



# Microalgae for salmon feed

Pro Algae Workshop  
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**EWOS**<sup>®</sup>  
Innovation

# EWOS AS

- ▶ Leading producer and supplier of salmonid feed
- ▶ Focus on use of sustainable raw materials
- ▶ Long experience with testing and use of new raw materials
- ▶ Have tested different algae products in later years



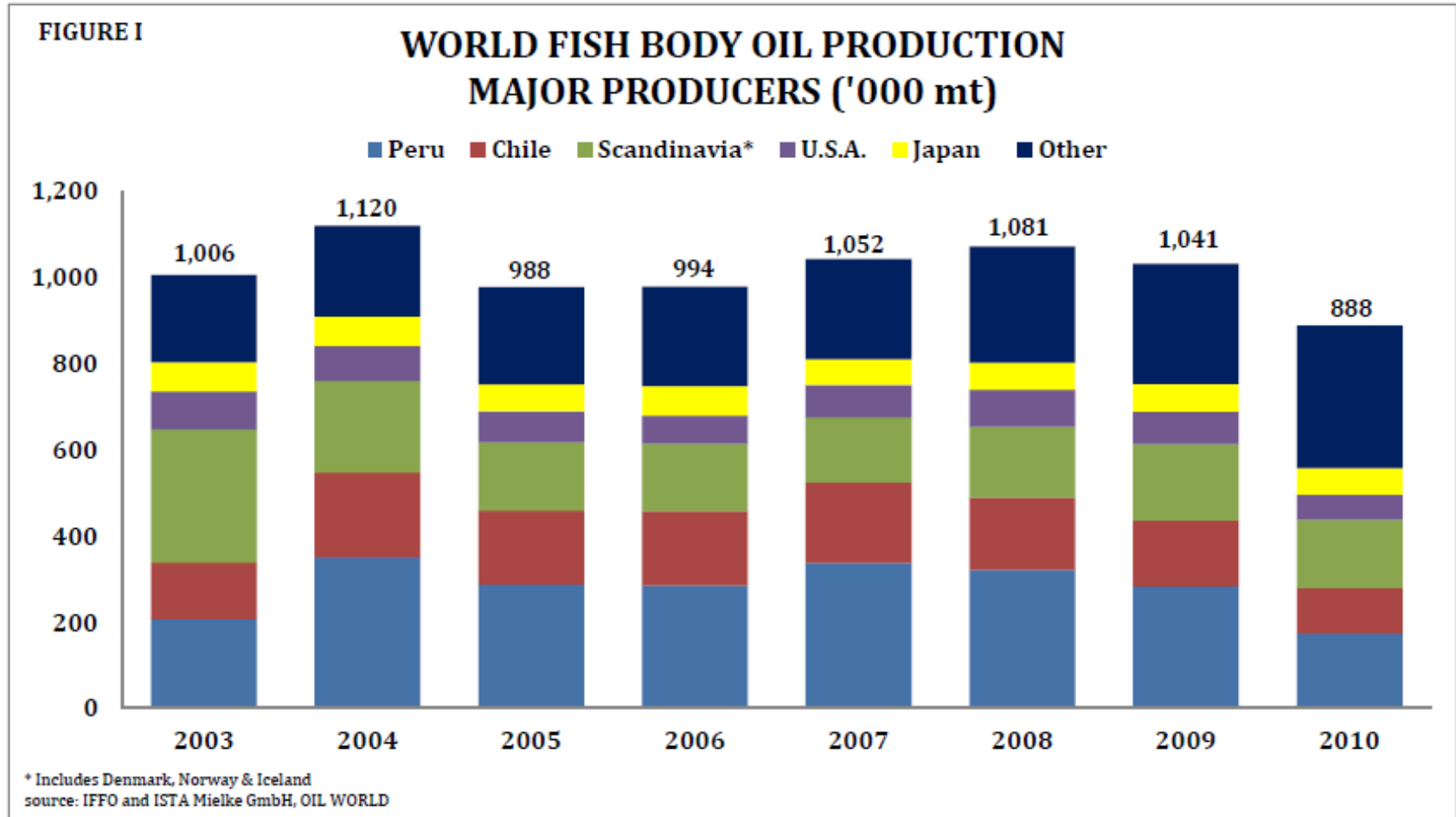
# Algae in salmon feed

- ▶ Priorities for use in salmon feed:
  - Marine omega-3 (EPA+DHA) source to replace fish oil.
  - Protein alternative for fishmeal replacement.
  - Astaxanthin less interesting due to relatively low current price.

# Marine omega-3 in salmon feed

- ▶ Fish oil is major marine omega-3 fatty acid (EPA+DHA) source in current salmon diets with fish meal supplying minor amounts.
- ▶ EPA+DHA varies between fish oil species sources and within batches from same source.
- ▶ Relatively low EPA+DHA required in feed for optimal growth of salmon.
  - 0.5-1% EPA+DHA of diet estimated.
- ▶ Surplus EPA+DHA in salmon feed mainly to enrich fillet for human health.
  - Feed and fillet EPA+DHA levels correlated.
  - Predict EPA+DHA in fillet with EWOS oilMIX model.
- ▶ EPA+DHA in salmon fillet important for human health.
  - Health claims for EPA+DHA focused on cardiovascular disease (CVD) but benefits also reported in brain function, mental health and inflammatory disease areas.
  - American Heart Association recommends those without CVD eat oily fish at least twice a week.
  - Human daily intake guidelines for EPA+DHA:
    - 500 mg per day from ISSFAL,
    - 250 mg per day from EFSA (EU).

