

# Report from the 3<sup>rd</sup> Workshop on Trait-based approaches to ocean life

August 20-23<sup>rd</sup> 2017, Solstrand, Norway



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## Summary.

How can the essential properties of community structure and ecosystem functioning be captured from a limited number of traits in organisms? In August 2017, 120 researchers from 31 nations met over four days at Solstrand to answer this question.

The trait-based approach has deep roots in terrestrial ecology, and the workshops have always focused on bringing in perspectives from general ecology. The first keynote this year was [Oswald Schmitz](#), from Yale University. His talk was on the 'evolutionary ecology of ecosystem functioning' - with examples on how behavioural plasticity in grazers in response to fear from specific predators can shift grazing pressure, plant communities and nutrient budgets in the soil. Our ability to quantify interactions between ecology and evolutionary or adaptive processes must improve to build predictive capacity on ecosystem responses.

[Helmut Hillebrand](#) followed up the next day with a keynote on how trait variability and environmental heterogeneity constrain community composition and ecosystem processes. The keynote gave an overview of biodiversity-ecosystem functioning themes, and showed how trait-based perspectives are useful in this debate. [Zoe Finkels'](#) keynote brought us to the unicellular domain, focusing on macromolecular and elemental composition of microalgae. The size and content of phytoplankton cells, their element-ratios and carbon content are key traits and state variables which feedback on ecosystem functioning. [Frede Thingstad](#) took us even further into the microbial world, to the interactions between viruses and bacteria, to the competition between algae and bacteria and the mixture of drivers shaping structure of microbial communities.

The workshop included 20 contributed talks, 80 posters and a set of breakout sessions, round-table group discussions and plenary discussions with prepared comments. The programme was relaxed with one afternoon session walk-and-talk to the Borgafjell, combining opportunities for individual communication with some exercise and a view over the Bjørnafjord and the Folgefonna glacier. The organizing committee strived to make it an interactive workshop, with rich possibilities for small group discussions and only a few, structured plenary sessions. In practice, most of the participants received some sort of assignment or challenge to think of and prepare for before the meeting.

[Ben Ward](#) has volunteered to organize the next meeting in 2019, UK.

## Introduction

Ecosystems are complex machineries, and our ability to predict how multiple drivers and environmental forcing structure communities are limited. One way to represent and understand organisms, communities and ecosystems is to think in terms of specific traits, not species, and how the dominant traits emerge in an evolutionary and ecological process from fundamental trade-offs between alternative traits. If we can identify and quantify the trade-offs between traits, including their trade-offs with the environment, we may have a tool for predicting trait distributions in nature or from given environmental perturbations.

Traits have been central in the thinking of evolutionary ecologists at least since 1966, when modern thinking about adaptation and natural selection (Willams, 1966). Plant ecologists have a long history in using trait-based perspectives to analyse plant communities, and more recently, ocean scientists have followed to invoke traits as a concept for making sense of and predicting changes in marine ecosystems.

## Workshop aims and goal

Marine ecologists and oceanographers have over the last decade turned to trait-based approaches to develop models and to understand ocean communities. While we often meet in our specialist conferences, the only meeting place dedicated to trait-based approaches has until now been three entirely community-driven workshops. [The third workshop on trait-based approaches to ocean life](#) was held in Solstrand, outside Bergen, Norway during 20-23rd of August. The earlier meetings in [2013 \(Copenhagen\)](#) and [2015 \(New Hampshire\)](#) set the stage for this arena as the vital meeting place for researchers working in this direction. In 2017, 120 researchers and foundation representatives attended the workshop, covering a wide range of ecosystems from reefs to pelagic microbes, with a common goal of improving our common ground on traits as a fundamental unit for understanding organisms, communities and ecosystems.

