

# National Algaepilot Mongstad

## Norway



Production of microalgae for aquaculture

*Dorinde Kleinegris (Uni Research)*

*Hans Kleivdal (Uni Research & University of Bergen)*





# *How to Farm a Better Fish?*

The world now produces more  
farmed fish than beef –  
and that's just the beginning

## **Feeding the World**

By 2050 we'll need to feed 2 billion more people.  
How can we do that without overwhelming the planet?

- Aquaculture has supplied more than half of the World's fish for food since 2013
- UN FAO: Aquacultured fish expected to reach 100 mill tonnes by 2025
- Growth in salmon will be slower because of the high demand for fishoil and fishmeal
- Large feed volumes are required to drive the sustainable growth
- Novel feed resources are introduced
- The sustainable growth should not rely on resources competing with human food
- WWF: Norway is leading the development of sustainable aquaculture



# Still a gap to bridge for commodities from microalgae

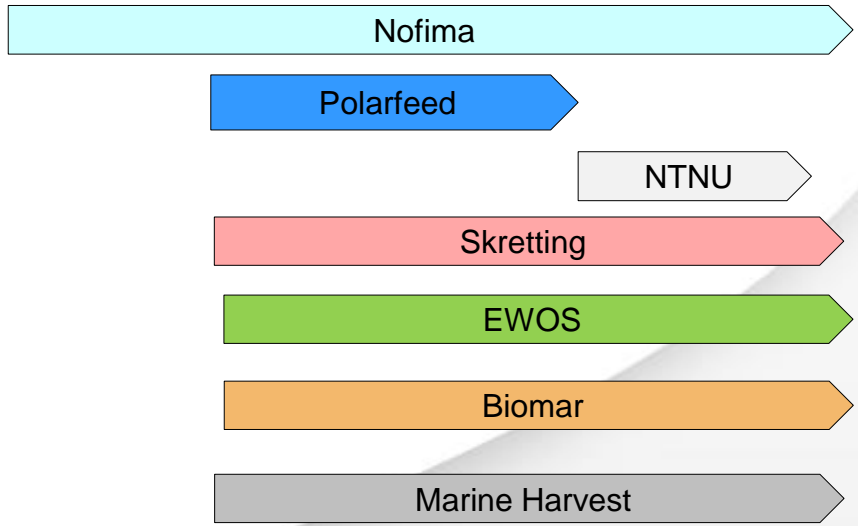
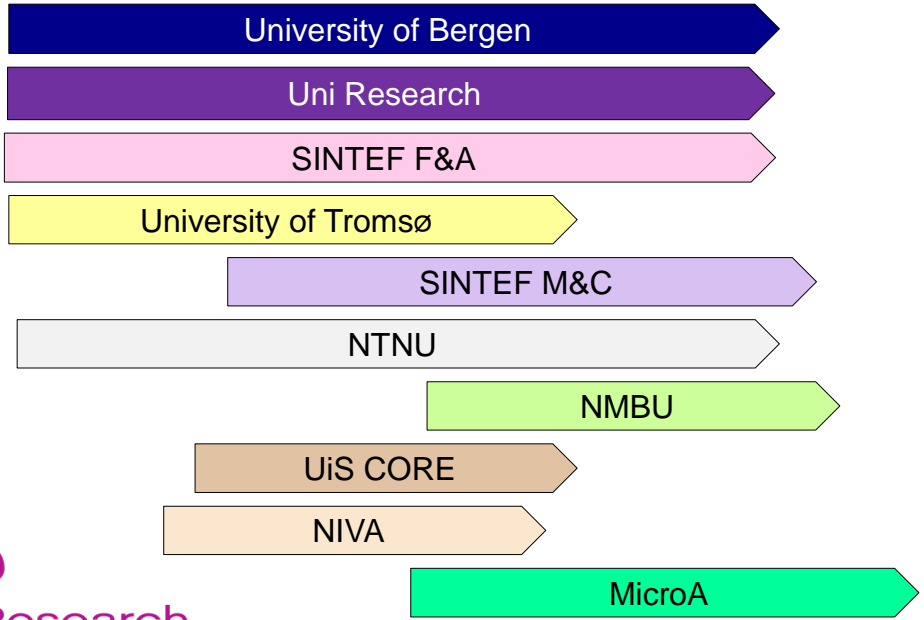
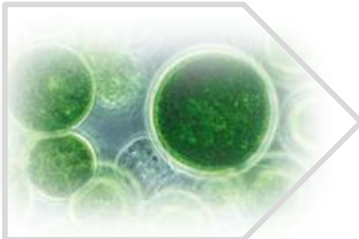




