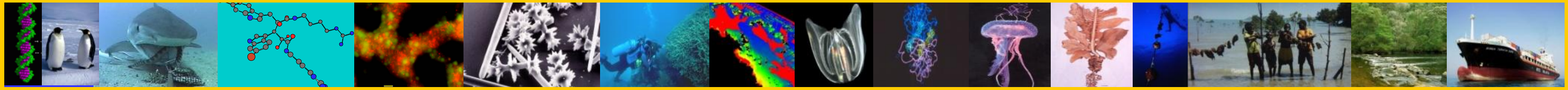
Aquaculture:
The Wider Picture and Potential for the Bay of Plenty

Chris Battershill

March 2012

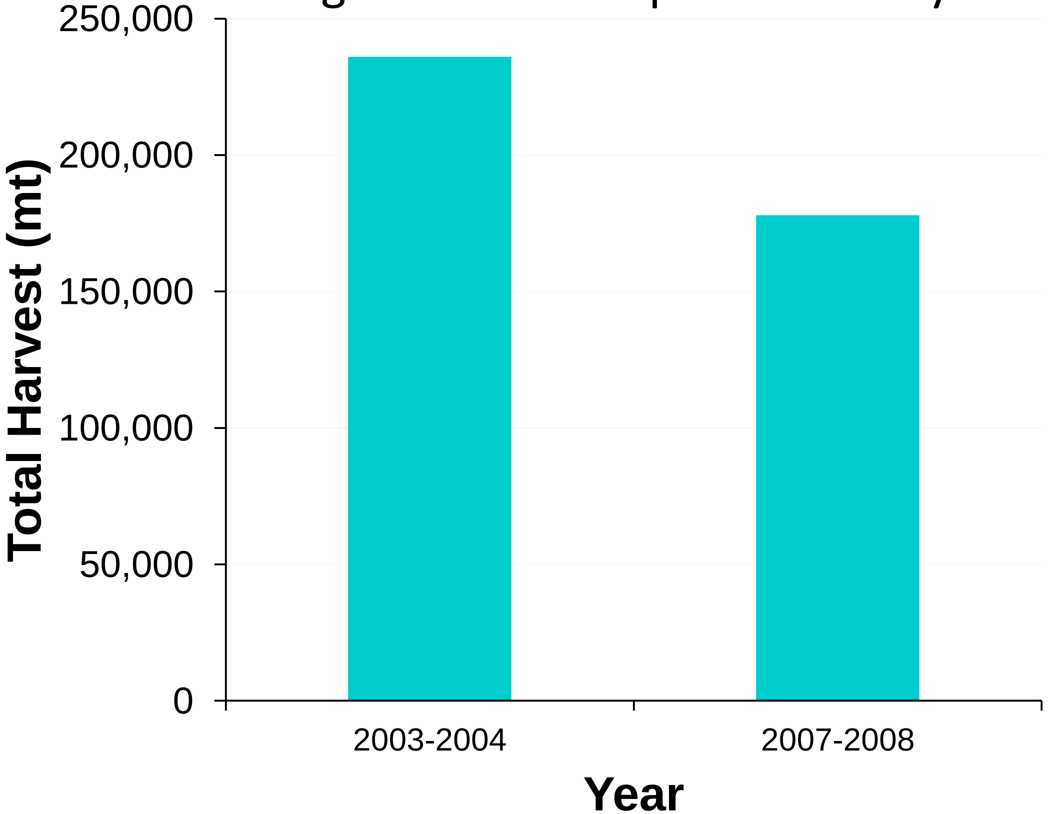


Sustainable Food Aquaculture

Developing Marine Crisis:

35% decrease in seafood harvest in 5 years.

- The Food & Agriculture Organisation (FAO) predicts that global consumer demand for seafood will almost double from 45 to 85 million tonnes by 2015.
- It is estimated that aquaculture will increase from 42% to 58% of global seafood production by 2020.



