted by a theoretical model that assumes random mating. Such low fertilization rates are normally related to environmental factors such as poor food or low densities, which we could not confirm in our experiment. Male density was negatively related to fertilization rate, and a large fraction of males did not mate in laboratory incubations. We therefore suggest that sexual selection, through mate choice or male–male competition could account for low fertilization rates of females in populations of pelagic copepods during some periods of the year.
Macroevolutionary patterns of sexual size dimorphism in copepods

Major theories compete to explain the macroevolutionary trends observed in sexual size dimorphism (SSD) in animals. Quantitative genetic theory suggests that the sex under historically stronger directional selection will exhibit greater interspecific variance in size, with covariation between allometric slopes (male to female size) and the strength of SSD across clades. Rensch's rule (RR) also suggests a correlation, but one in which males are always the more size variant sex. Examining free-living pelagic and parasitic Copepoda, we test these competing predictions. Females are commonly the larger sex in copepod species. Comparing clades that vary by four orders of magnitude in their degree of dimorphism, we show that isometry is widespread. As such we find no support for either RR or for covariation between allometry and SSD. Our results suggest that selection on both sexes has been equally important. We next test the prediction that variation in the degree of SSD is related to the adult sex ratio. As males become relatively less abundant, it has been hypothesized that this will lead to a reduction in both inter-male competition and male size. However, the lack of such a correlation across diverse free-living pelagic families of copepods provides no support for this hypothesis. By comparison, in sea lice of the family Caligidae, there is some qualitative support of the hypothesis, males may suffer elevated mortality when they leave the host and rove for sedentary females, and their female-biased SSD is greater than in many free-living families. However, other parasitic copepods which do not appear to have obvious differences in sex-based mate searching...
risks also show similar or even more extreme SSD, therefore suggesting other factors can drive the observed extremes.

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Authors: Hirst, A. G. (Intern), Kiørboe, T. (Intern)
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Marine microplastics - Method development for detection of plastic particles from sea water down to 10 μm

During the past few years and especially in 2014, plastic pollution has gained a lot of media attention and public awareness is rising. Management plans and policies start to adopt strategies for mitigating effects and reducing entry of marine litter and beached plastic. Strangled seals or plastic ingesting seabirds are perceived easily by the broad public through emotionally charged photographs and personal experiences on beaches all around the globe. Monitoring programs, beach clean-ups, source elimination, and societal changes such as local bans of single-use plastic bags or outphasing of microbeads in personal care products are being talked of frequently. All together, this increases the acceptance of allocation of public resources on environmental programs. In contrast it is hard to draw someones attention to possible effects of microplastics on community structures of organisms on the bottom of the food web, whose existence and importance we are rarely aware of. There are chances for severe impacts in plastic accumulating ocean gyres which are of oligotrophic nature and consequently low food availability. So far the concentrations, biological impact and the fate of disintegrating plastics in the marine environment are still not enough understood, especially with perspective on the ecosystem as a whole. Zooplankton, free-floating animals that often live of single-celled algae, form the link between primary production and higher trophic level organisms, including commercially important fish species and therefore human food resources. Microplastic, either as degradation product from plastic litter or directly introduced as microfibres, microbeads or plastic resin pellets, have been found by many studies down to sizes of a few micrometres, which is in the food size range of most zooplankter. The physical and chemical harm from ingestion can not be quantified yet, and also data on distribution of particles smaller than 300 μm is sparse. The handling and analysis of those small microplastics is still difficult and no working standard methods are in place. Here we show our ongoing work on a sample set from a cross Atlantic transect to estimate the concentration of microplastic from 10 μm and larger based on visual identification supported by Raman microspectrometry.
Mechanisms behind the metabolic flexibility of an invasive comb jelly

Mnemiopsis leidyi is an invasive comb jelly which has successfully established itself in European seas. The species is known to produce spectacular blooms yet it is holoplanktonic and not much is known about its population dynamics in between. One way to gain insight on how M. leidyi might survive between blooms and how it can bloom so fast is to study how the metabolism of this species actually responds to environmental changes in food and temperature over its different life-stages. To this end we combined modelling and data analysis to study the energy budget of M. leidyi over its full life-cycle using Dynamic Energy Budget (DEB) theory and literature data. An analysis of data obtained at temperatures ranging from 8 to 30 °C suggests that the optimum thermal tolerance range of M. leidyi is higher than 12 °C. Furthermore M. leidyi seems to undergo a so-called metabolic acceleration after hatching. Intriguingly, the onset of the acceleration appears to be delayed and the data do not yet exist which allows determining what actually triggers it. It is hypothesised that this delay confers a lot of metabolic flexibility by controlling generation time. We compared the DEB model parameters for this species with those of another holoplanktonic gelatinous zooplankton species (Pelagia noctiluca). After accounting for differences in water content, the comparison shows just how fundamentally different the two energy allocation strategies are. P. noctiluca has an extremely high reserve capacity, low turnover times of reserve compounds and high resistance to shrinking. M. leidyi adopts the opposite strategy: it has a low reserve capacity, high turnover rates of reserve compounds and fast shrinking.
Mechanisms of prey size selection in a suspension feeding copepod, Temora longicornis

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Authors: Gonçalves, R. (Intern), van Someren Gréve, H. (Intern), Couespel, D. F. (Intern), Kiørboe, T. (Intern)
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mizer: an R package for multispecies, trait-based and community size spectrum ecological modelling

1. Size spectrum ecological models are representations of a community of individuals which grow and change trophic level. A key emergent feature of these models is the size spectrum; the total abundance of all individuals that scales negatively with size. The models we focus on are designed to capture fish community dynamics useful for assessing the community impacts of fishing.

2. We present mizer, an R package for implementing dynamic size spectrum ecological models of an entire aquatic community subject to fishing. Multiple fishing gears can be defined and fishing mortality can change through time making it possible to simulate a range of exploitation strategies and management options.

3. mizer implements three versions of the size spectrum modelling framework: the community model, where individuals are only characterized by their size; the trait-based model, where individuals are further characterized by their asymptotic size; and the multispecies model where additional trait differences are resolved.

4. A range of plot, community indicator and summary methods are available to inspect the results of the simulations.

**General information**

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Modelled spatial and seasonal distribution of Blue Whiting (Micromesistius poutassou) larvae in the North-East Atlantic (1951 to 2005)

Blue whiting (Micromesistius poutassou, http://www.marinespecies.org/aphia.php?p=taxdetails&id=126439) is a small mesopelagic planktivorous gadoid found throughout the North-East Atlantic. This data contains the results of a model-based analysis of larvae captured by the Continuous Plankton Recorder (CPR) during the period 1951-2005. The observations are analysed using Generalised Additive Models (GAMs) of the the spatial, seasonal and interannual variation in the occurrence of larvae. The best fitting model is chosen using the Aikake Information Criteria (AIC). The probability of occurrence in the continuous plankton recorder is then normalised and converted to a probability distribution function in space (UTM projection Zone 28) and season (day of year). The best fitting model splits the distribution into two separate spawning grounds north and south of a dividing line at 53 N. The probability distribution is therefore normalised in these two regions (ie the space-time integral over each of the two regions is 1). The modelled outputs are on a UTM Zone 28 grid: however, for convenience, the latitude ("lat") and longitude ("lon") of each of these grid points are also included as a variable in the NetCDF file. The assignment of each grid point to either the Northern or Southern component (defined here as north/south of 53 N), is also included as a further variable ("component"). Finally, the day of year ("doy") is stored as the number of days elapsed from and included January 1 (ie doy=1 on January 1) - the year is thereafter divided into 180 grid points

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Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Pointin, F. (Intern), Payne, M. (Intern)
Reproduction in planktonic animals depends on numerous biotic and abiotic factors. One of them is predation pressure, which can have both direct consumptive effects on population density and sex ratio, and non-consumptive effects, for example on mating and migration behaviour. In copepods, predator vulnerability depends on their sex, motility pattern and mating behaviour. Therefore, copepods can be affected at multiple stages during the mating process. We investigated the reproductive dynamics of the estuarine copepod Eurytemora affinis in the presence and absence of its predator the mysid Neomysis integer in a mesocosm experiment. We found that the proportion of ovigerous females decreased in the presence of predators. This shift was not caused by differential predation as the absolute number of females was unaffected by mysid presence. Presence of predators reduced the ratio of males to non-ovigerous females, but not by predation of males. Our combined results suggest that the shift from ovigerous to non-ovigerous females under the presence of predators was caused by either actively delayed egg production or by shedding of egg sacs. Nauplii production was initially suppressed in the predation treatment, but increased towards the end of the experiment. The proportion of fertilized females was similar in both treatments, but constantly fell behind model predictions using a random mating model. Our results highlight the importance of non-consumptive effects of predators on copepod reproduction and hence on population dynamics.
Novel insight into the role of heterotrophic dinoflagellates in the fate of crude oil in the sea

Although planktonic protozoans are likely to interact with dispersed crude oil after a spill, protozoan-mediated processes affecting crude oil pollution in the sea are still not well known. Here, we present the first evidence of ingestion and defecation of physically or chemically dispersed crude oil droplets (1-86 mm in diameter) by heterotrophic dinoflagellates, major components of marine planktonic food webs. At a crude oil concentration commonly found after an oil spill (1 μL L⁻¹), the heterotrophic dinoflagellates Noctiluca scintillans and Gyrodinium spirale grew and ingested similar to 0.37 μg-oil mg-C⁻¹ d⁻¹, which could represent similar to 17% to 100% of dispersed oil in surface waters when heterotrophic dinoflagellates are abundant or bloom. Egestion of faecal pellets containing crude oil by heterotrophic dinoflagellates could contribute to the sinking and flux of toxic petroleum hydrocarbons in coastal waters. Our study indicates that crude oil ingestion by heterotrophic dinoflagellates is a noteworthy route by which petroleum enters marine food webs and a previously overlooked biological process influencing the fate of crude oil in the sea after spills.

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OpenFluor - an online spectral library of auto-fluorescence by organic compounds in the environment

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Authors: Murphy, K. R. (Ekstern), Stedmon, C. A. (Intern), Wenig, P. (Ekstern), Bro, R. (Ekstern)
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MULTIDISCIPLINARY, POLYCYCLIC AROMATIC-HYDROCARBONS, NOCTILUCA-SCINTILLANS MACARTNEY, ZOOPLANKTON FECAL PELLETS, DISPERSANT COREXIT 9500A, NORTHERN ADRIATIC SEA, SETO INLAND SEA, GULF-OF-MEXICO, MARINE SNOW, RED-TIDE, ECOLOGICAL ROLES

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Several hypotheses have been promoted for phytoplankton bloom onset in the North Atlantic. First we show that the bloom dynamics in the northeastern corner stand out from the rest of the subpolar Atlantic, and thus warrants focused attention. We hypothesized that, for this region, late and weak blooms are expected in years of a strong subpolar gyre, i.e. strong atmospheric forcing, and cold and low saline conditions. We apply novel phenology algorithms to satellite ocean colour data, and analyse the outcome together with the subpolar gyre index.

We find that the relationship between the bloom dynamics and the subpolar gyre is complex, showing no clear spatial pattern. Our hypothesis is therefore partly refuted, probably due to the disparity in the temporal and spatial resolutions of the subpolar gyre index, compared to indices describing spring bloom dynamics. The annually averaged gyre index represents the integrated oceanic dynamics over the Northern North Atlantic, while the timing of the spring bloom is more governed by direct atmospheric forcing during the pre-bloom weeks.

We, therefore, further investigate which published theories (Sverdrup [1953], Siegel et al [2002], Huisman et al [2002], Townsend et al [1994], and Taylor and Ferrari [2011]) for bloom onset are suited for this region. We construct indicator fields and time series which in various combinations provide models consistent with the principle dynamics proposed in these theories. Using a multi-model inference approach, we investigate the spatially dependent ranking of these models. It appears that different theories apply at different regions within the North-East Atlantic, depending on the local physical dynamics.

Phytoplankton bloom and subpolar gyre induced dynamics in the North Atlantic

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Phytoplankton bloom and subpolar gyre induced dynamics in the North Atlantic

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Population dynamic of high latitude copepods - with emphasis on Metridia longa

High latitude ecosystems are shaped by seasonality in light, ranging from complete darkness in winter to midnight sun in summer, influencing both temperature and primary production. Copepods are important grazers on phytoplankton in marine systems and occupy a central role in the marine food-web, linking smaller and larger organisms. Research of copepod communities in the Arctic has traditionally focused on larger taxa present in the surface layers. Consequently, little is known about reproduction strategies and population dynamics of smaller copepods located deeper in the water column. The aim of this thesis was to identify the dominant copepod species in an open ocean system covering different water masses in Baffin Bay and Davis Strait, as well as a sub-Arctic fjord during spring and summer. Both investigations were conducted using fine meshed nets, sampling of deeper water masses and including diurnal and nocturnal sampling. The seasonal fjord study further identified different life strategies with respect to seasonal adaptations in reproduction and migration patterns. In contrast to the general assumption that large calanoid copepods dominate high latitude ecosystems, we find that smaller species numerically dominated the copepod community in the fjord. The contribution of the smaller species was less pronounced in Baffin Bay. However, even in this region, smaller species dominated in the part of the study area when the large Calanus species had left the surface layer to overwinter at depth. The large calanoid Metridia longa dominated the biomass in the fjord during spring and represented a significant part of the biomass in Baffin Bay and Davis Strait. Metridia longa exhibited a pronounced diel vertical migration, avoiding the upper 150 meters of the water column during day. Thus, sampling only the upper water column during the day-as is a usual procedure-would underestimate this potential key species. Reproduction patterns of the large calanoids suggested lifecycles adapted to the seasonal and episodic food availability, and consequently had a pulsed reproduction. In contrast, small copepod species were less dependent on the spring phytoplankton bloom, and their reproduction and population dynamics were less pulsed. Likewise, a large proportion of Oithona similis was ovigerous from March to August. Reproduction of Microsetella norvegica, another of the small key species in the fjord, was more restricted and indicated a life-history strategy that combines the advantages of eggcarrying with inter-clutch duration independent of hatching time. Our findings stress the need for sampling with small meshed nets, sampling deeper in the water column, and sampling both diurnally and nocturnally to target the entire copepod community. We speculate that the complexity of the copepod community will increase in a warmer climate, as smaller species will profit more than the larger species from increased water temperatures.
Population dynamics and production of the small copepod Oithona spp. in a subarctic fjord of West Greenland

The small cyclopoid copepod Oithona is widely occurring in polar areas; however, knowledge of its biology and ecology is very limited. Here, we investigate the population dynamics, vertical distribution, and reproductive characteristics of Oithona spp. from late winter to summer, in a subarctic fjord of West Greenland. During winter–early spring, the abundance of Oithona spp. was low (1.8 × 10^3 ind. m^-2) and the population was mainly composed of late copepodites and adults, whereas in summer, abundance peaked and younger stages dominated (1.1 × 10^6 ind. m^-2). In general, all stages of Oithona spp. remained in the upper 100 m, with nauplii exhibiting a shallower distribution. Although no general seasonal migration was found, a deeper distribution of the adult females in winter was observed. The mean clutch size of Oithona spp. varied from 16 to 30 eggs per female, peaking in summer. Egg production rates (EPR) were low in winter–early spring (0.13 ± 0.03 eggs female^-1 day^-1) and reached maximum values in summer (1.6 ± 0.45 eggs female^-1 day^-1). EPR of Oithona spp. showed a significantly positive relationship with both temperature and protozooplankton biomass, and the development of the population seemed to be appreciably affected by temperature. Oithona spp. remained active throughout the study, stressing the key importance of these small copepods in high-latitude ecosystems, especially in periods when larger copepods are not present in the surface layer.

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Prey or predator – expanding the food web role of sandeel (Ammodytes marinus)

We report an unexpected observation of lesser sandeel Ammodytes marinus foraging on juveniles and late larval stages of the same species. This recording sheds new light on the cannibalistic and piscivorous capacity of forage fish and raises a number of questions about the role of forage fish in marine food webs. In 2012 and 2013 the stomachs of 748 sandeels from 36 different commercial sandeel hauls in the central North Sea were opened. 9% of these stomachs contained late stage sandeel larvae. In order to better understand the cannibalistic nature of sandeels, we made a detailed analysis of another 450 sandeels from a single haul with a high frequency of apparent cannibals. One-third of the stomachs contained a minimum of one young sandeel (mean length 2.7 cm; max. length 4.9 cm), 10 percent contained 5 or more, and one stomach contained 18. Analyses of sample DNA confirmed that predator and prey were conspecifics. Larger specimens were more likely to be cannibals. However, among cannibals the specific sandeel larvae consumption was independent of cannibal size. We argue that this piscivorous cannibalistic behaviour may not only be a key factor in explaining recruitment fluctuations in North Sea sandeel stocks, but it may also add a new element to the complexity of energy flow in marine food chains.

General information
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Organisations: National Institute of Aquatic Resources, Section for Ecosystem based Marine Management, Section for Marine Living Resources, Section for Marine Ecology and Oceanography, Centre for Ocean Life
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Publication information
Re-assessing copepod growth using the Moult Rate method

Estimating growth and production rates of mesozooplankton, and copepods in particular, is important in describing flows of material and energy though pelagic systems. Over the past 30 years, the Moult Rate (MR) method has been used to estimate juvenile copepod growth rates in ~40 papers. Yet the MR method has been shown to have serious flaws. Here we re-examine the results from the majority of published MR method studies and re-estimate growth rates using the modified Moult Rate (MMR) method, which ascribes changes in mass to the appropriate time period over which it was
accrued. The MR method has typically over-estimated growth rates (on 80% of occasions) for life stages where the subsequent stage is actively moulting; the median and mean MR values are 138 and 164%, respectively, of the corrected MMR values. We were unable to correct the original data for life stages that are followed by a non-moulting stage, e.g. copepodite stage 5 to adult. We performed experiments with Calanus pacificus to estimate growth of stage C5 using an alternative method. We found that the error size and sign varied between mass type (i.e. DW, C and N).

Recommendations for practical future assessments of growth in copepods are made.
Route optimisation and solving Zermelo’s navigation problem during long distance migration in cross flows

The optimum path to follow when subjected to cross flow was first considered over 80 years ago by the German mathematician Ernst Zermelo, in the context of a boat being displaced by ocean currents, and has become known as the ‘Zermelo navigation problem’. However, the ability of migrating animals to solve this problem has received limited consideration, even though wind and ocean currents cause the lateral displacement of flyers and swimmers, respectively, particularly during long-distance journeys of 1000s of kilometres. Here, we examine this problem by combining long-distance, open-ocean marine turtle movements (obtained via long-term GPS tracking of sea turtles moving 1000s of km), with a high resolution basin-wide physical ocean model to estimate ocean currents. We provide a robust mathematical framework to demonstrate that, while turtles eventually arrive at their target site, they do not follow the optimum (Zermelo’s) route. Even though adult marine turtles regularly complete incredible long-distance migrations, these vertebrates primarily rely on course corrections when entering neritic waters during the final stages of migration. Our work introduces a new perspective in the analysis of wildlife tracking datasets, with different animal groups potentially exhibiting different levels of complexity in goal attainment during migration.