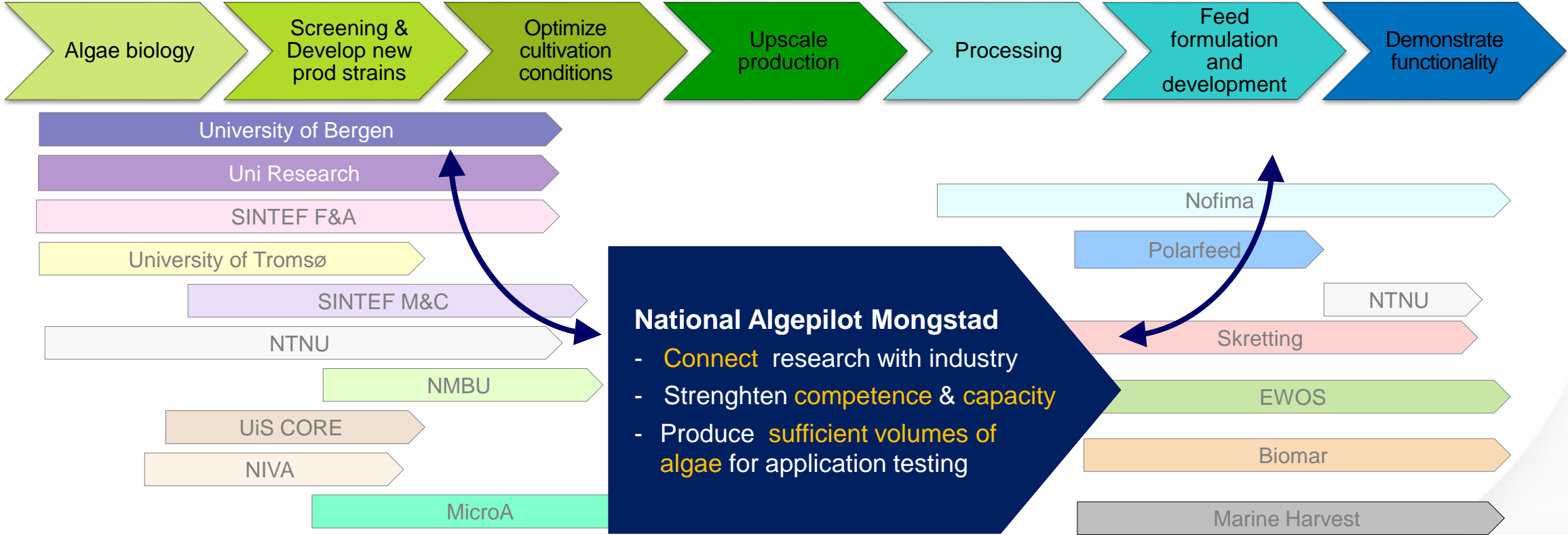
## Commercial production challenges:

- Product costs
- Scale
- Production chain analysis
- Market development

# Roadmap for microalgae based aquafeed



# Roadmap for microalgae based aquafeed



## INTRAFISH

### KYST.NO

Fishfarming Expert

### HORDAFØR

Producer of ingredients for the fish feed

### SALMOBREED

A genetics company specialising in selective breeding of Atlantic salmon

### PHARMAQ ANALYTIC

World's leading pharmaceutical company

### DNB SEAFOOD

The worlds largest network of locally-owned aquaculture companies

### HORDAFØR

Producer of ingredients for the fish feed

### EWOS/CARGILL

Leading supplier of feed and nutrition for the international aquaculture

### SALMON GROUP

The worlds largest network of locally-owned aquaculture companies



90 partners



15.000 employees

### GRIEG SEAFOOD

One of the world's leading fish farming companies

### MARINE HARVEST

One of the largest seafood companies in the world & the world's largest producer of Atlantic salmon

### LERØY

The leading exporter of seafood from Norway & the world's second largest producer of Atlantic Salmon

### UNI RESEARCH

One of Norway's largest research companies. UiB main owner.

### IMR

One of the worlds largest marine research institutions

### NOFIMA

One of Europe's largest institutes for applied research within fisheries, aquaculture and food

# Bergen



Norwegian Centres of Expertise  
**NCE Seafood**  
Innovation Cluster



8 bill USD gross revenue



50 mill USD R&D budget

## DIRECTORATE OF FISHERIES

### HIB

Bergen University College

### BI

Norwegian Business School

### NHH

The Norwegian School of Economics

### UIB

One of Norway's largest marine University

### CMR

A tech. research company focusing on commercial R&D - marine R&D one main focus area.

