



2013 annual report

This is the second annual report of the VKR center of Excellence *Centre for Ocean Life* (OceanLifeCentre.dk). In the following we firstly describe (i) *Centre staff*, hires, and visiting scientists, then (ii) briefly describe major *scientific activities and achievements*, and finally describe (iii) outreach activities that have given the Centre a strong national and international presence and have disseminated our results to scientists and the public (courses, workshops, conferences, public outreach). The report closes with lists of publications, lectures, and other concrete output.

Centre staff

As of December 1st 2013 we have 10 young researchers (PhD and post docs) hired on Centre funds. One post doc has left us prematurely to take up a faculty position, and another post doc is going on maternal leave. These were both modellers and we have thus intensified our search for skilled modellers to be hired in 2014. In addition to fellows hired directly by the Centre, post docs and PhDs financed by other funds work fully or partly with the Centre. We have been successful in augmenting Centre activities with other external funding, e.g. HC Ørsted fellowships (2) and post doctoral fellowships funded by the Research council (2) as well as a visiting professor (1). See appendix 1 for list of Centre staff and associates.

Research achievements

All individual student and post doc projects are briefly described on the Centre homepage (<http://www.oceanlifecentre.dk/Projects.aspx>).

The work within the Centre is organized under three inter-related themes; (I) *The individual – defining key traits and trade-offs*, (II) *Models- scaling from individual to ecosystem*, and (III) *Nature – analyses of patterns of traits*. Below we briefly report the major scientific developments within these themes.

Theme I. The individual – defining key traits and trade-offs

The largest source of organic material in the ocean is in dissolved form (DOM) and can only be utilized by bacteria that use substrate-specific enzymes to cleave particular compounds. The key trait of a bacterium is therefore the extracellular enzymes it can produce and the consequent resources it gets access to. **Sachia Jo Traving** has, through experiments and modelling successfully

described enzyme deployment traits for free-living bacteria. The work has inspired an analysis of the biogeochemical fate of DOM in the oceans and addressed an important issue and one of the big mysteries, viz. why most of the DOM in the ocean appears to be refractory and has turnover times on the order of 1000 years. The work describes how enzyme specificity and chemical diversity combine to explain the persistence of DOM.

Many eukaryotic unicellular organisms in the ocean are mixotrophic, i.e., they function as plants and animals simultaneously, and an overarching aim is to understand the spatio-temporal distribution and significance of mixotrophy in pelagic food webs. **Terje Berge** has experimentally characterized the mixotrophic life strategy and has demonstrated that heterotrophy and autotrophy are not fully complementary strategies, but are dependent on one another. This insight is now built into a mechanistic model of mixotrophy. **Starrlight Augustine** uses experimental data to quantify the trade-offs associated the mixotrophic strategy and is developing a mixotrophy model using the Dynamic Energy Budget approach. Preliminary attempts have been made to build the new insights into a food web model.

Zooplankton feed on bacteria and phytoplankton and we work on understanding the various feeding mechanisms employed by zooplankton to concentrate microscopic food particles from a dilute environment and to quantify the associated trade-offs. **Lasse Tor Nielsen** has described how various few- μm -sized but quantitatively important flagellates feed. For choanoflagellates, he has identified a prey capture mechanism that appears to be inconsistent with our current understanding of the fluid dynamics involved. Further, he has identified an as yet undescribed prey capture mode for a dinoflagellate, the physics of which is also difficult to understand. **Navish Wadhwa** and **Rodrigo Gonçalves** have quantified tradeoffs in copepod feeding; a balance between the volume of water scanned for food and predation risk. They have characterized and modelled the fluid disturbance as well as prey sensing mechanisms, which allows quantification of this tradeoff. Comparison of the tradeoffs for different feeding strategies allows generalizations and the resulting insights are being implemented directly into the global plankton model that we are developing (see theme II).

Interaction in the plankton is often mediated by chemical signals, and **Erik Selander** and **Jan Heuschele** have made significant progress in characterizing the smell of food as well as the sex pheromones that copepods produce. This has been intensive work with an uncertain chance of success, but by means of so-called metabolomics methods they have now been able to identify a dozen or so sex pheromone candidate molecules in two species of copepods. **Samuel Hylander** has concluded his work in the Centre (as planned) and his quantification of the fitness costs of UV exposure and has identification of defence mechanisms in pelagic copepods is now being published.

Theme II - Models- scaling from individual to ecosystem

We use the mechanistic insights gathered under (I) to develop models of marine populations, communities, and ecosystems; and we aim at testing our models against patterns observed under (III).

Julie Sainmont has examined the vertical migration behaviour of plankton using a game theoretical approach in which individuals balance their need to avoid predation (stay at depth) and their need to

feed (at the surface). Vertically migrating plankton have implications for the vertical transport of CO₂, and attempts are being made to include migration behaviour in larger-scale biogeochemical models. Within this context, standard optimization procedures are too computational demanding for feasible implementation, but a simpler (myopic) method appears to provide a suitable approach by which global implications can be assessed. **Lise Marty** has examined invasive species and has developed a mathematical framework for identifying life-history ‘invasive’ traits: invasion success is increased by maturation at an early age and a small size, while individuals in a population in steady state optimize their fitness by maturing at an intermediate size. These predictions are in accordance with what we have observed for source and invasive populations of the comb jelly, *Mnemiopsis* (‘killer jelly’), but have general application. She is also developing a framework to examine fisheries-induced selection of behavioural traits. **Nis Sand Jacobsen** has examined the effects of ‘balanced fishing’ (selective fishing on fastest growing size classes) on fish communities and shown that balanced fishing leads to higher yield and less disturbance than tradition fishing strategies, but also that the economic return is less. Other studies have examined fish migration and identified the key traits (sociality, individual preference, and memory) that contribute to school formation and migration efficiency. **Erik Martens** developed a minimal model of the predator-prey interaction in an entire marine ecosystem, from phytoplankton to whales, using “size” as the governing trait. He has used the model to show how the oscillating signal from seasonal forcing propagates up through the trophic levels in the ecosystem, and how the signal is eventually damped. **Irene Heilmann** developed methods for numerical analysis of bifurcations (numerical continuation and equation-free analysis). She applied the methods to a size-structured model of a zooplankton population and used that to identify transitions between extinction, stable populations and two types of cycles in the population. Further, she has initiated work on a proof of existence and uniqueness of solutions in the fundamental equation used to describe structured populations.

Fi Prowe has now implemented the zooplankton feeding traits and trade-offs in the global plankton model. The zooplankton encounter model developed in an idealized 0-dimensional seasonal cycle in the first year of the Centre has been tested and evaluated under realistic environmental conditions simulated by the MIT general circulation model. The global plankton model predicts a distinct biogeography of the different zooplankton feeding modes, passive ambush feeding vs. active cruising, which contrasts the high latitude oceans and most oligotrophic zones with more productive oceanic regimes. The predicted patterns are in good agreement with observations. Furthermore, the model simulates an overall realistic size structure of the phytoplankton community, in contrast to a more simplistic model of the type typically employed in global ocean ecosystem models. In addition, the encounter model captures different lengths of the food chain in different oceanic regions, and can thus via the export of organic matter in the next step be linked to global biogeochemical cycles of carbon and nutrients. Further work with the model and publication of results are put on halt due to Fi’s pregnancy.

Theme III - Nature – analyses of patterns of traits

The analysis of patterns of traits has two meanings, namely how traits are distributed in time and space, and how traits are distributed among species. The former provides the scenarios towards

which our models eventually will be tested; the latter is another – indirect – way of quantifying tradeoffs.

A major activity in the Centre during the past year has been the ‘Size in the Ocean’ project. The project involves most of the PIs and young researchers of the Centre and represents genuine collaboration between physicists, biologist, and mathematicians. The project is ambitious in its scope: To explain the differences in the strategies of all the major life forms in the ocean, from bacteria to whales, based only on the size of individuals. We have reviewed data on size-based scaling laws for resource acquisition, mobility, sensory range and progeny size for all pelagic marine life, from bacteria to whales, and developed simple theoretical arguments for observed validity ranges of scaling laws. We use these theoretical insights to divide life in the ocean into seven major realms based on their trophic strategy, physiology and life history strategy. The results have a form that allows implementation in trait-based models and will be a cornerstone in our future work. The synthesis paper is now in review with a leading, high impact journal. In addition to being the first collaborative “signature project” from the Centre, “Size in the Ocean” has also had a very positive impact on initiating cross-disciplinary collaborations among the young researchers (see report from the young researchers).

