A stochastic surplus production model in continuous time

Surplus production modelling has a long history as a method for managing data-limited fish stocks. Recent advancements have cast surplus production models as state-space models that separate random variability of stock dynamics from error in observed indices of biomass. We present a stochastic surplus production model in continuous time (SPICT), which in addition to stock dynamics also models the dynamics of the fisheries. This enables error in the catch process to be reflected in the uncertainty of estimated model parameters and management quantities. Benefits of the continuous-time state-space model formulation include the ability to provide estimates of exploitable biomass and fishing mortality at any point in time from data sampled at arbitrary and possibly irregular intervals. We show in a simulation that the ability to analyse subannual data can increase the effective sample size and improve estimation of reference points relative to discrete-time analysis of aggregated annual data. Finally, subannual data from five North Sea stocks are analysed with particular focus on using residual analysis to diagnose model insufficiencies and identify necessary model extensions such as robust estimation and incorporation of seasonality. We argue that including all known sources of uncertainty, propagation of that uncertainty to reference points and checking of model assumptions using residuals are critical prerequisites to rigorous fish stock management based on surplus production models.
Avoiding pitfalls in interdisciplinary education

As the world’s social-environmental problems increasingly extend across boundaries, both disciplinary and political, there is a growing need for interdisciplinarity, not only in research per se, but also in doctoral education. We present the
common pitfalls of interdisciplinary research in doctoral education, illustrating approaches towards solutions using the Nordic Centre for Research on Marine Ecosystems and Resources under Climate Change (NorMER) research network as a case study. We provide insights and detailed examples of how to overcome some of the challenges of conducting interdisciplinary research within doctoral studies that can be applied within any doctoral/postdoctoral education programme, and beyond. Results from a selfevaluation survey indicate that early-career workshops, annual meetings and research visits to other institutions were the most effective learning mechanisms, whereas single discipline-focused courses and coursework were among the least effective learning mechanisms. By identifying the strengths and weaknesses of components of NorMER, this case study can inform the design of future programmes to enhance interdisciplinarity in doctoral education, as well as be applied to science collaboration and academic research in general.

**General information**
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Organisations: National Institute of Aquatic Resources, Section for Oceans and Arctic, Section for Ecosystem based Marine Management, Section for Marine Ecology and Oceanography, University of Bergen, University of Iceland, Stockholm University, University of Oslo, University of Helsinki, University of the Faroe Islands, Abo Akademi University
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Web of Science (2009): Indexed yes
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Migration patterns of the Faroe Plateau cod (Gadus morhua, L.) revealed by data storage tags

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography, Section for Ecosystem based Marine Management, Faroe Marine Research Institute, Danish Meteorological Institute, University of the Faroe Islands
Authors: Maj Ottosen, K. (Intern), Pedersen, M. W. (Intern), Eliasen, S. K. (Ekstern), Steingrund, P. (Ekstern), Magnussen, E. (Ekstern), Rasmussen, T. A. S. (Ekstern)
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Volume: 195
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BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.21 SJR 1.12 SNIP 1.136
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.067 SNIP 1.133 CiteScore 2.01
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.105 SNIP 1.312 CiteScore 2.17
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.037 SNIP 1.173 CiteScore 1.85
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.93 SNIP 1.177 CiteScore 1.78
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.154 SNIP 1.135 CiteScore 1.7
ISI indexed (2011): ISI indexed yes
Historical DNA documents long distance natal homing in marine fish

General information
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Organisations: National Institute of Aquatic Resources, Section for Marine Living Resources, Greenland Climate Research Centre, Stanford University, Greenland Institute of Natural Resources, Aarhus University
Pages: 2727-2734
Publication date: 2016
Main Research Area: Technical/natural sciences

Publication information
Journal: Molecular Ecology
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Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 5.9 SJR 3.508 SNIP 1.651
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 3.862 SNIP 1.606 CiteScore 5.73
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 3.446 SNIP 1.602 CiteScore 5.43
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 3.13 SNIP 1.564 CiteScore 5.6
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
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Scopus rating (2012): SJR 3.068 SNIP 1.705 CiteScore 5.36
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 3.469 SNIP 1.823 CiteScore 5.56
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 3.513 SNIP 1.915
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 3.455 SNIP 2.024
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 3.326 SNIP 2.086
Web of Science (2008): Indexed yes
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 2.937 SNIP 1.918
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 2.932 SNIP 2.111
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 2.756 SNIP 2.099
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 2.544 SNIP 1.731
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Scopus rating (2001): SJR 2.148 SNIP 1.564
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Scopus rating (2000): SJR 1.964 SNIP 1.677
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Publication: Research - peer-review › Journal article – Annual report year: 2016
Trends in marine climate change research in the Nordic region since the first IPCC report

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.
Validation of state-space models using Template Model Builder

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High-precision, low-cost animal positioning in passive acoustic telemetry

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Marine Living Resources, University of Canterbury
Authors: Cagua, F. (Ekstern), Pedersen, M. W. (Intern), Roy, R. (Ekstern)
Publication date: 2015
Event: Abstract from Annual Conference. Australian Society for Fish Biology (ASFB), Sydney, Australia.
Main Research Area: Technical/natural sciences
Publication: Research › Conference abstract for conference – Annual report year: 2015

Movements, migrations and space use of fish in the North Sea in relation to offshore wind farms

General information
State: Published
Performance assessment of two whole-lake acoustic positional telemetry systems - is reality mining of free-ranging aquatic animals technologically possible?