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Web of Science (2016): Indexed yes
Sea surface temperature variability at the Scripps Institution of Oceanography Pier

Sea surface temperature (SST) has been measured from near the end of the SIO pier daily since 1916. It is one of the world’s longest instrumental time series of SST. It is widely used in studies of climate and marine ecosystems and in fisheries management. We hypothesized that a discontinuity exists in 1988, when the old pier was replaced with the present pier. A regression of annual mean SST at SIO (SSTSIO) on the Pacific Decadal Oscillation index for 1916-1987 was used to predict annual mean SST (SSTSIO, PDO) for 1916-present. The residual (ResSSTSIO = SSTSIO - SSTSIO, PDO) time series shows a positive discontinuity in 1988, when the present SIO pier was first used to measure SSTSIO. No discontinuity in 1988 was observed for ResSST at 12 other shore stations or nearby waters. Use of the first principal component of other shore station time series of annual mean SST as the predictor yields similar results. SSTSIO measured over three days shows a diel cycle and short-term variability consistent with rip current transport of warm surf zone water to the end of the SIO pier. We hypothesize that rip current transport increased with the change from the old to the present pier and contributed to the observed discontinuity in SIO pier SST. We estimate an artifact of ~ +0.45°C due to both rapid (1988 pier change) and gradual processes. Adjusting the SIO pier SST time series for this artifact reduces the long-term trend from +1.1°C/century to +0.6°C/century, consistent with the global rate of change of SST over the past century.
Sexual selection in marine plankton

Copepods are among the most abundant metazoans on the planet and play an important role in the marine food web. Many aspects of their ecology have consequently been studied, including details of their reproductive biology and mating behaviour. Sexual selection, the part of evolution which selects for increased mating and fertilization success, is an important evolutionary process, with consequences at individual, population and species level. Yet very little is known about the significance of sexual selection for the evolution and ecology of this key group of animals. The presented thesis used behavioural studies and genetic parentage analyses to examine the fertilization status and occurrence of mate choice and polygamy in the copepod Temora longicornis (Copepoda, Calanoida). The overall objective of my PhD project was to examine the intensity and direction of sexual selection in T. longicornis and elucidate the role of sexual selection for the behaviour of individuals, the dynamics of populations, and the functioning of the pelagic ecosystem. I wanted to address the following overarching questions: i) What is the fraction of fertilized females in field and laboratory populations? Is it influenced by adult abundance, male mating capacity and the environment? ii) Is mating in T. longicornis random, or do some individuals have a higher-than-average chance of fertilizing or being fertilized? iii) Which traits control mating in T. longicornis? Are body size and age significant factors influencing male fecundity (mating rate and sperm production) and female reproductive fitness? iv) Does multiple mating lead to multiple paternity? What is the effect of multiple mating on the female’s reproductive output as well as the longevity of the individual? The thesis is divided into 5 chapters that report on different efforts to address these objectives. It opens with a general introduction and synopsis that lays out the context for the research, summarizes the main findings and discusses perspective for future research (Chapter 1). In Chapter 2 we studied female fertilization status in North Sea summer populations and in laboratory cultures of T. longicornis. The study showed that the fractions of fertilized females in both field and laboratory populations were much smaller (< 500%) than predicted by a theoretical model that assumes random mating. Such low fertilization rates are normally related to environmental factors such as poor food or low densities, which we could not confirm in our experiment. Male density was negatively related to fertilization rate, and a large fraction of males did not mate in laboratory incubations. This led to Chapter 3, where we investigated age- and size-dependent reproductive performance (egg and sperm production, mating success) in T. longicornis. We found that ageing effects were evident: mortality rate increased with age, and fertility decreased rapidly with age. We also found that several aspects of reproductive performance increased with size in both males and females: large males produced more offspring than small ones, and large males mated more often, produced larger spermatophores containing more sperm cells and sired more offspring. The study also showed that repeated mating was not only potentially advantageous (e.g. in terms of higher genetic variability) for females, but can come at the disadvantage of increased mortality. Chapter 4 describes the identification and characterization of the six microsatellites primers used in Chapter 5 to do paternity testing of the offspring. To investigate if mating was random or under the influence of sexual selection, we tested which males sired the female’s offspring. By establishing paternity, we can precisely quantify the reproductive success of individual males and thus assess how successful particular males have been. Our study clearly demonstrated the occurrence of multiple paternity in T. longicornis. This is the first time that genetic polyandry has been documented in a pelagic copepod. Multiple paternity opens up for the possibility of post-copulatory sexual selection, such as sperm competition and cryptic female choice. We further found that mating was non-random, as we identified superior individuals with a higher than average mating success both among females and among males. Some of the variation between individuals could be explained by variation in size and age. Large males were superior to small males in terms of reproductive success, with the larger males (0.8 mm) mating about 3 times as frequent as the smaller males (0.6 mm). In accordance with the findings in Chapter 2, we found that a fraction of the males (8-14 %) in our study never mated during incubations, despite a plentiful supply of females. Only about half of the females in our experiments were fertilized, even though male availability was high and mate encounters not limiting. The strong size- and age-dependent fertility in this species is conducive to the existence of sexual selection via mate choice for young and large partners, as has been shown in another copepod species. We further suggest that sexual selection, through mate choice or male–male competition could account for low fertilization rates of females in populations of pelagic copepods during some periods of the year.

This thesis suggests that the processes and mechanisms of sexual selection have to be considered when studying reproductive rates in copepod populations

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Shifts in mass-scaling of respiration, feeding, and growth rates across life-form transitions in marine pelagic organisms

The metabolic rate of organisms may be viewed as a basic property from which other vital rates and many ecological patterns emerge and that follows a universal allometric mass scaling law, or it may be considered a property of the organism that emerges as a result of the adaptation to the environment, with consequently fewer universal mass scaling properties. Here, we examine the mass scaling of respiration and maximum feeding (clearance and ingestion rates) and growth rates of heterotrophic pelagic organisms over an ~10^15 range in body mass. We show that clearance and respiration rates have life-form-dependent allometries that have similar scaling but different intercepts, such that the mass-specific rates converge on a rather narrow size-independent range. In contrast, ingestion and growth rates follow a near-universal taxa-independent ~3/4 mass scaling power law. We argue that the declining mass-specific clearance rates with size within taxa is related to the inherent decrease in feeding efficiency of any particular feeding mode. The transitions between feeding mode and simultaneous transitions in clearance and respiration rates may then represent adaptations to the food environment and be the result of the optimization of trade-offs that allow sufficient feeding and growth rates to balance mortality.
Size-based predictions of food web patterns

We employ size-based theoretical arguments to derive simple analytic predictions of ecological patterns and properties of natural communities: size-spectrum exponent, maximum trophic level, and susceptibility to invasive species. The predictions are brought about by assuming that an infinite number of species are continuously distributed on a size-trait axis. It is, however, an open question whether such predictions are valid for a food web with a finite number of species embedded in a network structure. We address this question by comparing the size-based predictions to results from dynamic food web simulations with varying species richness. To this end, we develop a new size- and trait-based food web model that can be simplified into an analytically solvable size-based model. We confirm existing solutions for the size distribution and derive novel predictions for maximum trophic level and invasion resistance. Our results show that the predicted size-spectrum exponent is borne out in the simulated food webs even with few species, albeit with a systematic bias. The predicted maximum trophic level turns out to be an upper limit since simulated food webs may have a lower number of trophic levels, especially for low species richness, due to structural constraints. The size-based model possesses an evolutionary stable state and is therefore un-invadable. In contrast, the food web simulations show that all communities, irrespective of number of species, are equally open to invasions. We use these results to discuss the validity of size-based predictions in the light of the structural constraints imposed by food webs.
Stratification-mixing cycles and plankton dynamics in a shallow estuary (Limfjord, Denmark)
The biomass, production and consumption of phytoplankton, bacteria and zooplankton in a shallow Danish estuary (Limfjord) were analysed during a 9-day period. The water column changed between stratified and mixed conditions which influenced the dominant processes in the pelagic system. During strong stratification, phytoplankton was mainly controlled by microzooplankton grazing. A mixing event, which homogenized the water column, possibly provided food to a mussel-dominated benthic community. Concomitantly, zooplankton feeding and reproduction decreased. However, the nutrient input to the upper part of the water column during mixing and the subsequent stabilization provided the ideal conditions for the recovery of phytoplankton from the loss processes from previous days. Microzooplankton, which was also a significant consumer of bacteria throughout the sampling period, was not the only consumer controlling phytoplankton. The microbial food web was an important route for total plankton carbon during the study. However, the shorter food web increased in importance during mixing, possibly due to stronger benthic–pelagic coupling than during stratified periods. Stratification-mixing cycles, occurring during short-time periods, should be a key mechanism maintaining the benthic and pelagic communities in this shallow water system.

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Scopus rating (2014): SJR 1.095 SNIP 1.255 CiteScore 2.24
Web of Science (2014): Indexed yes
We establish that age and length at 50% proportion mature decreased from the 70’s to the 2000’s in North Sea cod (Gadus morhua), haddock (Melanogrammus aeglefinus), and whiting (Merlangius merlangus), but not in Norway pout (Trisopterus esmarkii). The potential contributions of demography, phenotypic plasticity, and evolution to these trends were assessed. First, maturation trends were extricated from demographic effects and growth-dependent plasticity by estimating probabilistic maturation reaction norms (PMRNs). PMRN midpoints have significantly shifted downwards at most ages for cod, haddock, and whiting, but not for Norway pout. Second, increased temperature and food abundance, loosened trophic competition, and relaxed social pressure may also trigger growth-independent plasticity in maturation. Principal component regression of PMRN midpoints on annual estimates of relevant environmental variables exhibiting a temporal trend suggest that, despite some evidence of environmental effects, PMRN trends were mostly independent of growth-independent plasticity in haddock, whiting, and male cod, but not in female cod. According to these findings, evolution of maturation, potentially in response to fishing, is plausible in haddock, whiting, and male cod, unlikely for Norway pout, but not needed to explain trends in female cod maturation. In agreement with life-history theory, the maturation response was larger in fast-growing, late- and large-maturing species exhibiting moderate reproductive effort.
Temporal trends in age.pdf. Embargo ended: 03/03/2017
The Baltic ATLANTIS model: Implementing a holistic framework to evaluate ecosystem wide responses to changes in climate and anthropogenic forcing

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography, Section for Ecosystem based Marine Management, Section for Marine Living Resources, Section for Monitoring and Data, Centre for Ocean Life, Aarhus University
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The bijection from data to parameter space with the standard DEB model quantifies the supply–demand spectrum

The standard Dynamic Energy Budget (DEB) model assumes that food is converted to reserve and a fraction $\kappa$ of mobilised reserve of an individual is allocated to somatic maintenance plus growth, while the rest is allocated to maturity maintenance plus maturation (in embryos and juveniles) or reproduction (in adults). The add_my_pet collection of over 300 animal species from most larger phyla, and all chordate classes, shows that this model fits energy data very well. Nine parameters determine nine data points at abundant food: dry/wet weight ratio, age at birth, puberty, death, weight at birth, metamorphosis, puberty, ultimate weight and ultimate reproduction rate. We demonstrate that, given a few other parameters, these nine data points also determine the nine parameters uniquely that are independent of food availability: maturity at birth, metamorphosis and puberty, specific assimilation, somatic maintenance and costs for structure, allocation fraction of mobilised reserve to soma, energy conductance, and ageing acceleration. We provide an efficient algorithm for mapping between data and parameter space in both directions and found expressions for the boundaries of the parameter and data spaces. One of them quantifies the position of species in the supply–demand spectrum, which reflects the internalisation of energetic control. We link eco-physiological properties of species to their position in this spectrum and discuss it in the context of homeostasis. Invertebrates and ray-finned fish turn out to be close to the supply end of the spectrum, while other vertebrates, including cartilaginous fish, have stronger demand tendencies. We explain why birds and mammals up-regulate metabolism during reproduction. We study some properties of the bijection using elasticity coefficients. The properties have applications in parameter estimation and in the analysis of evolutionary constraints on parameter values; the relationship between DEB parameters and data has similarities to that between genotype and phenotype

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Pages: 35-47
Publication date: 2014
Main Research Area: Technical/natural sciences
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Mediated principally by the sinking of organic rich particles from the upper ocean, the Biological Carbon Pump (BCP) is a significant component of the global carbon cycle. It transfers roughly 11 Gt C yr\(^{-1}\) into the ocean's interior and maintains atmospheric carbon dioxide at significantly lower levels than would be the case if it did not exist. More specifically, export by the BCP in the North Atlantic is ~0.55–1.94 Gt C yr\(^{-1}\). A rich set of observations suggests that a complex set of processes drives this export. However, significant uncertainties exist regarding the BCP in the North Atlantic, including both the magnitude of the downward flux and the ecological, chemical and physical processes by which it is sustained and controlled. Our lack of detailed mechanistic understanding has also hindered modelling attempts to quantify and predict changes to the BCP. In this paper, we assess current knowledge concerning the BCP in the North Atlantic in order to identify priorities for future research, as well as suggesting how they might be addressed.
The chemical ecology of copepods

An increasing number of studies show the importance of chemical interactions in the aquatic environment. Our understanding of the role of chemical cues and signals in larger crustaceans has advanced in the last decades. However, for copepods, the most abundant metazoan zooplankton and essential for the functioning of the marine food web, much is still unknown. We synthesize current knowledge about chemical ecology of copepods including foraging, survival and reproduction. We also compile information on the sensory apparatus and new analytical approaches that may facilitate the identification of signal molecules. The review illustrates the importance of chemical interactions in many aspects of copepod ecology and identifies gaps in our knowledge, such as the lack of identified infochemicals and electrophysiological studies to confirm the function of sensory structures. We suggest approaches that are likely to further our understanding of the role of chemical interactions in the pelagic ecosystem.

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Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, University of Gothenburg
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The community structure of over-wintering larval and small juvenile fish in a large estuary

The Skagerrak and Kattegat are estuarine straits of high hydrographical and ecological diversity, situated between the saline waters of the North Sea and the brackish waters of the Baltic Sea. These sustain important nursery grounds of many fish species, of which several overwinter during the larval and early juvenile stages. In order to give more insight into the communities of the overwintering ichthyoplankton in estuarine areas, we examine an annual series of observations from a standard survey carried out 1992–2010. Species differences and annual variability in distributions and abundances are described, and linkages between ichthyoplankton abundances and corresponding hydrographical information are analysed by GAM methods. Communities were dominated by herring, gobies, butterfish, sprat, pipefishes, lemon sole and European eel (i.e. glass eel), and all the sampled species showed large annual fluctuations in abundances. The species showed quite specific patterns of distribution although species assemblages with common distributional characteristics were identified. Within these assemblages, the ichthyoplankton abundances showed linkage to environmental characteristics described by bottom-depth and surface temperature and salinity. Hence the study points to a significant structuring of overwintering ichthyoplankton communities in large estuaries, based on the species habitat choice and its response to physical gradients.
The first "lost year" of Mediterranean sea turtles: dispersal patterns indicate subregional management units for conservation

Identifying highly frequented areas is a priority for sea turtle conservation, and the distribution of young individuals in open waters represents a major knowledge gap due to methodological biases. The drift of hatchlings from 38 loggerhead and 10 green turtle nesting sites in the Mediterranean were simulated for the first six months of life, with the simulations being repeated for five different years (2001 – 2005). The results indicate that hatchlings from the Levantine and south-central Mediterranean sites are mainly retained in the same areas of origin, while those from the Ionian area mainly disperse to the Ionian, Adriatic and south-central Mediterranean areas. Combining hatchling dispersal with existing empirical information on juveniles and adults, a general distribution model among nesting sites, oceanic and neritic foraging grounds for Mediterranean sea turtles is proposed. The Levantine zone may be particularly key for the conservation of the Mediterranean populations of both species, since it may host the highest concentration of individuals. Subregional management units identified by dispersal patterns may facilitate turtle conservation through a relatively small-scale international approach. In-water studies in specific zones are identified as a research priority for improving the current knowledge and inform conservation plans.
The Mystery of Microsetella – Combination of egg- and broadcast spawning in an Arctic fjord?
Different life-history stages of the pelagic harpacticoid Microsetella norvegica were sampled in a Greenland fjord, to investigate how this slowly growing species can achieve high abundances at low temperatures. We expected low but continuous reproduction coupled with a low mortality, but observed the opposite: a short reproductive period with high estimated weight-specific egg production and egg mortality, and indication of a life-history strategy combining the advantages of egg carrying with egg production rates independent of temperature.

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The North Atlantic Ocean as habitat for Calanus finmarchicus: environmental factors and life history traits

Here we present a new, pan-Atlantic compilation and analysis of data on Calanus finmarchicus abundance, demography, dormancy, egg production and mortality in relation to basin-scale patterns of temperature, phytoplankton biomass, circulation and other environmental characteristics in the context of understanding factors determining the distribution and abundance of C. finmarchicus across its North Atlantic habitat. A number of themes emerge: (1) the south-to-north transport of plankton in the northeast Atlantic contrasts with north-to-south transport in the western North Atlantic, which has implications for understanding population responses of C. finmarchicus to climate forcing, (2) recruitment to the youngest copepodite stages occurs during or just after the phytoplankton bloom in the east whereas it occurs after the...
bloom at many western sites, with up to 3.5 months difference in recruitment timing, (3) the deep basin and gyre of the southern Norwegian Sea is the centre of production and overwintering of C. finmarchicus, upon which the surrounding waters depend, whereas, in the Labrador/Irminger Seas production mainly occurs along the margins, such that the deep basins serve as collection areas and refugia for the overwintering populations, rather than as centres of production, (4) the western North Atlantic marginal seas have an important role in sustaining high C. finmarchicus abundance on the nearby coastal shelves, (5) differences in mean temperature and chlorophyll concentration between the western and eastern North Atlantic are reflected in regional differences in female body size and egg production, (6) regional differences in functional responses of egg production rate may reflect genetic differences between western and eastern populations, (7) dormancy duration is generally shorter in the deep waters adjacent to the lower latitude western North Atlantic shelves than in the east, (8) there are differences in stage-specific daily mortality rates between eastern and western shelves and basins, but the survival trajectories for cohort development from CI to CV are similar, and (9) early life stage survival is much lower in regions where C. finmarchicus is found with its congeners, C. glacialis and/or C. hyperboreus. This compilation and analysis provides new knowledge for evaluation and parameterisation of population models of C. finmarchicus and their responses to climate change in the North Atlantic. The strengths and weaknesses of modeling approaches, including a statistical approach based on ecological niche theory and a dynamical approach based on knowledge of spatial population dynamics and life history, are discussed, as well as needs for further research.

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Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Institute of Marine Research, University of Maine, Bedford Institute of Oceanography, Institut Maurice-Lamontagne, Sir Alister Hardy Foundation for Ocean Science, University of Maryland, Faroe Marine Research Institute, Marine Research Institute, University of Strathclyde, Alfred Wegener Institute for Polar and Marine Research, Fisheries and Oceans Canada, AZTI-Tecnalia
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Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.909 SNIP 1.461 CiteScore 3.65
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Scopus rating (2012): SJR 2.741 SNIP 1.794 CiteScore 4.17
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ISI indexed (2011): ISI indexed yes
Trophic role and top-down control of a subarctic protozooplankton community

Plankton succession was investigated in the subarctic Godthåbsfjord, Western Greenland, from March to August 2010. The trophic role of protozooplankton (ciliates and heterotrophic dinoflagellates) was evaluated with emphasis on their seasonal succession and as prey for the copepod community. The integrated protozooplankton biomass ranged between 0.1 and 4.0 g C m$^{-2}$, and was dominated by ciliates. Over the 6 mo study period, maximum potential ingestion rates of the protozooplankton ranged from 0.02 to 1.2 g C m$^{-2}$ d$^{-1}$, corresponding to 30 to 194% of primary production d$^{-1}$ or 0.5 to 37% of phytoplankton biomass d$^{-1}$. The highest copepod biomass (24 g C m$^{-2}$) occurred in spring, with Metridia longa alone contributing up to 92% of the biomass. A grazing experiment with M. longa feeding on a natural plankton assemblage confirmed that this species cleared cells in the size range 10 to 60 μm with an average clearance rate of 2.4 ml μg C$^{-1}$ d$^{-1}$. The copepod community, dominated by the genera Calanus, Metridia, Pseudocalanus, Oithona, Microsetella and Trichodia/Oncaea, accounted for 72 to 93% of the copepod biomass in the spring. After the large calanoid copepod species left the surface layer, the protozooplankton increased numerically and were the most important grazers for some weeks until a late summer copepod community, dominated by cyclopoids Oithona spp., controlled the protist community.

Our study indicated that protozooplankton succession is regulated by copepod grazing during most of the season, and that these protists provide an essential source of nutrition for the copepod populations.
Where have all the coast fish gone?