This major synthesis has been based on a number of more specific projects. **Karin Olsson** relates reproductive strategies to life history traits in marine fish based on an analysis conducted together with the ‘progeny size group’ of how progeny size relates to adult size in fish as well as other marine organisms. Based on the analyses, two major reproductive strategies have emerged, viz, ‘many small offspring’ and ‘fixed size-ratio offspring’ strategies, and we are currently trying to understand how these strategies emerge from offspring-size tradeoffs. **Erik Martens and Navish Wadhwa** have been leading forces in the ‘sensing group’ that has analyzed how different senses (chemical, mechanical, vision, hearing, etc.) are constrained by organism size in a watery environment. The analysis has resulted in a fundamental understanding of sensing mode and range in the ocean, which is fundamental for understanding predator-prey and other interactions. Other analyses have demonstrated major transitions in the size scaling of vital rates (i.e., metabolism, feeding, and growth rates) in marine organisms, in stark contrast to the current understanding of scaling laws. All these analyses have been or are in the process of being published, and will form a solid basis for our models.

We have initiated various projects describing trait biogeography: the spatial distribution of traits. **Mark Holm** is analyzing the spatial distribution of overwintering strategies in zooplankton. His main focus until now has been over resting eggs, and he is now continuing with analysis of other strategies (dormancy and starvation tolerance). **Philipp Brun** has just started his PhD project (December 2013) in which he will use new, extensive data bases on plankton distributions to describe global phytoplankton and zooplankton trait distributions, using species distribution models. The resulting trait-distributions will be used to test the global plankton models that we are developing (see above). We have also completed analyses of patterns in fish distribution, abundance, and diversity along latitudinal gradients, and analyses of temporal patterns in the

abundance of fish, demonstrating how warm-adapted species are replacing cold-adapted species in the North Sea and elsewhere.

Finally we have engaged in creating a global trait database for plankton. This work was initiated at our international workshop in Copenhagen and is led by Andrew Barton from the MIT group.

Centre activities

1. *International Workshops and summer schools*: The Centre for Ocean Life has organized several international activities that have put our Centre on the international Ocean Science map:
 - a. The international flagship activity during the year was the *International workshop on Trait-based approaches to Ocean Life* (trait-based-workshop.dk) held at the Royal Academy of Sciences and Letters in Copenhagen, 26-28 August 2013. Report from the workshop and other information is available at the work shop home page. We had planned with 60 participants but the workshop received an overwhelming interest with more than 200 applications. We had to expand to 82 participants (the limit of the facility) and turn away many highly relevant and qualified applicants. In addition to strengthening the international network and positioning the Centre for Ocean Life in the scientific landscape there were many concrete outcomes of the workshop: (i) establishing an international working group to develop a trait database; (ii) international project collaboration and research applications; and (iii) a follow-up workshop organized by Mick Follows and the MIT team in New England, USA, 2015. We expect the Copenhagen workshop to be the first in a series of international workshops.
 - b. We have been involved in organizing an international workshop on *Microscale interactions in aquatic Environments* (www.hull.ac.uk/MicroEnvSymp) at the Les Houches Physics School, Grenoble France, March 2013, and an EUR-OCEANS hot topics conference *A changing ocean* (6-8 Nov. 2013, PLOCAN, Gran Canaria, Spain).
 - c. Together with board members (Øyvind Fiksen, Mick Follows) we are organizing scientific sessions on trait-based approaches at major international conferences: (i) IMBER Future Ocean conference, Bergen, Juni 2014: [Modelling and data synthesis of marine planktonic ecosystems using functional types and trait-based approaches](http://www.imber.info/index.php/Meetings/IMBER-OSC-2014/Sessions-Workshops/Modelling-and-data-synthesis-of-marine-planktonic-ecosystems-using-functional-types-and-trait-based-approaches); <http://www.imber.info/index.php/Meetings/IMBER-OSC-2014/Sessions-Workshops/Modelling-and-data-synthesis-of-marine-planktonic-ecosystems-using-functional-types-and-trait-based-approaches>; (ii) ASLO Ocean Science meeting, Hawaii, Februar 2014: *Small bugs with a big impact: linking plankton ecology with ecosystem processes*. www.sgmeet.com/osm2014/sessionschedule.asp?SessionID=057

- d. We are organizing a mini-symposium and workshop in size- and trait-based models of fish communities in Charlottenlund, June 2-6, 2014. The event is organized in collaboration with Keith Farnsworth from Queens University of Belfast.
 - e. *PhD Summer Schools*: Centre PIs have been involved in teaching and organizing the following PhD summer schools: *From Bloom to Gloom* (Iceland, July-August 2013); *Climate-Biogeochemistry Interactions in the Tropical Ocean*, Kristineberg (University of Kiel), Sweden, 18-31 August 2013; *Multi-scale Analysis in Dynamical Systems*, Lyngby (DTU), 9th - 13 December, 2013; *CNRS Thematic School on Innovative Approaches in Marine Environment Modelling*, Brest, August 2013.
2. *Weekly science meetings*: Key to the coherence of the Centre is the weekly meetings where all students and post docs meet with PIs to discuss progress of their work and other topics of mutual interest. See the young researcher's evaluation of the meetings in appendix 6.
 3. *Annual retreat*: We had the second annual retreat 12-13 December 2013 at 'Søminestationen' at the Isefjord, with participation of almost all Centre members, students, and post docs, as well as a few international guests and an invited speaker, total 38 participants. All young researchers presented and discussed their research, we had a PI meeting, and the young researchers had a meeting to discuss the format of the weekly meetings and other Centre activities. See agenda for the retreat and minutes from meetings in appendix 6
 4. *Working groups*: Ad hoc working groups exploring specific problems have been established, e.g., 'Food chain modelling', 'Fluid dynamics of zooplankton feedings', 'Size in the ocean', 'Adaptive ecological-evolutionary modelling', 'Mixotrophy' 'Coarse analysis (equation-free analysis) of microscopic models'. These groups have also been a means to advise (groups of) students and post docs in their work. An attempt is made to bring different disciplines into each of these groups. In addition, some of the groups eg "Size in the ocean" contain sub-groups, which involve several people from the Centre assessing different aspects such as feeding modes, sensing mechanisms, progeny size, etc.
 5. *Outgoing International exchange*: Friederike Prowe spent 3 weeks with board member Mick Follows and his group at MIT for developing the global model, and PhD student Nis San Jacobsen visited Professor Tim E. Essington at the School of Fisheries and Aquatic sciences in Seattle for a four month research stay.
 6. *Scientific board*: We have had the following interaction with the board members during 2013: 5 board members attended the Trait-based workshop in August (Christopher Klausmeier, Elena Litchman, Jorn Bruggeman, Markus Pahlow, Øyvind Fiksen), where we also organised a board meeting. Markus Pahlow participated in the annual retreat of the Centre in December. KH Andersen spent 3 weeks with Mick Follows at MIT.

7. *Popular outreach*: Nationally, we have flashed the Centre for Ocean Life by means of intensified public outreach activities. Students and post docs are encouraged to produce popular material from their research because it forces them to define their project in a larger context. We have written popular science articles for magazines and for the science section of a newspaper (*Weekendavisen*). We have also managed to get a beautiful commented science image in the free magazine that DSB (DK railway) produces (*Ud og Se*). We have also been giving numerous popular science talks, both at high schools (Naturvidenskabsfestival), at popular science events, and on TV (Danskernes Akademi). For a list of articles, activities, and links see appendix 3. We are further organizing an Ocean Life lecture series at 'Folkeuniversitetet' in the 2014 spring semester (<http://www.fukbh.dk/program/forelaesningsraekker/biologi/biologi-livet-i-havet.aspx>). Finally, our work has led to media coverage in both Danish (various newspapers, Danmarks Radio, Videnskab.dk) and international media (National Public Radio (USA), NBC (USA), Time magazine (USA), Die Welt (Germany) and Christian Science Monitor (USA)).

Appendices

1. Scientific publications

We list here only those of our publications that are related to Centre for Ocean Life. We include papers that are submitted or ‘*in press*’, since a large fraction of our work is at that stage only.

