

Will fish oil be the limiting factor?

Alternative sources for Omega-3

**Marine Ingredients Conference
September 22-24, 2013**

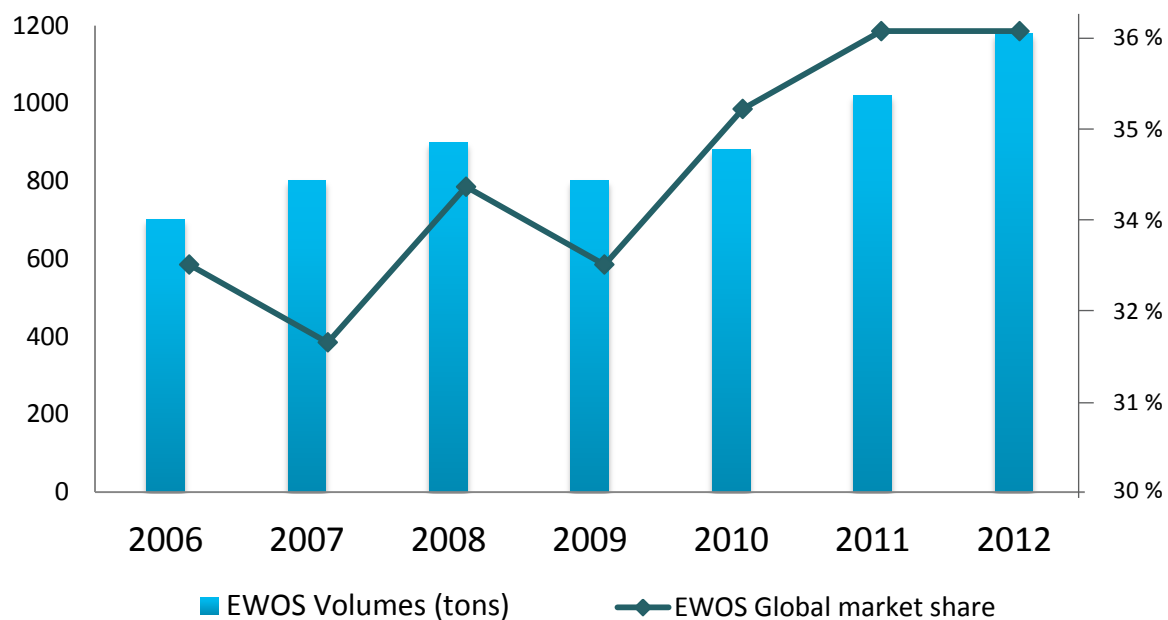
Petter Martin Johannessen, Supply Chain Director, EWOS

Outline

1. EWOS at a glance
2. Supply situation for Omega 3
3. Technology situation for industrial algae production
4. EWOS experience
5. Sustainable Aquaculture