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Ecosystem based Marine Management, Section for Marine Ecology and Oceanography, Centre for Ocean Life, Section for Monitoring and Data
Authors: Støttrup, J. (Intern), Munk, P. (Intern), Lund, S. (Ekstern), Kindt-Larsen, L. (Intern), Dutz, J. (Intern), Egekvist, J. (Intern)
Acquired phototrophy in Mesodinium and Dinophysis – A review of cellular organization, prey selectivity, nutrient uptake and bioenergetics

Acquired phototrophy, i.e. the use of chloroplasts from ingested prey, can be found among some species of dinoflagellates and ciliates. The best studied examples of this phenomenon in these groups are within the ciliate genus Mesodinium and the dinoflagellate genus Dinophysis, both ecologically important genera with a worldwide distribution. Mesodinium species differ considerably in their carbon metabolism. Some species rely almost exclusively on food uptake, while other species rely mostly on photosynthesis. In Mesodinium with acquired phototrophy, a number of prey organelles in addition to chloroplasts may be retained, and the host ciliate has considerable control over the acquired chloroplasts; Mesodinium rubrum is capable of dividing its acquired chloroplasts and can also photoacclimate. In Dinophysis spp., the contents of ciliate prey are sucked out, but only the chloroplasts are retained from the ingested prey. Some chloroplast house-keeping genes have been found in the nucleus of Dinophysis and some preliminary evidence suggests that Dinophysis may be capable for photoacclimation. Both genera have been claimed to take up inorganic nutrients, including NO3−, indicating that processes beyond photosynthesis have been acquired. M. rubrum seems to depend upon prey species within the Teleaulax/Plagioselmis/Geminigera clade of marine cryptophytes. Up until now, Dinophysis species have only been maintained cultured on M. rubrum as food, but other ciliates may also be ingested. Dinophysis spp. and M. rubrum are obligate mixotrophs, depending upon both prey and light for sustained growth. However, while M. rubrum only needs to ingest 1–2% of its carbon demand per day to attain maximum growth, Dinophysis spp. need to obtain about half of their carbon demand from ingestion for maximum growth. Both Mesodinium and Dinophysis spp. can survive for months in the light without food. The potential role for modeling in exploring the complex balance of phototrophy and phagoheterotrophy, and its ecological implications for the mixotroph and their prey, is discussed.
Analysing migrations of Atlantic cod Gadus morhua in the north-east Atlantic Ocean: Then, now and the future

The application of data storage tags bears the potential for a quantum leap in the research on fish migrations, because not only first-capture and recapture positions are known, but at least theoretically, the migration path during the period at large can be reconstructed. Position, however, cannot be measured directly but has to be estimated using the available data on light, temperature, pressure and salinity. The reconstructed locations based on advanced estimation techniques have been termed geolocations. Examples are discussed which illustrate the applicability of geolocations in individual path descriptions, separation of reproductively isolated populations, timing and areas of spawning, tidal transport and use of protected areas. The examples are based on archival tag data from the North Sea, the Baltic Sea, the Barents Sea and Faroese and Icelandic Waters. Besides presenting the state-of-the-art geolocations for cod Gadus morhua in the north-east Atlantic Ocean, the major aim of this review is to raise awareness of gaps in knowledge and to identify ideas for new research.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography, Department of Applied Mathematics and Computer Science, Centre for Ocean Life, Cefas, Marine Scotland, Havsmiljöinstitutet, Institute
A neural network-based estimate of the seasonal to inter-annual variability of the Atlantic Ocean carbon sink

The Atlantic Ocean is one of the most important sinks for atmospheric carbon dioxide (CO2), but this sink is known to vary substantially in time. Here we use surface ocean CO2 observations to estimate this sink and the temporal variability from 1998 to 2007 in the Atlantic Ocean. We benefit from (i) a continuous improvement of the observations, i.e., the Surface Ocean CO2 Atlas (SOCAT) v1.5 database and (ii) a newly developed technique to interpolate the observations in space and time. In particular, we use a 2 step neural network approach to reconstruct basin-wide monthly maps of the sea surface partial pressure of CO2 (pCO2) at a resolution of 1° × 1°. From those, we compute the air–sea CO2 flux maps using a standard gas exchange parameterization and high-resolution wind speeds. The neural networks fit the observed pCO2 data with a root mean square error (RMSE) of about 10 μatm and with almost no bias. A check against independent time series data reveals a larger RMSE of about 17 μatm. We estimate a decadal mean uptake flux of −0.45 ± 0.15 Pg C yr−1 for the Atlantic between 44° S and 79° N, representing the sum of a strong uptake north of 18° N (−0.39 ± 0.10 Pg C yr−1), outgassing in the tropics (18° S–18° N, 0.11 ± 0.07 Pg C yr−1), and uptake in the subtropical/temperate South Atlantic south of 18° S (−0.16 ± 0.06 Pg C yr−1), consistent with recent studies. We find the strongest seasonal variability of the CO2 flux in the temperature driven subtropical North Atlantic, with uptake in winter and outgassing in summer. The seasonal cycle is antiphased in the subpolar latitudes relative to the subtropics largely as a result of the biologically driven winter-to-summer drawdown of CO2. Over the analysis period (1998 to 2007) sea surface pCO2 increased faster than that of the atmosphere in large areas poleward of 40° N, but many other parts of the North Atlantic increased more slowly, resulting in a barely changing Atlantic carbon sink north of the equator (−0.007 Pg C yr−1 decade−1). Surface ocean pCO2 was also increasing less than that of the atmosphere over most of the Atlantic south of the equator, leading to a substantial trend toward a stronger CO2 sink for the entire South Atlantic (−0.14 Pg C yr−1 decade−1). The Atlantic carbon sink varies relatively little on inter-annual time-scales (±0.04 Pg C yr−1; 1σ)

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, University of East Anglia, ETH Zurich, National Institute of Environmental Studies, University of New South Wales
Authors: Landschützer, P. (Ekstern), Gruber, N. (Ekstern), Bakker, D. (Ekstern), Schuster, U. (Ekstern), Nakaoka, S. (Ekstern), Payne, M. (Intern), Sasse, T. (Ekstern), Zeng, J. (Ekstern)
Pages: 7793–7815
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Publication information
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Volume: 10
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Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
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Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 4.25 SJR 2.328 SNIP 1.305
Web of Science (2016): Indexed yes
A stable-isotope mass spectrometry-based metabolic footprinting approach to analyze exudates from phytoplankton

Phytoplankton exudates play an important role in pelagic ecology and biogeochemical cycles of elements. Exuded compounds fuel the microbial food web and often encompass bioactive secondary metabolites like sex pheromones, allelochemicals, antibiotics, or feeding attractants that mediate biological interactions. Despite this importance, little is known about the bioactive compounds present in phytoplankton exudates. We report a stable-isotope metabolic footprinting method to characterise exudates from aquatic autotrophs. Exudates from 13C-enriched alga were concentrated by solid phase extraction and analysed by high-resolution Fourier transform ion cyclotron resonance mass spectrometry. We used the harmful algal bloom forming dinoflagellate Alexandrium tamarense to prove the method. An algorithm was developed to automatically pinpoint just those metabolites with highly 13C-enriched isotope signatures, allowing us to discover algal exudates from the complex seawater background. The stable-isotope pattern (SIP) of the detected metabolites then allowed for more accurate assignment to an empirical formula, a critical first step in their identification. This automated workflow provides an effective way to explore the chemical nature of the solutes exuded from phytoplankton cells and will facilitate the discovery of novel dissolved bioactive compounds.
A state-space model for estimating detailed movements and home range from acoustic receiver data

We present a state-space model for acoustic receiver data to estimate detailed movement and home range of individual fish while accounting for spatial bias. An integral part of the approach is the detection function, which models the probability of logging tag transmissions as a function of distance to receiver. The same function is used to provide absence information at times where no detections occur. In a simulation study we found that the ability of the state-space model to estimate detailed movements outperform existing non-mechanistic techniques in terms of location error. We also found that the location error scales log-linearly with detection range and movement speed. This result can be used as guideline for designing network layout when species movement capacity and acoustic environment are known or can be estimated prior to network deployment. Finally, as an example, the state-space model is used to estimate home range and movement of a reef fish in the Pacific Ocean.
Attack or attacked: The sensory and fluid mechanical constraints of copepods' predator–prey interactions

Many animals are predator and prey at the same time. This dual position represents a fundamental dilemma because gathering food often leads to increased exposure to predators. The optimization of the tradeoff between eating and not being eaten depends strongly on the sensing, feeding, and mechanisms for mobility of the parties involved. Here, I describe the mechanisms of sensing, escaping predators, and capturing prey in marine pelagic copepods. I demonstrate that feeding tradeoffs vary with feeding mode, and I describe simple fluid mechanical models that are used to quantify these tradeoffs and review observations and experiments that support the assumptions and test the predictions. I conclude by presenting a mechanistically underpinned model that predicts optimal foraging behaviors and the resulting size-scaling and magnitude of copepods' clearance rates
Behavioral traits and their trade-off in the plankton

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Visser, A. (Intern)
Publication date: 2013
Event: Abstract from International Workshop on Trait-based approaches to Ocean Life, Copenhagen, Denmark.
Main Research Area: Technical/natural sciences

Bioavailability of riverine dissolved organic matter in three Baltic Sea estuaries and the effect of catchment land use

The microbial degradation of dissolved organic carbon and nitrogen (DOC, DON) was studied in three Finnish boreal estuaries with contrasting land use patterns (Kiiminkijoki - natural forest and peatland; Kyrönjoki - agricultural; Karjaanjoki - mixed/urban). Bioassays of 12-18 d long durations were used in 3 seasons at in situ temperatures. Besides the bulk parameters, a suite of dissolved organic matter (DOM) quality parameters were also investigated, including colored DOM (CDOM), fluorescent DOM and the molecular weight of DOM. Bioavailable DOC and DON pools varied significantly between the estuaries, from 7.9 to 10.6% and from 5.5 to 21.9%, respectively. DOM originating from the catchment dominated by natural forests and peatlands (Kiiminkijoki) had the lowest DOC and DON degradation rates, as well as the lowest proportions of biodegradable DOC and DON. A greater proportion of agricultural land in the catchment increased the bioavailability of DON, but not the bioavailability of DOC (Kyrönjoki). Additionally, DOM quality varied significantly between the estuaries, and DOM originating from the agricultural Kyrönjoki catchment sustained higher DOC and DON degradation rates and higher bacterial growth efficiency (BGE) compared to those of the natural forest and peat dominated Kiiminkijoki catchment. The quality of DOM, indicated by differences in CDOM, fluorescent DOM and molecular weight, varied between estuaries with differing land use and was concluded to be major driver of BGE of these systems and thereafter to the microbial CO2 fluxes from the estuaries. The differences in BGE resulted in a 5-fold difference in the calculated daily bacterial CO2 emissions between the study’s estuaries due to bacterial activity, ranging from 40 kg C d-1 in the Karjaanjoki estuary to 200 kg C d-1 in the Kyrönjoki estuary. Lower DOC:DON ratios, smaller molecular weight and higher CDOM absorption spectral slope values of DOM resulted in higher proportion of the initial DOC and DON being transferred to microbial growth and therefore to the pelagic food web. The pristine, peatland and forest-dominated Kiiminkijoki catchment had the lowest BGE, and therefore proportionally highest CO2 fluxes

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Finnish Environment Institute, University of Helsinki
Authors: Asmala, E. (Ekstern), Autio, R. (Ekstern), Kaartokallio, H. (Ekstern), Pitkänen, L. (Ekstern), Stedmon, C. (Intern), Thomas, D. (Ekstern)
Biological oceanography across the Southern Indian Ocean – basinscale trends in the zooplankton community

We present a study on the protozooplankton 45 mm and copepods larger than 50 mm at a series of contrasting stations across the Southern Indian Ocean (SIO). Numerically, over 80% of the copepod community across the transect was less than 650 mm in size, dominated by nauplii, and smaller copepods, while 80% of the biomass (as mg C m$^3$) was larger than 1300 mm in body length. Predation by the carnivorous copepod Corycaeus sp. was estimated to be able to remove up to 2% d$^{-1}$ of the copepods o1000 mm in size. By the help of grazing models we estimated that primary producers were mainly grazed upon by ciliates and heterotrophic dinoflagellates (40–80% d$^{-1}$ combined) in temperate waters but appendicularians became increasingly important in the tropical waters grazing about 40% of the biomass per day. Despite their high abundance and biomass, copepods contributed less than 20% of the grazing at most stations. Secondary production was low (carbon specific egg production o0.14 d$^{-1}$) but typical for food limited oligotrophic oceans

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Stockholm University, Aarhus University, Phuket Marine Biological Center
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Pages: 16-27
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Main Research Area: Technical/natural sciences

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BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.76 SJR 1.45 SNIP 1.119
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.369 SNIP 1.174 CiteScore 2.77
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.557 SNIP 1.279 CiteScore 2.67
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 2.077 SNIP 1.314 CiteScore 3.11
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 2.024 SNIP 1.165 CiteScore 2.81
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.916 SNIP 1.164 CiteScore 2.68
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.865 SNIP 1.202
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.734 SNIP 1.305
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 1.505 SNIP 1.109
Chimera states in mechanical oscillator networks

The synchronization of coupled oscillators is a fascinating manifestation of self-organization that nature uses to orchestrate essential processes of life, such as the beating of the heart. Although it was long thought that synchrony and disorder were mutually exclusive steady states for a network of identical oscillators, numerous theoretical studies in recent years have revealed the intriguing possibility of “chimera states,” in which the symmetry of the oscillator population is broken into a synchronous part and an asynchronous part. However, a striking lack of empirical evidence raises the question of whether chimeras are indeed characteristic of natural systems. This calls for a palpable realization of chimera states without any fine-tuning, from which physical mechanisms underlying their emergence can be uncovered. Here, we devise a simple experiment with mechanical oscillators coupled in a hierarchical network to show that chimeras emerge naturally from a competition between two antagonistic synchronization patterns. We identify a wide spectrum of complex states, encompassing and extending the set of previously described chimeras. Our mathematical model shows that the self-organization observed in our experiments is controlled by elementary dynamical equations from mechanics that are
ubiquitous in many natural and technological systems. The symmetry-breaking mechanism revealed by our experiments may thus be prevalent in systems exhibiting collective behavior, such as power grids, optomechanical crystals, or cells communicating via quorum sensing in microbial populations.
Climate-induced response of commercially important flatfish species during the 20th century

The consequence of elevated ocean temperatures on commercial fish stocks is addressed using time series of commercial landings (1906–2004) and juvenile survey catch data (1904–2006) collected around Denmark. We analyze (i) whether warm-water sole (Solea solea) has increased relative to Boreal plaice (Pleuronectes platessa) and (ii) whether two related warm-water species (turbot, Psetta maxima and brill, Scophthalmus rhombus) show similar responses to increasing temperature or, alternatively, whether turbot (which has a broader juvenile diet) has been favored. Since the early 1980s, both sole and turbot have constituted an increasing part of the commercial landings and survey catches, as compared with plaice and brill, respectively. These changes in species composition were linked to sea surface temperatures, Northern Hemisphere temperature anomalies (NHA) and the North Atlantic Oscillation. NHA was closely related and explained 43% of the observed variation in sole survey catches relative to the plaice catches and almost 38% of the observed variation in the sole landings relative to the plaice landings. For the less common species, turbot and brill, none of the global change indicators explained more than 15% of the variation, although all showed a positive relationship. Survey catch per unit effort increased significantly for both sole and turbot around the early 1980s, whereas catch per unit effort for plaice and brill remained constant. The results indicate that the abundance of warm-water species is likely to increase with increasing temperature but also that species with similar life histories might react differently according to degree of specialization.
Coexistence of structured populations with size-based prey selection

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Section for Marine Ecology and Oceanography
Authors: Hartvig, M. (Intern), Andersen, K. H. (Intern)
Pages: 24-33
Publication date: 2013
Main Research Area: Technical/natural sciences

Publication information
Journal: Theoretical Population Biology
Volume: 89
ISSN (Print): 0040-5809
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Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 1.091 SNIP 0.754 CiteScore 1.53
BFI (2015): BFI-level 1
Changes in climate, in combination with intensive exploitation of marine resources, have caused large-scale reorganizations in many of the world's marine ecosystems during the past decades. The Baltic Sea in Northern Europe is one of the systems most affected. In addition to being exposed to persistent eutrophication, intensive fishing, and one of the world's fastest rates of warming in the last two decades of the 20th century, accelerated climate change including atmospheric warming and changes in precipitation is projected for this region during the 21st century. Here, we used a new multimodel approach to project how the interaction of climate, nutrient loads, and cod fishing may affect the future of the open Central Baltic Sea food web. Regionally downscaled global climate scenarios were, in combination with three nutrient load scenarios, used to drive an ensemble of three regional biogeochemical models (BGMs). An Ecopath with Ecosim food web model was then forced with the BGM results from different nutrient-climate scenarios in combination with two different cod fishing scenarios. The results showed that regional management is likely to play a major role in determining the future of the Baltic Sea ecosystem. By the end of the 21st century, for example, the combination of intensive cod fishing and high nutrient loads projected a strongly eutrophicated and sprat-dominated ecosystem, whereas low cod fishing in combination with low nutrient loads resulted in a cod-dominated ecosystem with eutrophication levels close to present. Also, nonlinearities were observed in the sensitivity of different trophic groups to nutrient loads or fishing depending on the combination of the two. Finally, many climate variables and species biomasses were projected to levels unseen in the past. Hence, the risk for ecological surprises needs to be addressed, particularly when the results are discussed in the ecosystem-based management context.
Coupling the UV-visible spectroscopic properties of dissolved organic matter to its chemical characteristics evidence across contrasting environments

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Lund University, University of Copenhagen
Authors: Stedmon, C. (Intern), Christensen, J. (Ekstern), Kritzberg, E. (Ekstern), Nielsen, N. (Ekstern), Reader, H. (Ekstern)
Publication date: 2013
Event: Abstract from ASLO 2013 Aquatic Sciences Meeting, New Orleans, United States.
Main Research Area: Technical/natural sciences
Links:
Publication: Research › Conference abstract for conference – Annual report year: 2013

Data compilation of respiration, feeding, and growth rates of marine pelagic organisms
The metabolic rate of organisms may either be viewed as a basic property from which other vital rates and many ecological patterns emerge and that follows a universal allometric mass scaling law; or it may be considered a property of the organism that emerges as a result of the organism’s adaptation to the environment, with consequently less universal mass scaling properties. Data on body mass, maximum ingestion and clearance rates, respiration rates and maximum growth rates of animals living in the ocean epipelagic were compiled from the literature, mainly from original papers but also from previous compilations by other authors. Data were read from tables or digitized from graphs. Only measurements made on individuals of know size, or groups of individuals of similar and known size were included. We show that clearance and respiration rates have life-form-dependent allometries that have similar scaling but different elevations, such that the mass-specific rates converge on a rather narrow size-independent range. In contrast, ingestion and growth rates follow a near-universal taxa-independent ~3/4 mass scaling power law. We argue that the declining mass-specific clearance rates with size within taxa is related to the inherent decrease in feeding efficiency of any particular feeding mode. The transitions between feeding mode and simultaneous transitions in clearance and respiration rates may then represent adaptations to the food environment and be the result of the optimization of tradeoffs that allow sufficient feeding and growth rates to balance mortality

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Kiørboe, T. (Intern), Hirst, A. G. (Intern)
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Original language: English
Main Research Area: Technical/natural sciences
Links:
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Publication: Research › Dataset – Annual report year: 2013
Distinct communities of free-living and copepod-associated microorganisms along a salinity gradient in Godthåbsfjord, West Greenland

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Dziallas, C. (Ekstern), Grossart, H. (Ekstern), Tang, K. W. (Ekstern), Nielsen, T. G. (Intern)
Pages: 471-480
Publication date: 2013
Main Research Area: Technical/natural sciences

Publication information
Journal: Arctic, Antarctic, and Alpine Research
Volume: 45
Issue number: 4
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BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.7 SJR 0.791 SNIP 0.667
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.908 SNIP 0.847 CiteScore 1.78
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.752 SNIP 0.754 CiteScore 1.69
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.775 SNIP 0.815 CiteScore 1.71
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.848 SNIP 0.884 CiteScore 1.67
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.89 SNIP 0.811 CiteScore 1.68
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.959 SNIP 0.926
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.901 SNIP 0.694
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.774 SNIP 0.745
Scopus rating (2007): SJR 0.734 SNIP 0.783
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.805 SNIP 0.761
Scopus rating (2005): SJR 0.627 SNIP 0.909
Scopus rating (2004): SJR 0.749 SNIP 0.804
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 0.737 SNIP 0.82
Scopus rating (2002): SJR 0.747 SNIP 0.89
Scopus rating (2001): SJR 0.869 SNIP 1.025
Scopus rating (2000): SJR 1.011 SNIP 1.101
Scopus rating (1999): SJR 1.078 SNIP 1.257
Diversitet og fordeling af fiskelarver i Sargassohavet

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Ayala, D. J. (Intern), Munk, P. (Intern), Riemann, L. (Forskerdatabase)
Publication date: 2013
Event: Poster session presented at 17. Danske havforskermøde, Roskilde, Denmark.
Main Research Area: Technical/natural sciences

Dynamics regulating major trends in Barents Sea temperatures and subsequent effect on remotely sensed particulate inorganic carbon

A more comprehensive understanding of how ocean temperatures influence coccolithophorid production of particulate inorganic carbon (PIC) will make it easier to constrain the effect of ocean acidification in the future. We studied the effect of temperature on Emiliania huxleyi PIC production in the Barents Sea using ocean colour remote sensing data. Gross annual PIC production was calculated for 1998-2011 from SeaWiFS and MODIS data and coupled with results from previous studies to create a time-series from 1979-2011. Using that data, we investigated (1) correlations between various climate indices, models and temperature recordings of the Kola transect, and (2) the dynamics of temperature and PIC production. A strong inverse correlation (r² = 0.88) was found between the strength of the North Atlantic subpolar gyre (SPG) with a 3 yr lead and major trends in temperatures from the Kola transect. The effect of ocean temperature on PIC production was complex but generally positive, explaining roughly 50% of the annual variability and indicating that rising temperatures in the North Atlantic may favour coccolithophorid PIC production in the Barents Sea. Positive phases of the Atlantic multidecadal oscillation tended to precede PIC blooms by 1 yr.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Norwegian University of Science and Technology
Authors: Hovland, E. K. (Ekstern), Dierssen, H. M. (Ekstern), Ferreira, A. S. (Intern), Jonsen, G. (Ekstern)
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Publication date: 2013
Main Research Area: Technical/natural sciences

Publication information
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Volume: 484
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Ratings:
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Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 2.4
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 2.56
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 2.75
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Early development of Calanus hyperboreus nauplii: Response to a changing ocean

To forecast effects of temperature changes on recruitment and population dynamics of the Arctic copepod Calanus hyperboreus, laboratory experiments investigating temperature and food effects on early development were performed in Disko Bay, western Greenland, in 2009, and ascent rates of C. hyperboreus eggs collected in east Greenland were measured in the laboratory. Ascent rates were highly variable both between and within clutches, ranging from 0.7 to 27.7 m d⁻¹, suggesting variability in the biochemical composition of the egg. Development of eggs were investigated between 0.8°C and 6.6°C, and hatching was fitted to a Belehrádek temperature function ($r^2 = 0.99$) with mean development time (MDT) of eggs ranging from 2.8 to 5.8 d. MDT of fed and starved nauplii was calculated for nauplii raised at 5°C. Fed nauplii developed through the first five nauplius stages (N1–N5) during 40 d of incubation, whereas development of starved nauplii ceased at N3. Nauplii were able to survive at least 30 d of starvation. Respiration rate was measured for N1 and N3 at 0°C, 5°C, and 10°C, and it increased with development stage and temperature from 0.05 ± 0.01 to 0.29 ± 0.08 nmol O₂ nauplii⁻¹ h⁻¹ for N1 at 0°C and N3 at 10°C, respectively. A decrease in carbon and lipid content from egg to N3 indicates that nauplii are using stored lipids to cover their metabolic costs during the nonfeeding stages. Early stages of C. hyperboreus seem more affected by temperature than later stages, a vulnerability that might affect future recruitment.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Aarhus University, Greenland Institute of Natural Resources, Roskilde University
Authors: Jung-Madsen, S. (Forskerdatabase), Nielsen, T. G. (Intern), Grønkjær, P. (Ekstern), Hansen, B. W. (Ekstern), Møller, E. F. (Ekstern)
Pages: 2109-2121
Publication date: 2013
Main Research Area: Technical/natural sciences
Early life of inshore fishes in Greenland: With emphasis on Atlantic cod (Gadus morhua)

During their early life stages, the fishes face a range of challenges. To sustain the development of the pelagic eggs and larvae spawning needs to occur where the offspring is retained in optimal environmental conditions. The larvae rely on a spatial and temporal match to their prey in order to ensure fast growth and avoid starvation. Inshore areas may provide such favorable conditions, as these are sheltered from offshore currents and act as physical barriers that restrict dispersal and drift of eggs and larvae. Even though inshore spawning grounds of e.g. Atlantic cod (Gadus morhua) has been reported from numerous fjords in Norway, Canada and Greenland, very little is known about their early life history and the physical-biological mechanisms impacting their survival in such inshore areas.