1. Andersen KH, Berge T, Neuheimer AB, Olsson K, Palacz A, Prowe F, Sainmont J, Traving SJ, Visser A, Wadhwa N, Goncalves TR, Hartvig M, Heuschele J, Hylander S, Jacobsen NS, Lindemann C, Martens EA, Kiørboe T (submitted). Characteristic sizes of life in the oceans, from bacteria to whales. Submitted to *Ecol Lett*
2. Andersen KH, Beyer JE (2014). Size structure, not metabolic scaling rules, determines fisheries reference points. To appear in *Fish and Fisheries*.
3. Andersen KH, Brander K, Ravn-Jensen L. Compatible and coherent strategies for managing fisheries. Submitted for publication.
4. Barton A, Pershing A, Litchman E, Record N, Edwards K, Finkel Z, Kiørboe T, Ward B (2013). The Biogeography of Marine Plankton Traits. *Ecol. Lett.* 16: 522–534. doi: 10.1111/ele.12063
5. Brander K (2013) Climate and current anthropogenic impacts on fisheries. *Climatic Change* 119: 9–21
6. Brander K, Neuheimer A, Andersen KH, Hartvig M (2013). Food for Thought: Overconfidence in model projections. *ICES Journal of Marine Science* 70(6), 1065–1068.
7. Bureau E, Schilder F, Santos I, Thomsen J, Starke J (2013). Experimental Bifurcation Analysis of an Impact Oscillator – Tuning a Non-Invasive Control Scheme. *Journal of Sound and Vibration* 332(22), 5883–5897.
8. Calduch-Verdiell N, MacKenzie BR, Vaupel JW, Andersen KH. A life-history evaluation of the impact of maternal effects on recruitment and fisheries reference points. Submitted for publication.
9. Casale P, Mariani P (2014). The first “lost year” of Mediterranean sea turtles: dispersal patterns indicate subregional management units for conservation. *Marine Ecology Progress Series*. doi: 10.3354/meps10640
10. Dickey-Collas M, Engelhard GH, Rindorf A, Raab K, Smout S, Aarts G, van Deurs M, Brunel T, Hoff A, Lauerburg RAM, Garthe S, Andersen KH, Scott F, van Kooten T, Beare D, Peck MA (2013). Ecosystem-based management objectives for the North Sea: riding the forage fish rollercoaster. *ICES Journal of Marine Science*; doi:10.1093/icesjms/fst075
11. De Luca G, Mariani P, MacKenzie BR, Marsilli M. Fishing out collective memory of migratory schools. Submitted.
12. Elmegaard M, Krauskopf B, Osinga H, Starke J, Thomsen JJ (2013). Bifurcation analysis of the smoothing of an impact oscillator and comparison with experiment. Submitted. See <http://arxiv.org/abs/1308.3647>.
13. Engelhard GH, Peck MA, Rindorf A, Smout S, van Deurs M, Raab K, Andersen KH, Garthe S, Lauerburg RAM, Scott F, Brunel T, Aarts G, van Kooten T, Dickey-Collas M. Forage fish, their fisheries, and their predators: who drives whom? To appear in *ICES Journal of Marine Science*.
14. Ferreira AS, Visser AW, MacKenzie BR, Payne MR. Estimating phytoplankton phenology metrics from noisy, gappy data. Submitted.

15. Flynn KJ, Hansen PJ (2013). Cutting the canopy to defeat the "selfish gene"; conflicting selection pressures for the integration of phototrophy in mixotrophic protists. *Protist*. 164: 811-823.
16. Gaididei Y, Gorria C, Berkemer R, Kawamoto A, Shiga T, Christiansen P, Sørensen M, Starke J (2013). Traffic jam control by time-modulating the safety distance. *Physical Review E* 88(4), 042803–042815.
17. Gaididei Y, Gorria C, Berkemer R, Christiansen P, Kawamoto A, Sørensen M, Starke J (2013). Stochastic control of traffic patterns. Invited article for special issue “Nonlinear Partial Differential Equations: Theory and Applications to Complex Systems”
18. (editors: Henri Berestycki, Danielle Hilhorst, Frank Merle, Masayasu Mimura and Khashayar Pakdaman) of *NHM (Networks and Heterogeneous Media)*, 8(1), 261–273, dedicated to Professor Hiroshi Matano on the occasion of his 60th birthday.
19. Gonçalves RJ, van Someren Gréve H, Couespel D, Kiørboe T. Mechanisms of prey size selection in a suspension feeding copepod, *Temora longicornis*. Submitted.
20. Hansen PJ, Nielsen LT, Johnson M, Berge T, Flynn KJ (2013). Acquired phototrophy in *Mesodinium* and *Dinophysis* – A review of cellular organization, prey selectivity, nutrient uptake and bioenergetics. *Harmful Algae* 28:126-139.
21. Hartvig M, Andersen KHA (2013). Coexistence of structured populations with size-based prey selection. *Theoretical Population Ecology* 89:24-33.
22. Hays GC, Christensen A, Fossette S, Schofield G, Talbot J, Mariani P (2014). Route optimization and solving Zermelo's navigation problem during long distance migration in cross flows. *Ecology Letters*. DOI: 10.1111/ele.12219
23. Heuschele J, Eliassen S, Kiørboe T (2013). Optimal mate choice patterns in pelagic copepods. *Oecologia* 172:399-408. DOI 10.1007/s00442-012-2516-4
24. Hirst A G, Bonnet D, Conway DVP, Kiørboe T (2013). Female-biased sex ratios in marine pelagic copepods: Comment on Gusmão et al. (2013). *Mar. Ecol. Prog. Ser.* doi: 10.3354/meps10522
25. Hollowed AB, Barange M, Beamish RJ, Brander, K, et al (2013). Projected impacts of climate change on marine fish and fisheries. *ICES Journal of Marine Science* (ISSN: 10543139) (DOI: <http://dx.doi.org/10.1093/icesjms/fst081>), vol: 70, issue: 5, pages: 1023-1037
26. Houle JE, Andersen KH, Farnsworth KD, Reid DG (2013). Emerging asymmetric interactions between forage and predator fisheries impose management trade-offs. *Journal of Fish Biology* 83(4) 890-904.
27. Hylander S, Grenwald J, Kiørboe T (2013). Fitness cost of UVR exposure in marine pelagic copepods. *Funct. Ecol.* doi: 10.1111/1365-2435.12159
28. Jacobsen NS, Gislason H, Andersen KH (in press) The consequences of balanced harvesting of fish communities. *Proceedings of the Royal Society B: Biological Sciences* 281 (1775), 20132701
29. Jansen T, Gislason H (2013). Population Structure of Atlantic Mackerel (*Scomber scombrus*) *PLoS one* 8 (5), e64744
30. Jaspers C, Haraldsson M, Lombard F, Bolte S, Kiørboe T (2013). Seasonal dynamics of early life stages of invasive and native ctenophores give clues to invasion and bloom potential in the Baltic Sea. *J. Plankton Res.* 35: 582–594.
31. Kiørboe T (2013). Attack or attacked: The sensory and fluid mechanical constraints of copepod predator-prey interactions. *Int Comp Biol*, pp. 1–11 doi:10.1093/icb/ict021
32. Kiørboe T (2013). Zooplankton body composition. *Limnol. Oceanogr.* 58:1843-1850. doi:10.4319/lo.2013.58.5.1843

33. Kiørboe T, Hirst AG (2013). Shifts in mass-scaling of respiration, feeding, and growth rates across life-form transitions in marine pelagic organisms. *Am. Nat.* In press
34. Kiørboe T, Jiang H (2013). To eat and not be eaten: Optimal foraging behavior in suspension feeding copepods. *J. Roy. Soc. Int.* 10: 20120693. doi.org/10.1098/rsif.2012.0693
35. Kristensen K, Thygesen UH, Andersen KH, Beyer JE. Estimating spatio-temporal dynamics of size-structured populations. To appear in *Canadian Journal of Fisheries and Aquatic Science*.
36. Kristiansen KU, Brøns M, Starke J (2013). An iterative method for the approximation of fibers in slow-fast systems. Submitted. See <http://arxiv.org/abs/1208.6420>.
37. Lika K, Augustine S, Pecquerie L, Kooijman SALM. The bijection from data to parameter space with the standard DEB model quantifies the supply-demand spectrum. Submitted
38. Litchman E, Ohman M, Kiørboe T (2013). Trait-based approaches to zooplankton communities. *J Plankton Res* 35: 473–484.