We received more than 140 applicants during the registration process, but had only 90 rooms blocked out for the workshop. We could not accommodate everyone that wanted to come, but since many were willing to share room, we could fit in most of them. We (the SSC) had some discussions over what is an ideal number of people in a workshop like this, and had a target of around 100. In the end, the participants were all very engaged in the theme, and it was difficult not to let as many as possible in. The size of the workshop is now bordering a full conference.

## Funding support and budgets

The workshop received supporting funds from (in total 460 000 NOK). Without this funding, it would not be possible to arrange the workshop.

Source	Support
Norwegian Research Council	150 000 NOK
EuroMarine	7500€ (67500 NOK)
Simons Foundation	15000\$ (128 000 NOK)
Moore Foundation	7500\$ (64 000 NOK)

The support were spent on travel and accommodation for keynote speakers and the Scientific Steering Committee, accommodation for 15 students, some support to all participants (one lunch, refreshments at poster sessions, and a net reduction of accommodation costs), poster walls and some transport/meeting material. We included a registration fee of 1000 NOK, but then subsidized the accommodation costs by 2130 NOK per regular participant - so the net support was 1130 NOK per participant.

## Themes, keynotes and talks

### Session 1, Sunday: Evolutionary and environmental perspectives on traits

Keynote Oswald Schmitz (Yale University): *The evolutionary ecology of ecosystem functioning: Functional traits, trophic interactions, and ecosystem nutrient cycling*

An important factor in understanding ecosystem functioning is the adaptive flexibility in trait expression as organisms respond to environmental conditions. Professor Oswald Schmitz presented his own work on the behavioural responses of grasshoppers to the presence of predators, and used this as an example of how trait flexibility in consumer



species can structure whole ecosystems. As the consumers responded to presence of certain predators, the grazing pressure on plants were altered which again lead to a change in nutrient cycling in soil. This demonstrates that evolutionary and adaptive trait expressions (behaviour) can propagate through an ecosystem and alter its structure (Schmitz, 2008;2009;2010;Ohgushi et al., 2012;Schmitz et al., 2017).

Following the keynote, the [programme](#) included a series of contributed talks on trait expressions, trade-offs, environmental factors and eco-evolutionary dynamics:

<u>Jasmin Godbold</u>	<i>Impacts of biotic and abiotic context on functional trait expression and ecosystem functioning in the marine benthos</i>
<u>Hans Dam</u>	<i>Trade off between grazer-induced toxin production and growth in a marine dinoflagellate</i>
<u>Sinead Collins</u>	<i>Trait reversion during adaptation in marine and freshwater microbes</i>
<u>Gil Rilov</u>	<i>Bioinvasions and climate change cause fundamental traits and functional shifts of eastern Mediterranean reef communities</i>
<u>Sonia Bejarano</u>	<i>The shape of success in a turbulent world: Wave exposure filtering of coral reef herbivory</i>
<u>Romain Forestier</u>	<i>Eco-evolutionary dynamics in a trait-based fish community model</i>

### Session 2, Monday: Traits, biodiversity and ecosystem functioning

Keynote Helmut Hillebrand (University of Oldenburg): *Trait variability and environmental heterogeneity constrain community composition and ecosystem processes*

What is the link between traits and environmental variability?

- The relationship between richness and ecosystem function is essentially a relationship of environmental heterogeneity selecting for trait heterogeneity, which translates into resource use efficiency.
- If the trait variability matches environmental variability, increased trait diversity enhances corresponding ecosystem functions.
- Trait identity is highly important if single species are highly dominant or divergent.
- Autotrophic organisms show broad intra- and interspecific variance in resource incorporation.
- These traits are plastic with regard to the competitive surrounding. The compositional difference in trait space alters this plasticity.
- Heterotrophic organisms are not per se less flexible in resource use traits, but little information on intraspecific variability is available.
- Some related papers: (Ptacnik et al., 2010;Hodapp et al., 2016)

Talks in the session (hyperlinks to presentations with permission from authors):