### NIFES

The principal generator of knowledge on fish nutrition & seafood safety, nationally and internationally

# National Algaepilot Mongstad

University of Bergen	6 mNOK
Seafood Research Fund	3 mNOK
Government	6 mNOK
Hordaland County	2 mNOK
Municipality councils	1 mMOK
	18 mNOK = 1.9 m€



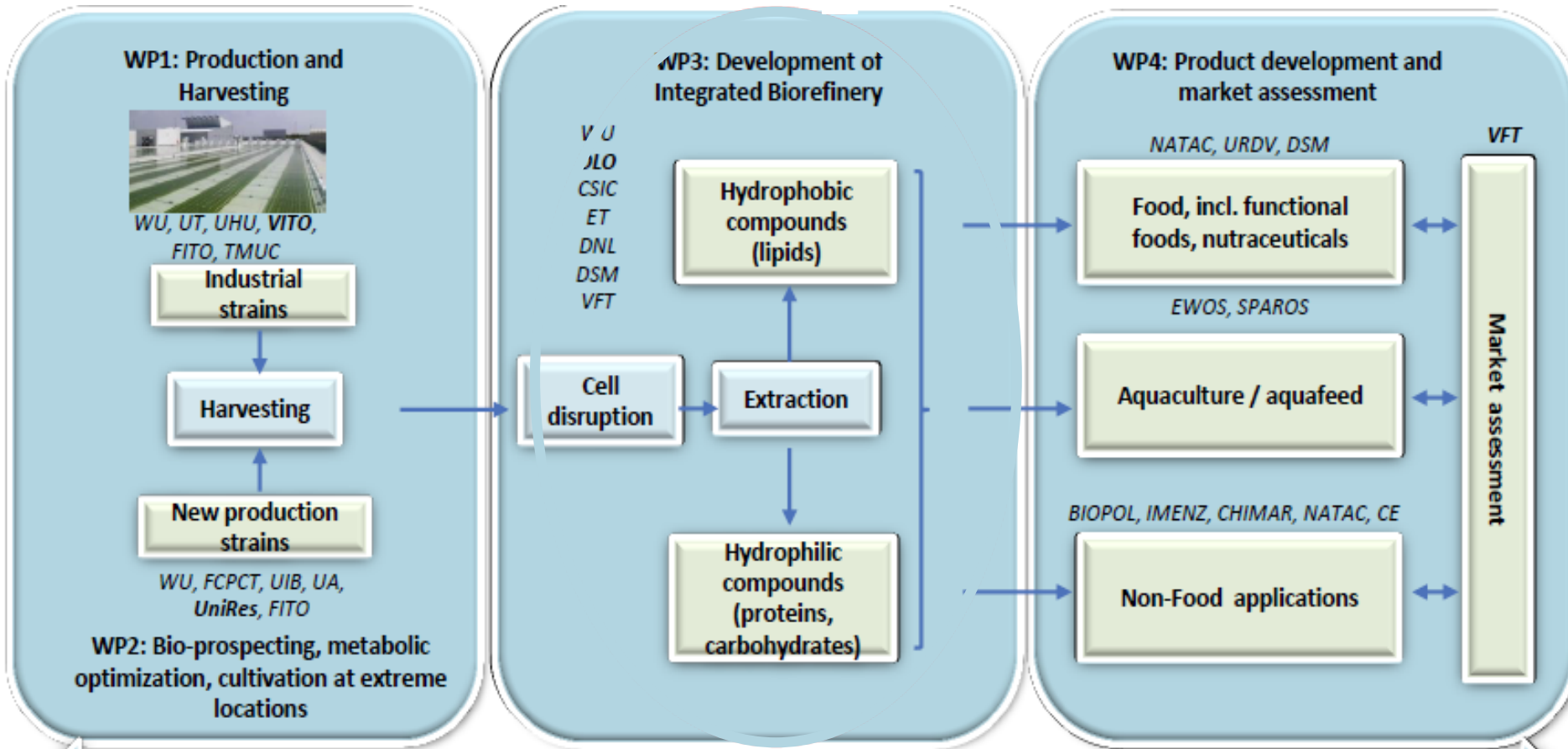
National platform for the industrialization of microalgae



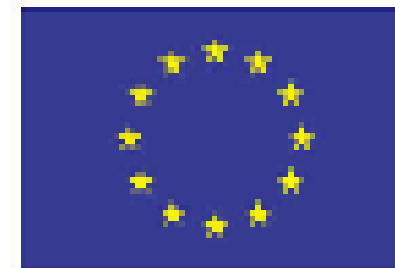
We develop the full microalgae production chain:  
from bioprospecting to process optimization and biomass production at pilot scale

A photograph showing four scientists in white lab coats standing in a large-scale microalgae cultivation facility. They are surrounded by rows of long, narrow, green bioreactors. The scientists are smiling and appear to be engaged in a discussion. The background shows more rows of bioreactors, creating a sense of a large-scale production environment.