Acoustic positional telemetry systems (APTs) represent a novel approach to study the behaviour of free ranging aquatic animals in the wild at unprecedented detail. System manufactures promise remarkably high temporal and spatial resolution. However, the performance of APTs has rarely been rigorously tested at the level of entire ecosystems. Moreover, the effect of habitat structure on system performance has only been poorly documented. Two APTs were deployed to cover two small lakes and a series of standardized stationary tests were conducted to assess system performance. Furthermore, a number of tow tests were conducted to simulate moving fish. Based on these data, we quantified system performance in terms of data yield, accuracy and precision as a function of structural complexity in relation to vegetation. Mean data yield of the two systems was 40%(Lake1) and 60%(Lake2). Average system accuracy (acc) and precision (prec) were Lake1: acc = 3.1 m, prec = 1.1 m; Lake2: acc = 1.0 m, prec = 0.2 m. System performance was negatively affected by structural complexity, i.e., open water habitats yielded far better performance than structurally complex vegetated habitats. Post-processing greatly improved data quality, and sub-meter accuracy and precision were, on average, regularly achieved in Lake2 but remained the exception in the larger and structurally more complex Lake1.

Moving transmitters were tracked well by both systems. Whereas overestimation of moved distance is inevitable for stationary transmitters due to accumulation of small tracking errors, moving transmitters can result in both over-and underestimation of distances depending on circumstances. Both deployed APTs were capable of providing high resolution positional data at the scale of entire lakes and are suitable systems to mine the reality of free ranging fish in their natural environment. This opens important opportunities to advance several fields of study such as movement ecology and animal social networks in the wild. It is recommended that thorough performance tests are conducted in any study utilizing APTs. The APTs tested here appear best suited for studies in structurally simple ecosystems or for studying pelagic species. In such situations, the data quality provided by the APTs is exceptionally high.
RevFisk – et projekt som kvantificerer stenrems betydning for fisk

General information
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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
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**ReVfisk – et projekt som kvantificerer stenrevs (et lavliggende stenrev i den fotiske zone og et dybere liggende stenrev i den afotiske zone) betydning for fisk**

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- **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
- **Authors:** Stenberg, C. (Intern), Christoffersen, M. (Intern), Aarestrup, K. (Intern), Deurs, M. V. (Intern), Støttrup, J. (Intern), Nielsen, A. (Intern), Andersen, N. G. (Intern), Mariani, P. (Intern), Baktoft, H. (Intern), Pedersen, M. W. (Intern), Dahl, K. (Ekstern), Lundsteen, S. (Ekstern), Stæhr, P. (Ekstern), Rasmussen, M. B. (Ekstern), Mohn, C. (Ekstern), Møhlenberg, F. (Ekstern), Hansen, F. T. (Ekstern), Uhrenholt, T. (Ekstern), Mandviwalla, X. R. (Ekstern)
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**Umbrella species in marine systems: using the endangered humphead wrasse to conserve coral reefs**

Extinction risk is closely tied to body size, home range, and species distribution. Quantifying home range is critical for conservation, and can enable the use of concepts such as ‘umbrella species’, whose conservation protects other species due to shared habitat. To determine the value of the humphead wrasse as an umbrella species for coral reef conservation, we conducted a multi-year study of humphead wrasse home range at Palmyra Atoll, Central Tropical Pacific, tagging juvenile, female, and male individuals with acoustic transmitters. We quantified home range using 2 metrics, length and area, and determined if these metrics were related to the sex and maturity status of the individual. We recorded individual movements during 5030 fish-days, yielding detailed records for 14 individuals comprising 3 juveniles, 5 females, and 6 males. The home range of humphead wrasse measured over a 2 yr study was 0.4 to 14 km and changed with ontogeny. Females had larger home ranges than other reef fishes studied to date (n = 68), indicating value as an umbrella species for coral reefs. We compared the home range of the species to the size distribution of tropical marine protected areas (MPAs), and used a model to estimate the MPA length necessary to retain humphead wrasse. Most MPAs are too small to effectively protect the humphead wrasse.