(Featured on the front cover)

39. Lombard F, Guidi L, Kiørboe T (2013). Effect of type and concentration of ballasting particles on sinking rate of marine snow produced by the appendicularian *Oikopleura dioica*. *PlosOne* 8(9): e75676. doi:10.1371/journal.pone.0075676
40. Lombard F, Koski M, Kiørboe T (2013). Copepods use chemical trails to find sinking marine snow aggregates. *Limnol. Oceanogr.* 58: 185-192.
41. MacKenzie BR, Payne MR, Boje J, Høyer JL, Siegstad H. A cascade of warming impacts brings bluefin tuna to Greenland waters. Submitted.
42. MacKenzie B, Payne MR (2013). Fisheries: Manage declines. *Nature*, 495: 314.
43. Mariani P, Andersen KH, Visser AW, Barton AD, Kiørboe T (2013). Control of plankton seasonal succession by adaptive grazing. *Limnol Oceanogr* 58(1) 173-184.
44. Marschler C, Ellsäcker C, Starke J, van Hemmen JL (2013). Bifurcation analysis of learning and structure formation in a neuronal map. Submitted.
45. Marschler C, Sieber J, Berkemer R, Kawamoto A, Starke J (2013). Implicit methods for equation-free analysis: Convergence results and analysis of emergent waves in microscopic traffic models. Submitted. See <http://arxiv.org/abs/1301.6044v2>.
46. Marschler C, Starke J, Liu P, Kevrekidis I (2013). Coarse analysis of a pedestrian model using diffusion maps. Submitted.
47. Marty L, Rochet M-J, Ernande B. Temporal trends in age and size at maturation of four North Sea gadid populations: cod, haddock, whiting, and Norway pout. *Marine Ecology Progress Series*. doi: 10.3354/meps10580. In press.
48. Marty L, Dieckmann U, Ernande B. Fishing-induced neutral and adaptive evolution at the genotypic and phenotypic levels in harvested populations. *Evolutionary Applications*. Submitted.
49. Mitra K, Flynn J, Burkholder JM, Berge T, Calbet A, Raven JA, Granéli E, Glibert PM,
50. Hansen PJ, Stoecker DK, Thingstad F, Tillmann U, Våge S, Wilken S, Zubkov MV (2013). The role of mixotrophic protists in the biological carbon pump. *Biogeosciences Discussions* 10: 13535-13562.
51. Neuheimer AB, MacKenzie BR (2013). Explaining variation in life history timing across a species' range: Spawning time in an exploited marine fish. *ICES Annual Science Conference*, Sept. 23-27, 2013.
52. Payne MR (2013). Climate change at the dinner table. *Nature*, 497: 320–321.

(Featured as the 2013 Editors choice in *Nature* 504: 386)

53. Peck MA, Neuenfeldt S, Essington T, Trenkel VM, Takasuka A, Gislason H, Dickey-Collas M, Andersen KH, Ravn-Jonsen L, Vestergaard N, Kvamsdal S, Gårdmark A, Link J, Rice JC (2013). Forage fish interactions: A symposium on creating the tools for ecosystem-based management of marine resources. *ICES Journal of Marine Science*, 71:1-4 doi:10.1093/icesjms/fst174
54. Poloczanska ES, ..., Brander K, et al (2013) Global imprint of climate change on marine life. *Nature Clim.Change* 3 (10): 919-25.
55. Prowe AEF, Pahlow M, Dutkiewicz S, Oschlies A (2013). Small diversity effects on ocean primary production under environmental change in a diversity-resolving ocean ecosystem model. *Biogeosciences Discuss.* 10:12571-12591. doi:10.5194/bgd-10-12571-2013.
56. Reuman DC, Gislason H, Barnes C, Mélin F, Jennings S (accepted). The Marine diversity spectrum. *Journal of Animal Ecology*.
57. Rice J, Daan N, Gislason H, Pope JG (2013). Does functional redundancy stabilize fish communities? *ICES Journal of Marine Science: Journal du Conseil* 70 (4), 734-742.
58. Ross SD, Behrens JW, Brander K, Methling C, Mork J (2013) Haemoglobin genotypes in cod (*Gadus morhua* L): their geographic distribution and physiological significance. *Comparative Biochemistry and Physiology. Part A: Molecular & Integrative Physiology*. 166:158-168.
59. Sainmont J, Andersen KH, Thygesen UH, Fiksen Ø, Visser AW. Long versus short term behavior strategy optimization in seasonal environments. Submitted.
60. Sainmont J, Andersen KH, Varpe Ø, Visser AW. Capital versus Income breeding in a seasonal environment. *American Naturalist*. Submitted.
61. Sainmont, J., Thygesen, U. H., and Visser, A. W. (2013). Diel vertical migration arising in a habitat selection game. *Theoretical Ecology*, 6(2):241–251. doi: 10.1007/s12080-012-0174-0
62. Sainmont J, Gislason A, Heuschele J, Webster C, Sylvander P, Wang M, Varpe Ø. Inter and intra-specific diurnal habitat selection of zooplankton during the spring bloom observed by video plankton recorder. *Marine Biology*. Submitted.
63. Salinger MJ, Bell JD, Evans K, Hobday AJ, Allain V, Brander K, Dexter P, Harrison DE, Hollowed AB, Lee B, Stefanski R (2013) Climate and oceanic fisheries: recent observations and projections and future needs. *Climatic Change*. 119: 213-221.
64. Sanders R, Henson S, Koski M, De La Rocha CL, Painter SC, Poulton A, Riley J, Salihoglu B, Visser AW, Yool A, Bellerby R, Martin A. The Biological Carbon Pump in the North Atlantic. Accepted in Progress in Oceanography
65. Sparrevojn C, Lindegren M, MacKenzie BR (2013). Climatic induced response of commercially important flatfish species near Denmark during the 20th century. *Fisheries Oceanography* 22: 400-408.
66. Starke J (2013). Dynamical System Approaches to Combinatorial Optimization. Invited Chapter. Pages 1065-1124 in Pardalos P, Du D-Z, Graham R: *Handbook of Combinatorial Optimization*, 2nd Edition. Springer Verlag, Heidelberg, New York.
67. Tiselius P, Saiz E, Kiørboe T (2013). Sensory capabilities and food capture of two small copepods, *Paracalanus parvus* and *Pseudocalanus* sp. *Limnol Oceanogr.* 58: 1657-1666. doi:10.4319/lo.2013.58.5.1657
68. Trenkel VM, Huse G, MacKenzie BR, Alvarez P, Hrrizabalaga H, Castonguay M, Goñi N, Grégoire F, Hátún H, Jansen T, Jacobsen JA, Lehodey P, Lutcavage M, Mariani P, Melvini G, Neilson JD, Nøttestad L, Óskarsson G, Payne M, Richardson D, Senina I, Speirs DC. Comparative ecology of widely distributed pelagic fish species in the North Atlantic: implications for modelling climate and fisheries impacts. Accepted in Progress in Oceanography.

69. Tsoukali S, Visser AW, MacKenzie BR (2013). Comparative impacts of temperature on egg ecology of pelagic fish species in the north Atlantic. (submitted)
70. Visser AW, Fiksen Ø (2013). Optimal foraging in marine ecosystem models: selectivity, profitability and switching. *Mar Ecol Prog Ser* 473: 91-101.
71. Zhang L, Hartvig M, Knudsen M, Andersen KH (2013): Size-based predictions of food web patterns. *Theoretical Ecology*.