<u>Martin Lindegren</u>	<i>A trait-based assessment towards understanding long-term changes in ecosystem functioning: the Central Baltic Sea as a case study</i>
<u>Maren Striebel</u>	<i>Trait-based biodiversity and multitrophic dynamics under external forcing</i>
<u>Stephanie Moorthi</u>	<a href="#"><i>Inter- and intraspecific consumer trait variation determine consumer diversity effects in multispecies predator-prey systems</i></a>
<u>Bernd Blasius</u>	<a href="#"><i>Trait-based approach to community structure in a spatial gradient</i></a>
<u>Mark Ohman</u>	<i>Zooglider-derived trait recognition across the California Current Ecosystem</i>
<u>Matthew McLean</u>	<a href="#"><i>Principal Response Curves to explain the spatiotemporal dynamics of fish functional traits in the Eastern English Channel</i></a>

Session 3, Tuesday: Plasticity and physiological traits in unicellular organisms

Keynote Zoe Finkel (Mount Allison University): *Macromolecular and elemental composition of microalgae*

Finkel reviewed recent developments in how we organize phytoplankton traits and attributes, such as their macromolecular stoichiometry and Extended Redfield Ratio, and the use of Tilman's Resource ratio hypothesis. Are there phylum level differences in macromolecular stoichiometry across the microalgae that cause phylum level differences in C:N:P? Are there systematic changes in macromolecular composition with cell size? Future directions: How did the change in taxonomic structure and cell size influence biogeochemical cycling over geological time? The decrease in C:N with latitude parallels the increase in RNA and protein relative to lipid and carbohydrate. Why do the compositions of N, protein, carbon (lipids) differ among groups and cell size? Key references: (Quigg et al., 2003;Follows et al., 2007;Finkel et al., 2010;Follows and Dutkiewicz, 2011;Quigg et al., 2011)

Talks in this session:

<u>Ben Ward</u>	<a href="#"><i>Balancing resource acquisition and metabolism in phytoplankton growth models: Cellular stoichiometry and size-dependent growth</i></a>
<u>Martina Doblin</u>	<a href="#"><i>Phytoplankton trait expression in dynamic seascape</i></a>
<u>Lee Karp-Boss</u>	<a href="#"><i>Selective pressures on phytoplankton shape</i></a>
<u>Jeff Bowman</u>	<a href="#"><i>Identification of microbial community traits and application to ecophysiological modeling</i></a>
<u>Robert Ptacnik</u>	<a href="#"><i>Stoichiometric upgrading – planktivores increase assimilation efficiency through mixotrophy in aquatic deserts</i></a>
<u>Onur Kerimoglu</u>	<i>Modelling the physiological regulation of autotrophs: upscaling from microcosms to ecosystems</i>

## Session 4, Wednesday: Traits in microbes – and future directions for trait-based approaches to ocean life

Keynote Frede Thingstad and Selina Våge (University of Bergen): *Can we constrain the “everything” in “everything is everywhere”?*

The assumption that ‘everything is everywhere, but the environment selects’ has been a central tenet of nineteenth century microbiology (O'Malley, 2007). Thingstad presented the microbial trait-space as a gradient of fear and greed, alluding to some organisms as defense-specialists, and others as competitions specialists. The ecological consequence of this is that competition specialists are winners in poor, low nutrient settings, while the competition specialist wins in nutrient rich, or predator-sparse environments. This place certain constraints on everything. Key references: (Vage et al., 2013a;Vage et al., 2013b;Thingstad et al., 2014;Larsen et al., 2015;Vage et al., 2016)

Contributed talks in this session:

<u>Kyle Edwards</u>	<a href="#"><i>Host traits drive viral life history traits across phytoplankton viruses</i></a>
<u>Elena Litchman</u>	<i>Future directions and challenges of trait-based approaches</i>

## Breakouts

The core activity during a workshop is to talk to others, so we reserved all afternoon on Monday for smaller discussion groups. We organized and planned the breakouts in a variety of different formats. First, we had four sessions going in parallel, with rotation every 45 minutes. In advance of the workshop, participants suggested themes for each breakout group. During the workshop, everyone were free to select which group to join. A detailed plan for each of these sessions activities are available [here](#).