To better understand the processes of importance to the early life success of fish, I carried out a seasonal study on a West Greenlandic inshore population of Atlantic cod. I followed the distribution, development and mortality of eggs and larvae in relation to the physical conditions and the prey availability.

The spawning of this population of cod was restricted to a shallow inshore area located at the innermost part of the fjord branch Kapisigdlit, in the Godthåbsfjord system. This shallow area was characterized by elevated temperatures within the upper part of the water column, which increased the development rate of the pelagic eggs. The mortality in the immediate spawning area was low and egg dispersal from the area was limited. Later, the seasonal breakup of ice in a connecting river resulted in an increased freshwater outflow, then enhancing the dispersal of the older larvae. Throughout the study, marked spatial and temporal differences in the zooplankton community composition were observed. The distribution of larvae generally overlapped the distribution of their preferred prey. Although no direct relationship could be found between prey availability and cod larval growth, the otolith growth rate was significantly improved in larvae that dispersing away from the spawning area. This was despite lower temperatures, suggesting that prey availability had some influence on the growth pattern. The relatively low mortality rates of eggs and larvae, and high larval growth rates compared to other studies, indicate that this fjord affords especially favorable conditions for the early life stages of cod. These conditions may result in a strong recruitment, which again might be the background of the relatively high cod spawning stock biomass found in Kapisigdlit.

Since different species of fish may vary in their spawning strategies and adaptations to physical and biological conditions, the larval assemblages in inshore areas with variable physical and biological characteristics are likely to be strongly structured. Therefore, I assessed the distributional patterns of larval fish assemblages comparing distributions to the variability in hydrography and prey availability. This was carried out across the West Greenlandic Godthåbsfjord system and the offshore Fyllas Bank, which encompass different oceanographic regimes, and which harbor different zooplankton communities in specific regions. Significantly different patterns of distribution were shown for the fish larvae and these appeared linked to the specific hydrographical conditions and the availability of preferred prey. Generally few larvae were found close to the glacier suggesting that this was a poor habitat for most species, while habitats at the entrance and in other branches of the fjord was relatively rich in species of fish larvae.

With changes in wind regimes, relative inflow of Atlantic water, temperature increase, glacial melting and runoff from land, the environment off West Greenland will undergo significant changes in the future. This thesis points out that in fjord systems, where such processes might change the timing and magnitude of freshwater outflow and circulation patterns the distributional patterns and life of the early life stages of fishes can be markedly affected.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Swalethorp, R. (Intern), Nielsen, T. G. (Intern), Munk, P. (Intern)
Number of pages: 117
Publication date: 2013

Publication information
Place of publication: Kgs. Lyngby
Publisher: Technical University of Denmark (DTU)
Original language: English
Main Research Area: Technical/natural sciences
Publication: Research › Ph.D. thesis – Annual report year: 2013

Effect of type and concentration of ballasting particles on sinking rate of marine snow produced by the Appendicularian Oikopleura dioica

Ballast material (organic, opal, calcite, lithogenic) is suggested to affect sinking speed of aggregates in the ocean. Here, we tested this hypothesis by incubating appendicularians in suspensions of different algae or Saharan dust, and observing
the sinking speed of the marine snow formed by their discarded houses. We show that calcite increases the sinking speeds of aggregates by ~100% and lithogenic material by ~150% while opal only has a minor effect. Furthermore the effect of ballast particle concentration was causing a 33 m d-1 increase in sinking speed for a 5×105 μm3 ml-1 increase in particle concentration, near independent on ballast type. We finally compare our observations to the literature and stress the need to generate aggregates similar to those in nature in order to get realistic estimates of the impact of ballast particles on sinking speeds.

**General information**

State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Technical University of Denmark, Universite Pierre et Marie Curie
Authors: Lombard, F. (Ekstern), Guidi, L. (Ekstern), Kiørboe, T. (Intern)
Publication date: 2013
Main Research Area: Technical/natural sciences

**Publication information**

Journal: PLoS ONE
Volume: 8
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Article number: e75676
ISSN (Print): 1932-6203
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BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.11 SJR 1.201 SNIP 1.092
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.414 SNIP 1.131 CiteScore 3.32
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.545 SNIP 1.141 CiteScore 3.54
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.74 SNIP 1.147 CiteScore 3.94
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.945 SNIP 1.142 CiteScore 4.15
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 2.369 SNIP 1.23 CiteScore 4.58
ISI indexed (2011): ISI indexed no
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 2.631 SNIP 1.161
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 2.473 SNIP 0.985
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 2.323 SNIP 0.96
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.289 SNIP 0.525
Effects of angling and manual handling on pike behaviour investigated by high-resolution positional telemetry

Human disturbances such as angling and manual handling may have long-term effects on the behaviour of pike, Esox lucius L., an ecologically important species. Using continuous high-resolution positional telemetry, this study compared the swimming activity of handled and unhandled pike in a small lake. Pike pre-equipped with acoustic transmitters were angled and exposed to a handling protocol including measurements of length and mass. Pike not recaptured constituted an unhandled control group. Results demonstrated that the handling protocol caused temperature-dependent changes in pike activity, with higher temperatures leading to lower activity of the recaptured pike. The effects, however, were transitory and not detectable after 48-h post-release. These findings indicate that pike are relatively resilient to handling and quickly resume pre-handling activity.
Effekt af øget pH på forårsopblomstringen i Arktis

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Riisgaard, K. (Intern), Hansen, P. J. (Ekstern), Nielsen, T. G. (Intern)
Publication date: 2013
Event: Poster session presented at 17. Danske havforskermøde, Roskilde, Denmark.
Main Research Area: Technical/natural sciences
Publication: Research › Poster – Annual report year: 2013

En spektral lysdæmpningsmodel for 2 grønlandske fjorde

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Murray, C. (Ekstern), Stedmon, C. (Intern), Markager, S. (Ekstern), Pedersen, T. J. (Ekstern), Sejr, M. (Ekstern)
Publication date: 2013
Event: Abstract from 17. Danske havforskermøde, Roskilde, Denmark.
Main Research Area: Technical/natural sciences
Publication: Research › Conference abstract for conference – Annual report year: 2013

Estimating phytoplankton phenology metrics from noisy, gappy data

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Publication date: 2013
Event: Poster session presented at International Workshop on Trait-based approaches to Ocean Life, Copenhagen, Denmark.
Feeding season duration and the relative success of capital and income spawning copepods

In high latitude environments, two closely related Calanus copepods have developed opposite reproduction strategies to cope with the strongly seasonal fluctuation. Calanus finmarchicus copepods breeds relying on the available food (income breeder), while Calanus hyperboreus copepods spawn prior to the spring bloom, using only its reserves accumulated the previous year (capital breeder). The success of these two strategies is related to the length of the spring bloom, the only source of nutrients for these copepods. We use an individual based model to approach the question of income versus capital breeders in a highly seasonal environment, and find that the capital breeders have a higher fitness during short spring bloom while the income breeder has an improved performance over long productive seasons.

Female-biased sex ratios in marine pelagic copepods: Comment on Gusmao et al. (2013)

Gusmao et al. (2013; Mar Ecol Prog Ser 482:279-298) review causes of sex ratio skew in pelagic copepods and in doing so repeatedly dispute the paper of Hirst et al. (2010) ‘Does predation control adult sex ratios and longevities in marine pelagic copepods?’ Here we respond to some important errors in their citation of our paper and briefly highlight where future work is needed in order to attribute the causes of strong sex ratio skew seen in some copepod families.
Female choice in eutrophied waters - an individual based model of sticklebacks

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Heuschele, J. (Intern)
Publication date: 2013
Event: Abstract from International Workshop on Trait-based approaches to Ocean Life, Copenhagen, Denmark.
Main Research Area: Technical/natural sciences
Links:
Publication: Research › Conference abstract for conference – Annual report year: 2013

Fisheries: Climate change at the dinner table

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Payne, M. (Intern)
Pages: 320-321
Publication date: 2013
Main Research Area: Technical/natural sciences

Publication information
Journal: Nature
Volume: 497
Issue number: 7449
ISSN (Print): 0028-0836
Ratings:
BFI (2018): BFI-level 3
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 13.33
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Fisheries-induced neutral and adaptive evolution at the genotypic and phenotypic levels in exploited fish populations

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Marty, L. (Intern), Diekmann, U. (Ekstern), Ernande, B. (Ekstern)
Publication date: 2013
Event: Abstract from International Workshop on Trait-based approaches to Ocean Life, Copenhagen, Denmark.
Main Research Area: Technical/natural sciences
Links:
Publication: Research › Conference abstract for conference – Annual report year: 2013

Fisheries: Manage declines

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Fluorescence spectroscopy and multi-way techniques. PARAFAC
PARAllel FACtor analysis (PARAFAC) is increasingly used to decompose fluorescence excitation emission matrices (EEMs) into their underlying chemical components. In the ideal case where fluorescence conforms to Beers Law, this process can lead to the mathematical identification and quantification of independently varying fluorophores. However, many practical and analytical hurdles stand between EEM datasets and their chemical interpretation. This article provides a tutorial in the practical application of PARAFAC to fluorescence datasets, demonstrated using a dissolved organic matter (DOM) fluorescence dataset. A new toolbox for MATLAB is presented to support improved visualisation and sensitivity analyses of PARAFAC models in fluorescence spectroscopy. © 2013 The Royal Society of Chemistry.
Food for thought: Overconfidence in model projections

There is considerable public and political interest in the state of marine ecosystems and fisheries, but the reliability of some recent projections has been called into question. New information about declining fish stocks, loss of biodiversity, climate impacts, and management failure is frequently reported in the major news media, based on publications in prominent scientific journals. Public and political awareness of the generally negative changes taking place in marine ecosystems is welcome, especially if it results in effective remedial action, but the scientific basis for such action must be reliable and uncertainties arising from models and data shortcomings must be presented fully and transparently. Scientific journals play an important role and should require more detailed analysis and presentation of uncertainties.
Food preferences in Atlantic cod larvae, Gadus morhua, in Godthåbsfjord, Greenlandic waters

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Malanski, E. (Intern), Swalethorp, R. (Intern), Munk, P. (Intern), Nielsen, T. G. (Intern)
Publication date: 2013
Event: Abstract from 37th Annual Larval Fish Conference, Miami, United States.
Main Research Area: Technical/natural sciences
Publication: Research › Conference abstract for conference – Annual report year: 2013

Forhøjet overlevelse og vækst gennem tidsmæssig og rumlig fordeling af torskeæg og larver fra en arktisk fjordpopulation af atlantisk torsk

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Swalethorp, R. (Intern), Munk, P. (Intern), Nielsen, T. G. (Intern)
Publication date: 2013
Event: Abstract from 17. Danske havforskermøde, Roskilde, Denmark.
Main Research Area: Technical/natural sciences
Publication: Research › Conference abstract for conference – Annual report year: 2013

From phytoplankton to fish

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography, Centre for Ocean Life
Global imprint of climate change on marine life
Past meta-analyses of the response of marine organisms to climate change have examined a limited range of locations1,2, taxonomic groups2–4 and/or biological responses5,6. This has precluded a robust overview of the effect of climate change in the global ocean. Here, we synthesized all available studies of the consistency of marine ecological observations with expectations under climate change. This yielded a metadatabase of 1,735 marine biological responses for which either regional or global climate change was considered as a driver. Included were instances of marine taxa responding as expected, in a manner inconsistent with expectations, and taxa demonstrating no response. From this database, 81–83% of all observations for distribution, phenology, community composition, abundance, demography and calcification across taxa and ocean basins were consistent with the expected impacts of climate change. Of the species responding to climate change, rates of distribution shifts were, on average, consistent with those required to track ocean surface temperature changes. Conversely, we did not find a relationship between regional shifts in spring phenology and the seasonality of temperature. Rates of observed shifts in species' distributions and phenology are comparable to, or greater, than those for terrestrial systems.
Haemoglobin genotypes in cod (Gadus morhua L): their geographic distribution and physiological significance

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Ecosystem based Marine Management, Section for Marine Ecology and Oceanography, Centre for Ocean Life, Norwegian University of Science and Technology, University of Copenhagen
Authors: Ross, S. D. (Intern), Behrens, J. W. (Intern), Brander, K. (Intern), Methling, C. (Ekstern), Mork, J. (Ekstern)
Pages: 158-168
Publication date: 2013
Main Research Area: Technical/natural sciences

Publication information
Journal: Comparative Biochemistry and Physiology. Part A: Molecular & Integrative Physiology
Volume: 166
Issue number: 1
ISSN (Print): 1095-6433
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.16 SJR 0.794 SNIP 0.879
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.917 SNIP 0.915 CiteScore 2.01
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.983 SNIP 0.94 CiteScore 2.18
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.956 SNIP 1.058 CiteScore 2.36
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.773 SNIP 1.032 CiteScore 2.18
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.858 SNIP 1.048 CiteScore 2.2
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.836 SNIP 1.041
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.794 SNIP 0.944
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.725 SNIP 0.806
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.639 SNIP 0.893
Havets dufe

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Kiørboe, T. (Intern), Heuschele, J. (Intern), Selander, E. (Intern)
Pages: 30-34
Publication date: 2013
Main Research Area: Technical/natural sciences

Publication information
Journal: Aktuel naturvidenskab
Issue number: 3
ISSN (Print): 1399-2309
Ratings:
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Original language: Danish
Links:
http://aktuelnaturvidenskab.dk/nyeste-numre/3-2013/
Publication: Communication › Journal article – Annual report year: 2013

Imigranter sydfra på tallerkenen

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Payne, M. (Intern), Kiørboe, T. (Intern)
Pages: 3
Publication date: 2013
Main Research Area: Technical/natural sciences

Publication information
Pages (from-to): 3
Newspaper: Weekendavisen
No.: 20
Ratings:
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Main Research Area: Technical/natural sciences
Publication: Communication › Newspaper article – Annual report year: 2013
Infection of North Sea cod (Gadus morhua L.) postlarvae and juveniles with the parasites Hysterothylacium aduncum Rudolphi and Caligus sp.

Parasitic infections of individual juvenile and adult Atlantic cod (Gadus morhua L.) have been well studied for decades, but infections of early life stages and the impact of parasitism on population level have been less well elucidated. It is generally assumed that early developmental stages of fish are more vulnerable to infection compared to older age groups, but merely few investigations on parasitic infections in young cod are available. We have therefore performed a parasitological investigation of a total of 3361 specimens of Atlantic cod post larvae and juveniles sampled from the North Sea in 1992, 1993, 1994, 1999 and 2001. Two metazoan parasites Caligus sp. and Hysterothylacium aduncum (Rudolphi) were found at relatively high frequencies. Caligus sp. showed a higher infection level in 1992 compared to the following years, whereas the prevalence of H. aduncum increased from 1992 to 2001. It was indicated that these young stages of cod were not able to tolerate high parasite burdens which suggests that survival may be affected by a high infection pressure. We also analysed if infection with H. aduncum would influence growth of cod post-larvae. This was done by comparing the body size of infected (1-2 parasites per fish) and uninfected fish sizes in various age groups. Ageing was performed by otolith readings, and it was indicated that cod younger than 44 days were negatively affected by infection whereas cod older than 44 days tolerated this low parasite burden.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Technical University of Denmark, University of Copenhagen
Authors: Mehrdana, F. (Ekstern), Bahlood, Q. M. (Ekstern), Skovgaard, A. (Ekstern), Kuhn, J. A. (Ekstern), Kania, P. W. (Ekstern), Munk, P. (Intern), Buchmann, K. (Ekstern)
Number of pages: 1
Publication date: 2013
Event: Abstract from DAFINET Workshop: Diagnosis and Control of Fish Diseases, Frederiksberg, Denmark.
Main Research Area: Technical/natural sciences
Electronic versions:
Pages_from_DAFINET_April_2013_Abstracts_5.pdf
Links:
http://www.dafinet.dk/DAFINET/Abstract_books_files/DAFINET%20April%202013%20Abstracts.pdf
Publication: Research › Conference abstract for conference – Annual report year: 2013

Inner filter correction of dissolved organic matter fluorescence
The fluorescence of dissolved organic matter (DOM) is suppressed by a phenomenon of self-quenching known as the inner filter effect (IFE). Despite widespread use of fluorescence to characterize DOM in surface waters, the advantages and constraints of IFE correction are poorly defined. We assessed the effectiveness of a commonly used absorbance-based approach (ABA), and a recently proposed controlled dilution approach (CDA) to correct for IFE. Linearity between corrected fluorescence and total absorbance (ATotal; the sum of absorbance at excitation and emission wavelengths) across the full excitation-emission matrix (EEM) in dilution series of four samples indicated both ABA and CDA were effective to an absorbance of at least 1.5 in a 1 cm cell, regardless of wavelength positioning. In regions of the EEMs where signal to background noise (S/N) was low, CDA correction resulted in more variability than ABA correction. From the ABA algorithm, the onset of significant IFE (>5%) occurs when absorbance exceeds 0.042. In these cases, IFE correction is required, which was the case for the vast majority (97%) of lakes in a nationwide survey (n= 554). For highly absorbing samples, undesirably large dilution factors would be necessary to reduce absorbance below 0.042. For rare EEMs with ATotal > 1.5 (3.0% of the lakes in the Swedish survey), a 2-fold dilution is recommended followed by ABA or CDA correction. This study shows that for the vast majority of natural DOM samples the most commonly applied ABA algorithm provides adequate correction without prior dilution.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Uppsala University, University of New South Wales
Authors: Kothawala, D. (Ekstern), Murphy, K. (Ekstern), Stedmon, C. (Intern), Weyhenmeyer, G. (Ekstern), Tranvik, L. (Ekstern)
Pages: 616-630
Publication date: 2013
Main Research Area: Technical/natural sciences
Publication information
Journal: Limnology and Oceanography: Methods
Volume: 11
Issue number: December
ISSN (Print): 1541-5856
Klorofyl i arktiske farvande målt med satellit

**General information**
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Howe, E. (Ekstern), Høyer, J. (Ekstern), Nielsen, T. G. (Intern)
Publication date: 2013
Event: Abstract from 17. Danske havforskermøde, Roskilde, Denmark.
Main Research Area: Technical/natural sciences
Publication: Research - peer-review › Journal article – Annual report year: 2014

Konkurrerer krill om føden?

**General information**
State: Published
Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography, Centre for Ocean Life
Krill – not a fussy eater

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Agersted, M. D. (Intern), Nielsen, T. G. (Intern)
Publication date: 2013
Event: Abstract from ASLO 2013 Aquatic Sciences Meeting, New Orleans, United States.
Main Research Area: Technical/natural sciences

Linking optical and chemical properties of dissolved organic matter in natural waters

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, North Carolina State University, Woods Hole Research Center, Skidaway Institute of Oceanography
Authors: Osburn, C. (Ekstern), Stedmon, C. (Intern), Spencer, R. (Ekstern), Stubbins, A. (Ekstern)
Publication date: 2013
Main Research Area: Technical/natural sciences
Pages: 78-82
Publication information
Journal: Limnology and Oceanography Bulletin
Volume: 22
Issue number: 3
ISSN (Print): 1539-607X
Ratings:
BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.312 SNIP 0.801 CiteScore 0.47
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.143 SNIP 0.111 CiteScore 0.1
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.132 SNIP 0.043 CiteScore 0.02
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.127 SNIP 0.039 CiteScore 0.03
ISI indexed (2013): ISI indexed no
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.101 SNIP 0 CiteScore 0.03
ISI indexed (2012): ISI indexed no
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.101 SNIP 0 CiteScore 0.02
ISI indexed (2011): ISI indexed no
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.116 SNIP 0.024
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.135 SNIP 0.284
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.103 SNIP 0
Live discrimination of Calanus glacialis and C. finmarchicus females – can we separate sibling species?