**General information**
- **State:** Published
- **Organisations:** National Institute of Aquatic Resources, Section for Marine Living Resources, College of William and Mary, University of Hawaii, University of California
- **Authors:** Weng, K. C. (Ekstern), Pedersen, M. W. (Intern), Del Raye, G. A. (Ekstern), Caselle, J. E. (Ekstern), Gray, A. E. (Ekstern)
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  - ISI indexed (2013): ISI indexed no
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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.
A quantitative approach to static sensor network design

Static sensor networks to observe animals are widely used in ecological, management and conservation research, but quantitative methods for designing these networks are underdeveloped. In the context of aquatic systems, we present a method for quasi-optimal network design, which accounts for blocking of detections by obstacles, horizontal and vertical movement behaviour of the target animals, and type of research question (is the network intended for estimation of detailed movement or home range?). Optimal design is defined as the sensor configuration that maximizes the expected number of unique animal detections. As finding the global optimum is generally time consuming, we use a greedy algorithm instead, which places sensors optimally relative to already placed sensors. The design method requires access to topographic data of the study site and knowledge of the sensor detection range. We illustrate the method with real topographic data from a rugose coral reef where network performance is highly influenced by detection shadowing. Network performance is visualized by a coverage map indicating the probability of detection at any location in the study area. The reported unique recovery rate summarizes the expected ability of the network to collect data given the design constraints. Because sensors are placed sequentially, the information gain per sensor can be evaluated and used as a proxy for sensor value. The presented method formalizes important considerations, when designing sensor networks, that were previously often based on heuristics and intuition. The method provides a guide to maximizing the information potential of future monitoring studies as well as a means to improve existing networks. The method is available as an R package and can be tested via an online web tool. 10.1111/(ISSN)2041-210X

General information

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Organisations: National Institute of Aquatic Resources, Section for Marine Living Resources, University of Hawaii
Authors: Pedersen, M. W. (Intern), Burgess, G. (Ekstern), Weng, K. C. (Ekstern)
Modelling group dynamic animal movement

Group dynamic movement is a fundamental aspect of many species' movements. The need to adequately model individuals' interactions with other group members has been recognised, particularly in order to differentiate the role of social forces in individual movement from environmental factors. However, to date, practical statistical methods which can include group dynamics in animal movement models have been lacking. We consider a flexible modelling framework that distinguishes a group-level model, describing the movement of the group's centre, and an individual-level model, such that each individual makes its movement decisions relative to the group centroid. The basic idea is framed within the flexible class of hidden Markov models, extending previous work on modelling animal movement by means of multi-state random walks. While in simulation experiments parameter estimators exhibit some bias in non-ideal scenarios, we show that generally the estimation of models of this type is both feasible and ecologically informative. We illustrate the approach using real movement data from 11 reindeer (Rangifer tarandus). Results indicate a directional bias towards a group centroid for reindeer in an encamped state. Though the attraction to the group centroid is relatively weak, our model successfully captures group-influenced movement dynamics. Specifically, as compared to a regular mixture of correlated random walks, the group dynamic model more accurately predicts the non-diffusive behaviour of a cohesive mobile group.

General information

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Organisations: National Institute of Aquatic Resources, Section for Marine Living Resources
Authors: Langrock, R. (Ekstern), Hopcraft, J. G. C. (Ekstern), Blackwell, P. G. (Ekstern), Goodall, V. (Ekstern), King, R. (Ekstern), Niu, M. (Ekstern), Patterson, T. A. (Ekstern), Pedersen, M. W. (Intern), Skarin, A. (Ekstern), Schick, R. S. (Ekstern)
Pages: 190-199
Publication date: 2014
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.
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.

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.
Estimating individual animal movement from observation networks

1. Observation network data comprise animal presences detected by observer stations at fixed spatial locations. Statistical analysis of these data is complicated by spatial bias in sampling and temporal variability in detection conditions. Advanced methods for analysis of these data are required but are currently underdeveloped.

2. We propose a state-space model (SSM) for observation network data to estimate detailed movements of individual animals. The underlying movement model is an Ornstein–Uhlenbeck (OU) process, which is stationary, and therefore has an inherent mechanism that models home range behaviour. An integral part of the approach is the detection function, which models the probability of logging animal presences. The detection function is also used to provide absence information when animals are undetected. Since the ability to detect an animal often depends on time-varying external factors such as environmental conditions, we use covariate information about detection efficiency as control variables.

3. Via simulation, we found that movement estimation error scales log-linearly with network sparsity. This result can be
used to indicate the number of stations necessary to achieve a desired upper bound on estimation error. Furthermore, we found that the SSM outperforms existing techniques in terms of estimating detailed movements and that estimates are robust towards mis-specification of the detection function. We also tested the importance of accounting for time-varying detection conditions and found that the probability of making wrong conclusions decreases substantially when covariate information is exploited.