### Parallel group discussions (Monday 13:30-16:00)

Parallel Breakout Session 1: Monday 13:30-14:15

- A. **Tutorial: Trait-based modeling with Mathematica (part 1).** Chris Klausmeier
- B. **Discussion: Mapping Trait Space: Linking marine trophic levels through traits (part 1).** Maria Aranguren-Gassis, Pier Luigi Buttigieg, Jessica Luo, Deepa Rao, Karen Stamieszkin. L [here](#).

- C. **Discussion: *Toward a unified view of predation mortality in copepods.*** Neil Banas, Mark Ohman, Øystein Varpe
- D. **Chalk Talks/Discussion: *Brainstorming for ways to clarify the role of intra-specific variability in sustaining the biodiversity and adaptive capacity of communities.*** S. Lan Smith, Susanne Menden-Deuer, Bingzhang Chen, Carmen García-Comas, Greg Torda

Parallel Breakout Session 2: Monday 14:15-15:00

- A. **Tutorial: *Trait-based modeling with Mathematica (part 2).*** Chris Klausmeier
- B. **Discussion: *Mapping Trait Space: Linking marine trophic levels through traits (part 2).*** Maria Aranguren-Gassis, Pier Luigi Buttigieg, Jessica Luo, Deepa Rao, Karen Stamieszkin
- C. **Seminar/Discussion: *Developing a conceptual understanding of key traits and trade-offs in fish and benthos (part 1).*** Martin Lindegren, Anna Törnroos, Thomas Kjørboe
- D. **Discussion: *The special role of mixotrophs in the microbial loop - light dependent bacterivory and implications for food web dynamics and stoichiometry.*** Robert Ptacnik, Stefanie Moothi, Maren Striebel

Parallel Breakout Session 3: Monday 15:15-16:00

- A. **Discussion: Observations to Traits and Function.** Sakina-Dorothee Ayata, Meike Vogt, Lee-Karp Boss, Nicole Aberle-Malzahn. See summary of this discussion [as detailed report, or short version](#). Summary slides [here](#).
- B. **Discussion: *Predicting trait changes in photosynthetic microbes.*** Sinead Collins, Marina Doblin, Naomi Levine. [Report](#)
- C. **Seminar/Discussion: *Developing a conceptual understanding of key traits and trade-offs in fish and benthos (part 2).*** Martin Lindegren, Anna Törnroos, Thomas Kjørboe
- D. **Discussion: *Increasing use of quantitative variables.*** Henrike Andresen. [Report](#).

### World café- Round table discussions

After the breakout sessions, we reconvened and had 90 minutes with short, intensive discussions on specific questions in smaller groups. The themes were chosen by 10 table hosts, acting as moderators of discussions, each lasting for 15 minutes before we rotated the groups. The table hosts remained in place, and then had three iterations on the same question with new people each time.

Here are the questions discussed at the tables:

**Table 1. Pier Buttigieg:** Capturing the knowledge surrounding trait-based modelling: creating flexible basis to link data across and beyond the domain?

**Table 2. Naomi Levine:** What are the key measurements that experimentalists should make in order to facilitate/improve the inclusion of trait-trade-offs in numerical models? Are there alternatives to growth rate as a metric for evaluating the 'winning' strategy?



**Table 3. Jan Heuchele:** Improving the the collaboration between modellers and experimentalists. Here we discuss the best approaches to present experimental and modelling results, data, and hypotheses to ensure that our publications matter.