...development of new valuable products from microalgae



  
**MIRACLES**  
 SPECIALTIES FROM ALGAE



2013-2017



Aquaculture feed



Food & Nutraceuticals



Non-food specialties



# Microalgae show great potential as functional ingredients in aquaculture feeds

## Experiments:

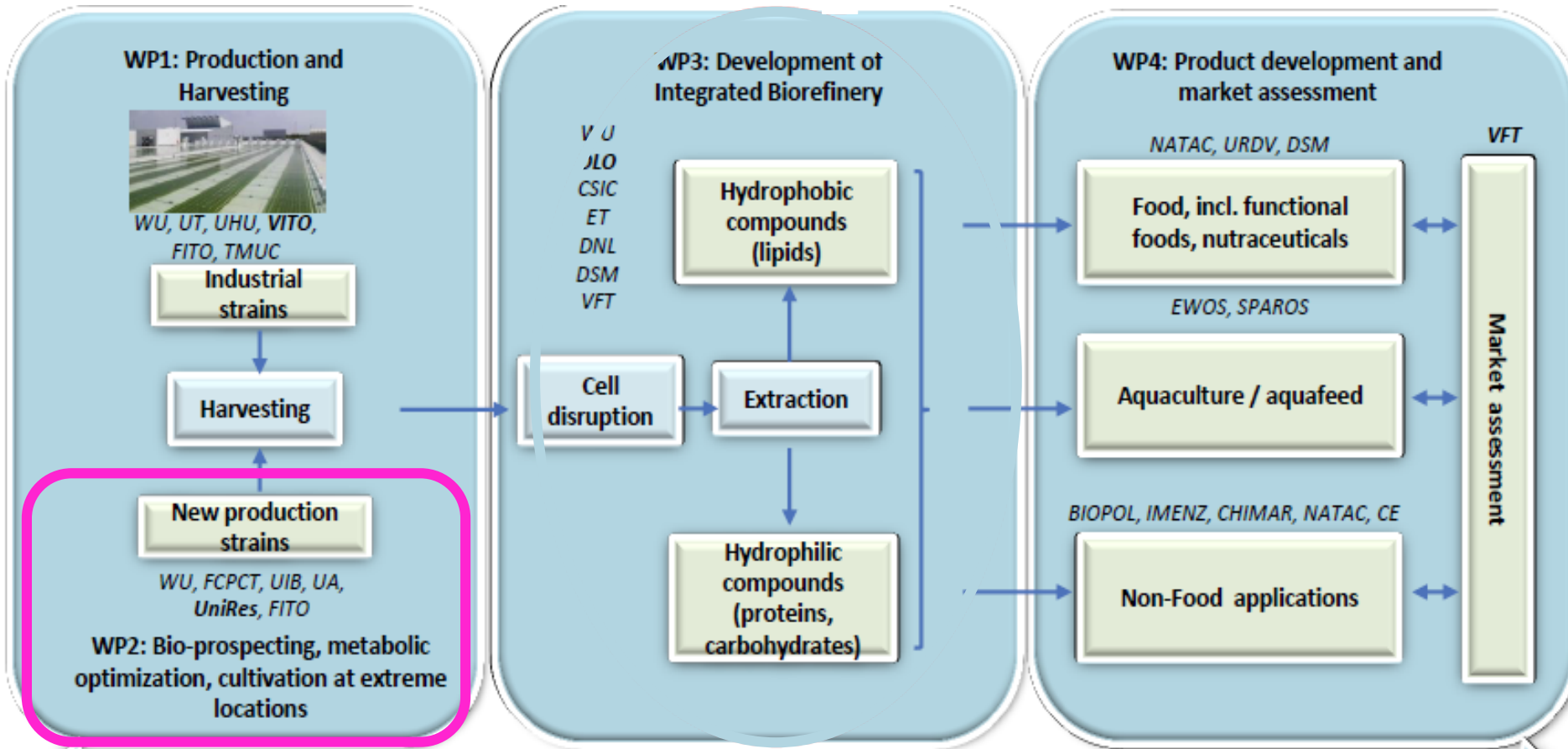
- *Nannochloropsis* and *Phaeodactylum* (whole cells, disrupted, residual biomass, oil)
- Diets with 1 – 8 % inclusion rates
- Tested on: salmon, gilthead seabream, senegalese sole



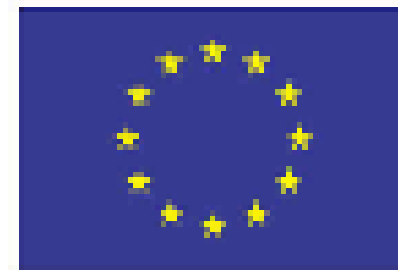
## Demonstrated benefits on:

- **Animal welfare** (stress resistance, immunity, improved survival of larvae)
- **Consumer quality traits** (more vivid and typical external pigmentation)
- **Reduce reliance on finite marine-harvested resources** (e.g. replacement of fish meal (80%) and fish oil (30%) )





  
**MIRACLES**  
 SPECIALTIES FROM ALGAE



Aquaculture feed



Food & Nutraceuticals



Non-food specialties



# Bioprospecting + strain selection – Nordic climate

Search for: strains with high EPA/DHA content.