4. The model is used to estimate movements and home range of a humphead wrasse (Cheilinus undulatus) at Palmyra Atoll in the central Pacific Ocean. Here, detection conditions have a strong diel component, which is controlled for using detection efficiency information from a reference device.

5. The presented approach enhances the toolbox for analysis of observation network data as collected by acoustic telemetry or potentially other aspiring methods such as camera trapping and mobile phone tagging. By explicitly modelling movement and observation processes, the model integrates all sources of uncertainty and provides a sound statistical basis for making well-informed management decisions from imperfect information.
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.
Can metabolic properties explain variation in individual behaviour?

General information
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Organisations: Section for Freshwater Fisheries Ecology, National Institute of Aquatic Resources, Section for Ocean Ecology and Climate
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Event: Abstract from 1st International Conference on Fish Telemetry, Sapporo, Japan.
Main Research Area: Technical/natural sciences
Source: orbit
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Publication: Research › Conference abstract for conference – Annual report year: 2011

Can metabolic properties explain variation in individual behaviour? Attempting to link physiology and morphology with field behavior

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Organisations: Section for Freshwater Fisheries Ecology, National Institute of Aquatic Resources, Section for Ocean Ecology and Climate
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Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 281697
Publication: Research › Conference abstract for conference – Annual report year: 2011

Estimating animal behaviour and residency from movement data

We present a process-based approach to estimate residency and behavior from uncertain and temporally correlated movement data collected with electronic tags. The estimation problem is formulated as a hidden Markov model (HMM) on a spatial grid in continuous time, which allows straightforward implementation of barriers to movement. Using the grid to
explicitly resolve space, location estimation can be supplemented by or based entirely on environmental data (e.g. temperature, daylight). The HMM method can therefore analyze any type of electronic tag data. The HMM computes the joint posterior probability distribution of location and behavior at each point in time. With this, the behavioral state of the animal can be associated to regions in space, thus revealing migration corridors and residence areas. We demonstrate the inferential potential of the method by analyzing satellite-linked archival tag data from a southern bluefin tuna Thunnus maccoyii where longitudinal coordinates inferred from daylight are supplemented by latitudinal information in recorded sea surface temperatures.

General information
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling, Section for Population Ecology and Genetics, National Institute of Aquatic Resources, Commonwealth Scientific and Industrial Research Organisation
Authors: Pedersen, M. W. (Intern), Patterson, T. A. (Ekstern), Thygesen, U. H. (Intern), Madsen, H. (Intern)
Pages: 1281-1290
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Main Research Area: Technical/natural sciences

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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
Scopus rating (2015): SJR 2.389 SNIP 1.346 CiteScore 3.59
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.494 SNIP 1.486 CiteScore 3.69
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.24 SNIP 1.375 CiteScore 3.55
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.364 SNIP 1.419 CiteScore 3.53
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 2.475 SNIP 1.305 CiteScore 3.28
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.575 SNIP 1.537
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 2.47 SNIP 1.446
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 2.648 SNIP 1.502
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 2.814 SNIP 1.545
Scopus rating (2006): SJR 2.773 SNIP 1.487
Scopus rating (2005): SJR 2.467 SNIP 1.45
Scopus rating (2004): SJR 2.255 SNIP 1.349
Scopus rating (2003): SJR 2.14 SNIP 1.384
Scopus rating (2002): SJR 2.451 SNIP 1.343
Scopus rating (2001): SJR 2.484 SNIP 1.336
Estimation methods for nonlinear state-space models in ecology

The use of nonlinear state-space models for analyzing ecological systems is increasing. A wide range of estimation methods for such models are available to ecologists, however it is not always clear, which is the appropriate method to choose. To this end, three approaches to estimation in the theta logistic model for population dynamics were benchmarked by Wang (2007). Similarly, we examine and compare the estimation performance of three alternative methods using simulated data. The first approach is to partition the state-space into a finite number of states and formulate the problem as a hidden Markov model (HMM). The second method uses the mixed effects modeling and fast numerical integration framework of the AD Model Builder (ADMB) open-source software. The third alternative is to use the popular Bayesian framework of BUGS. The study showed that state and parameter estimation performance for all three methods was largely identical, however with BUGS providing overall wider credible intervals for parameters than HMM and ADMB confidence intervals.