**Table 4. Colleen Mouw:** How do we integrate across observational technologies observing traits at different levels?

**Table 5. Alex Ryabov:** How can we link morphological and behavioral traits with physiological traits?

**Table 6. Meike Vogt:** From cells to the globe – traits across spatio-temporal scales. Are relationships between trait characteristics and environmental or ecological properties conserved across different spatio-temporal scales? I.e. which links between individual or community-scale trait characteristics, environmental conditions and/or ecological function can we observe in the laboratory, at the ecosystem scale in mesocosms or at time series stations, or for point observations on cruises? And what expectations do we expect to confirm for trait biogeography at the macroecological scale?

**Table 7. Neil Banas:** What management and policy problems in marine ecology (like climate impacts, fisheries, water quality, harmful algal blooms) would benefit from a trait-based approach? How would we get started?»



**Table 8. Colin Kremer:** Pitfalls and possibilities of trait-environment relationships – how do we identify them, what do they really mean, and how can we apply them?

**Table 9. Andre Visser.** Are traits interesting in themselves, or do they only take on significant meaning in light of the trade-offs they invariably engender?

**Table 10. Ken Andersen.** How does temperature changes affect physiology? A changing temperature affects all physiological processes in an organism. How does the differential responses of different processes manifest themselves in organismal-level responses, such as maximum growth rate? What are the traits that control whether an organism can tolerate a narrow or a wide range of temperatures? And, what is the interaction between temperature responses and traits, such as body size?



**Conclusions:** The table hosts summarized their feedback and impressions from around the tables in a short plenary session and in writing after the meeting. The summaries are available [here](#).

### Walk and talk

Tuesday afternoon the weather was very pleasant and invited for outdoor activities. Luckily, we had already planned an opening here for more informal meetings and interactions without a specified program, so everyone was invited for a hike. We walked directly from the hotel to [Borgafjell](#), a small mountain (353 moh) nearby. Most of the participants came along,

and enjoyed the surroundings, view of the fjord and a glimpse of the glacier Folgefonna on the other side of the Hardangerfjord.



The hike was a welcomed activity. In a busy and intensive workshop, we do get exhausted and fresh air and exercise reset our brains and minds. Walking also randomly mix people, generating new encounters and makes it easier to make contact with colleagues later on.

## Posters

In total, [75 posters](#) were presented over three afternoons, and all of them remained accessible throughout the workshop next to the main meeting room and with direct access to the garden area.

We found it difficult to organize the posters into three coherent themes, and grouped presenters randomly to present their posters Sunday, Monday or Tuesday. This organization makes it easier for the audience to find relevant presenters each day, but may also isolate posters from other activities in the workshop.



The posters (see list of authors and titles [here](#)) truly pictures the diversity of trait-based thinking and research in the marine research community. A large number of them address traits and trade-offs in phytoplankton, or microbial community structures; others look at zooplankton, fish or benthic organisms in similar ways.



The word-cloud includes the titles of all posters, including words repeated more than three times. The picture visualize how dominant phytoplankton is in this research community. Still, our impression from the workshop is that terminology and general concepts do transfer across trophic groups and interests of

researchers. In particular, the understanding of trade-offs among traits, trait plasticity and the importance trade-offs and plasticity in forming communities and ecosystems appear to yield generalities valid at all levels.

## Plenary discussions

We only had a limited number of plenary discussions, as we prioritized discussions in smaller groups. We gathered for plenaries in the morning, with a keynote followed by contributed talks, but a general discussion only took place towards the end of the workshop. After each talk, we used a live interactive online communication system with the audience (<https://www.polleverywhere.com/>) to collect questions for the speaker. We aggregated all response in a single file (can be seen in [this hyperlink](#)). After Elena Litchman's talk on Wednesday we left the wall open, and the comments that came in was a stimulating transit into the final discussion part.