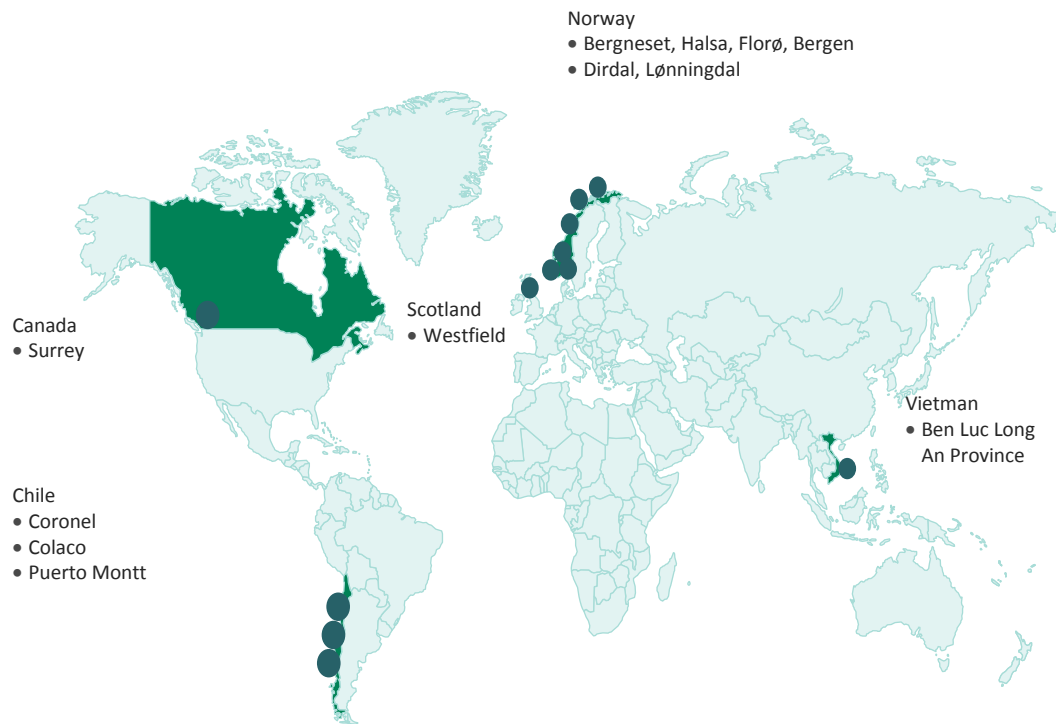
EWOS AT A GLANCE

- One of three major salmonid fish feed companies globally, with a #1 overall market position
- Production 2012: 1.2 Million Metric tons
- 1,000 employees globally



EWOS AT A GLANCE

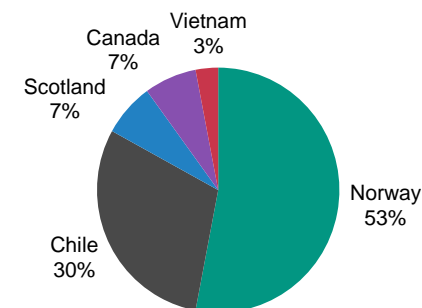
OPERATIONS IN 5 COUNTRIES



VOLUMES & MARKET SHARE

(NOKm, FYE 31-Dec)	2010	2011	2012
Operating revenues	7,388	9,337	10,276
EBITDA	653	788	871
Margin (%)	8.8%	8.4%	8.5%
ΔNWC	(459)	(201)	(447)
Capex	96	140	168
Unlevered FCF (pre-tax)	98	447	183

2012 REVENUES BY COUNTRY



Source: Company information

Strong R&D commitment

The trend-setting innovator

- 2012: NOK 100 million spent on R&D
- Our innovations have changed the global fish feed industry



First to introduce feed supply in true bulk directly to the fish farm's feed silo