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Kjellerup, S. (Intern), Lindeque, P. (Ekstern), Nielsen, T. G. (Intern)
Publication date: 2013
Event: Poster session presented at ASLO 2013 Aquatic Sciences Meeting, New Orleans, United States.
Main Research Area: Technical/natural sciences
Publication: Research › Poster – Annual report year: 2013

Marine climate change research in Nordic regions: recent trends and current state

General information
State: Published
Organisations: Department of Applied Mathematics and Computer Science, National Institute of Aquatic Resources, Centre for Ocean Life, Section for Marine Ecology and Oceanography, Section for Marine Living Resources
Publication date: 2013
Event: Poster session presented at ICES Annual Science Conference 2013, Reykjavik, Iceland.
Main Research Area: Technical/natural sciences
Source: dtu
Source-ID: u::9868
Publication: Research › Poster – Annual report year: 2013

Measuring small organisms under microscope: the case for fish larvae

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Malanski, E. (Intern), Muelbert, J. H. (Ekstern)
Publication date: 2013
Event: Abstract from 37th Annual Larval Fish Conference, Miami, United States.
Main Research Area: Technical/natural sciences
Publication: Research › Conference abstract for conference – Annual report year: 2013

Mesozooplankton abundance data from Disko Bay, West Greenland, 2008

The study site was located in the Disko Bay off Qeqertarsuaq, western Greenland. Due to land-connected sea ice coverage during winter, 2 sampling sites were combined. At the first site in winter (21 February to 23 March 2008), sampling was conducted through a hole in the ice at ca. 65 to 160 m depth approximately 0.5 nautical mile (n mile) south of Qeqertarsuaq (69° 14' N, 53° 29' W). In spring and summer (9 April to 18 July), sampling was done at a monitoring station 1 n mile south from Qeqertarsuaq (69° 14' N, 53° 23' W) at 300 m depth. Sampling was carried out between 10:00 and 17:00 h. During sampling from the ice, mesozooplankton was collected using a modified WP-2 net (45 µm) equipped with a closing mechanism (Hydrobios). Samples were collected in 3 depth strata (0-50, 50-100, and 100-150 m). During ship-based sampling, mesozooplankton was collected with a net (50 µm) equipped with a flow meter (Multinet, Hydrobios type midi), and 2 additional depth strata (150-200m and 200-250 m) were included. In addition to the seasonal study one diurnal investigation with sampling every 6 h was conducted from 29 April at 12:00 h to 30 April 30 at 12:00 h. Samples were immediately preserved in buffered formalin (5% final concentration) for later analyses. Biomass values of the different copepod species were calculated based on measurements of prosome length, and length/weight relationships. Two regressions for Calanus spp. were established for biomass calculations: one applicable prior to and during the phytoplankton bloom until 4 May, and another from 9 May onwards

General information
State: Published
Mesozooplankton abundance data from the fjord branch Kapisigdlit located in the Godthaabsfjord system, West Greenland, 2010

Sampling was conducted from March 24 to August 5 2010, in the fjord branch Kapisigdlit located in the inner part of the Godthaabsfjord system, West Greenland. The vessel "Lille Masik" was used during all cruises except on June 17-18 where sampling was done from RV Dana (National Institute for Aquatic Resources, Denmark). A total of 15 cruises (of 1-2 days duration) 7-10 days apart was carried out along a transect composed of 6 stations (St.), spanning the length of the 26 km long fjord branch. St. 1 was located at the mouth of the fjord branch and St. 6 was located at the end of the fjord branch, in the middle of a shallower inner creek. St. 1-4 was covering deeper parts of the fjord, and St. 5 was located on the slope leading up to the shallow inner creek. Mesozooplankton was sampled by vertical net tows using a Hydrobios Multinet (type Mini) equipped with a flow meter and 50 µm mesh nets or a WP-2 net 50 µm mesh size equipped with a non-filtering cod-end. Sampling was conducted at various times of day at the different stations. The nets were hauled with a speed of 0.2-0.3 m s^{-1} from 100, 75 and 50 m depth to the surface at St. 2 + 4, 5 and 6, respectively. The content was immediately preserved in buffered formalin (4% final concentration). All samples were analyzed in the Plankton sorting and identification center in Szczecin (www.nmfri.gdynia.pl). Samples containing high numbers of zooplankton were split into subsamples. All copepods and other zooplankton were identified down to lowest possible taxonomic level (approx. 400 per sample), length measured and counted. Copepods were sorted into development stages (nauplii stage 1 - copepodite stage 6) using morphological features and sizes, and up to 10 individuals of each stage was length measured.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Swalethorp, R. (Intern), Kjellerup, S. (Intern), Nielsen, T. G. (Intern)
Publication date: 2013

Mesozooplankton biomass data from Disko Bay, West Greenland, 2008

The study site was located in the Disko Bay off Qeqertarsuaq, western Greenland. Due to land-connected sea ice coverage during winter, 2 sampling sites were combined. At the first site in winter (21 February to 23 March 2008), sampling was conducted through a hole in the ice at ca. 65 to 160 m depth approximately 0.5 nautical mile (n mile) south of Qeqertarsuaq (69° 14' N, 53° 29' W). In spring and summer (9 April to 18 July), sampling was done at a monitoring station 1 n mile south from Qeqertarsuaq (69° 14' N, 53° 23' W) at 300 m depth. Sampling was carried out between 10:00 and 17:00 h. During sampling from the ice, mesozooplankton was collected using a modified WP-2 net (45 µm) equipped with a closing mechanism (Hydrobios). Samples were collected in 3 depth strata (0-50, 50-100, and 100-150 m). During ship-based sampling, mesozooplankton was collected with a multinet (50 µm) equipped with a flow meter (Multinet, Hydrobios type midi), and 2 additional depth strata (150-200m and 200-250 m) were included. In addition to the seasonal study one diurnal investigation with sampling every 6 h was conducted from 29 April at 12:00 h to 30 April 30 at 12:00 h. Samples were immediately preserved in buffered formalin (5% final concentration) for later analyses. Biomass values of the different copepod species were calculated based on measurements of prosome length, and length/weight relationships. Two regressions for Calanus spp. were established for biomass calculations: one applicable prior to and during the phytoplankton bloom until 4 May, and another from 9 May onwards.

General information
State: Published
Mesozooplankton biomass data from the Kapisigdlit an inner fjord branch of the Godthaabsfjord system, West Greenland, 2010

Sampling was conducted from March 24 to August 5 2010, in the fjord branch Kapisigdlit located in the inner part of the Godthaabsfjord system, West Greenland. The vessel "Lille Masik" was used during all cruises except on June 17-18 where sampling was done from RV Dana (National Institute for Aquatic Resources, Denmark). A total of 15 cruises (of 1-2 days duration) 7-10 days apart was carried out along a transect composed of 6 stations (St.), spanning the length of the 26 km long fjord branch. St. 1 was located at the mouth of the fjord branch and St. 6 was located at the end of the fjord branch, in the middle of a shallower inner creek. St. 1-4 was covering deeper parts of the fjord, and St. 5 was located on the slope leading up to the shallow inner creek. Mesozooplankton was sampled by vertical net tows using a Hydrobios Multinet (type Mini) equipped with a flow meter and 50 µm mesh nets or a WP-2 net 50 µm mesh size equipped with a non-filtering cod-end. Sampling was conducted at various times of day at the different stations. The nets were hauled with a speed of 0.2-0.3 m s⁻¹ from 100, 75 and 50 m depth to the surface at St. 2 + 4, 5 and 6, respectively. The content was immediately preserved in buffered formalin (4% final concentration). All samples were analyzed in the Plankton sorting and identification center in Szczecin (www.nmfri.gdynia.pl). Samples containing high numbers of zooplankton were split into subsamples. All copepods and other zooplankton were identified down to lowest possible taxonomic level (approx. 400 per sample), length measured and counted. Copepods were sorted into development stages (nauplii stage 1 - copepodite stage 6) using morphological features and sizes, and up to 10 individuals of each stage was length measured.

Mesozooplankton size data from Disko Bay, West Greenland, 2008

The study site was located in the Disko Bay off Qeqertarsuaq, western Greenland. Due to land-connected sea ice coverage during winter, 2 sampling sites were combined. At the first site in winter (21 February to 23 March 2008), sampling was conducted through a hole in the ice at ca. 65 to 160 m depth approximately 0.5 nautical mile (n mile) south of Qeqertarsuaq (69° 14′ N, 53° 29′ W). In spring and summer (9 April to 18 July), sampling was done at a monitoring station 1 n mile south from Qeqertarsuaq (69° 14′ N, 53° 23′ W) at 300 m depth. Sampling was carried out between 10:00 and 17:00 h. During sampling from the ice, mesozooplankton was collected using a modified WP-2 net (45 µm) equipped with a closing mechanism (Hydrobios). Samples were collected in 3 depth strata (0-50, 50-100, and 100-150 m). During ship-based sampling, mesozooplankton was collected with a
multinet (50 µm) equipped with a flow meter (Multinet, Hydrobios type midi), and 2 additional depth strata (150-200m and 200-250 m) were included. In addition to the seasonal study one diurnal investigation with sampling every 6 h was conducted from 29 April at 12:00 h to 30 April 30 at 12:00 h. Samples were immediately preserved in buffered formalin (5% final concentration) for later analyses. Biomass values of the different copepod species were calculated based on measurements of prosome length, and length/weight relationships. Two regressions for Calanus spp. were established for biomass calculations: one applicable prior to and during the phytoplankton bloom until 4 May, and another from 9 May onwards.

**General information**
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Swalethorp, R. (Intern), Kjellerup, S. (Intern), Nielsen, T. G. (Intern)
Publication date: 2013
Mikrobiel dannelse af sværtnedbrydelige organiske humusstoffer i arktiske egne

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, University of Copenhagen
Authors: Jørgensen, L. (Intern), Middelboe, M. (Forskerdatabase), Stedmon, C. (Intern)
Publication date: 2013
Event: Abstract from 17. Danske havforskermøde, Roskilde, Denmark.
Main Research Area: Technical/natural sciences
Publication: Research › Conference abstract for conference – Annual report year: 2013

Mikrobielle interaktioner i Nordatlanten

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Paulsen, M. L. (Intern), Riisgaard, K. (Intern), Nielsen, T. G. (Intern)
Publication date: 2013
Event: Abstract from 17. Danske havforskermøde, Roskilde, Denmark.
Main Research Area: Technical/natural sciences
Publication: Research › Conference abstract for conference – Annual report year: 2013

Molecular evidence for bipolar distribution of sea ice algae: A phylogenic study on Polarella glacialis (Dinophyceae) from Arctic and Antarctic

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Harðardóttir, S. (Ekstern), Nielsen, T. G. (Intern), Lundholm, N. (Ekstern)
Publication date: 2013
Event: Abstract from 17. Danske havforskermøde, Roskilde, Denmark.
Main Research Area: Technical/natural sciences
Publication: Research › Conference abstract for conference – Annual report year: 2013

Novel insight from Mnemiopsis ecophysiological data using a coherent framework

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Section for Marine Ecology and Oceanography, Sebastiaan A.L.M. Kooijman, University of Porto, Royal Netherlands Institute for Sea Research - NIOZ, Aix Marseille Universite
Authors: Augustine, S. (Intern), Jaspers, C. (Intern), Kooijman, S. A. (Ekstern), Freitas, V. (Ekstern), Wairaven, L. V. (Ekstern), Veer, H. V. D. (Ekstern), Poggiale, J. (Ekstern), Carlotti, F. (Ekstern)
Number of pages: 1
Publication date: 2013
Event: Abstract from Dynamic Energy Budget (DEB) symposium, Island of Texel, Netherlands.
Main Research Area: Technical/natural sciences
Electronic versions:
Publication: Research › Conference abstract for conference – Annual report year: 2013

Olien og vandloppen - effekten af pyren på Calanus hyperboreus

General information
State: Published
Optimal foraging and diel vertical migration in a life history model
Zooplankton such as copepods are known to perform diel vertical migration, avoiding the food rich surface during bright hours to avoid visual predator when they are most dangerous, and returning to the surface to feed at night. The resolution of this foraging behaviour requires fine time scale in the model, unsuited for life history modeling. We propose a method based on optimal foraging theory to take into account the emergent feeding rates as a function of the copepod metabolic cost, latitude, time and predation. We predict that copepods will balance their growth rate and mortality, playing a safe strategy when food is plentiful, but taking greater risks at low food concentrations. We apply these concepts to high latitude ecosystems where there is a strong seasonal variation in both food availability and day length. Specifically, during the summer, the midnight sun will force the animals to take more risk and maintain some feeding at the surface to cover their nutritional needs, compensate for predation mortality and sustain their growth.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, University of Bergen
Authors: Visser, A. W. (Intern), Fiksen, Ø. (Ekstern)
Pages: 91-101
Publication date: 2013
Main Research Area: Technical/natural sciences
Publication information
Journal: Marine Ecology Progress Series
Volume: 473
ISSN (Print): 0171-8630
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
Phytoplankton community effects on productivity changes in a global reduced mixing scenario

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Prowe, F. (Intern), Pahlow, M. (Ekstern), Oschlies, A. (Ekstern)
Publication date: 2013
Event: Poster session presented at 45th international liege colloquium on ocean dynamics, Liège, Belgium.
Main Research Area: Technical/natural sciences
Publication: Research › Poster – Annual report year: 2013

Plankton beskytter sig med solcreme
Plante- og dyreplankton, der lever nær havoverfladen, udsættes for kraftigt sollys. De bliver solbrændte og akkumulerer solcreme for at beskytte sig mod skadelig UV-stråling. Beskyttelsesmechanismerne har betydning for livet højere i
The cyclopoid copepod Oithona similis is one of the most abundant copepods in the oceans, and has a potentially important role in pelagic food webs. However, there is a lack of knowledge on aspects of Oithona's biology and function in plankton communities. In the present study, we aimed to assess and compare its trophic role in Greenlandic coastal waters during the winter-spring transition, with a focus on its winter behaviour, when large calanoids are not present in the surface layer. Two locations were studied: waters offshore from Godthåbsfjord (Nuuk) in winter, and Qeqertarsuaq (Disko Bay) in spring (bloom and post-bloom period). The potential prey of adult females of O.similis was quantified, and grazing experiments were conducted to determine feeding rates of adult females on phytoplankton and protozooplankton >10µm. The abundance, stage composition, and egg production of O.similis was also investigated. We found that ciliates were the preferred prey for O.similis, which confirms its importance as a link from the microbial food web to higher trophic levels. We observed high egg production rates and efficiencies of O.similis in winter, confirming that it is active and successfully reproductive in food-limiting winter conditions. Our results stress that O. similis is a key component in Arctic and subarctic waters throughout the year, linking the microbial part of the food web to higher trophic levels.
Plankton med helgardering

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Nielsen, L. T. (Intern), Kiørboe, T. (Intern)
Pages: 4-5
Publication date: 2013

Publication information
Pages (from-to): 4-5
Newspaper: Weekendavisen
No.: 31
Ratings:
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Main Research Area: Technical/natural sciences
Publication: Communication › Newspaper article – Annual report year: 2013

Planktonøkologi i ørkenen

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, University of Copenhagen
Authors: Enghoff-Poulsen, S. (Ekstern), Nielsen, T. G. (Intern)
Pages: 18-22
Publication date: 2013
Preferential feeding in West Greenlandic inshore cod larvae (Gadus morhua) – relationship between prey availability and larval distribution

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Swalethorp, R. (Intern), Kjellerup, S. (Intern), Malanski, E. (Intern), Munk, P. (Intern), Nielsen, T. G. (Intern)
Publication date: 2013
Event: Paper presented at 37th Annual Larval Fish Conference, Miami, United States.
Main Research Area: Technical/natural sciences
Publication: Research › Journal article – Annual report year: 2013

Prey/predator size ratio in feeding of Temora Longicornis

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Gonçalves, R. (Intern)
Publication date: 2013
Event: Abstract from International Workshop on Trait-based approaches to Ocean Life, Copenhagen, Denmark.
Main Research Area: Technical/natural sciences
Publication: Research › Conference abstract for conference – Annual report year: 2013

Projected impacts of climate change on marine fish and fisheries
This paper reviews current literature on the projected effects of climate change on marine fish and shellfish, their fisheries, and fishery-dependent communities throughout the northern hemisphere. The review addresses the following issues: (i) expected impacts on ecosystem productivity and habitat quantity and quality; (ii) impacts of changes in production and habitat on marine fish and shellfish species including effects on the community species composition, spatial distributions, interactions, and vital rates of fish and shellfish; (iii) impacts on fisheries and their associated communities; (iv) implications for food security and associated changes; and (v) uncertainty and modelling skill assessment. Climate change will impact fish and shellfish, their fisheries, and fishery-dependent communities through a complex suite of linked processes. Integrated interdisciplinary research teams are forming in many regions to project these complex responses. National and international marine research organizations serve a key role in the coordination and integration of research to accelerate the production of projections of the effects of climate change on marine ecosystems and to move towards a future where relative impacts by region could be compared on a hemispheric or global level. Eight research foci were identified that will improve the projections of climate impacts on fish, fisheries, and fishery-dependent communities.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Plymouth Marine Laboratory, Fisheries and Oceans Canada, Department of Ichthyology and Fisheries Science, Institute of Marine Research, National Oceanographic and Atmospheric Administration, Tohoku National Fisheries Research Institute, Pukyong National University, University of Alaska Fairbanks, University of Victoria, Institute for Hydrobiology and Fisheries Science, Pacific Research Institute of Fisheries and Oceanography, Department of Fisheries and Oceans, Fisheries Research Agency, Hokkaido University, National Oceanography Centre
Authors: Hollowed, A. B. (Ekstern), Barange, M. (Ekstern), Beamish, R. J. (Ekstern), Brander, K. (Intern), Cochrane, K. (Ekstern), Drinkwater, K. (Ekstern), Foreman, M. G. G. (Ekstern), Hare, J. A. (Ekstern), Holt, J. (Ekstern), Ito, S. (Ekstern),
Radiocarbon age, lability and optical fingerprints of riverine dissolved organic matter exported from a northern peat-dominated catchment

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Hulatt, C. (Ekstern), Kaartokallio, H. (Ekstern), Stedmon, C. (Intern), Sonninen, E. (Ekstern), Oinonen, M. (Ekstern), Thomas, D. (Ekstern)
Publication date: 2013
Event: Abstract from ASLO 2013 Aquatic Sciences Meeting, New Orleans, United States.
Main Research Area: Technical/natural sciences
Links:

Recruitment decline in North Sea herring is accompanied by reduced larval growth rates
The stock of North Sea autumn spawning herring (Clupea harengus L.) has shown an unprecedented sequence of ten years of sharply reduced recruitment, in spite of a high spawning biomass. Recent work has identified this below-expected recruitment as being determined during the larval phase; however, the underlying mechanism remains elusive. In this study we analysed archived larval samples captured before and after the onset of the reduced survival to test the hypothesis of a concurrent change in the larval growth rate. Individual larval growth rates, averaged over the 21 days prior to capture, were estimated for two hundred larvae from four different years using a model-based analysis of the otolith ring-widths. Hydrographic-backtracking models complemented the otolith analysis by reconstructing the environmental history and spawning origin of each larva. A significant reduction in net larval growth rate of 8%, concurrent with the reduced larval survival and recruitment, was identified: after correcting for the effect of other explanatory variables (e.g. temperature changes), the gross reduction was found to be 12%. This reduction is most probably due to changes in either the amount or quality of available food. The study demonstrates the potential in coupling of two different techniques, the otolith microstructure analysis and the hydrographic modelling, for affording new insights into fish early-life history. Finally, the study provides a novel indication of the association between reduced growth and larvae survival, thereby narrowing the range of potential mechanisms underlying the observed reduction in the recruitment of North Sea autumn spawning herring

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Section for Ecosystem based Marine Management, Section for Marine Living Resources
Authors: Payne, M. (Intern), Ross, S. D. (Intern), Worsøe Clausen, L. (Intern), Munk, P. (Intern), Mosegaard, H. (Intern), Nash, R. D. (Ekstern)
Pages: 197-211
Publication date: 2013
Main Research Area: Technical/natural sciences

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Journal: Marine Ecology - Progress Series
Volume: 489
ISSN (Print): 0171-8630
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 2.4
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 2.56
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 2.75
Relative success of income and capital breeder in a seasonal environment