Assumption: Microalgae from northern high latitudes are expected promising candidates, as low growth temperatures can increase fatty acid unsaturation.

## Sampling



58 events

## Isolation



110 plates

## Cultivation



149 clonal cultures

## Screening

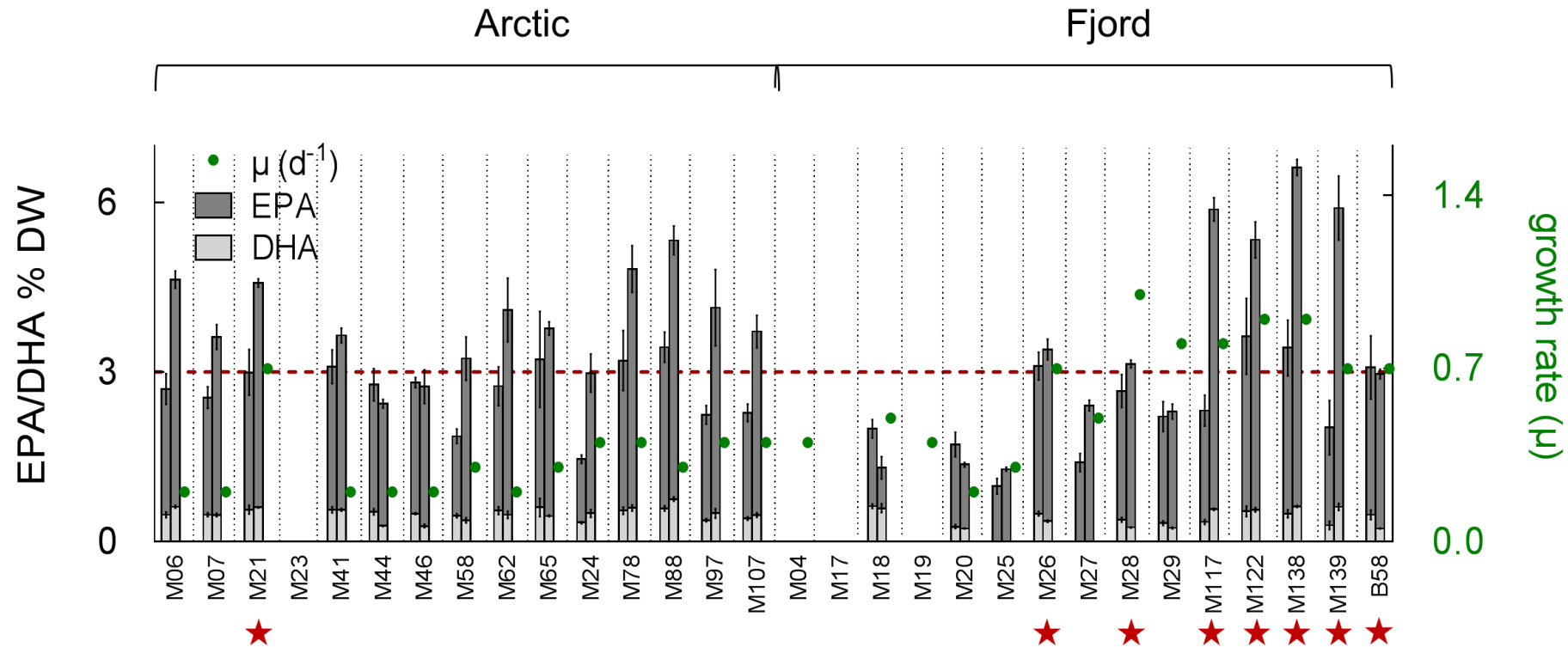


30 strains:

- Growth
- Fatty acids

Promising strains:  
growth rates  $> 0.7 \text{ d}^{-1}$   
EPA/DHA  $> 3\% \text{ DW}$   
→ 8 selected for further  
characterization