For the final plenary discussion, we invited selected groups of participants to deliver short impressions and opinions to structure the discussions. We formed the groups to be relatively homogeneous internally, but to represent the audience well in sum:

**Group 'PhDs':** Beukhof, Bisson, Grigoratou, Langbehn

**Group 'Postdocs':** Thomas, Lewandowska, van Denderen

**Group a:** Menden-Deuer, Heino, Irwin

**Group b:** Aksnes, Kiørboe, Visser

**Group c:** Lan-Smith, Klausmeier, Doblin

**Group d:** Degen, Fragoso, Varpe

**Group e:** Carlson, Noble-James, Jones

Each of these groups delivered brief (five minutes) statements in plenary, and some (the PhD students and postdocs) also summarized their thoughts and discussions in separate documents. These are available [here](#) (PhD's) and [here](#) (postdocs).

As always, written material persists. The PhD students state that we must communicate better what we mean by ‘a trait-based approach’ – even within the group at the workshop different meanings of the term seem to exist. The postdoc group also support this point:

*The community at the trait-based workshop was working with very different conceptions of what trait-based research is or aims to achieve. A good proportion of participants thought about traits from the modelling/theory perspective, as parameters that can be put into dynamical models to understand a system better. This group tended to focus on trade-offs as being key to making progress. A second group of people seemed to think of traits as a way to compare systems across space and time. This group tended to comprise people who think about trait diversity and functional diversity metrics.*

The remedy they suggest is to engage people that understand both sides of this divide, and to encourage all parties to make their perspectives clear from the start.

**Several important questions** appeared in the final plenary session:

*Ben Ward* asked for evidence that the trait-based approach yields more robust predictions than alternative approaches. *Hans Dam* pointed out that *elements of trait-based approach outlined in Elena Lichtman's presentation are almost identical to those of evolutionary ecology. So, is this approach really unique?* 3) *We must put more emphasis on studies that actually measure fitness.*

## Feedback and evaluation of the workshop

After the workshop, we sent an evaluation form to all, asking their opinions on what functioned well, and what could improve to next meeting. We received 17 answers, and all comments and feedback is available in [this document](#). The [survey](#) on our allocation of time among various activities reveals that respondents support our format, except that they would like to see even more time to breakout groups.

We interpret the general feedback on the workshop as positive, from both the evaluation form and other comments during the workshop. As always, evaluation reveals that people have different preferences and experience activities differently, but many suggestions are certainly worth keeping in mind, for instance:

- Shorter, less specialized keynotes and talks
- Smaller breakout groups
- Start next meeting with a summary of issues from earlier meetings
- Parallel sessions of contributed talks

## Posters

Hyperlink to list [here](#). See [this list](#) to get all abstracts.

## List of participants

Hyperlink to pdf [here](#).

## Time schedule and [programme](#)

Time		Sessions/Titles
<b>Sunday</b>		
13:00-14:00	Lunch	
14:00	Opening	Welcome and introduction. Øyvind Fiksen
	Chair: Jorn Bruggeman	<b>Session 1: Evolutionary and environmental perspectives on traits</b>
14:10-15:10	Keynote: <b>Oswald Schmitz</b>	The evolutionary ecology of ecosystem functioning: Functional traits, trophic interactions, and ecosystem nutrient cycling
15:10-15:30	Jasmin Godbold	Impacts of biotic and abiotic context on functional trait expression and ecosystem functioning in the marine benthos
15:30-15:50	Gil Rilov	Bioinvasions and climate change cause fundamental traits and functional shifts of eastern Mediterranean reef communities
15:50-16:10	Hans Dam	Trade off between grazer-induced toxin production and growth in a marine dinoflagellate
16:10-16:30	Sonia Bejarano	The shape of success in a turbulent world: Wave exposure filtering of coral reef herbivory
16:30-16:50	Sinead Collins	Trait reversion during adaptation in marine and freshwater microbes
16:50-17:10	Romain Forestier	Eco-evolutionary dynamics in a trait-based fish community model
17:30-19:00	Poster session 1 & Icebreaker	Poster session 1.
19:00-20:30	Dinner	
	Social	
<b>Monday</b>		
	Chair: Ago Merico	<b>Session 2: Traits, biodiversity and ecosystem functioning</b>
9:00-10:00	Keynote: <b>Helmut Hillebrand</b>	Trait variability and environmental heterogeneity constrain community composition and ecosystem processes
10:00-10:20	Martin Lindegren	A trait-based assessment towards understanding long-term changes in ecosystem functioning: the Central Baltic Sea as a case study
10:20-10:40	Maren Striebel	Trait-based biodiversity and multitrophic dynamics under external forcing
10:40-11:00	Coffe/tea	
11:00-11:20	Stephanie Moorthi	Inter- and intraspecific consumer trait variation determine consumer diversity effects in multispecies predator-prey systems
11:20-11:40	Bernd Blasius	Trait-based approach to community structure in a spatial gradient