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Sainmont, J. (Intern)
Publication date: 2013
Event: Abstract from International Workshop on Trait-based approaches to Ocean Life, Copenhagen, Denmark.
Main Research Area: Technical/natural sciences
Links:
Publication: Research › Conference abstract for conference – Annual report year: 2013

Reproduction of European eel and larval culture: state of the art

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography, Section for Ecosystem based Marine Management, Centre for Ocean Life
Authors: Tomkiewicz, J. (Intern), Stettrup, J. (Intern), Corraze, G. (Ekstern), Kausik, S. (Ekstern), Holst, L. (Ekstern), McEvoy, F. (Ekstern), Dufour, S. (Ekstern), Lafont, A. (Ekstern), Asturiano, J. (Ekstern), Sørensen, S. R. (Intern), Tveiten, H. (Ekstern), De Schryver, P. (Ekstern), Butts, I. (Intern), Munk, P. (Intern), Zambonino-Infante, J. (Ekstern), Politis, S. N. (Intern), Krüger-Johnsen, M. (Intern), Lauesen, P. (Intern)
Riverine dissolved organic matter in three boreal estuaries entering the Baltic Sea

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Asmala, E. (Ekstern), Autio, R. (Ekstern), Kaartokallio, H. (Ekstern), Pitkänen, L. (Ekstern), Stedmon, C. (Intern), Thomas, D. (Ekstern)
Publication date: 2013
Event: Abstract from ASLO 2013 Aquatic Sciences Meeting, New Orleans, United States.
Main Research Area: Technical/natural sciences
Publication: Research › Conference abstract for conference – Annual report year: 2013

Seasonal dynamics of early life stages of invasive and native ctenophores give clues to invasion and bloom potential in the Baltic Sea

Recently, both the invasive ctenophore Mnemiopsis leidyi and the arctic Mertensia ovum were discovered in the Baltic Sea but their range expansion remains unclear due to misidentification of their larval stages. Supported by molecular species verification we describe seasonal abundance and distribution of larvae and eggs of these two species. We show that their occurrence is significantly but inversely related to salinity. Mertensia ovum was present year round throughout the brackish Baltic Sea but also occurred in high-saline areas during cold seasons. Larvae of M. leidyi occurred throughout all seasons in high-saline areas but never extended further into the central Baltic. Highest ctenophore egg abundances were observed in high-saline areas during summer along with the first appearance of M. leidyi adults. The M. leidyi population peaked 2 months after the first occurrence of adults in high-saline areas, suggesting these areas as a source for lower saline regions. Low larvae abundances and a reduced transitional-to-adult ratio in the southern Baltic point to reduced or no active recruitment, suggesting that drift of animals from high-saline into lower saline regions sustains the M. leidyi population in the southern Baltic such as the Arkona and Bornholm basins

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, GEOMAR - Helmholtz Centre for Ocean Research Kiel, University of Gothenburg
Authors: Jaspers, C. (Intern), Haraldsson, M. (Ekstern), Lombard, F. (Ekstern), Bolte, S. (Ekstern), Kiørboe, T. (Intern)
Pages: 582-594
Publication date: 2013
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Plankton Research
Volume: 35
Issue number: 3
ISSN (Print): 0142-7873
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Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.92 SJR 1.098 SNIP 0.848
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.025 SNIP 0.796 CiteScore 1.77
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Seksuel selektion hos en pelagisk copepod, Temora longicornis

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Section for Marine Living Resources
Authors: Sichlau, M. H. (Intern), Eg Nielsen, E. (Intern), Kjaerboe, T. (Intern)
Publication date: 2013
Event: Abstract from 17. Danske havforskermøde, Roskilde, Denmark.
Main Research Area: Technical/natural sciences
Selective incorporation of dissolved organic matter (DOM) during sea ice formation

This study investigated the incorporation of DOM from seawater into b2 day-old sea ice in tanks filled with seawater alone or amended with DOM extracted from the microalga, Chlorella vulgaris. Optical properties, including chromophoric DOM (CDOM) absorption and fluorescence, as well as concentrations of dissolved organic carbon (DOC), dissolved organic nitrogen (DON), dissolved carbohydrates (dCHOs) and dissolved uronic acids (dUAs) were measured. Enrichment factors (EFs), calculated from salinity-normalized concentrations of DOM in bulk ice, brine and frost flowers relative to under-ice water, were generally N1. The enrichment factors varied for different DOM fractions: EFs were the lowest for humic-like DOM (1.0–1.39) and highest for amino acid-like DOM (1.10–3.94).

Enrichment was generally highest in frost flowers with there being less enrichment in bulk ice and brine. Size exclusion chromatography indicated that there was a shift towards smaller molecules in the molecular size distribution of DOM in the samples collected from newly formed ice compared to seawater. Spectral slope coefficients did not reveal any consistent differences between seawater and ice samples. We conclude that DOM is incorporated to sea ice relatively more than inorganic solutes during initial formation of sea ice and the degree of the enrichment depends on the chemical composition of DOM.
Sensory capabilities and food capture of two small copepods, *Paracalanus parvus* and *Pseudocalanus* sp.

Detection, handling, and selection of prey are key features of suspension-feeding copepods. Using high-speed video, we determined detection distances and durations of all elements of the food gathering process in two small calanoid copepods, *Paracalanus parvus* and *Pseudocalanus* sp. Animals were freely swimming and presented with various phytoplankton species with equivalent spherical diameters ranging from 7 µm to 33 µm. Prey detection occurred very close—within a few cell radii—to the second antennae (53% of the cases) or the maxilliped (42%). There was no effect of prey size on detection distance, but larger prey caused a significantly longer handling time. Post-detection processing of the cells was exceedingly fast. The time from detection to the cell being placed at the mouth lasted 35 ± 19 ms and rejection of unwanted cells 61 ± 21 ms. Grooming of antennules and carapace occurred intermittently and lasted 215–227 ms. The weak feeding current and fast response of the copepods allowed ample time for detection of cells entrained in the feeding current and no distant olfaction was observed. Modeled effect of cell size on cell surface concentration of cue chemicals show that only cells with a radius larger than ∼ 15 µm may be detected chemically and that only very much larger and/or very leaky cells can be detected at distance. Copepods have elaborate and exceedingly fast handling techniques that allow effective prey detection and capture, but there is no evidence of remote chemically mediated sensing when feeding on algal cells up to a size of 35 µm.
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Original language: English

Electronic versions:

Publisher's version

DOIs:

10.4319/lo.2013.58.5.1657

Publication: Research - peer-review › Journal article – Annual report year: 2013
Small diversity effects on ocean primary production under environmental change in a diversity-resolving ocean ecosystem model

Marine ecosystem models used to investigate how global change affects ocean ecosystems and their functioning typically omit pelagic diversity. Diversity, however, can affect functions such as primary production and their sensitivity to environmental changes. Using a global ocean ecosystem model that explicitly resolves phytoplankton diversity within four phytoplankton functional types (PFTs) we investigate the model's ability to capture diversity effects on primary production under environmental change. An idealized scenario with a sudden reduction in vertical mixing causes diversity and primary-production changes that turn out to be largely independent of the number of coexisting phytoplankton types. The model provides a small number of niches with respect to nutrient use in accordance with the PFTs defined in the model, and increasing the number of phytoplankton types increases the resolution within the niches. The variety of traits and trade-offs resolved in the model constrains diversity effects such as niche complementarity, which operate between, but not within PFTs. The number and nature of the niches formulated in the model, for example via trade-offs or different PFTs, thus determines the diversity effects on ecosystem functioning captured in ocean ecosystem models.
Some like it hot, some not –Arktiske vandloppers respons på fremtidige temperaturstigninger

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Roskilde University
Authors: Jung-Madsen, S. (Intern), Nielsen, T. G. (Intern), Hansen, B. W. (Forskerdatabase)
Publication date: 2013
Event: Abstract from 17. Danske havforskermøde, Roskilde, Denmark.
Main Research Area: Technical/natural sciences
Publication: Research - peer-review › Journal article – Annual report year: 2013

The biogeography of marine plankton traits

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Barton, A. (Ekstern), Pershing, A. (Ekstern), Lichtman, E. (Ekstern), Record, N. (Ekstern), Edwards, K. (Ekstern), Finkel, Z. (Ekstern), Klørboe, T. (Intern), Ward, B. (Ekstern)
Pages: 522-534
Publication date: 2013
Main Research Area: Technical/natural sciences
Publication: Research › Conference abstract for conference – Annual report year: 2013
The dynamics of the marine nitrogen cycle across the last deglaciation

We use a geochemical box model to investigate the changes in marine N-fixation and denitrification required to match the observed sedimentary $\delta^{15}N$ changes between 30 kyr B.P. and the late Holocene. This is achieved by optimizing a set of seven parameters that describe the strengths of three ocean-internal N feedbacks and the response of the oceanic N cycle to four external forcings. Scenarios that best match the $\delta^{15}N$ constraints indicate a strong transient decrease in N-fixation in the early deglacial in response to the decrease in iron input by dust. Around 15 kyr B.P., N-fixation rebounds primarily in response to an abrupt increase in water column denitrification caused by an expansion of anoxia. Benthic denitrification is not well constrained by our model but tends to increase in sync with water column denitrification. As a result of the transient imbalance between N-fixation and denitrification, we infer a glacial-to-interglacial decrease in the marine N inventory of between 15 and 50%. The model diagnoses this reduction in order to simultaneously fit the data from all ocean basins, requiring it to reduce the degree by which water column denitrification in the oxygen minimum zones is influencing the $\delta^{15}N$ of nitrate of the whole ocean (dilution effect). Our optimal solution suggests a glacial N cycle that operated at nearly the same rates as that in pre-industrial times, but sensitivity cases with substantially lower rates fit the data only marginally worse. An important caveat of our study is the assumption of an unchanging ocean circulation. An initial sensitivity experiment shows that this affects primarily the magnitude of the change in the N inventory, while the diagnosed deglacial dynamics with global marine N-fixation taking a dip before the onset of denitrification remains a robust result.
The North Sea autumn spawning herring (Clupea harengus L.) Spawning Component Abundance Index (SCAI)

The North Sea autumn-spawning herring (Clupea harengus) stock consists of a set of different spawning components. The dynamics of the entire stock have been well characterized, but although time-series of larval abundance indices are available for the individual components, study of the dynamics at the component level has historically been hampered by missing observations and high sampling noise. A simple state-space statistical model is developed that is robust to these problems, gives a good fit to the data, and proves capable of both handling and predicting missing observations well. Furthermore, the sum of the fitted abundance indices across all components proves an excellent proxy for the biomass of the total stock, even though the model utilizes information at the individual-component level. The Orkney-Shetland component appears to have recovered faster from historic depletion events than the other components, whereas the Downs component has been the slowest. These differences give rise to changes in stock composition, which are shown to vary widely within a relatively short time. The modelling framework provides a valuable tool for studying and monitoring the dynamics of the individual components of the North Sea herring stock.
To eat and not be eaten: En dag i en vandloppes liv

Trait-based approaches to zooplankton communities

Trait-based approaches to zooplankton should assemble a comprehensive matrix of key traits for diverse groups and explore it for general patterns; develop novel predictive models that explicitly incorporate traits and associated trade-offs; and utilize these traits to explain and predict zooplankton community structure and dynamics under different environmental conditions, including global change scenarios.
Variability of North Sea pH and CO$_2$ in response to North Atlantic Oscillation forcing

[1] High biological activity causes a distinct seasonality of surface water pH in the North Sea, which is a strong sink for atmospheric CO$_2$ via an effective shelf pump. The intimate connection between the North Sea and the North Atlantic Ocean suggests that the variability of the CO$_2$ system of the North Atlantic Ocean may, in part, be responsible for the observed variability of pH and CO$_2$ in the North Sea. In this work, we demonstrate the role of the North Atlantic Oscillation (NAO), the dominant climate mode for the North Atlantic, in governing this variability. Based on three extensive observational records covering the relevant levels of the NAO index, we provide evidence that the North Sea pH and CO$_2$ system strongly responds to external and internal expressions of the NAO. Under positive NAO, the higher rates of inflow of water from the North Atlantic Ocean and the Baltic outflow lead to a strengthened north-south biogeochemical divide. The limited mixing between the north and south leads to a steeper gradient in pH and partial pressure of CO$_2$ (pCO$_2$).
between the two regions in the productive period. This is exacerbated further when coinciding with higher sea surface
temperature, which concentrates the net community production in the north through shallower stratification. These effects
can be obscured by changing properties of the constituent North Sea water masses, which are also influenced by NAO.
Our results highlight the importance of examining interannual trends in the North Sea CO₂ system with consideration of
the NAO state.
Zooplankton body composition

I compiled literature on zooplankton body composition, from protozoans to gelatinous plankton, and report allometric relations and average body composition. Zooplankton segregate into gelatinous and non-gelatinous forms, with few intermediate taxa (chaetognaths, polychaetes, and pteropods). In most groups body composition is size independent. Exceptions are protozoans, chaetognaths, and pteropods, where larger individuals become increasingly watery. I speculate about the dichotomy in body composition and argue that differences in feeding mechanisms and predator avoidance strategies favor either a watery or a condensed body form, and that in the intermediate taxa the moderately elevated water content is related to buoyancy control and ambush feeding.

General information

State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life
Authors: Kiørboe, T. (Intern)
Pages: 1843-1850
Publication date: 2013
Main Research Area: Technical/natural sciences

Publication information

Journal: Limnology and Oceanography
Volume: 58
Issue number: 5
ISSN (Print): 0024-3590
Ratings:
- BFI (2018): BFI-level 2
- Web of Science (2018): Indexed yes
- BFI (2017): BFI-level 2
- Web of Science (2017): Indexed yes
- BFI (2016): BFI-level 2
- Scopus rating (2016): CiteScore 3.5 SJR 1.712 SNIP 1.225
- Web of Science (2016): Indexed yes
- BFI (2015): BFI-level 2
- Scopus rating (2015): SJR 2.472 SNIP 1.422 CiteScore 3.93
- Web of Science (2015): Indexed yes
- BFI (2014): BFI-level 2
- Scopus rating (2014): SJR 2.112 SNIP 1.584 CiteScore 3.73
Zooplankton feeding traits and community composition in a global ecosystem model

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Section for Marine Ecology and Oceanography
Authors: Prowe, F. (Intern), Andersen, K. H. (Intern), Kiørboe, T. (Intern), Visser, A. (Intern)
Publication date: 2013
Event: Abstract from International Liège Colloquium, Liège, Belgium.
Main Research Area: Technical/natural sciences
Publication: Research - peer-review › Journal article – Annual report year: 2013
Zooplankton feeding traits and community composition in a global ecosystem model

**General information**

State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Section for Marine Ecology and Oceanography
Authors: Prowe, F. (Intern), Andersen, K. H. (Intern), Kiørboe, T. (Intern), Visser, A. (Intern)
Publication date: 2013
Event: Poster session presented at International Workshop on Trait-based approaches to Ocean Life, Copenhagen, Denmark.
Main Research Area: Technical/natural sciences
Publication: Research › Poster – Annual report year: 2013

**Effects of ocean acidification, temperature and nutrient regimes on the appendicularian Oikopleura dioica: a mesocosm study**

Increasing pCO2 is hypothesized to induce shifts in plankton communities toward smaller cells, reduced carbon export rates and increased roles of gelatinous zooplankton. Appendicularians, among the most numerous pan-global “gelatinous” zooplankton, continuously produce filter-feeding houses, shortcutting marine food webs by ingesting submicron particles, and their discarded houses contribute significantly to carbon fluxes. We present a first mesocosm-scale study on the effects of temperature, pCO2 and bloom structures on the appendicularian, Oikopleura dioica. There were effects of temperature and nutrients on phytoplankton communities. No shifts in functional phytoplankton groups, nor changes in particle sizes/morphotypes, known to impact appendicularian feeding, were observed under manipulated pCO2 conditions. However, appendicularian abundance was positively correlated with increased pCO2, temperature and nutrient levels, consistent with hypotheses concerning gelatinous zooplankton in future oceans. This suggests appendicularians will play more important roles in marine pelagic communities and vertical carbon transport under projected ocean acidification and elevated temperature scenarios.

**General information**

State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Skidaway Institute of Oceanography, Aarhus University, Uni Research AS, Universidad de Oviedo, University of Zagreb, Russian Academy of Sciences, Technical University of Denmark, University of Bergen, University of Gothenburg
Pages: 2175-2187
Publication date: 2012
Main Research Area: Technical/natural sciences

**Publication information**

Journal: Marine Biology
Volume: 160
Issue number: 8
ISSN (Print): 0025-3162
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.41 SJR 1.198 SNIP 0.993
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.315 SNIP 0.932 CiteScore 2.21
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.204 SNIP 1.041 CiteScore 2.32
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.272 SNIP 1.064 CiteScore 2.4
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.306 SNIP 1.107 CiteScore 2.43
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.145 SNIP 1.073 CiteScore 2.22
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.235 SNIP 1.069
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.178 SNIP 1.052
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 1.236 SNIP 1.022
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.348 SNIP 1.21
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.195 SNIP 1.09
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.253 SNIP 1.198
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 1.392 SNIP 1.228
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 1.333 SNIP 1.274
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 1.268 SNIP 1.19
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 1.241 SNIP 1.158
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 1.22 SNIP 1.124
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 1.448 SNIP 1.303
Original language: English
DOIs: 10.1007/s00227-012-2137-9
Links: http://link.springer.com/content/pdf/10.1007%2Fs00227-012-2137-9
Source: dtu
Source-ID: n::oai:DTIC-ART:springer/390433215::36303
Publication: Research - peer-review › Journal article – Annual report year: 2012


General information
State: Published
Organisations: National Institute of Aquatic Resources, Research Secretariat, Centre for Ocean Life, Station Biologique, Roscoff
State-space models for bio-loggers: A methodological road map

Ecologists have an unprecedented array of bio-logging technologies available to conduct in situ studies of horizontal and vertical movement patterns of marine animals. These tracking data provide key information about foraging, migratory, and other behaviours that can be linked with bio-physical datasets to understand physiological and ecological influences on habitat selection. In most cases, however, the behavioural context is not directly observable and therefore, must be inferred. Animal movement data are complex in structure, entailing a need for stochastic analysis methods. The recent development of state-space modelling approaches for animal movement data provides statistical rigor for inferring hidden behavioural states, relating these states to bio-physical data, and ultimately for predicting the potential impacts of climate change. Despite the widespread utility, and current popularity, of state-space models for analysis of animal tracking data, these tools are not simple and require considerable care in their use. Here we develop a methodological “road map” for ecologists by reviewing currently available state-space implementations. We discuss appropriate use of state-space methods for location and/or behavioural state estimation from different tracking data types. Finally, we outline key areas where the methodology is advancing, and where it needs further development.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Section for Marine Ecology and Oceanography, Section for Population Ecology and Genetics
Authors: Jonsen, I. (Ekstern), Basson, M. (Ekstern), Bestley, S. (Ekstern), Bravington, M. (Ekstern), Patterson, T. (Ekstern), Pedersen, M. W. (Intern), Thomson, R. (Ekstern), Thygesen, U. H. (Intern), Wotherspoon, S. (Ekstern)
Pages: 34-46
Publication date: 2012
Main Research Area: Technical/natural sciences

Publication information
Volume: 88-89
ISSN (Print): 0967-0645
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.35 SJR 1.335 SNIP 0.962
Subpolar gyre strength influences phytoplankton bloom dynamics

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography, Centre for Ocean Life, Faroe Marine Research Institute
Publication date: 2012
Main Research Area: Technical/natural sciences
Publication: Research Annual report year: 2012

Weak subpolar Gyre lead to early blooms

General information
State: Published
Monitoring organic loading to swimming pools by fluorescence excitation–emission matrix with parallel factor analysis (PARAFAC)

Fluorescence Excitation–Emission Matrix spectroscopy combined with parallel factor analysis was employed to monitor water quality and organic contamination in swimming pools. The fluorescence signal of the swimming pool organic matter was low but increased slightly through the day. The analysis revealed that the organic matter fluorescence was characterised by five different components, one of which was unique to swimming pool organic matter and one which was specific to organic contamination. The latter component had emission peaks at 420nm and was found to be a sensitive indicator of organic loading in swimming pool water. The fluorescence at 420nm gradually increased during opening hours and represented material accumulating through the day.
Phytoplankton spring bloom influence on larval and juvenile fish survival

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography, Centre for Ocean Life
Authors: Ferreira, A. S. (Intern), Visser, A. (Intern), MacKenzie, B. (Intern), Payne, M. (Intern)
Publication date: 2011
Event: Abstract from NorMER Annual Meeting 2011, Oslo, Norway.
Main Research Area: Technical/natural sciences
Publication: Research › Conference abstract for conference – Annual report year: 2011

Expected rate of fisheries-induced evolution is slow
Commercial fisheries exert high mortalities on the stocks they exploit and the consequent selection pressure leads to fisheries induced evolution of growth rate, size at maturation, and reproductive output. Productivity and yields may decline as a result, but little is known about the rate at which such changes are likely to occur. Fisheries-induced evolution of exploited populations has recently become a subject of concern for policy makers, fisheries managers and the general public, with prominent calls for mitigating management action. We make a general evolutionary impact assessment of fisheries by calculating the expected rate of fisheries induced evolution and the consequent changes in yield. Rates of evolution are expected to be on the order of 0.1–0.4 % per year. Resulting relative changes in fisheries yield are less than 0.5 % per year. These rates are much lower than published values based on experiments and analysis of population time series and we explain why published values may have overestimated the rates. Dealing with evolutionary effects of fishing is less urgent than reducing the direct detrimental effects of overfishing on exploited stocks and on their marine ecosystems.
Productivity patterns and abundance-area relationships in 3 marine fish species (cod, herring and haddock); meta-analyses on the effects of temperature, life-history and habitat size across the N Atlantic

Stock status evaluation and recovery policies in fisheries management rely largely on reference points derived from spawner-recruit (SR) models. The key-parameters of these models, representing productivity and carrying capacity, have been shown to be sensitive to environmental forcing and to depend on the biological and ecological characteristics of the stocks. Our aim was to identify the patterns of the temperature, habitat size and life-history effects on the SR dynamics across the N Atlantic range of 3 species; cod (21 stocks), herring (16 stocks) and haddock (7 stocks). Using hierarchical, Bayesian SR models, we combined the data across the distribution of the species in order (i) to determine the functional forms of the SR parameters dependence on these factors among and within stocks and (ii) to borrow strength and provide estimates of increased precision. Temperature during the spawning season was found to have significant effects on the productivities of all species, while carrying capacity was shown to depend also on the available habitat size. Using the derived relationships, it was possible to predict the expected changes in population-specific dynamics resulting from temperature increases. Synthesizing these patterns can improve our understanding of environmental impacts on key population parameters, which is required for ecosystem approach to management.
longicornis have coprophagous behavior and clear fecal pellets at a rate of 10-15 ml/female/d. Observations of fecal pellet production, sedimentation, and abundance collected during a 10-d late summer study in the North Sea revealed that less than 5% of the fecal pellet production in the upper 50 m was lost as flux below 50 m depth. Estimates of coprophagy rates showed, however, that the zooplankton community > 200 μm could account for only a few percent of the fecal pellet loss. Thus, plankton organisms < 200 μm must be responsible for the degradation of the fecal pellets.