General information
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling, Section for Population Ecology and Genetics, National Institute of Aquatic Resources
Pages: 1394-1400
Publication date: 2011
Main Research Area: Technical/natural sciences

Publication information
Journal: Ecological Modelling
Volume: 222
Issue number: 8
ISSN (Print): 0304-3800
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 2.43 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
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.135 SNIP 1.353 CiteScore 2.7
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.153 SNIP 1.329 CiteScore 2.53
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.029 SNIP 1.229 CiteScore 2.28
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.183 SNIP 1.134 CiteScore 2.34
Individual based population inference using tagging data

General information
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling, Section for Population Ecology and Genetics, National Institute of Aquatic Resources, Section for Freshwater Fisheries Ecology
Publication date: 2011
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 275820
Publication: Research - peer-review › Journal article – Annual report year: 2011

Movement patterns of yellowfin tuna in the Coral Sea region: defining connectivity with stocks in the western Pacific Ocean region

General information
State: Published
Organisations: Section for Ocean Ecology and Climate, National Institute of Aquatic Resources
Authors: Evans, K. (Ekstern), Patterson, T. (Ekstern), Pedersen, M. W. (Intern)
Number of pages: 64
Publication date: 2011

Publication information
Publisher: Australian Fisheries Management Authority
Original language: English
Main Research Area: Technical/natural sciences
Source: orbit
Nonlinear tracking in a diffusion process with a Bayesian filter and the finite element method

A new approach to nonlinear state estimation and object tracking from indirect observations of a continuous time process is examined. Stochastic differential equations (SDEs) are employed to model the dynamics of the unobservable state. Tracking problems in the plane subject to boundaries on the state-space do not in general provide analytical solutions. A widely used numerical approach is the sequential Monte Carlo (SMC) method which relies on stochastic simulations to approximate state densities. For offline analysis, however, accurate smoothed state density and parameter estimation can become complicated using SMC because Monte Carlo randomness is introduced. The finite element (FE) method solves the Kolmogorov equations of the SDE numerically on a triangular unstructured mesh for which boundary conditions to the state-space are simple to incorporate. The FE approach to nonlinear state estimation is suited for off-line data analysis because the computed smoothed state densities, maximum a posteriori parameter estimates and state sequence are deterministic conditional on the finite element mesh and the observations. The proposed method is conceptually similar to existing point-mass filtering methods, but is computationally more advanced and generally applicable. The performance of the FE estimators in relation to SMC and to the resolution of the spatial discretization is examined empirically through simulation. A real-data case study involving fish tracking is also analysed.
Performance of a wireless acoustic telemetry system in a natural lake: the role of data processing and habitat structure

General information
State: Published
Organisations: Section for Freshwater Fisheries Ecology, National Institute of Aquatic Resources, Section for Ocean Ecology and Climate
Authors: Zajicek, P. (Ekstern), Baktoft, H. (Intern), Klefoth, T. (Ekstern), Pedersen, M. W. (Intern), Sisak, M. M. (Ekstern), Arlinghaus, R. (Ekstern)
Publication date: 2011
Event: Abstract from 1st International Conference on Fish Telemetry, Sapporo, Japan.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 279244
Publication: Research › Conference abstract for conference – Annual report year: 2011

Hidden Markov modelling of movement data from fish

Movement data from marine animals tagged with electronic tags are becoming increasingly diverse and plentiful. This trend entails a need for statistical methods that are able to filter the observations to extract the ecologically relevant content. This dissertation focuses on the development and application of hidden Markov models (HMMs) for analysis of movement data from fish. The main contributions are represented by six scientific publications. Estimation of animal location from uncertain and possibly indirect observations is the starting point of most movement data analyses. In this work a discrete state HMM is employed to deal with this task. Specifically, the continuous horizontal plane is discretised into grid cells, which enables a state-space model for the geographical location to be estimated on this grid. The estimation model for location is extended with an additional state representing the behaviour of the animal. With the extended model can migratory and resident movement behaviour be related to geographical regions. For population inference multiple individual state-space analyses can be interconnected using mixed effects modelling. This framework provides parameter estimates at the population level and allows ecologists to identify individuals that deviate from the rest of the tagged population. The thesis also deals with geolocation on state-spaces with complicated geometries. Using an unstructured discretisation and the finite element method tortuous shore line geometries are closely approximated. This furthermore enables accurate probability densities of location to be computed. Finally, the performance of the HMM approach in analysing nonlinear state space models is compared with two alternatives: the AD Model Builder framework and BUGS, which relies on Markov chain Monte Carlo estimation.

General information
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling, Section for Population Ecology and Genetics, National Institute of Aquatic Resources
Publication date: 2010
Individual based population inference using tagging data

A hierarchical framework for simultaneous analysis of multiple related individual datasets is presented. The approach is very similar to mixed effects modelling as known from statistical theory. The model used at the individual level is, in principle, irrelevant as long as a maximum likelihood estimate and its uncertainty (Hessian) can be computed. The individual model used in this text is a hidden Markov model. A simulation study concerning a two-dimensional biased random walk is examined to verify the consistency of the hierarchical estimation framework. In addition, a study based on acoustic telemetry data from pike illustrates how the framework can identify individuals that deviate from the remaining population.