First to introduce a new way of benchmarking growth performance

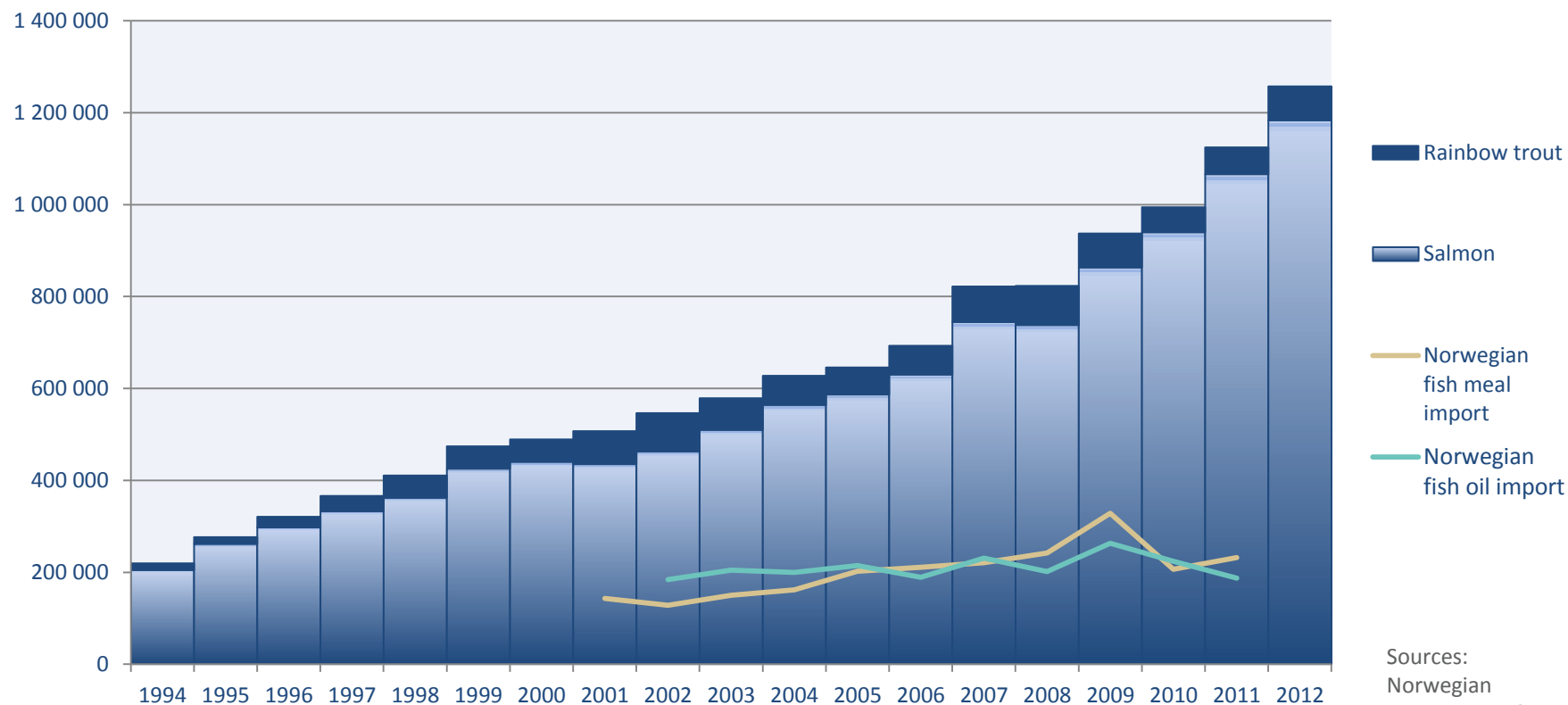


First to introduce functional feed

Supply situation for Omega 3

Increased farming demands more feed

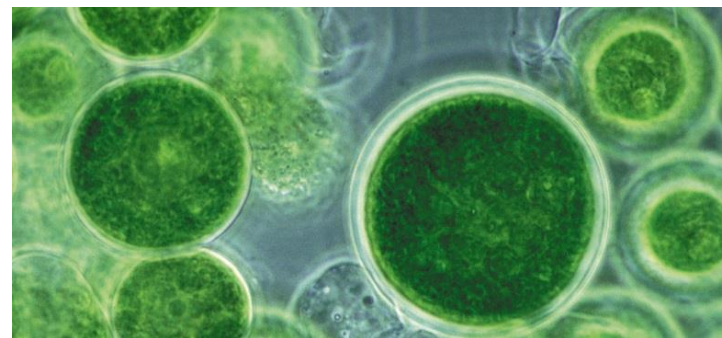
Two-fold increase in Norwegian salmon production over the last decade without increased use of marine raw materials



Sources:
Norwegian
Directorate of
Fisheries, IFFO

Alternative sources for Omega 3

- Krill
- GMO oil seeds
- Yeast/bacteria
- Microalgae
- Fish waste and trimmings



Technology situation for industrial algae production

ProAlgae Report: Two examples of algae companies scaling up

Sapphire Phototrophic example

- Algae bred to tolerate high pH conditions and salty water
- Secrete bio-crude oil by using proprietary strains - saves harvesting and processing costs
- 40 hectar facility producing 2 barrels per day
- Expected production by 2014: 1 mill gallons biofuel per year
- 75–85 USD/barrel (industry estimates)