**General information**
- State: Published
- Organisations: National Institute of Aquatic Resources, Danish Shellfish Centre, Centre for Ocean Life
- Authors: Poulsen, L. K. (Intern), Kiørboe, T. (Intern)
- Publication date: 2004
- Main Research Area: Technical/natural sciences
- Publication: Research › Conference abstract for conference – Annual report year: 2004

The wave plus current flow over vortex ripples at an arbitrary angle
This work concerns the wave plus current flow over a sand bed covered by vortex ripples, with the current and the waves coming from different angles. Experiments were performed in a basin, where current and waves were perpendicular, in order to determine the conditions (current strength) leading to a regular ripple pattern formation. Numerical simulations were conducted changing the direction between the waves and the current from 0 degrees to 90 degrees and the ratio between the current strength and the wave orbital velocity from 0.2 to 1.5. Close to the bed, the current aligns parallel to the ripple crests, leading to a veering current profile with the vertical coordinate. The current-related friction coefficient was calculated. It was found that it decreases as the angle approaches 90 degrees, while it increases for decreasing values of the current with a trend that can be described by a power law. (C) 2002 Elsevier Science B.V. All rights reserved.

**General information**
- State: Published
- Organisations: Department of Mechanical Engineering, National Institute of Aquatic Resources, Centre for Ocean Life, University of Catania
- Authors: Andersen, K. H. (Intern), Faraci, C. (Ekstern)
- Pages: 431-441
- Publication date: 2003
- Main Research Area: Technical/natural sciences

**Publication information**
- Journal: Coastal Engineering
- Volume: 47
- Issue number: 4
- ISSN (Print): 0378-3839
- Ratings:
  - BFI (2018): BFI-level 2
  - Web of Science (2018): Indexed yes
  - BFI (2017): BFI-level 2
  - Web of Science (2017): Indexed yes
  - BFI (2016): BFI-level 2
  - Scopus rating (2016): CiteScore 3.44 SJR 1.98 SNIP 2.252
  - Web of Science (2016): Indexed yes
  - BFI (2015): BFI-level 2
  - Scopus rating (2015): SJR 1.925 SNIP 2.097 CiteScore 2.9
  - Web of Science (2015): Indexed yes
  - BFI (2014): BFI-level 2
  - Scopus rating (2014): SJR 1.785 SNIP 2.123 CiteScore 2.55
  - Web of Science (2014): Indexed yes
  - BFI (2013): BFI-level 2
  - Scopus rating (2013): SJR 1.727 SNIP 2.264 CiteScore 2.58
  - ISI indexed (2013): ISI indexed yes
  - Web of Science (2013): Indexed yes
  - BFI (2012): BFI-level 2
  - Scopus rating (2012): SJR 1.912 SNIP 2.226 CiteScore 2.21
  - ISI indexed (2012): ISI indexed yes
Mechanistic approach to ocean ecology (39427)

The overarching goal of the proposed research is to develop a mechanistically underpinned, trait-based model of marine plankton ecosystems ranging across multiple trophic levels from bacteria to zooplankton. The rationale and methods and rooted in the trait-based approach developed by the Centre for Ocean Life. Zooplankton has a key role in the model, and the themes guiding model design are trait biogeography (i.e., spatio-temporal distributions of traits) and vertical material fluxes and carbon sequestration.

The work will be organized in four interlinked work packages (WPs), each guided by a particular research question. All models will be implemented in a physical setting, and WPs 1-3 represent an increasing degree of complexity from unicellular plankton in a 0D environment toward a full size-based model in 2D environment. WP1 and 2 develop the unicellular and multicellular components, WP3 the full size based model, and WP4 sets up the model for the California Current system and tests the model against field observations collected by the Zooglider and through the CalCOFI monitoring program.

The project is coordinated by DTU Aqua.
The project is funded by Gordon and Betty Moore Foundation.

National Institute of Aquatic Resources
Centre for Ocean Life
Scripps Institution of Oceanography
Period: 01/01/2017 → 30/06/2020
Number of participants: 4
Research areas: Oceanography & Marine Populations and Ecosystem Dynamics
Contact person:
Visser, Andre (Intern)
Project participant:
Andersen, Ken Haste (Intern)
Chakraborty, Subhendu (Intern)
Project Coordinator:
Kiørboe, Thomas (Intern)

**Marine management of ecosystem dynamics under climate change (MARmaED) (39300)**
MARmaED is an EU Initial Training Network that unifies specific and complementary competences in marine sciences from Norway, Finland, Denmark, the Netherlands, Germany and France to investigate how the cumulative stress from biodiversity loss, climate change and harvesting will affect Europe’s complex marine systems and the consequences for optimal resource management. MARmaED incorporates feedbacks between the socioeconomic and the ecological systems that give rise to critical transitions.

This project is coordinated by University of Oslo, Norway.

The project is funded by EU, Marie Curie.
National Institute of Aquatic Resources
Centre for Ocean Life
University of Oslo
University of Hamburg
Åbo Academy University
Wageningen University
University of Helsinki
University of Bergen
Météo-France
Period: 01/10/2015 → 01/10/2019
Number of participants: 4
Research area: Marine Populations and Ecosystem Dynamics
Project participant:
Lindegren, Martin (Intern)
PhD Student:
von Gemert, Rob (Intern)
Beukhof, Esther (Intern)
Project Manager, academic:
Andersen, Ken Haste (Intern)

**Ocean Literacy capacity for DK**
The workshop builds on previous TOL efforts, but with a more specific focus. The overarching goal is to draft recommendations on how Ocean Literacy can serve marine research projects for greater societal impact, and contribute to Blue Growth objectives (What is Blue Growth? A short, and a long version) through more effective knowledge exchange and engagement with non-academic stakeholders and the public.

The recommendations should assist transatlantic marine research consortia supporting the Galway Statement on Atlantic Ocean Cooperation to capitalize on citizen science, promote a science-literate citizenry, and increase public awareness on Societal Challenges issues (e.g., ocean health, responsible ocean stewardship, food security, climate mitigation).
EUROMARINE Consortium (39185)

EuroMarine is a European, marine science network launched in 2014. It represents the scientific communities of three former European Networks of Excellence: EUR-OCEANS, Marine Genomics Europe, and MarBEF. It was designed by the EuroMarine FP7 preparatory project (2011-13) as a bottom-up organization and meant to be a voice for the European marine scientific community. It is intended as a durable structure and was established as a consortium for an initial duration of 10 years. A legal entity will be established in 2016 as a support structure under the control of the consortium. As of 2016 EuroMarine counts 72 member organisations (MOs), 57 of which are ‘full voting’ members contributing to the budget. Two primary goals of EuroMarine are:

- to support the identification and initial development of important emerging scientific topics and methodologies in marine sciences
- to foster new services relevant to the marine scientific community.

EuroMarine will achieve these goals through internal competitive calls for proposals, within the available budget. It is expected that support for these activities and their outcomes will help to leverage larger projects under European, national or joint research funding programmes.

EuroMarine also intends to advocate for marine science and to contribute to improving the science-governance interface, providing expertise and transferring knowledge.

This project is coordinated by French Research Institute for Exploitation of the Sea & The National Center for Scientific Research, France.

The project is self-funded.
Period: 01/01/2014 → 31/12/2017
Number of participants: 1
Research area: Oceanography
Project participant:
Mariani, Patrizio (Intern)

Center for Ocean Life (COOL) - a Villum-Kahn Rasmussen Centre of excellence for the study of life in a changing ocean (38960)

Our goal is to develop a fundamental understanding and predictive capability of marine ecosystems through the use of novel trait-based approaches and models.

The Centre is organized around three main research activities:
- Identification and mechanistic description of the traits and trade-offs required to characterize the main Darwinian missions (feed, survive, reproduce) of the various life forms in the ocean through experimental and theoretical work, as well as analysis of literature data.
- Models: scaling of individual behavior to population and ecosystem dynamics through the development of trait-based models.
- Testing model prediction by comparing to observed trait patterns in the ocean.

The Centre involves biologists, physicist, chemists, and mathematicians and has a very strong training component through the supervision of master students, and about 30 PhD and postdoctoral fellows as well as by offering PhD summer schools and organizing international workshops. The Centre in addition host many visiting students and scientists.

The Centre is lead by DTU Aqua.

The project is funded by the Villum Kahn-Rasmussen Foundation (Velux Foundations) as well as through various national and European fellowship programs (Research Council, H.C. Ørsted Fellowship programme, Marie Curie, Carlsberg Foundation, etc).

National Institute of Aquatic Resources
Centre for Ocean Life
Roskilde University
University of Copenhagen
Massachusetts Institute of Technology
University of Oxford
Michigan State University
University of Bergen

Kiel University
Period: 01/01/2012 → 31/12/2017
Number of participants: 10
Research areas: Oceanography & Marine Populations and Ecosystem Dynamics & Marine Living Resources & Ecosystem based Marine Management
Project participant:
Andersen, Ken Haste (Intern)
Visser, Andre (Intern)
Stedmon, Colin (Intern)
Gislason, Henrik (Intern)
Payne, Mark (Intern)
Thygesen, Uffe Høgsbro (Intern)
MacKenzie, Brian (Intern)
Mariani, Patrizio (Intern)
Nielsen, Torkel Gissel (Intern)

Project Manager, academic:
Kiørboe, Thomas (Intern)

Project
Optical properties of Greenlandic coastal waters: modeling light penetration in a changing climate (38931)

The availability and spectral quality of light are key parameters controlling the productivity of Greenlandic coastal waters. Although solar elevation and sea ice cover play an important role, light is also regulated by water constituents (e.g. organic matter, phytoplankton and suspended sediments). Changing ocean circulation patterns and enhanced glacial melt stand to considerably alter the underwater light environment. This project will develop a 1D model for spectral light attenuation based on field measurements planned in two contrasting fjord systems. Results will provide valuable ground-truth data for remote sensing applications and more accurate description of the light environment for hydrodynamic models.

The project is coordinated by DTU Aqua.

National Institute of Aquatic Resources
Centre for Ocean Life
Aarhus University
Period: 01/01/2011 → 31/12/2012
Number of participants: 1
Research area: Oceanography
Project Coordinator:
Stedmon, Colin (Intern)

Climate change on marine ecosystems and resource economics (NorMER) (38898)

Marine ecosystems are under pressure from both anthropogenic climate change and high exploitation rates. A major challenge to managers and scientists is to identify ways that oceans can provide food and other services in a sustainable way under changing climatic and socioeconomic conditions. As physical, biological and socioeconomic factors interact at several levels, cross-disciplinary approaches are needed to meet this challenge.

This Nordic project has
(1) evaluated climate effects on Nordic marine ecosystems,
(2) built new tools for predicting biological consequences of climate change,
(3) quantified impacts on profit, employment, and harvesting of cod.

This has been achieved through the work of 16 PhDs, 4 postdocs, 1 climate scientist, and the combined expertise of 45 senior scientists located at 10 institutions in 8 Nordic countries.

The project was coordinated by University of Oslo, Norway.

The project was funded by Nordforsk, Nordic Council of Ministers.

National Institute of Aquatic Resources
Centre for Ocean Life
University of Oslo
Stockholm University
Åbo Academy University
University of Helsinki
Swedish Meteorological and Hydrological Institute
University of Iceland
University of the Faroe Islands
Greenland Institute of National Resources
University of Bergen
Period: 01/01/2011 → 31/12/2015
Number of participants: 6
Research areas: Oceanography & Marine Population and Ecosystem Dynamics & Population Genetics
Project participant:
Andersen, Ken Haste (Intern)
Visser, Andre (Intern)
Improvement of aquaculture high quality fish fry production (IMPAQ) (38904)
IMPAQ aims at increasing the sustainability of the Danish marine aquaculture farms producing high value fish through the development of large-scale cultures of copepods as start feed for larval fish. Copepods represent an important alternative food to present classical live feed organisms in marine fish hatcheries. Their use is known to improve survival, growth, and development of fish larvae.

The specific aims of DTU Aqua contributions to the project have been (i) to describe copepod behaviors that are mediated through water-borne chemical cues (pheromones, grazing attractants); (ii) to chemically characterize these chemical cues and develop bioassays that can facilitate the identification of water fractions containing active substances; and (iii) to test the quality of developed live feeds in pilot-scale fish larval cultures.

IMPAQ is built on knowledge transfer and direct collaboration between fundamental and applied scientists and private enterprises (SMEs and industries) and has devoted substantial effort into PhD and Postdoc training.

External partners of the project are Roskilde University (coordinator), University of Copenhagen, Aarhus University, universities in France and Taiwan and four Danish private enterprises.

The project is funded by the Danish Council for Strategic Research.

Integration of European marine research networks of excellence (EUROMARINE) (38903)
EuroMarine seeks to integrate three major European marine FP6 networks of excellence (EUR-OCEANS, MarBEF and Marine Genomics Europe) into one organization, “The EuroMarine Consortium” with a road map for joint programming, creating synergies between different scientific fields, towards a common research strategy and a shared vision for the oceans of tomorrow. EuroMarine will bring together leading European marine scientists to create a major internationally competitive network.

The goal is to exploit the knowledge created within the consortium to address questions related to the functioning of marine ecosystems and the needs of society. This project also wishes to engage the European marine data management and scientific communities in shaping the long-term integration of data, historical, present and future. Moreover, EuroMarine aims to create a 21st century marine scientist, with deep knowledge in one discipline and basic “fluency” in several others, as well as a natural ability and desire to work as part of a team.

The project is coordinated by University of Gothenburg, Sweden.

University of Gothenburg
Centre of Marine and Environmental Research
Centro de Ciências do Mar do Algarve
Centre National de la Recherche Scientifique
Only a very small fraction of the enormous amount of eggs that a fish population spawns survives the larval stage and enters the population as young fish: the majority die as larvae. The synchronicity between the timing of the plankton blooms and the food requirements of larval fish is thought to be one of the most important factors for the survival of larvae. This “match-mismatch” hypothesis will be tested using data from fish populations across the planet and global satellite observations of plankton dynamics. The results will increase our understanding of why fish populations vary throughout time and thereby contribute to their sustainable management.

The project is coordinated by DTU Aqua.

National Institute of Aquatic Resources

Centre for Ocean Life

Swiss Federal Institute of Technology

Period: 01/01/2011 → 01/04/2012
Number of participants: 1
Research area: Oceanography

Payne, Mark (Intern)

Project

Response of pelagic food webs to warmer, acidified oceans (Pelagic foods) (38923)

Atmospheric CO2 is projected to double by 2100, resulting in increased global temperature, ocean acidification (OA) and changes in the balance of marine ecosystems. A general lack of multifactorial studies means very limited knowledge on the combined effects of these pressures on ecosystem structure and function. Preliminary mono-factorial data indicate important but little studied appendicularians (pan-global pelagic urochordates) may be strongly impacted, directly and indirectly via altered phytoplankton growth and chemical composition. Effects on other key plankton such as copepods may depend on phytoplankton size. Appendicularians repetitively secrete and discard filter-feeding houses. Discarded houses with trapped particles make a significant contribution to global vertical carbon flux. We will study combined effects of temperature and CO2 on these dominant zooplankton by manipulating natural plankton in mesocosms. We hypothesize climate change will impact the important zooplanktonic trophic level through top down altered predation fields and bottom up changes in prey type and size. Copepods are size-selective feeders and recent data suggest appendicularians are bottom up regulated by large and spiny particles. We will test these hypotheses in mesocosms by generating blooms of diatoms (large) or flagellates (small) and evaluate subsequent zooplankton population dynamics. Under these different conditions, we will also examine competitive predatory interactions between copepods and appendicularians, leading to
models of projected effects of p(CO2) and temperature on appendicularians and copepods through alterations in phytoplankton community structure and uni-directional predatory pressure. Both appendicularians and copepods are important in oceanic carbon sequestration, but do so via different pathways. Data from these experiments should also have important predictive value on the nature and extent of future carbon sequestration in marine pelagic communities.

The project is coordinated by University of Bergen, Norway.

National Institute of Aquatic Resources
University of Bergen
Uni Research AS
Skidaway Institute of Oceanography
University of Gothenburg
Russian Academy of Sciences
Leibniz Institute of Marine Sciences

Period: 01/01/2011 → 31/12/2011
Number of participants: 2
Research area: Oceanography
Project participant:
Dutz, Jörg (Intern)
Koski, Marja (Intern)

Trait based plankton ecology (38896)
Plankton is the dominating life-form in the ocean. It is mainly invisible and lives in a viscous world that is not part of our sensed experience. As a consequence, important properties of life in the oceans remain poorly understood. This project has aimed to further a cross-disciplinary research activity to promote an understanding of the dynamics of marine pelagic ecosystems that is based on mechanistic descriptions of the functioning of and interaction between its individuals. We provided trait-based descriptions of the key functions of plankton, formulate their associated trade-offs, and develop trait-based models of plankton ecosystem that we will test against observations.

The core activity of the project was the development of mechanistic descriptions of key plankton traits and their trade-offs and development of trait-based models of pelagic systems. The immediate goal of the project was to achieve fundamental insights in the functioning of pelagic ecosystems but ultimately the models to examine effects of environmental changes and human impact. The project was a ‘precursor’ for the Centre for Ocean Life.

The project was coordinated by DTU Aqua.

The project was funded by the Danish Council for Independent Research.

National Institute of Aquatic Resources
Centre for Ocean Life
Roskilde University
Aarhus University

Period: 01/01/2011 → 31/12/2013
Number of participants: 5
Research areas: Oceanography & Marine Populations and Ecosystem Dynamics
Project participant:
Andersen, Ken Haste (Intern)
Nielsen, Torkel Gissel (Intern)
Thygesen, Uffe Høgsbro (Intern)
Mariani, Patrizio (Intern)

Project Manager, academic:
Kiørboe, Thomas (Intern)
Physical oceanography in Greenland waters under climate change (38767)

Changing climatic conditions will have considerable effects on the seas around Greenland. Melting glaciers, the formation of sea ice, large scale circulation of the Atlantic Ocean as well as more local changes in weather patterns will have direct impact, with cascading effects to biological processes and sustainable harvesting of marine resources. The aim of this project is to prepare modeling tools and analyses to describe expected oceanic conditions around Greenland under climate change. Particular focus will be on coupling these models and process studies to biology, biogeochemical cycling, and sea ice processes, with eventual feed backs to climate itself.

The project is coordinated by DTU Aqua.

National Institute of Aquatic Resources
Centre for Ocean Life
Danish Meteorological Institute
VitusLab

Aarhus University
Period: 01/01/2010 → 31/12/2014
Number of participants: 2
Research area: Oceanography
Project participant:
Visser, Andre (Intern)
Koski, Marja (Intern)

Advanced modelling tool for scenarios of the Baltic Sea ecosystem to support decision making (ECOSUPPORT) (38733)

The Baltic Sea is subject to several major human impacts, and three of the most important are fishing, eutrophication and climate change. Understanding and projecting how these impacts will affect the food web and its fish populations in future is therefore challenging, and requires modelling approaches which include climatic-hydrographic forcing, nutrient loading scenarios and likely fishing intensities.