# Bioprospecting + strain selection – Nordic climate



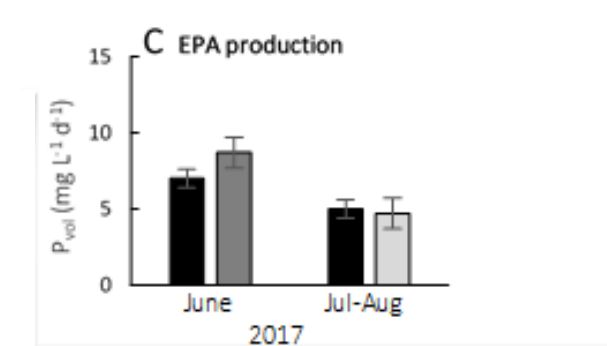
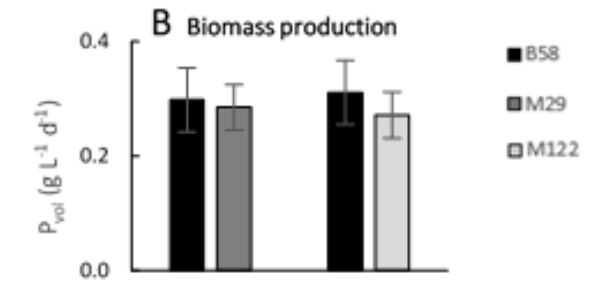
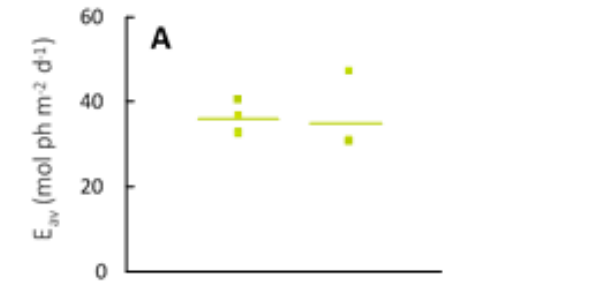
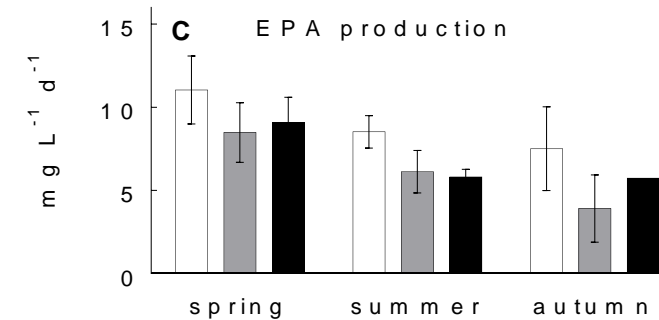
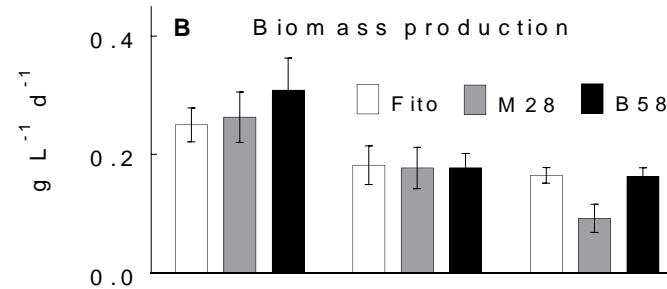
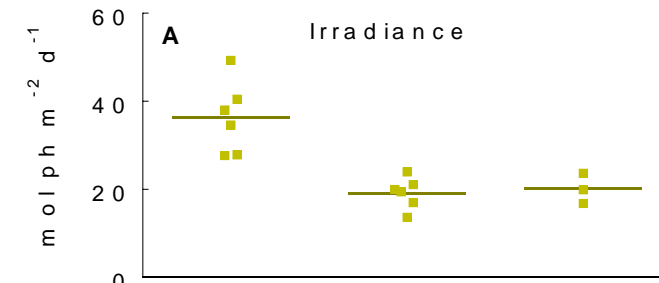
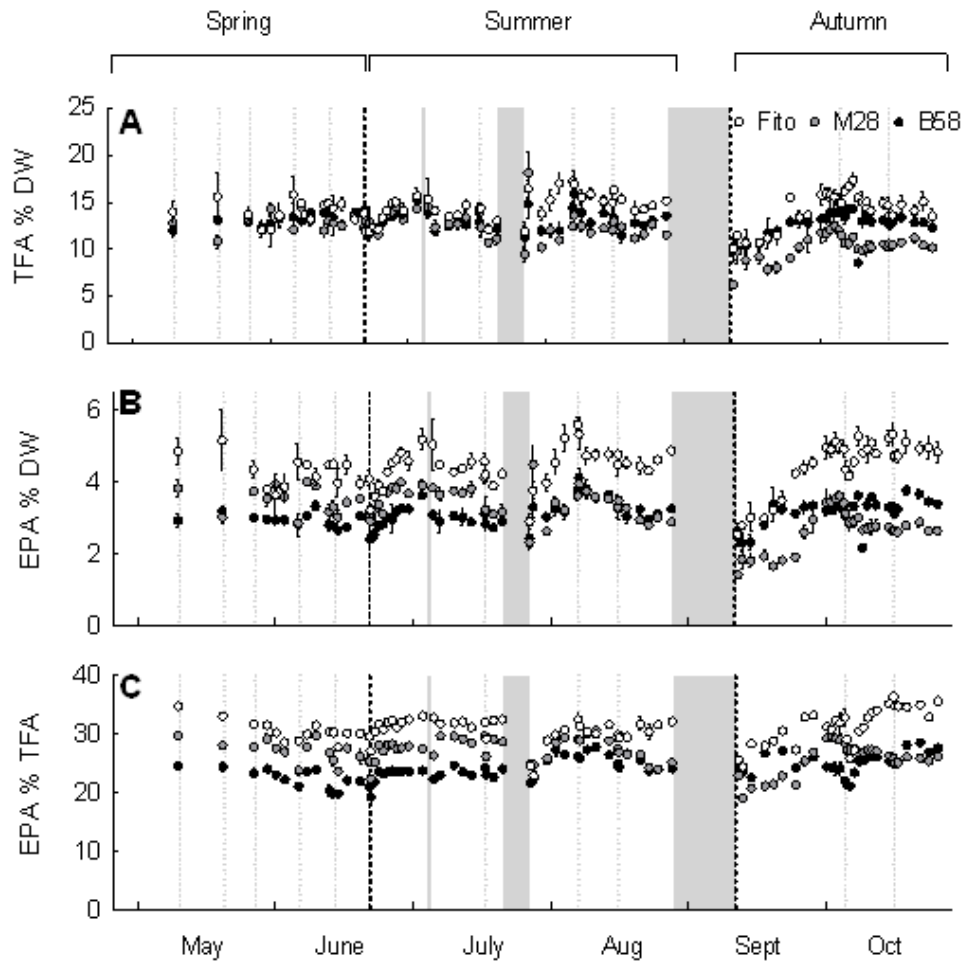
## Conclusions