2. Presentations at scientific meetings and institutions

1. Andersen A, Nielsen LT, Couespel D, Haaning K, Aagaard J, Thomsen HA, Kiørboe T. *Hydrodynamics of Filter Feeding in Choanoflagellates*. Poster. International Workshop on Trait-Based Approaches to Ocean Life, Copenhagen, 26-28 August 2013
2. Andersen A. *Introduction to Flight and Propulsion of Animals*. Invited Talk. DANSIS workshop, 4 September 2013, DTU Aqua, Charlottenlund
3. Andersen A, Nielsen LT, Kiørboe T. *Hydrodynamics of Choanoflagellate Feeding*. Contributed Talk. 66th Annual Meeting of the APS Division of Fluid Dynamics, Pittsburgh, USA, 24-26 November 2013
4. Andersen KH. (Invited talk): *Trait-based approaches to ecosystem modelling* at the 2013 CNRS Thematic School on Innovative Approaches in Marine Environment Modelling, Brest, France.
5. Andersen KH: *Conflicting objectives for optimal ecosystem management of fisheries* at the 2013 Annual Science Conference in the International Council for the Exploration of the Sea, Iceland.
6. Andersen KH (Poster): *Simulate the impact of fishing on a stock* at the 2013 Annual Science Conference in the International Council for the Exploration of the Sea, Iceland.
7. Berge T, Hansen PJ. *Mixotrophy*. Poster. International workshop on Trait-based approaches to Ocean Life, 26-28 August 2013. Copenhagen, Denmark.
8. Berge T, Daugbjerg N, Moldrup M, Moestrup Ø, Mogensen SB, Poulsen LK, Hansen PJ: *Multiple roles of a mixotrophic dinoflagellate in the marine food web*. Poster. 17. danske havforsker møde. Januar 2013, Roskilde, Denmark; Øresund Plankton Meeting, November 2013, Lund, Sweden.
9. Berge T, Daugbjerg N, Jakobsen HH, Hansen PJ. Poster. *Elevated pH, intraspecific variation and laboratory selection in two red-tide marine dinoflagellates*. 15th International Conference on Harmful Algae. October 29 - November 2 2012. Changwon, Korea.
10. Gonçalves R, Kiørboe T. Prey/predator size ratio in feeding of *Temora longicornis* (poster). International workshop on Trait-based approaches to Ocean Life, Copenhagen 28/8-2013
11. Gonçalves R, Kiørboe T. Feeding mechanisms in suspension-feeding copepods (poster). 2nd annual meeting of Centre for Ocean Life, Holbæk. 12/12-2013
12. Hansen PJ, Nielsen LT, Johnson M, Berge T, Flynn KJ. Acquired phototrophy in *Mesodinium* and *Dinophysis* – A review of cellular organization, prey selectivity, nutrient uptake and bioenergetics. October 29 - November 2 2012. Changwon, Korea
13. Hansen PJ, Nielsen LT, Johnson M, Berge T, Flynn KJ. Acquired phototrophy in *Mesodinium* and *Dinophysis* – A review of cellular organization, prey selectivity, nutrient uptake and bioenergetics. Øresund Plankton Meeting, November 2013, Lund, Sweden.
14. Hansen PJ. *Mixotrofi i plankton*. Inviteret Sessionsforedrag. Dansk Havforsker møde 21-23. Jan 2013, Roskilde, DK

15. Heilmann I, Starke J, Andersen KH, Thygesen UH, Lorenz T, Sørensen MP. *Analysis of size structured population models in marine ecosystem*. Poster presentation at SIAM conference on Applications of Dynamical Systems, Snowbird, Utah, USA, May 19-23 2013
16. Jacobsen NS. *Balanced Harvesting and size spectrum models – A multispecies approach to fisheries management*. Quantitative seminar, School of aquatic sciences and fisheries, University of Washington, Seattle, 5/4-2013.
17. Jacobsen NS. *The consequences of balanced harvesting of fish communities*. ICES Annual Scientific meeting, September 2013.
18. Kiørboe T. (Invited talk) *Attack or attacked: Sensory and fluid mechanical constraints of copepod predator-prey interactions*. Invited lecture at Annual Meeting Society for Integrative & Comparative Biology, San Francisco 4-7 January 2013
19. Kiørboe T, Andersen A, Bohr T. (Invited talk) *How to catch the interest of a friendly physicist. Microscale interactions in aquatic environments*. Ecole de Physique, Les Houches, France. 10 March 2013
20. Kiørboe T. (Invited talk) *Fluid mechanics of small animals in the Sea*. DANSIS workshop, 4 September 2013, Charlottenlund
21. Kiørboe T. (Invited) *The fluid mechanics of swimming and feeding in zooplankton*. The biomechanics group, University of California, Berkeley, 11/10-2013
22. Kiørboe T. (Invited) *Conflicting missions: How zooplankton feed, survive, and reproduce*. Department of Integrative Biology, University of California, Berkeley, 5/12 2013
23. Lindemann C, Palacz A, Prowe F. *Towards an adaptive evolutionary and ecological trait-based model*. Poster, International Workshop on Trait-based approaches to Ocean Life, Copenhagen
24. Marty, L, Dieckmann U, Ernande B. *Fisheries-induced neutral and adaptive evolution*. Poster, International Workshop on Trait-based approaches to Ocean Life, Copenhagen
25. Neuheimer AB, MacKenzie BR. *Explaining variation in life history timing across a species' range: Spawning time in an exploited marine fish*. ICES Annual Science Conference, Sept. 23-27, 2013.
26. Nielsen LT, Couespel D, Haaning K, Aagaard J, Thomsen HA, Andersen A, Kiørboe T. *Hydrodynamics of Choanoflagellate Feeding*. Poster. 2013 International Choanoflagellate Workshop, Cologne, Germany, 22-25 May 2013.
27. Nielsen LT, Andersen A, Bohr T, Kiørboe T. *Traits and trade-offs in microzooplankton feeding*. Poster. International Workshop on Trait-Based Approaches to Ocean Life, Copenhagen, 26-28 August 2013
28. Prowe F. *A new trait-based zooplankton model for the Darwin-2 framework*, MIT, USA, Feb 22, 2013.
29. Prowe AEF, Andersen KH, Kiørboe T, Visser AW. *Zooplankton feeding traits and community composition in a global ecosystem model*. Presentation, 45th International Liège Colloquium, 16/5 2013, Liège, Belgium.
30. Prowe AEF, Pahlow M, Oschlies A. *Phytoplankton community effects on productivity changes in a global reduced mixing scenario*. Poster, 45th International Liège Colloquium, 16/5 2013, Liège, Belgium.

31. Prowe AEF, Andersen KH, Kiørboe T, Visser AW. *Zooplankton feeding traits and community composition in a global ecosystem model*. Poster, International Workshop on Trait-based approaches to Ocean Life, Copenhagen
32. Prowe AEF, Andersen KH, Kiørboe T, Visser AW, Dutkiewicz S, Follows M. *Trait-based trophic interactions in a global ecosystem model*. 29th Annual Meeting of the German Limnological Society & 43rd Annual Meeting of the Ecological Society of Germany, Austria and Switzerland, 9/11 2013, Potsdam, Germany.
33. Sainmont J, Varpe Ø, Andersen KH, Visser AW. *Feeding season duration and the relative success of capital and income spawning copepods*. ASLO, 20/02-2013 Aquatic Sciences Meeting, New Orleans (Oral presentation)
34. Sainmont J, Andersen KH, Visser AW. *Optimal foraging and diel vertical migration in a life history model*. ASLO, 19/02-2013 Aquatic Sciences Meeting, New Orleans (Poster)
35. Sainmont J, Varpe Ø, Andersen KH, Visser AW. *Income versus Capital breeders*. Trait-based workshop, Copenhagen, 26-28 August 2013 (Poster).
36. Starke J. *Bifurcation Analysis of Learning and Structure Formation in a Neuronal Map*. BrainModes 2013: *Criticality, connectivity, and neural masses*, VU University Amsterdam, Plenary talk on invitation by A. DAFFERTSHOFER (VU University Amsterdam, The Netherlands) and T. BOONSTRA (University of New South Wales, Australia), 2.12.2013
37. Starke J. *Implicit methods for equation-free analysis*. *Workshop on Slow-Fast Dynamics: Theory, Numerics, Application to Life and Earth Sciences*, Centre de Recerca Matemàtica (CRM), Bellaterra, Barcelona, Spain, invited talk in minisymposium *Numerical methods for multi-scale systems* on invitation by D. AVITABILE (University of Nottingham, UK) and G. SAMAEY (KU Leuven, Belgium), 6/2013
38. Starke J. *Continuation and bifurcation analysis of vibrations in mechanical experiments*. SIAM Conference on Applications of Dynamical Systems, Snowbird, Utah, USA, invited talk in minisymposium *Nonlinear dynamics in experiments* on invitation by J. SIEBER (University of Exeter, UK) and D. BARTON (University of Bristol, UK), 5/2013
39. Starke J. *Bifurcation analysis of controlled lab experiments*, talk on invitation by A. DAFFERTSHOFER, VU University Amsterdam, The Netherlands, 4.12.2013
40. Starke J. *Implicit methods for equation-free analysis and applications to particle models*, talk on invitation by I. KEVREKIDIS, Princeton University, USA, 7/2013
41. Starke J. *Bifurcation analysis of controlled lab experiments*, talk on invitation by V. JIRSA, CNRS and Aix-Marseille Université, France, 3/2013
42. Starke J. *Multiscale analysis of traveling waves and oscillations in particle models*, talk on invitation by T. LORENZ and P.E. KLOEDEN, University of Frankfurt, Germany, 2/2013
43. Starke J. *Equation-free analysis of the collective behaviour of microscopic pedestrian models*, talk, Traffic and Granular Flow '13, Forschungszentrum Jülich, Germany, 9/2013
44. Traving SJ, Rowe OF, Paczkowska J, Lefebure R, Brutemark R, Miranda F, Lindehoff E, Stedmon CA, Båmstadt U, Andersson A, Riemann L. *The influence of increased river inflow on a coastal bacterial community in the Baltic Sea*. Poster at Dansk Havforsker møde, Roskilde, Denmark, 16 January 2013