11:40-12:00	Mark Ohman	Zooglider-derived trait recognition across the California Current Ecosystem
12:00-12:20	Matthew McLean	Principal Response Curves to explain the spatiotemporal dynamics of fish functional traits in the Eastern English Channel - ok
12:20		Organizing breakout sessions and round table discussions
12:30-13:30	Lunsj	
13:30-15:00	Break outs: chalk-talks & discussions	This is an opportunity for group discussions/breakouts suggested by participants. The list of proposed themes, activities and tutorials is provided <a href="#">here</a> . Note that we have grouped them, but it is up to participants to break up in smaller groups. We encourage participants to contact others with similar themes and make plans before the workshop.
15:00-15:15	Coffe/tea	
15:15-16:00	Round-table discussions	<b>World cafe - round-tables.</b> We will use a 'World-cafe' round-table discussion format where table hosts present a topic and take notes from the discussion. We rotate tables every 15 minutes while table hosts remain at the table. This section is organized by the steering committee.
16:00-17:30	Plenary discussion	Summary of round-table discussions by table hosts, and a general discussion
17:30-19:00	Poster session 2	
19:00 - 20:30	Dinner	
20:30-	Social	
<b>Tuesday</b>		
	Chair: Stephanie Dutkiewicz	<b>Session 3: Plasticity and physiological traits in unicellular organisms</b>
09:00-10:00	Keynote: <b>Zoe Finkel</b>	Macromolecular and elemental composition of microalgae
10:00-10:20	Ben Ward	Balancing resource acquisition and metabolism in phytoplankton growth models: Cellular stoichiometry and size-dependent growth
	Martina Doblin	Phytoplankton trait expression in dynamic seascapes
10:40-11:00	Break	
11:00-11:20	Lee Karp-Boss	Selective pressures on phytoplankton shape
11:20-11:40	Jeff Bowman	Identification of microbial community traits and application to ecophysiological modeling
11:40-12:00	Robert Ptacnik	Stoichiometric upgrading – planktivores increase assimilation efficiency through mixotrophy in aquatic deserts
12:00-12:20	Onur Kerimoglu	Modelling the physiological regulation of autotrophs: upscaling from microcosms to ecosystems
12:30-13:30	Lunch	

13:30-17:30	Outdoor activity, hike, walk & talk	Walk (or swim?) and talk, or continue group discussions. There are <a href="#">several possibilities for walks directly from the hotel</a> , also to 4-500 m altitude
17:30-19:00	Poster session 3	
19:00-20:30	Dinner	
20:30-	Social	
<b>Wednesday</b>		
	Chair: Andrew Barton	<b>Session 4: Traits in microbes - and future directions for trait-based approaches to ocean life</b>
09:00-10:00	Keynote <b>Frede Thingstad and Selina Våge</b>	Can we constrain the “everything” in “everything is everywhere”?
10:00-10:20	Kyle Edwards	Host traits drive viral life history traits across phytoplankton viruses
10:20-10:40	Elena Litchman	Future directions and challenges of trait-based approaches
10:40-11:00	Break	Check out
11:00-11:45	Conclusions, opinions and perspectives	Short prepared invited statements from groups of attendants
11:45-12:30	Plenary discussion	Open final discussion.
12:30-13:30	Lunch, departure	

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