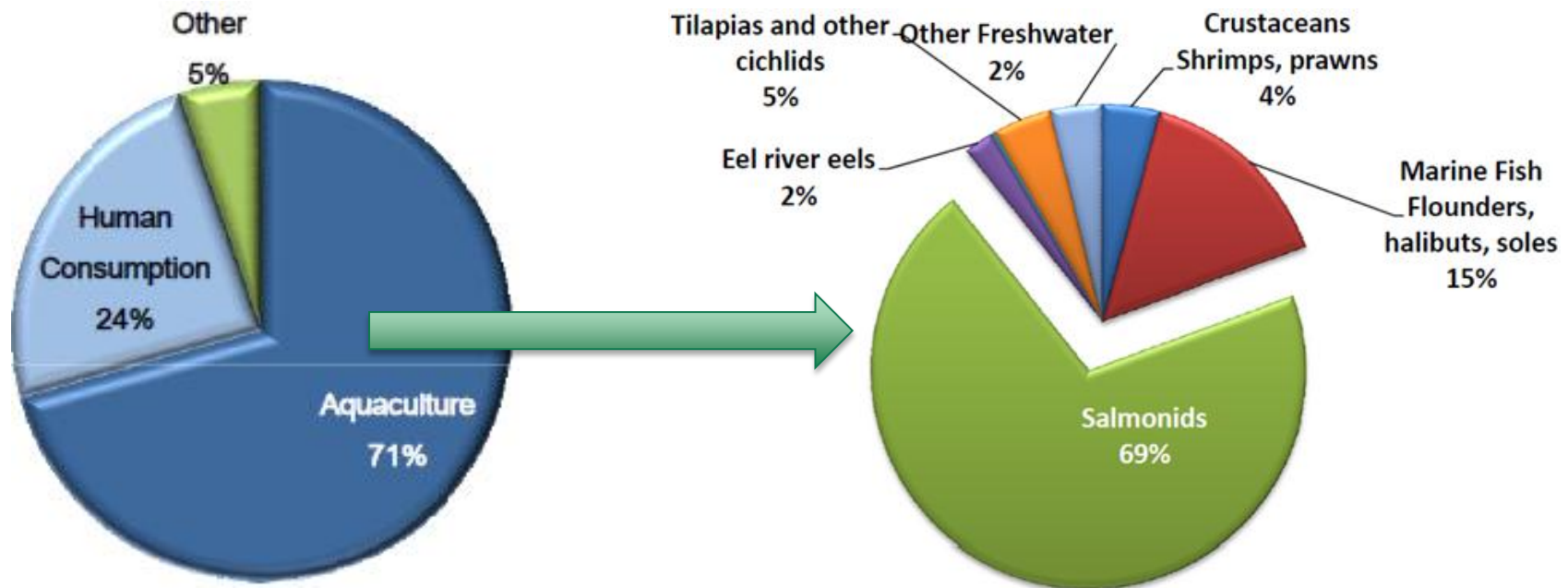
# Sustainable global fish oil supply



- ▶ 8 year average is ca. 1 million tons of fish oil per year.

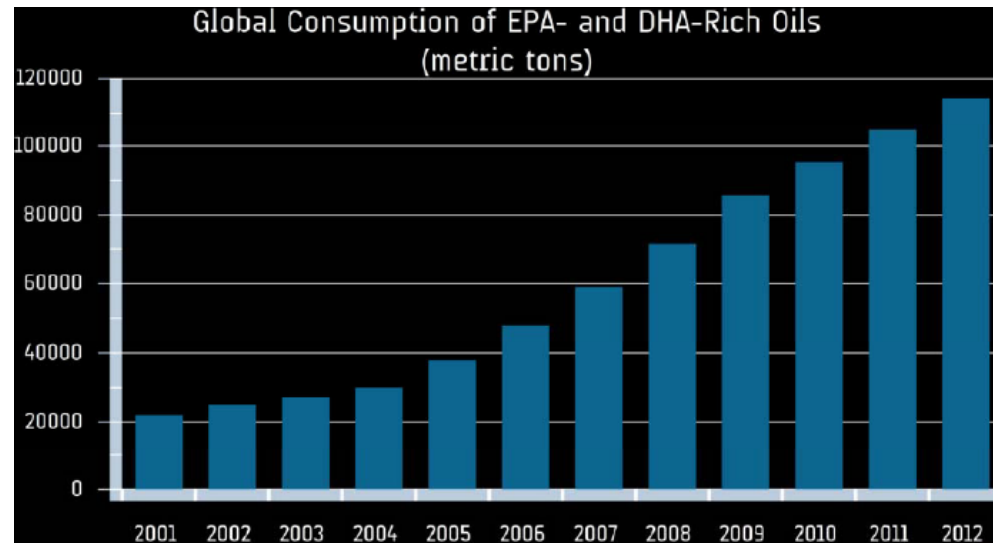
# Aquaculture is major user of fish oil

- ▶ Aquaculture is largest user of fish oil and salmonids are largest users of fish oil in aquaculture.
- ▶ Fish oil for direct human consumption also uses an increasingly large amount of fish oil.