45. Traving SJ, Thygesen U, Stedmon CA, Riemann L. *Bacterial diversity meets chemical complexity*. Talk at Nordic Environmental Nucleotide Network workshop and Microbial Ecology Theory PhD course, Swedish University of Agricultural Sciences and Uppsala University, Uppsala, Sweden, 6-10 May 2013
46. Traving SJ, Thygesen UH, Riemann L, Stedmon CA. *Extracellular enzymes – Foraging strategy for free-living marine bacteria*. Flash-talk and poster at International workshop on Trait-based approaches to Ocean Life, Royal Academy of Sciences and Letters, Copenhagen, Denmark, 26-28 August 2013
47. Traving SJ, Thygesen UH, Stedmon CA, Riemann L. *My PhD research*. Invited presentation at MSc course Marine Biology, University of Copenhagen, Helsingør, Denmark 10 October 2013
48. Traving SJ, Thygesen UH, Riemann L, Stedmon CA. *Extracellular enzymes – Foraging strategy for free-living marine bacteria*. Flash-talk and poster at BIO, PhD Day 2013, University of Copenhagen, Copenhagen, Denmark, 14 November, 2013
49. Tsoukali S, Visser AW, MacKenzie BR. *Comparative impacts of temperature on egg ecology of pelagic fish species in the north Atlantic*. ICES Annual Science Conference, Sept. 23-27, 2013.
50. Visser AW, Behavioral traits and their trade-off in the plankton. International Workshop on Trait-Based Approaches to Ocean Life, Copenhagen, 26-28 August 2013
51. Wadhwa N, Andersen A, Kiørboe T. *Size dependent flow structure changes in swimming copepods (poster)*. Microscale interactions in aquatic environments, Les Houches, France. 10/3-2013
52. Wadhwa N. *Swimming by jumping in marine zooplankton (talk)*. Fluid•DTU Summer School, Humlebæk, Denmark, 7/8-2013
53. Wadhwa N, Andersen A, Kiørboe T. *Swimming by jumping in marine zooplankton (poster)*. International workshop on Trait-based approaches to Ocean Life, Copenhagen 28/8-2013
54. Wadhwa N. *Swimming by jumping in marine zooplankton (talk)*. Department of Physics, DTU, Kgs. Lyngby. 2/10-2013
55. Wadhwa N. *Swimming by jumping in marine zooplankton (invited lecture)*. Physical Oceanography, DTU, Charlottenlund. 3/10-2013
56. Wadhwa N. *Swimming by jumping in marine zooplankton (invited lecture)*. Introduction to Biophysics, DTU, Kgs. Lyngby. 23/10-2013
57. Wadhwa N. *Hydrodynamics of jumping copepod nauplii and adults (talk)*, 2nd annual meeting of Centre for Ocean Life, Holbæk. 12/12-2013

3. Outreach activities

Popular articles

1. Kiørboe T, Andersen A (2013) Sirupssvømmerne. Weekendavisen, Ideer, 19: 8-9
2. Payne MR, Kiørboe T (2013) Immigranter sydfra på tallerkenen. Weekendavisen, Ideer, 20: 3
3. Nielsen LT, Kiørboe T (2013) Plankton med helgardering. Weekendavisen, Ideer, 31: 4-5

4. Kiørboe T, Heuschele J, Selander E (2013) Havets dufte. *Aktuel Naturvidenskab* 3: 30-33
http://aktuelnaturvidenskab.dk/fileadmin/Aktuel_Naturvidenskab/nr-3/AN_3_2013dufte.pdf
5. Kiørboe T, Hylander S (2013) Plankton beskytter sig med solcreme. *Videnskab.dk* 18 november.
<http://videnskab.dk/miljo-naturvidenskab/plankton-beskytter-sig-med-solcreme>
6. *Havets usynlige liv*, Billed-artikel i 'Ud og Se', Juni 2013.
<http://ipaper.ipapercms.dk/DSB/udogse/2013/Juni2013/>

Popular lectures

1. Kiørboe T. *To eat and not be eaten. Vandloppers kvantitative naturhistorie*. Dansk Havforsker møde. Inviteret plenarforelæsning. 16 januar 2013
2. Kiørboe T. *Havets usynlige liv*. Foredrag ved videnskabsarrangementet *HØRT* (Hovedstadsregionen) med Peter Lund Madsen 24 maj 2013
3. Kiørboe T. *Verdens almindeligste dyr*. Dansk naturhistorisk forening, 26 september 2013.
4. Kiørboe T. *Oceanernes biologi*, Dansk Naturvidenskabs festival,
Roskilde Gymnasium 23/9 2013
Ørestad Gymnasium, 24/9 2013
5. Starke J. *Robots, Swarms and Labyrinths*, public talk at DTU for Allerød Gymnasium and Grønnemose Skole, 3/2013
6. Sichlau MH. Danskernes Akademi, DR2, *Har vandlopper mange elskere og deres afkom mange fædre?*

http://www.dr.dk/DR2/Danskernes+akademi/Natur_Matematik/Har_vandloppheunner_mange_elskere_og_har_deres_afkom_mange_faedre.htm

4. Staff

Students and post docs: We have made the following hires on Centre funds:

Friederike Prowe (WP 2.2-3, Post doc, hired February 2012, on maternal leave from November 2013)
 Terje Berge (WP 1.2, Post doc, February 2012)
 Erik Martens (WP 6.1, Post doc, hired August 2012, finished October 2013)
 Sachia Jo Traving (WP 1.1, PhD student, February 2012, on maternal leave from March 2014)
 Karin Olsson (WP 5.1, PhD student, March 2012)
 Navish Wadhwa (WP 2.1, PhD student, August 2012)
 Nis Sand Jacobsen (WP 3.2, PhD student, November 2012)
 Julie Sainmont (WP 2.2, PhD, expected graduation 2014, co-funded by Climate Centre, Nuuk)
 Irene Heilmann (WP 6, PhD, expected graduation 2015)
 Philipp Brun (WP 4, PhD December 2013)
 Laurén Pécuchet (WP 3.4, PhD December 2013)
 Martin Lindegren (Scientist, February 2014)
 Mark Wejlemann Holm (WP 5.2, PhD student, hired April 2013)
 Lise Marty (WP 5.1, Post doc hired July 2013)
 Lasse Tor Nielsen (WP 2.4, Post doc, hired March 2013; paternity leave December 2013-January 2014)

Their projects are briefly described on the Centre homepage (<http://www.oceanlifecentre.dk/Projects.aspx>)

Other students and post docs: A number of additional students and post docs, funded by other sources, are working partly or entirely within the Centre and participate in the annual meetings:

Erik Selander (WP 2, Post Doc, January 2012-December 2013, Funded by Danish Council for Strategic research)

Jan Heuschele (WP 2, Post Doc, February 2012-June 2014, Funded by Danish Council for Strategic research)

Ana Sofia Ferreira (WP5, PhD student, expected graduation 2014, Funded by Nordic Centre for Excellence NorMER)

Stavroula Tsoukali (WP3, PhD student, expected graduation 2015, Centre for Macroecology, Evolution and Climate)

Samuel Hylander (WP2, Post Doc, March 2011-February 2013, Funded by The Carlsberg Foundation and the HC Ørsted Post Doc program)

Christian Lindemann (WP 5, PhD student, expected graduation 2015, Funded by FP7 EURO-BASIN Project)

Artur Palacz (WP6, Post Doc, March 2012-February 2013, Funded by FP7 VECTOR project)

Starrlight Augustine (WP1, post doc, July 2013, co-funded by a HC Ørsted Fellowship and the Danish National Science Foundation).