- Nordics are promising for prospecting microalgae with high EPA
- EPA content was predominantly higher in the stationary phase
- EPA contents of >6 % DW in stationary phase are higher than typically found
- First report on a high EPA content for *A. septentrionalis* and *Entomoneis sp.*

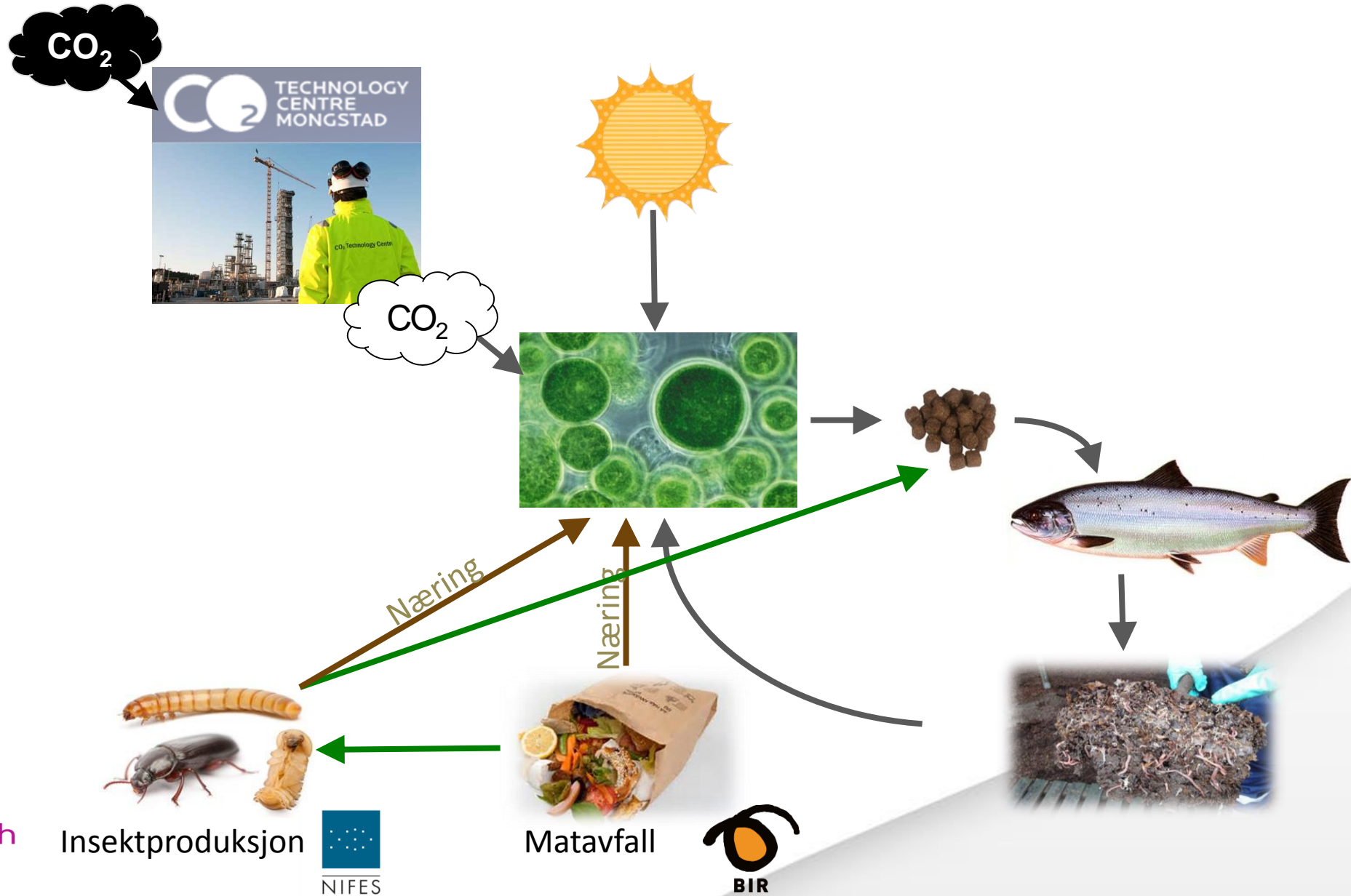
Steinrucken et al. 2017

# Bioprospecting + strain selection – Nordic

Comparison under Nordic outdoor conditions in flat-panel PBRs  
 Compared vs. Commercial *Phaeodactylum* reference strain