Estimating spatially and temporally dependent behaviour switching of tagged marine animals

Geolocating fish using Hidden Markov Models and Data Storage Tags

Geolocation of fish based on data from archival tags typically requires a statistical analysis to reduce the effect of measurement errors. In this paper we present a novel technique for this analysis, one based on Hidden Markov Models (HMM’s). We assume that the actual path of the fish is generated by a biased random walk. The HMM methodology produces, for each time step, the probability that the fish resides in each grid cell. Because there is no Monte Carlo step in
our technique, we are able to estimate parameters within the likelihood framework. The method does not require the
distribution to be Gaussian or belong to any other of the usual families of distributions and can thus address constraints
from shorelines and other nonlinear effects; the method can and does produce bimodal distributions. We discuss merits
and limitations of the method, and perspectives for the more general problem of inference in state-space models of
animals. The technique can be applied to geolocation based on light, on tidal patterns, or measurement of other variables
that vary with space. We illustrate the method through application to a simulated data set where geolocation relies on
depth data exclusively.

General information
State: Published
Organisations: Section for Population- and Ecosystem Dynamics, National Institute of Aquatic Resources, Mathematical
Statistics, Department of Informatics and Mathematical Modeling
Authors: Thygesen, U. H. (Intern), Pedersen, M. W. (Intern), Madsen, H. (Intern)
Number of pages: 452
Pages: 277-293
Publication date: 2009

Host publication information
Title of host publication: Tagging and Tracking of Marine Animals with Electronic Devices : Volume 8 reviews: methods
and technologies in fish biology and fisheries
Volume: Part 2: Geolocation Methods
Publisher: Springer
Editor: Nielsen, J.
ISBN (Print): 14-02-09639-9

Series: Reviews: Methods and Technologies in Fish Biology and Fisheries
Number: 9
ISSN: 1571-3075
Series: Reviews: Methods and Technologies in Fish Biology and Fisheries
Volume: 9
ISSN: 1571-3075
Main Research Area: Technical/natural sciences
DOI:
10.1007/978-1-4020-9640-2_17
Source: orbit
Source-ID: 250427
Publication: Research - peer-review › Book chapter – Annual report year: 2009

New insights in pike behaviour using 2D/3D telemetry

General information
State: Published
Organisations: Section for Freshwater Fisheries Ecology, National Institute of Aquatic Resources, Mathematical Statistics,
Department of Informatics and Mathematical Modeling
Authors: Baktoft, H. (Intern), Jacobsen, L. (Intern), Skov, C. (Intern), Aarestrup, K. (Intern), Svendsen, J. C. (Intern), Berg,
S. (Intern), Pedersen, M. W. (Intern), Koed, A. (Intern)
Publication date: 2009
Event: Abstract from 8th Conference on Fish Telemetry held in Europe; Umeå, Sweden; September 14-18,.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 252533
Publication: Research › Conference abstract for conference – Annual report year: 2009

Geolocation of North Sea cod (Gadus morhua) using Hidden Markov Models and behavioural switching
When geolocating fish based on archival tag data, a realistic assessment of uncertainty is essential. Here, we describe an
application of a novel Fokker–Planck-based method to geolocate Atlantic cod (Gadus morhua) in the North Sea area. In
this study, the geolocation relies mainly on matching tidal patterns in depth measurements when a fish spends a
prolonged period of time at the seabed with a tidal database. Each day, the method provides a nonparametric probability
distribution of the position of a tagged fish and therefore avoids enforcing a particular distribution, such as a Gaussian
distribution. In addition to the tidal component of the geolocation, the model incorporates two behavioural states, either high
or low activity, estimated directly from the depth data, that affect the diffusivity parameter of the model and improves the
precision and realism of the geolocation significantly. The new method provides access to the probability distribution of the
position of the fish that in turn provides a range of useful descriptive statistics, such as the path of the most probable
movement. We compare the method with existing alternatives and discuss its potential in making population inference
from archival tag data.
Increasing confidence in tidal-based geolocation models by including temperature information: the case of cod in the northern North Sea

General information
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling, Marine Scotland, University of Tasmania
Authors: Berx, B. (Ekstern), Neat, F. (Ekstern), Pedersen, M. W. (Intern), Wright, P. (Ekstern), Proctor, R. (Ekstern)
Pages: 1-3
Publication date: 2008
Main Research Area: Technical/natural sciences

Publication information
Journal: IC E S Council Meeting
Volume: P:05
ISSN (Print): 1015-4744
Ratings:
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Web of Science (2003): Indexed yes
Original language: English
Source: orbit
Source-ID: 208035
Publication: Research - peer-review » Journal article – Annual report year: 2008

Indirect observation of fish movements: a general methodology applied at different scales