Martin Hartvig (WP6, Postdoc, funded by Centre for Macroecology, Evolution and Climate, Dansk Grundforskningsfond)

Christian Marschler (WP6, PhD student, expected graduation 2014, Funded by DTU Scholarship, Department of Applied Mathematics and Computer Science)

Visiting Scientists, adjunct professors. We have many scientists visiting the Centre for a few days or weeks, but in addition we have the following visitors working in the Centre for longer periods:

Professor Daniel Grünbaum, University of Washington, USA, VKR-visiting professor Aug-December 2013

Rodrigo Gonçalves, Estación de Fotobiología Playa Unión-CONICET, Argentina; CONICET visiting scientist, 2012-2014

Hans van Someren Gréve, Utrecht University, Netherlands, Visiting student researcher, March-June 2013

Dr. Andrew G. Hirst, Adjunct Professor within the Centre and Senior Lecture at Queen Mary University of London

5. Students graduated

MSc thesis

Coilin Jeritslev, Master student from DTU Mathematics. Currently writing masters thesis “Size-dependent adaptive foraging” with supervisors K.H. Andersen and U.H Thygesen.

Nicolas Schnedler-Meyer, Master student from DTU Aqua. Currently writing masters thesis “Movement patterns and anti-cannibalistic behavior in small adult pike. Modelling growth/predation risk trade-offs based on positional telemetry”. Supervisors: U.H.Thygesen and K.H. Andersen.

Hans van Someren Gréve (Utrecht University, Netherlands). Title: Feeding performance of the marine calanoid copepod *Temora longicornis*. Supervisors: Thomas Kiørboe and Rodrigo J. Gonçalves.

6. Annual Retreat – minutes from PI and Young researchers meetings and program



Group picture from the Ocean Life Annual Retreat, 12-13 December 2013

6.1. Ocean Life PI meeting at the annual meeting, December 12, 2013

Present: Ken H Andersen (DTU Aqua), Andy Visser (DTU Aqua), Patrizio Mariani (DTU Aqua), Mark Payne (DTU Aqua), Colin Stedmon (DTU Aqua), Anders Andersen (DTU FYS), Markus Pahlow (IFM, Geomar, DE), Lasse Riemann (KU), Henrik Gislason (DTU Aqua), Per Jul Hansen (KU), Benni Hansen (RUC), Brian MacKenzie (DTU Aqua), Uffe Thygesen (DTU Aqua), Agostino Merico (ZMT-Bremen, DE), Gunnar Brandt (ZMT-Bremen, DE).

Discussion topics:

Public outreach ideas aimed towards increasing the visibility of activities in Ocean Life in relation to the public and the VKR foundation.

- Benni Hansen: Write a popular (or more scientifically oriented) book. This is apparently a big plus for VKR. Also mentioned, a small popular volume for schools
- Public lectures as we are doing in folkeuniversitet or a TV series
- Radio: videnskabens verden
- Publicize activities – teaching sabbaticals, conferences
- Pod casts – face book
- Posters – post cards at aquaria around DK

Possible extension of the Centre's network

- Approach CMEC at KU for a 1 day common symposium; Brian MacKenzie will look into this.
- Agostino Merico: Consider engaging with social economics departments/institutes.

New initiatives:

- Lasse Riemann: Consider integrating genomics and trait-based models. Lasse Riemann to give an overview at an Ocean Life Wednesday meeting.
- New workshop; in collaboration with US colleagues. Andrew Barton from Duke University taking lead.

6.2 Minutes from Young Researchers meeting

Søminestationen, 12th December 2013

Young researchers (YRs) meeting

Weekly meetings

Overall the YRs feel that the Wednesday meetings have developed in a positive direction and find the weekly meetings both important and very rewarding to attend. The meetings facilitate a comfortable environment wherein to present and discuss your research. There is an overall wish to encourage the YRs in the audience to participate more actively in discussions (to avoid ending up in a singular conversation between the presenter and a handful of PIs). Also, the presenters should be encouraged to improve their ways to engage the audience in the conversation. The YRs agrees that these weekly meetings are a core activity and asset in the VKR Centre for Ocean Life.

Changes: It was suggested to move the weekly meetings from 9-10 to 10-11. This could be taken up at the first meeting in the new year (so far scheduled to fall on Wednesday the 15th of January, 2014).

Looking back: at the 2012 annual retreat several ideas were proposed and tested during 2013 i) mindmap over all the talks given at the weekly meetings and kept on the wiki-page and ii) organizing the meeting series into major themes. The conclusion was that these initiatives were ambitious and did not work very well; primarily due to being every presenter's own responsibility to maintain, it lost momentum. There is no support to continue this in 2014.

Improving the formats: since the beginning of the center our format for the weekly meetings has changed quite a lot. Also, there is no single strict rule-set for what or how to present. It was suggested to write a short inspirational text for people who present during the weekly meetings (see at the end of this document). This text should be displayed together with the program for the meeting series on the wiki-page. This is meant for new people who are not sure of our format and old people who need reminding. Encourage more creative ways to present the topics and ideas. Our format during the weekly meetings has developed in many subtle ways (e.g. short presentation of preliminary results or ideas with the aim to discuss the presented material with the meeting participants, discussion groups, theoretical discussion based on a paper or idea), which are much appreciated and something all the YRs want to continue and further develop. One new suggestion was the option to train your project in conference format (a complete story line in 15 min + 5 min questions, several people could present during a meeting to fill out the time) as a training to gain confidence when talking to an audience.

Who presents at the weekly meetings: the YRs agree that the primary body of presentations should come from the YRs. Previous year's concern of lack of material has been negated by the age of the center and continuous recruitment. Many of the YRs have been with the center for a period long enough for them to have accumulated data and results, to a point where each one easily has material enough for two yearly presentations.

Organizing the meeting program: there was a continued wish for the option to cooperate with others for organizing a meeting. This was particularly for people located outside DTU Aqua and new people. Remember, the ones responsible for organizing do not necessarily have to present.

Knowledge exchange within the center

Most felt confident to know who to approach outside their official collaborations, if in need of new knowledge, be it of technical or theoretical nature.

Size in the Ocean

Overall all participating YRs have been very satisfied with being part of the internal, cross-discipline project: the Size in the Ocean. The YRs found Size in the Ocean to be a rewarding and learning experience, which opened up for new collaborations across the center. The participants felt the idea and theme of the paper very much emphasizes the essence of the VKR Centre for Ocean Life. Also, the participants were grateful for KHA, navigating the project safely underway. Several expressed a desire for sharing the massive dataset produced in Size in the Ocean, through an open source outlet. We suggest a wrap-up meeting in 2014 for all Size in the Ocean participants, to decide the fate of the data set. This will also offer an excellent opportunity to keep an update on the several spin-off papers. However, there have also been complications during the work process, due to the nature of the project and the amount of people involved. The source of issues and possible solutions are listed below in *Looking back and changes*. We greatly recommend any future project group to consider the advice, as it would greatly improve future projects if a similar nature.

Looking back and changes: for the future projects, we would recommend a more efficient and better structured exchange of up-to-date information between the subgroups. During Size in the Ocean we noticed for example that between sensing modes and feeding modes groups there was a lot of unnecessary doubling of effort due to miscommunication about e.g. updated file versions on both parts. Some people personally got frustrated with wasted time and effort that could have been avoided. We would also recommend maintaining a formal central documentation of all choices and decisions made throughout the project. This way all

members can see what has been accepted or rejected centrally, and within subgroups, even for such seemingly trivial tasks as choice of units.

Goal: There was unanimous agreement that a similar cross-collaboration project should be made an official goal for the center in 2014. The project does not have to match Size in the Ocean in size, nor does it have to be the same people that participate. The wish is, that if anyone (YR and PI) have an idea or theme they think could work in such a framework, then that there is general support (does not necessarily equals participation) for the project to develop.

Social activities

Summer meeting: YRs were happy with a summer meeting during 2013 and wish for a repetition in 2014. This offers the opportunity to visit yet another of the collaborating institutes in the VKR Centre for Ocean Life.

Annual retreat

Improvements: Suggested that the program start later on day 1, and instead extending the program on day 2 (this to avoid having such a long day on the 1st day, which includes traveling etc). Repeat the overall goals and themes for the VKR centre of Ocean Life. The annual retreat offers a perfect opportunity to remind everyone of the themes in the center. Especially, since many PIs attend the annual retreat but not the weekly meetings on a consistent basis.

Other:

The YRs feel that there currently is a lack of communication between PIs running the center and the YRs with regards to the internal politics and goals of the center. There is a wish for a better communication flow regarding more general center development and decisions. This is not for wishing to change how decisions are made in the center, but more for consolidating a feeling of being a part of the center. For example many expressed dismay over having to learn of job positions and new colleagues, through the official advertisements or on the day the person arrives. This stimulates the communal sense and you feel more confident that you as a person are part of the center and not only a worker who executes certain tasks and would increase the eagerness in recommending the center to people outside.