ECOSUPPORT was a project whose objective was to develop an advanced modelling tool for conducting scenario simulations of how these human impacts affect the marine ecosystem and fish populations. The project coupled several different types of models so that end-to-end ecosystem models were developed which to understand how human impacts could influence the Baltic food web and fish populations. The models to be linked included regional climate models, oceanographic-lower trophic level ecosystem models (Nutrient-Phytoplankton-Zooplankton-Detritus) and fish population models. Key project results included new scenario simulations how regionally downscaled global climate model outputs would affect the development of Baltic cod populations under scenarios of climate change and seal (predator) population growth, and under different combinations of eutrophication, exploitation and climate change. These simulations included all key elements of the foodweb via an Ecopath model which included competitive and predatory interactions between the major fish species in the Baltic. The results demonstrated the vulnerability of the cod population to successful implementation of key ecosystem management policies for the Baltic Sea, including those related to exploitation and nutrient loading. Additional model scenarios focused on the sprat population which is a key intermediary link in the Baltic foodweb as prey and predator for cod and of zooplankton. These scenarios illustrated the range of future biomass and yields under assumed ranges of climate change and natural mortality.

One of the major novelties of the project was the availability of 3 different NPZD models, which enable estimation of output uncertainties to different model parameterizations and assumptions in the lower trophic levels and physical oceanographic processes, and to compare these with uncertainties due to fish population dynamics (e. g., recruitment variability). These comparisons suggest that the biological uncertainty associated with fish population dynamics was larger than that associated with the choice of the oceanographic NPZD model.

Partners in the project are the above mentioned and five other marine research institutes around the Baltic Sea.

The project is coordinated by Swedish Meteorological and Hydrographic Institute, Sweden.

The project was funded by EU, BONUS (Science for a Better Future of the Baltic Sea Region), ERA-NET.

National Institute of Aquatic Resources
Centre for Ocean Life
Swedish Meteorological and Hydrographic Institute (SMHI)
Leibniz-Institute for Baltic Sea Research
**Baltic zooplankton cascades (BAZOOCA) (38584)**

The alien ctenophore *Mnemiopsis leidyi*, notorious for wrecking havoc in the Black Sea, was recently introduced to the Baltic, where it thrives. As an enclosed brackish water system where many organisms live close to their tolerance thresholds, the Baltic is very sensitive to such disturbances. We aim to test the overall hypothesis that *Mnemiopsis* in the Baltic causes cascading effects throughout the pelagic food web, from gelatinous and top predators to microbes. Using field studies, experiments and modeling we will address a specific set of research aims (organized as work packages). We will consider these research aims within the natural spatial (Baltic proper, Bothnian Sea, Bothnian Bay) and environmental (oxygen, temperature, salinity, light, N, P) gradients in the Baltic. Understanding such food web effects and potential cascades is crucial given the overall stress from contemporary environmental challenges, e.g. eutrophication, increased maritime activities, and climate change. The results will be useful for both scientists and policy makers. The current regime shift towards more jellyfish is unprecedented in the Baltic. Its effects on this specific ecosystem cannot be forecast solely on the basis of lessons from other ecosystems.

The project is coordinated by University of Gothenburg, Sweden.

**Marine fish atlas of Denmark (38852)**

This project will produce an atlas of all the marine fish species found in waters around Denmark. The species occurrence data for the atlas will be based on all types of observational data, such as; fisheries research surveys, commercial fish landings data, recreational fishermen’s landings and diver observations. Users and target audience of the atlas are university and high school students and instructors, scientists, government officials, private companies, NGOs, and the wider Danish public. The atlas will be a reference for scientific outreach product and is a collaboration between DTU Aqua, the Zoological Museum of the Natural History Museum of Denmark and a small private consulting company operated by the former biologist of the Danish Fishermen’s Association. The atlas will contain photographs and maps of the distributional area each species and a short (3-5 page) text describing current knowledge of species’ biology and life history in Danish waters.

The project is coordinated by DTU Aqua.
The biological pump in the Nordic seas: Copepods and appendicularians as producers and consumers of sinking particles (BIOPUMP) (38757)

BIOPUMP is a research network investigating the vertical flux, its production and consumption, and how it is affected by the climate change. The main activities of the network are annual research workshops concentrating on diverse aspects of vertical flux, such as the role of different zooplankton groups in producing and degrading of sinking particles, and how will the changing temperature and CO2 concentrations of the ocean influence the dynamics of these groups. BIOPUMP is also involved in organizing a Nordic PhD course on vertical flux and factors influencing it.

The project is coordinated by DTU Aqua.

Elucidating the structure and functioning of marine ecosystems through synthesis and comparative analysis (META-OCEANS) (38154)

This project was an EU Marie Curie Early Stage Training PhD network. The project was designed to improve and apply meta-analytical methods to oceanographic and fishery research questions.

There are significant gaps in knowledge regarding the structure of marine food webs, the ecological roles of taxa of different sizes and the factors controlling linkages between different functional groups. Moreover, marine ecosystems continue to suffer from the impacts of human society superimposed on naturally and anthropogenically induced climate variability. These impacts include exploitation, eutrophication, pollution, species transfers and habitat alteration; they cause changes in the structure, function and biodiversity of marine ecosystems. However, the ability of marine scientists to predict the magnitude and direction of how marine taxa, functional groups and entire ecosystems respond to these changes, remains fragmentary. As a result, when asked by society for advice about how marine ecosystems will respond...
to different kinds of perturbations (including management actions), the marine science community can often only provide answers with high levels of uncertainty.

Students were trained in the use of meta-analysis techniques for marine ecological problems. The statistical methods were comparative and involved regression analysis, time series analysis, Bayesian analysis and trophic modelling. Students attended seminars organized by network scientists and visited scientists in partner institutes to attain additional training.

Meta-analyses approaches make use of existing data, produced in the context of different specific analyses, but which gain new value when assembled and re-analysed in a broader perspective. Meta-analyses involve several stages: (1) data mining; (2) quality control, (3) data analysis, and (4) validation. Students were trained in all these steps.

DTU Aqua had two PhD students involved in the project. These projects used Bayesian and meta-analytical methods to show that standardized estimates of maximum population growth rate for all assessed cod stocks vary spatially across the Atlantic and in a dome-shaped relationship with temperature, and that extremely good or bad recruitment occurs in years with extreme temperatures. In addition, new time series-based ways of forecasting cod population dynamics under climate change-exploitation scenarios were developed and the role of a trawling ban on a local cod population was shown to override temperature or other climate effects on stock productivity. Both projects produced papers in high impact journals (2 in Proc. Roy. Soc., 1 in PNAS), as well as in other leading fishery-marine ecology journals (MEPS, ICES, JMS, etc.)

This project was coordinated by AZTI Tecnalia, Spain.

This project was funded by EU, Marie Curie.

National Institute of Aquatic Resources
Centre for Ocean Life
AZTI-Tecnalia
Plymouth Marine Laboratory
National Center for Scientific Research
CSIC
University of Bergen
Period: 01/03/2006 → 09/12/2011
Number of participants: 3
Research areas: Oceanography & Marine Populations and Ecosystem Dynamics
Phd Student:
Lindegren, Martin (Intern)
Mantzouni, Irene (Intern)
Project Manager, academic:
MacKenzie, Brian (Intern)
Project

Fatty acids in the marine food chain (38160)

Primary production by autotrophic phytoplankton fuels the marine ecosystem and this energy is passed through the food web by trophic interactions. Understanding how energy flows through these interactions is vital for understanding how marine ecosystems function. The efficiency of energy transfer from primary producers to higher trophic levels depends on the efficiency of secondary producers utilizing the new carbon. This crucial link is still poorly understood and most often we observe that secondary production is not simply correlated with phytoplankton biomass. However, reproduction and growth of secondary producers, such as copepods, depend also on food quality. The goal of this project is to investigate the effect of essential fatty acids on copepod reproduction, growth and survival. Essential fatty acid are the ones the copepod need but has to attain from the food, as it cannot synthesize those de-novo. The project is based on series of laboratory, field and mesocosm studies with the focus on understanding on how food composition, both chemical composition and type affect growth and mortality all contribution to population dynamics of the copepod species. In addition the project has a strong teaching factor for masters and PhD students in form of advanced summer schools.

The project is coordinated by DTU Aqua.

National Institute of Aquatic Resources
Centre for Ocean Life
Aarhus University
Activities:

**Complex Motion in Fluids Summer School**
Period: 24 Sep 2017 → 29 Sep 2017
Seyed Saeed Asadzadeh (Participant)
Jens Honore Walther (Participant)
Lasse Tor Nielsen (Participant)
Julia Dölger (Participant)
Thomas Kierboe (Participant)
Anders Peter Andersen (Participant)
Department of Mechanical Engineering
Fluid Mechanics, Coastal and Maritime Engineering
National Institute of Aquatic Resources
Centre for Ocean Life
Department of Physics
Biophysics and Fluids

**Description**
The school will consist of 16 lectures in total, given by 8 speakers (90'+60' each), contributed talks, poster sessions and other activities.
Degree of recognition: International
Documents:
Asadzadeh

**Related event**

**Complex Motion in Fluids Summer School**
24/09/2017 → 30/09/2017
Cambridge, United Kingdom
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

**EGU2017-18355 Passive vs Active Knowledge Transfer: boosting grant proposal impact**
Period: 24 Apr 2017
Ivo Grigorov (Speaker)
Georgia Bayliss-Brown (Other)
David Murphy (Other)
Thomas Lindberg Thøgersen (Other)
Patrizio Mariani (Other)
National Institute of Aquatic Resources
Research Secretariat
Centre for Ocean Life
Section for Marine Ecology and Oceanography

**Description**
Research funders are increasingly concerned with measurable socio-economic impact of investment in research, and on increasingly shorter timescales. Innovation, and “open innovation” are the policy priorities of the moment and optimising the flow of ideas along the lab-2-market spectrum is essential for re-use of results, fuelling open innovation, and boosting socio-economic impact or public funded research.

The presentation showcases two complimentary strategies that Project Managers can employ pre- and/or post-award in order to optimise the exploitation and impact of research project: passive and active knowledge transfer. Passive Knowledge Transfer relies on maximum disclosure of research output (other than commercially exploitable research via patents and other IPR) in the interest of optimal reproducibility, independent validation and re-use by both academic and non-academic users, without necessarily targeting specific users. Tools of the trade include standard public & academic dissemination means (research articles, online media publications, newsletters, generic policy briefs). Additional transparency of the research workflow can be achieved by integrating “open science” (open notebooks, open data, open research software and open access to research publications) as well as Virtual Research Environments (VREs) in the methodology of the proposed work. Ensuring that the proposal partners are suitably trained in best practices of open science, makes proposal grant more competitive at evaluation and the resulting maximum access to research outputs does contribute to better return on investment for funders (Beagrie 2016) and economic growth objectives of publics e.g. Blue Growth (Houghton & Swan 2011, Marine Knowledge 2020 Roadmap). Active Knowledge Transfer, or the pro-active translation of research into policy or commercial context, is the more classical and better known approach (also referred to as extension services, or researchers providing advice e.g. to fisheries and aquaculture governance bodies and private sector). Horizon2020 COLUMBUS Consortium proposes and tests a methodology for categorizing the diverse output of research into verifiable “knowledge outputs”, and documenting the execution of an transfer plan to very specific and identified potential users, in order to transfer knowledge along the lab-2-market spectrum. The presentation will demonstrate how Open Science and detailed knowledge transfer plans complement each other, enhance grant proposal evaluation pre- and post-award, and can address Blue Growth policy objectives. Concepts presented are developed by FP7/H2020 FOSTER (www.fosteropenscience.eu), H2020 COLUMBUS (www.columbusproject.eu).

Degree of recognition: International

Documents:
EGU2017-18355-2

Links:
https://www.fosteropenscience.eu/event/ipr-open-science-and-technology-transfer

**Related event**
EGU General Assembly 2017: European GEosciences Union 2017
24/04/2017 → 28/04/2017
Vienna, Austria
Activity: Talks and presentations › Conference presentations

**ICES - Working Group on Widely Distributed Stocks - WGWIDE (External organisation)**
Period: 2015
Mark Payne (Participant)
National Institute of Aquatic Resources
Centre for Ocean Life
Degree of recognition: International

**Related external organisation**

**ICES - Benchmark Workshop on Pelagic Stocks - WKPELA (External organisation)**
Period: 2014
Mark Payne (Participant)
National Institute of Aquatic Resources
Centre for Ocean Life
Degree of recognition: International

**Related external organisation**
**ICES - Benchmark Workshop on Pelagic Stocks - WKPELA**  
Activity: Membership › Membership of committees, commissions, boards, councils, associations, organisations, or similar

**ICES - Working Group on the Ecosystem Effects of Fishing Activities - WGECO (External organisation)**  
Period: 2014  
Nis Sand Jacobsen (Participant)  
National Institute of Aquatic Resources  
Centre for Ocean Life  
Degree of recognition: International  

Related external organisation

**ICES - Working Group on the Ecosystem Effects of Fishing Activities - WGECO**  
Activity: Membership › Membership of committees, commissions, boards, councils, associations, organisations, or similar

**ICES - Working Group on Widely Distributed Stocks - WGWIDE (External organisation)**  
Period: 2014  
Mark Payne (Participant)  
National Institute of Aquatic Resources  
Centre for Ocean Life  
Degree of recognition: International  

Related external organisation

**ICES - Working Group on Widely Distributed Stocks - WGWIDE**  
Activity: Membership › Membership of committees, commissions, boards, councils, associations, organisations, or similar

**ASLO 2013 Aquatic Sciences Meeting**  
Period: 2013 → …  
Mie Hylstofte Sichlau (Participant)  
National Institute of Aquatic Resources  
Centre for Ocean Life  

Related event

**ASLO 2013 Aquatic Sciences Meeting: Learning for the future**  
17/02/2013 → 22/02/2013  
New Orleans, United States  
Activity: Attending an event › Participating in or organising a conference

**ASLO 2013 Aquatic Sciences Meeting**  
Period: 2013 → …  
Mie Hylstofte Sichlau (Participant)  
National Institute of Aquatic Resources  
Centre for Ocean Life  

Related event

**ASLO 2013 Aquatic Sciences Meeting: Learning for the future**  
17/02/2013 → 22/02/2013  
New Orleans, United States  
Activity: Attending an event › Participating in or organising a conference

**ICES - Benchmark Workshop on Pelagic Stocks - WKPELA (External organisation)**  
Period: 2013 → …  
Mark Payne (Participant)
National Institute of Aquatic Resources
Centre for Ocean Life
Degree of recognition: International

Related external organisation
ICES - Benchmark Workshop on Pelagic Stocks - WKPELA
Activity: Membership › Membership of committees, commissions, boards, councils, associations, organisations, or similar

ICES - Herring Assessment Working Group for the Area South of 62ºN - HAWG (External organisation)
Period: 2013 → …
Mark Payne (Participant)
National Institute of Aquatic Resources
Centre for Ocean Life
Degree of recognition: International

Related external organisation
ICES - Herring Assessment Working Group for the Area South of 62ºN - HAWG
Activity: Membership › Membership of committees, commissions, boards, councils, associations, organisations, or similar

ICES - Working Group on Widely Distributed Stocks - WGWIDE (External organisation)
Period: 2013 → …
Mark Payne (Participant)
National Institute of Aquatic Resources
Centre for Ocean Life
Degree of recognition: International

Related external organisation
ICES - Working Group on Widely Distributed Stocks - WGWIDE
Activity: Membership › Membership of committees, commissions, boards, councils, associations, organisations, or similar

ICES - Workshop on Global Assessment of the Implications of Climate Change on the Spatial Distribution of Fish and Fisheries - WKSICCME-Spatial (External organisation)
Period: 2013 → …
Mark Payne ( Participant)
National Institute of Aquatic Resources
Centre for Ocean Life
Degree of recognition: International

Related external organisation
ICES - Workshop on Global Assessment of the Implications of Climate Change on the Spatial Distribution of Fish and Fisheries - WKSICCME-Spatial
Activity: Membership › Membership of committees, commissions, boards, councils, associations, organisations, or similar

ICES - Workshop on Northeast Atlantic mackerel monitoring and methodologies including science and industry involvement - WKNAMMM (External organisation)
Period: 2013 → …
Mark Payne (Participant)
National Institute of Aquatic Resources
Centre for Ocean Life
Degree of recognition: International

Related external organisation
ICES - Workshop on Northeast Atlantic mackerel monitoring and methodologies including science and industry involvement - WKNAMMM
Et arktis i problemer
Period: 21 Nov 2013
Torkel Gissel Nielsen (Lecturer)
National Institute of Aquatic Resources
Centre for Ocean Life
Links:
http://snm.ku.dk/dnf/foredrag/2013-etfraaar/et-arktis-i-problemer/ (Link to abstract)

Related event
Foredrag i Naturhistorisk Forening
21/11/2013 → …
København, Denmark
Activity: Talks and presentations › Conference presentations

Galathea - 3
Period: 19 Nov 2013
Torkel Gissel Nielsen (Invited speaker)
National Institute of Aquatic Resources
Centre for Ocean Life
Description
Dansk Militærmedicinsk Selskab (DMMS)
Related external organisation
Unknown external organisation
Activity: Talks and presentations › Conference presentations

Nordic-Baltic IHSS Symposium
Period: 10 Jun 2013 → 12 Jun 2013
Colin Stedmon (Invited speaker)
National Institute of Aquatic Resources
Centre for Ocean Life
Description
Coupling the UV-visible spectroscopic properties of dissolved organic matter to its chemical characteristics: Evidence across contrasting environments

Related event
Nordic-Baltic IHSS Symposium
10/06/2013 → 12/06/2013
Uppsala, Sweden
Activity: Talks and presentations › Conference presentations

37th Annual Larval Fish Conference
Period: 2 Jun 2013 → 6 Jun 2013
Evandro Malanski (Participant)
National Institute of Aquatic Resources
Centre for Ocean Life
Links:
http://www.rsmas.miami.edu/LFC2013/
Related event

37th Annual Larval Fish Conference
02/06/2013 → 06/06/2013
Miami, United States
Activity: Attending an event › Participating in or organising a conference

Effekter af olie på den Arktiske marine fødkæde
Period: 16 Apr 2013
Torkel Gissel Nielsen (Invited speaker)
National Institute of Aquatic Resources
Centre for Ocean Life
Description
SAFT - Selskabet for Arktisk Forskning og Teknologi
Related external organisation
Unknown external organisation
Activity: Talks and presentations › Conference presentations

Gordon Research Conference: Polar Marine Science
Period: 11 Mar 2013
Colin Stedmon (Invited speaker)
National Institute of Aquatic Resources
Centre for Ocean Life
Description
Conservative and non conservative behavior of DOM in polar environments: insight into macro and micro scale processes
Related event

Gordon Research Conference: Polar Marine Science: Linking Polar Observations, Processes and Models at Regional and Global Scales
10/03/2013 → 15/03/2013
Ventura, United States
Activity: Talks and presentations › Conference presentations

ASLO 2013 Aquatic Sciences Meeting
Period: 22 Feb 2013
Mette Dalgaard Agersted (Speaker)
National Institute of Aquatic Resources
Centre for Ocean Life
Description
Krill - not a fussy eater
Related event

ASLO 2013 Aquatic Sciences Meeting: Learning for the future
17/02/2013 → 22/02/2013
New Orleans, United States
Activity: Talks and presentations › Conference presentations

17. Danske havforskermøde
Period: 21 Jan 2013 → 23 Jan 2013
Mette Dalgaard Agersted (Speaker)
National Institute of Aquatic Resources
Centre for Ocean Life

Description
Konkurrerer krill om føden?

Related event
17. Danske havforskermøde
21/01/2013 → 23/01/2013
Roskilde, Denmark
Activity: Talks and presentations › Conference presentations

Nordic Centre for Research on Marine Ecosystems and Resources under Climate Change (External organisation)
Period: 1 Dec 2012 → 30 Nov 2015
Evandro Malanski (Participant)
National Institute of Aquatic Resources
Centre for Ocean Life

Description
NorMER brings together the expertise of leading research groups from all Nordic countries, and several North American institutions, to implement a collective and multidisciplinary research strategy to explore the biological, economic, and management consequences of global climate change on fisheries resources. It will achieve this through a unique program of primary research, implemented by PhDs and Postdocs in a system of collaborative projects, with a focus on the Atlantic cod (Gadus morhua). Though our Nordic focus is on cod, this research is intended to be a platform to extend this knowledge to other marine systems.

Body type: NorMER
Degree of recognition: International

Related external organisation
Nordic Centre for Research on Marine Ecosystems and Resources under Climate Change
Activity: Membership › Membership of research networks or expert groups

Prizes:
Science without Borders - Brazil
Evandro Malanski (Recipient)
National Institute of Aquatic Resources, Centre for Ocean Life

Description
PhD scholarship

Details
Awarded date: 1 Dec 2012
Granting Organisations: Technical University of Denmark
Prize: Prizes, scholarships, distinctions