General information
State: Published
Organisations: Section for Population- and Ecosystem Dynamics, National Institute of Aquatic Resources, Section for Fisheries- and Monitoring Technology, Section for Fisheries Advice, Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: Thygesen, U. H. (Intern), Karlsen, J. (Intern), Nielsen, A. (Intern), Pedersen, M. W. (Intern)
Publication date: 2008
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 229070
Publication: Research » Paper – Annual report year: 2008
Spatial dynamics of Atlantic cod (Gadus morhua) in the North Sea: results from a large-scale electronic tagging programme

General information
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling, Cefas, Marine Scotland
Authors: Righton, D. (Ekstern), Quayle, V. (Ekstern), Neat, F. (Ekstern), Pedersen, M. W. (Intern), Wright, P. (Ekstern), Armstrong, M. (Ekstern), Svedang, H. (Ekstern), Hobson, V. (Ekstern), Metcalfe, J. (Ekstern)
Pages: 1-32
Publication date: 2008
Main Research Area: Technical/natural sciences

Publication information
Journal: ICES Council Meeting
Volume: P:04
ISSN (Print): 1015-4744
Ratings:
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Web of Science (2003): Indexed yes
Original language: English
Source: orbit
Source-ID: 245243
Publication: Research › Conference article – Annual report year: 2008

An alternative geolocation method using Hidden Markov Models

General information
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling, National Institute of Aquatic Resources
Authors: Pedersen, M. W. (Intern), Thygesen, U. H. (Intern)
Publication date: 2007
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 208048
Publication: Research › Conference abstract for conference – Annual report year: 2007

Projects:

Improvement of the foundation for stock assessment for data limited stocks with importance for Danish fishery (39310)

Objectives
The aim of this project is to improve the knowledge basis, data, and methodology for providing robust stock assessment and short term forecast according to MSY for data limited fish stocks with importance for Danish commercial fishery.

Background
A number of fish stocks in the Baltic, Skagerrak-Kattegat and North Sea area with importance for Danish commercial fishery either as target species, commercially important by-catch species, or as unintended by-catch species are data limited stocks with no analytical stock assessment. More than 60% of fish stocks that ICES gives advice on are category 3 and 4. These categories include stocks for which the data and knowledge are insufficient to conduct a full analytical assessment of their state and exploitation. Until now, ICES has not been able to assess their state relative to the objective of achieving MSY (Maximum Sustainable Yield) sustainability. A major task of fisheries management is broadening from the narrow analysis of few main commercial species toward accounting for by-catches, i.e. the great range of species and sizes of lesser importance caught at the same time in non-selective fisheries (mixed-fisheries). This unwanted part of catches is becoming politically important because it may trigger restrictive management decisions for the commercial fisheries, both as part of the ecosystem-based marine management (EU MSFD), and because of the potential of these species to become limiting for some fleets in the frame of the landing obligation (=discard ban) of the EU CFP, i.e. when a fishery can be closed because it has reached the authorized catch quantity (quota) of a low-value species even though it still has some quota left for more valuable commercial species (so-called “choke species” effect).
Tasks and Deliverables
- Develop assessment and forecast models and methods for stocks in the categories 3-4 and integrate them as standard models and software in the ICES advisory framework in relation to method development and assessing data poor stocks in special working groups (ICES WKLIFE V-VI, ICES WKPROXY) and in standard stock assessment working groups covering the Skagerrak-Kattegat, Baltic Sea and North Sea areas (ICES WGNSSK, ICES WGBFAS).
- Apply the models to selected fish stocks with importance for Danish fishery with the aim of promoting analytical and benchmark assessments to assess stock status relative to MSY objectives. Application of these methods mean that the status of those category 3 and 4 stocks can be classified as desirable or undesirable in relation to MSY objectives, and the stocks can be lifted to category 2 or 1 stocks with analytical assessments. The stocks are selected in close collaboration and agreement with the Ministry of Environment and Food (several directorates), the fishing industry and associations (DF), NGO environmental stakeholders and Science (DTU Aqua).
- The work includes estimation of fish stock growth parameters, performing yield per recruit analyses, and conducting stock assessments with application of a stochastic stock production model and/or a length based stochastic assessment model, as well as where possible a stochastic age based VPA stochastic assessment model.
- Management Strategy Evaluation (MSE) for selected stocks: Establishment of biological (biomass- or fishing mortality based) reference points for each of the selected stocks involving growth models and logistic models (ogives). MSE for establishing output-based harvest control rules according to short to medium term forecasts for the selected stocks. This includes provision and further development of model software to carry out MSE of the selected stocks.
This project is coordinated by DTU Aqua.
The project is funded by the Danish Ministry og Environment and Food (under Framework Contract with DTU).