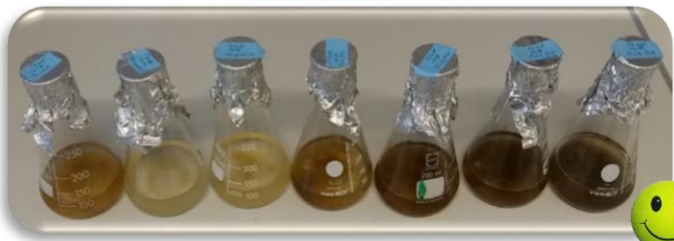


# Industrial symbiosis for development of new value chains

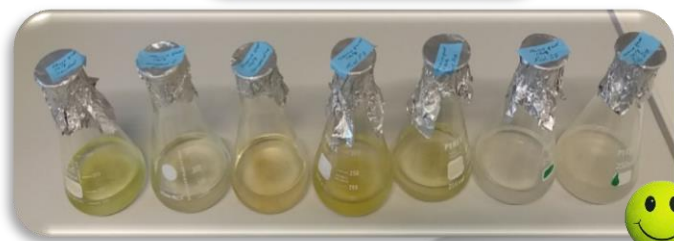
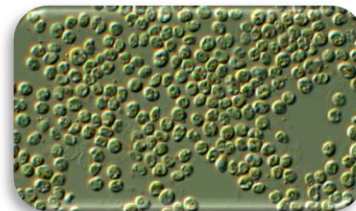
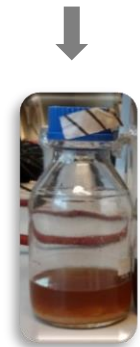


# Preliminary experiments – integration with waste streams

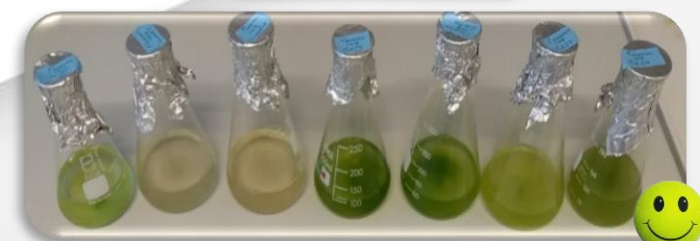
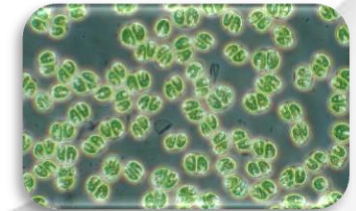
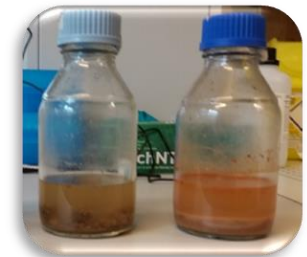
Municipality Biodegradable Waste



Insect manure



Fish manure



# Thank you for your attention

## Questions?