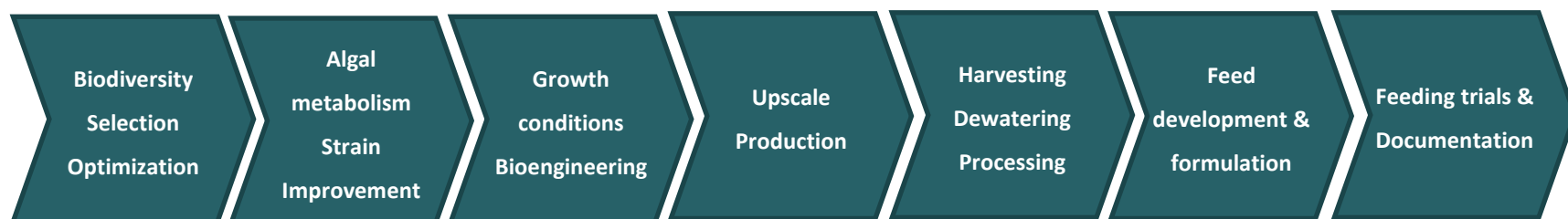


Solazyme Heterotrophic example

- Low-cost plant-based sugars into high-value oils
- Current production capacity ca. 8,000 tons
 - expects 550,000 tons by 2015
- Expected manufacture cost below 1,000 USD per ton
 - if produced in built-for-purpose plant



ProAlgae Report: R&D Challenges



EWOS experience

EPA/DHA algae in salmon feed issues

EPA/DHA algae may be simpler to use as extracted oil for coating pellet.

Potential reasons below:

- High fat algae meal could exceed maximum fat level in meal mix for proper pellet expansion in extruder, stick in silos and be difficult to grind
- Low EPA+DHA level in meal taking space in formulation with potentially high carbohydrate, indigestible protein, ash and/or salt
- Potential negative effects of EPA/DHA algae meal on fish performance, health or fillet quality
 - See examples on small fish growth in next slide
- Poor nutrient digestibility of algae meal due to cell walls
- EPA/DHA not stable in algae meal through extrusion

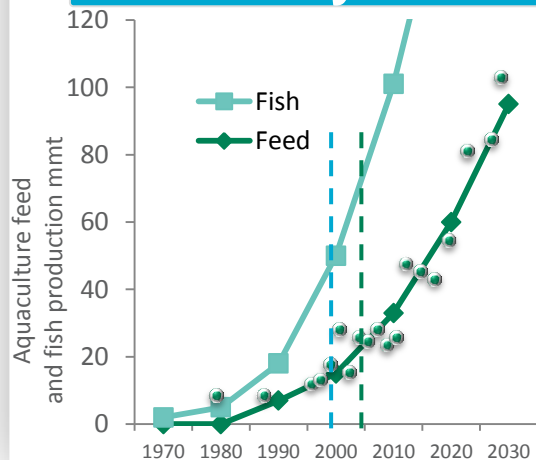


Sustainable Aquaculture

CO2Bio – omega 3 from algal biomass

- Microalgae as fish oil replacement in salmon feed

Why?



What?



CO₂

How?



Omega-3
Fish feed

Why EWOS and CO2Bio?

- Contribute to facilitate research and innovation
- Bridge the gap – contribute to successfully upscale production
- Contribute to strengthen focused research on microalgae as a marine resource in the future
- Sustainable aquaculture



By-products, waste and trimmings

Global overview

- Total catch, globally >90 million tons
 - Industrial fish for meal and oil → 20 million tons
 - For consumption 70 million tons, 50 % of weight to human consume, rest is trimmings, potential for increased value in fisheries → 35 million tons
- **Total available** → **=55 million tons**

(source: FAO)



By-products, waste and trimmings

Norway overview

- By-products; trimmings and discard, are not fully used
 - Norway 2011: 816.000 tons of by-products produced, 620.000 tons used, the rest was discarded (Source: Rubin)
 - Major part of what is being discarded is from cod fisheries
- With 2013s cod quotas more than 300.000 tons of by-products are likely to be dumped



By-products, waste and trimmings

EWOS overview

- Ensiled fish protein concentrate (FPC) as raw material for fish feed
 - FPC is an silage with water and fat removed
 - FPC has been used by EWOS for 20 years; recognized as a valuable raw material
 - Traceability of raw material – good quality control
 - FPC has a positive effect on technical quality of the fish feed; it holds good binding properties
 - Optimizing the product and increased use in the fish feed could increase the advantages of using FPC further
 - The possibility for other nutritional advantages should be further explored

- 2012: 24% of marine ingredients was by-products



Summary

The use of marine raw materials in salmon aquaculture has been stable the last 10 years - even with doubled production

The aquaculture industry and world population need more Omega 3

The known sources will be fully utilised within 5-8 years

We need to make use of marine by products and new technology

Large scale algae production is the way to provide more omega-3