Section for Ecosystem based Marine Management
Period: 01/07/2015 → 01/03/2017
Number of participants: 5
Research areas: Fisheries Management & Marine Living Resources
Project participant:
Pedersen, Martin Wæver (Intern)
Berg, Casper Willestofte (Intern)
Kokkalis, Alexandros (Intern)
Phd Student:
Bossier, Sieme (Intern)
Project Coordinator:
Nielsen, J. Rasmus (Intern)

Tender for scientific support to the Saudi Arabian fisheries sector (SaudiTender I) (39153)
Objective
The general aim of the Fisheries Program at the Marine Studies Section, Center for Environment and Water, Research Institute, King Fahd University of Petroleum and Minerals (KFUMP/RI), is to establish a modern system of data collection, biological and ecological assessment, stock assessment modelling, and government management, in order to evaluate the exploitation status and enhance the sustainability of finfish and invertebrate stocks of Saudi Arabia (SA) Exclusive Economic Zone in the Arabian Gulf. The overall principle underlying this effort is the food security of SA, and the duty to carry out the best efforts to guarantee sustainable exploitation of fishery resources and ensure economic viable fisheries. The Program is organized in four main branches, or Work Packages: Population Dynamics and Stock Assessment, Essential Fish Habitats, Environmental Impacts of Fishing Methods, and Management Strategy Framework.

Background
The KFUPM/RI of Saudi Arabia and AZTI-Tecnalia, Marine and Food Research Institute of the Basque Country, Spain, in partnership with DTU-Aqua, runs this project with an extensive collaboration program in fisheries monitoring, research, and management advice. A service contract according has been signed between KFUPM/RI and AZTI. A sub-contract to this service contract has been made between AZTI and DTU Aqua where parts of the service contract forms an integral part of the subcontract and where DTU Aqua is co-responsible for the below listed specific tasks and deliverables.

Tasks and Deliverables
Population Dynamics and Stock Assessment: Provision and further development of suitable model software to carry out stock assessment for data limited fish stocks. Stock assessment models suitable to data-poor fisheries are applied to historical catch and effort data (2002-2012) and to data from the new Data Collection Framework (2013-) for major stocks. DTU Aqua is responsible for provision of model software to carry out assessments and application of this to 5 major finfish stocks out of the appointed 13 major stocks exploited by SA in the area. The work include estimation of fish stock growth parameters, performing yield per recruit analyses, and conducting stock assessments with application of a stochastic stock production model using the above data to estimate MSY (Maximum Sustainable Yield) sustainability reference levels
according to exploitation. Templates for assessment and advice are developed on the basis of the data and knowledge available in cooperation with AZTI which includes a Stock Summary Sheet for each of the stocks.

Management Strategy Evaluation (MSE) for Major Stocks: Conducting and reporting MSE for data-poor fisheries considering several prospective harvest control rules in the short to medium term according to MSY. This involves identification of biological reference points (biomass- and fishing mortality based reference points) and identification of input or output based harvest control rules according to short term forecast for the 5 major fish stocks. Also, this involves provision and further development of model software to carry out MSE according to MSY in the short to medium term.

Management Strategy Framework: Provision of formal considerations, evaluations, recommendations and reporting of relevant and appropriate management regimes and systems of data collection and stock assessments for scientifically-based advice to the SA Ministry of Agriculture on basis of current fishery system and exploitation of the 13 major stocks. This addresses needs for data, methods, institutional set-up, provision of advice, and possible management systems. This project is coordinated by AZTI Technalia, Spain.

The project is funded by AZTI Technalia, Spain as to KFUPM University Saudi Arabia.

National Institute of Aquatic Resources
Section for Ecosystem based Marine Management
AZTI-Tecnalia
King Fahd University of Petroleum and Minerals
Period: 01/05/2015 → 30/06/2017
Number of participants: 5
Research area: Fisheries Management
Project participant:
Pedersen, Martin Wæver (Intern)
Berg, Casper Willestofte (Intern)
Degel, Henrik (Intern)
Bastardie, Francois (Intern)
Project Coordinator:
Nielsen, J. Rasmus (Intern)

Statistical modelling of tagging data from marine animals
Department of Informatics and Mathematical Modeling
Period: 01/07/2007 → 02/02/2011
Number of participants: 6
Phd Student:
Pedersen, Martin Wæver (Intern)
Supervisor:
Thygesen, Uffe Høgsbro (Intern)
Main Supervisor:
Madsen, Henrik (Intern)
Examiner:
Poulsen, Niels Kjølstad (Intern)
Huse, Geir (Ekstern)
Zucchini, Walter (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: DTU-lønnet stipendie
Project: PhD

Activities:

ICES - Benchmark Workshop on Baltic Cod Stocks - WKBALTCOD (External organisation)
Period: 2015
Martin Wæver Pedersen (Participant)
National Institute of Aquatic Resources
Section for Marine Living Resources
Degree of recognition: International

Related external organisation

ICES - Benchmark Workshop on Baltic Cod Stocks - WKBALTCOD
Activity: Membership › Membership of committees, commissions, boards, councils, associations, organisations, or similar