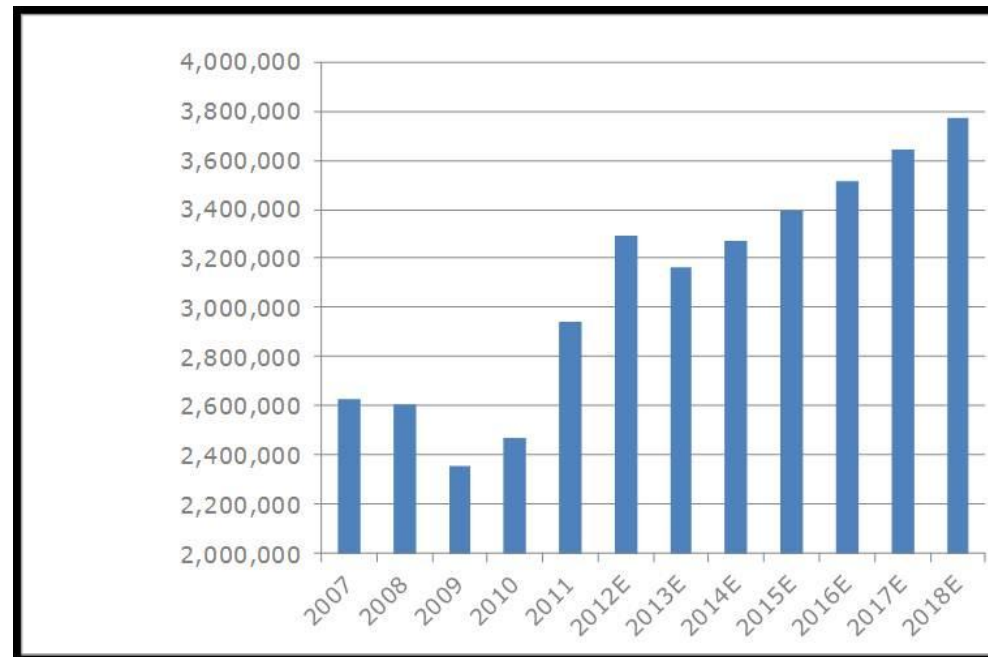


# Increased fish oil demand for direct human consumption and salmonid feed

- ▶ Nearly 10% per year omega-3 industry growth (DHC).



- ▶ 3.6% average growth in salmonid production last 5 years.



# Alternative marine omega-3 sources

- ▶ Krill oil
  - Likely under 5K tons by 2017.
  
- ▶ GMO plant oil
  - EPA/DHA-enriched (ca. 4-10 years).
  - SDA-enriched GMO plant oil shorter term.
  
- ▶ Algae
  - Currently low volumes and high prices.
  - EWOS activities:
    - CO2Bio
    - industry partner on research project collaborations
    - algae product screening





## EPA/DHA algae in salmon feed issues

- ▶ Algae oil needs to be price competitive with fish oil on EPA+DHA per weight of product basis to get into feed formulation.
- ▶ EPA/DHA algae may be simpler to use as extracted oil for coating pellet but this can add extra cost. Potential reasons below:
  - High fat algae meal exceeds maximum fat level in meal mix for proper pellet expansion in extruder.
  - Low EPA+DHA level with high carbohydrate/ indigestible protein/ ash in algae meal takes up too much space in formulation.
  - Negative effect of EPA/DHA algae meal on fish performance, health or fillet quality.
  - Poor nutrient digestibility of algae meal due to cell walls.
  - EPA/DHA not stable in algae meal through extrusion.

# Algae as fish oil replacement in salmon feed

- ▶ Extracted algae oil example to directly replace fish oil as EPA/DHA source:
  - 15-30% EPA+DHA of total FA or higher.
  - Mix of EPA and DHA.
  - Low omega 6 (<5% of total FA).
  - Low saturated FA ( $\leq$  ca. 20-30% of total FA; negative effect on fat digestibility).

# Algae as protein source in salmon feed

- ▶ Potential defatted byproduct from algae biofuel and nutraceutical industries.
  
- ▶ Algae as protein source in salmon feed:
  - Greater than 60-65% protein DM to directly replace fishmeal and avoid taking up space in formulation.
  - Similar amino acid composition to fishmeal to avoid supplementation of deficient amino acids.
  - Highly digestible protein (ca. 90%).
  
- ▶ Price competitive with plant protein concentrate alternatives to fishmeal to get into feed formulation.
  - Fishmeal is unique ingredient required for optimal growth at low levels.
  
- ▶ Evaluate potential negative effect of algae meal on fish performance, health and fillet quality.

An aerial photograph of a lush green landscape, possibly a forest or a large park, with a bright sunburst effect in the center. The sunburst is a bright white light source with rays extending outwards, creating a lens flare effect. The greenery is dense and vibrant, with some lighter green areas that could be paths or clearings. The overall tone is bright and positive.

Thanks for  
your attention

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