Communicating center relevant information during the weekly meetings would be ideal. It has been somewhat done during 2013, but overall encouragement for more consistent updates, especially of things being planned, rather than when they have been executed. Also, all attendants should be reminded this also goes the other way, and if they have anything that could be relevant to the center, they should make use of this brief update window.

Guidelines and inspiration to put on the wiki-page:

Meeting-participants cover a large range in fields, remember to be broad when introducing your subject and engaging the audience.

We embrace many formats, within a core frame (time: 60 min, from 8 to 9 am, every Wednesday, within the meeting series calendar. Location: Havestuen, Slottet, DTU Aqua, unless otherwise advertised. Normally we spend 5 minutes in the beginning on general information relevant for the VKR Centre for Ocean Life.). It is

encouraged not to simply do a 50 min long presentation but think in some form of discussion, for alternative ideas, see below.

Ideas:

- Do a short presentation of preliminary results or ideas you want to discuss with participants. Leave the majority of time to discussion and feedback.
- Present an idea, paper, theory and put it up for discussion.
- Train your talk and presentation skills in a conference format (15 min + 5 min questions). An option to work your results into a streamlined storyline and rehearse it in a comfortable environment. Optimally 2 people could present during one meeting.
- Present a finished product. A project or paper you have completed or are close to complete.
- Newcomers: present your project ideas and themes that you will be working with during your time at the center.
- Get people to work! Put them into discussion groups.
- Get a relevant presentation from a person outside the VKR Centre for Ocean Life.

6.3 Program for Annual Retreat



2nd annual meeting of *Centre for Ocean Life*

Sømine Stationen (Holbæk)

12-13 December 2013

Please see below the program of activities for the 2nd annual meeting of Centre for Ocean Life at Sømine Stationen (Holbæk) to be held on 12-13 December 2013.

After the program you will see a list of the talks/posters and who is presenting them (in alphabetical order), as well as the abstract for the talk of our keynote speaker Agostino Merico.

For any other information please contact Rodrigo Gonçalves (rgon@aqu.dtu.dk)

Looking forward to see you there!

Organizing Committee: Sachia, Starrlight, Nis, Mark & Rodrigo

Notes Please be there at 8:30 on Thursday

Each oral presentation is 20 minutes (including questions)

Hour	min	Thu 12	Fri 13
8:00 AM	00-10		
	10-20		
	20-30		
	30-40	8:30 – 9:00 People arrive and “settle” (find a room, leave their stuff, toilette, etc.)	8:00 – 9:00 Breakfast
	40-50		
	50-60		
9:00 AM	00-10	Ken – welcome & opening words (10 min)	Andy – fitness/trade-offs (20 min)
	10-20	Oral presentation 01 (20 min) Navish Wadhwa	Oral presentation 10 (20 min) Nicolas Azaña Schnedler-Meyer
	20-30	Oral presentation 02 (20 min) Jan Heuschele	Oral presentation 11 (20 min) Nis Sand Jacobsen
	30-40	Oral presentation 03 (20 min) Coilin P. Boylan Jeritslev	Oral presentation 12 (20 min) Maria Moreno de Castro
	40-50		
	50-60		
10:00 AM	00-10	Coffee break (30 min)	Coffee break (20 min)
	10-20		
	20-30	Poster presentations (5 min each)	Oral presentation 13 (20 min) Fi Prowe
	30-40	40 min	Oral presentation 14 (20 min) Starrlight Augustine
	40-50	Oral presentation 04 (20 min) Henrik Gislason	Oral presentation 15 (20 min) Yury Zablotki
	50-60	Oral presentation 05 (20 min) Sachia Jo Traving	Oral presentation 16 (20 min) Karin Olsson
11:00 AM	00-10		
	10-20		
	20-30	Lunch 40 min	Lunch 40 min
	30-40		
	40-50	Oral presentation 06 (20 min) Lise Marty	Andy – wrap up 20 min
	50-60		
1:00 PM	00-10	Discussions 50 min	Clean up and farewells Please empty and leave your room. 40 min
	10-20		
	20-30		
	30-40		
	40-50		
	50-60		
2:00 PM	00-10	Walk 50 min	--- END of DAY 02 ---
	10-20		
	20-30		
	30-40		
	40-50	Coffee break (20 min)	
	50-60		
3:00 PM	00-10	Agostino Merico (keynote speaker) 50 min	
	10-20		
	20-30		
	30-40		
	40-50		
	50-60	mini break (toilette, etc.) (10 min)	
4:00 PM	00-10	Oral presentation 07 (20 min) Mark Wejlemann Holm	
	10-20	Oral presentation 08 (20 min) Gunnar Brandt	
	20-30	Oral presentation 09 (20 min) Terje Bergen	
	30-40		
	40-50		
	50-60		

(continues in next page)

daily.program

5:00 PM	00-10	mini break (toilette, etc.) (10 min)
	10-20	Ken: progress and overview of the Center
	20-30	Board meeting
	30-40	Young researchers meeting
	40-50	
	50-60	50 min
6:00 PM	00-10	Poster session 1 hour
	10-20	
	20-30	
	30-40	
	40-50	
	50-60	19:00 – 20:00 Dinner
7:00 PM	00-10	
	10-20	
	20-30	
	30-40	
	40-50	
	50-60	
8:00 PM	00-10	END of DAY 01

Talks

name	Title
Agostino Merico (keynote speaker)	A trait-based approach for modelling changes in plankton community structures
Coilin P. Boylan Jeritslev	Adaptive foraging in a size-structured model of marine ecosystem
Fi Prowe	Zooplankton feeding strategies in a global ocean ecosystem model
Gunnar Brandt	A trait perspective on the use of ecological resource
Henrik Gislason	Changes in fish community structure with latitude
Jan Heuschele	Chemical ecology of copepods - food, sex and survival
Karin Olsson	A model for optimal offspring size under density-dependent mortality
Lise Marty	Consequences of fishing-induced selection on behavioural types
Maria Moreno de Castro	Understanding Variability in CO2 Experiments using an Adaptive Trait-Based Model
Mark Wejlemann Holm	Overwintering strategies of Copepods
Navish Wadhwa	Hydrodynamics of jumping copepod nauplii and adults
Nicolas Azaña Schnedler-Meyer	Movement patterns and antipredation behavior in small adult pike. Modelling growth/predation risk trade-offs based on positional telemetry data.
Nis Sand Jacobsen	"Senses and size in the ocean" by AV Visser, NS Jacobsen, C Lindemann, EA Martens, N Wadhwa and KH Andersen.
Sachia Jo Traving	Enzymatic foraging strategies by heterotrophic bacteria
Starrlight Augustine	Mixotrophy in marine pelagic food webs
Terje Bergen	Synergistic effects between tertiary plastids and phagotrophy in a predatory dinoflagellate
Yury Zablotski	Sympatric speciation by optimal specialisation

Posters

name	Title
Anders Andersen	Hydrodynamics of Choanoflagellate Feeding
Irene Louise Torpe Heilmann	Seasonal variation in size structured population models
Julie Sainmont	Income vs capital breeders
Markus Pahlow	Optimal intraspecific diversity
Rodrigo Gonçalves	Feeding mechanisms in suspension-feeding copepods
Sofia Ferreira	Estimating phytoplankton phenology metrics from noisy, gappy data



A trait-based approach for modelling changes in plankton community structures

Agostino Merico (agostino.merico@zmt-bremen.de)

Systems Ecology, Leibniz Center for Tropical Marine Ecology, Bremen, Germany
School of Engineering and Sciences, Jacobs University Bremen, Germany

Abstract

Being characterised by fixed parameters, classical ecosystem models can be regarded in a sense as "static representations of reality". That is, the actual processes governing the interactions within plankton communities and between a community and the environment are based on fixed traits (i.e. fixed algal food value, fixed algal competitive ability, etc.). Excluding the possibility for communities to adapt and to "change" their phenotypic types in order to better fit the prevailing forcing at a certain time can result in serious mispredictions. I will present here a method based on succession-driven evolution of community-aggregated properties. I will show that models of aggregate group behaviour can have great advantages in terms of downscaling the complexity of multi-species models and are able to capture the macroscopic characteristics of an entire community such as total aggregate biomass, average trait and trait variance. I will also show that this approach appropriately describe seasonal changes in the size compositions of two phytoplankton communities (tropical and temperate) of the Atlantic Ocean and produces surprising yet robust results in terms of species diversity.