(ABARE 2010)

Fishery Yields Declining

MPA's do not address supply issue

V
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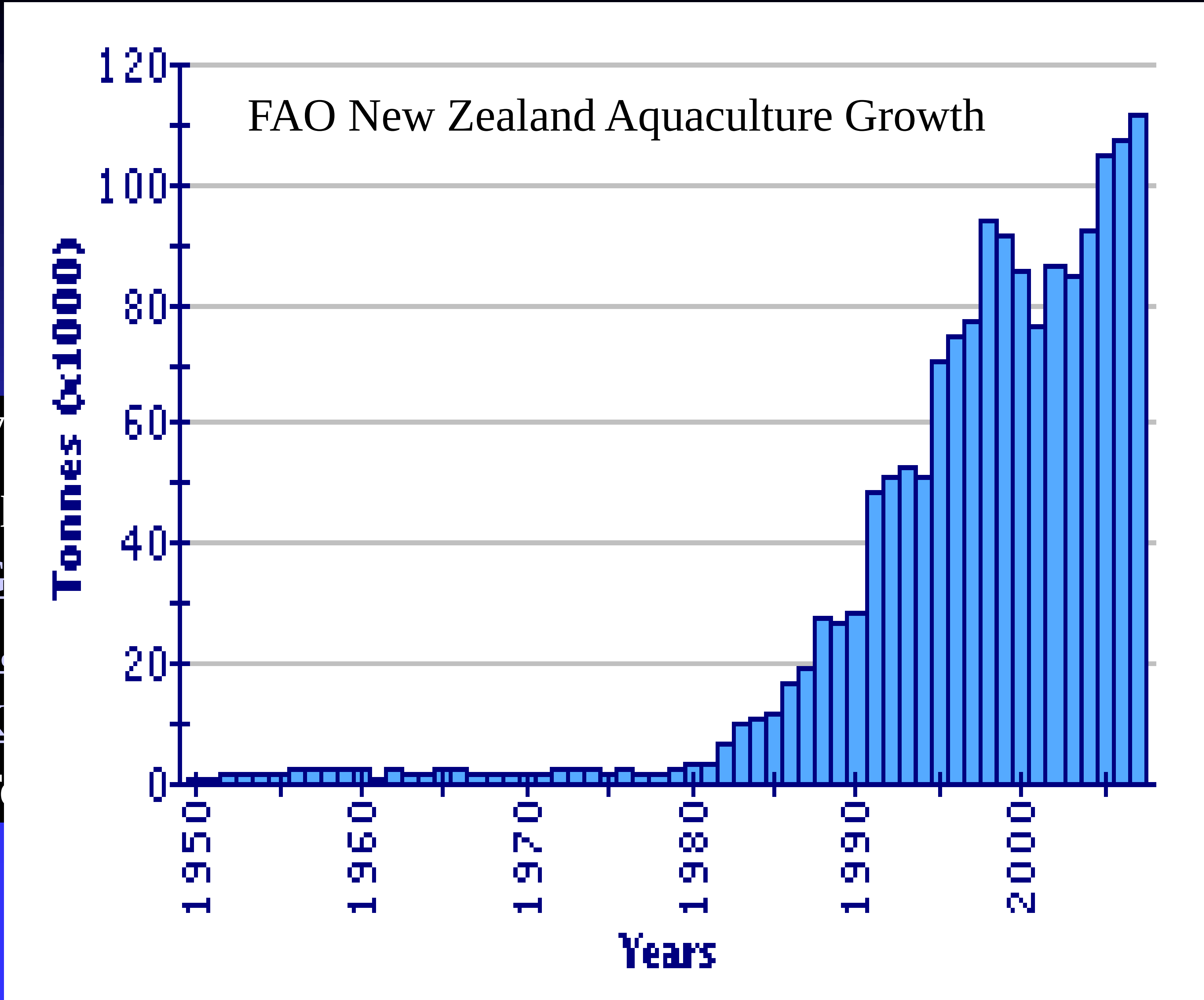


FAO New Zealand Aquaculture Growth
Tonnes (x1000)
120
100
80
60
40
20
0
1950
1960
1970
1980
1990
2000
Years

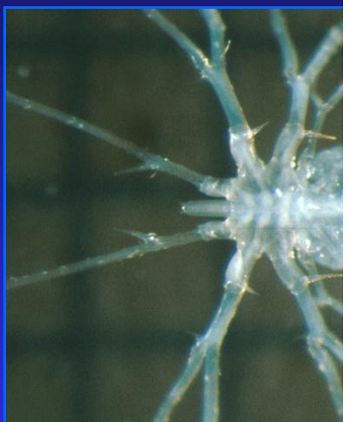
New Targets for Marine Protein Production

New
Targets
For
Aquaculture

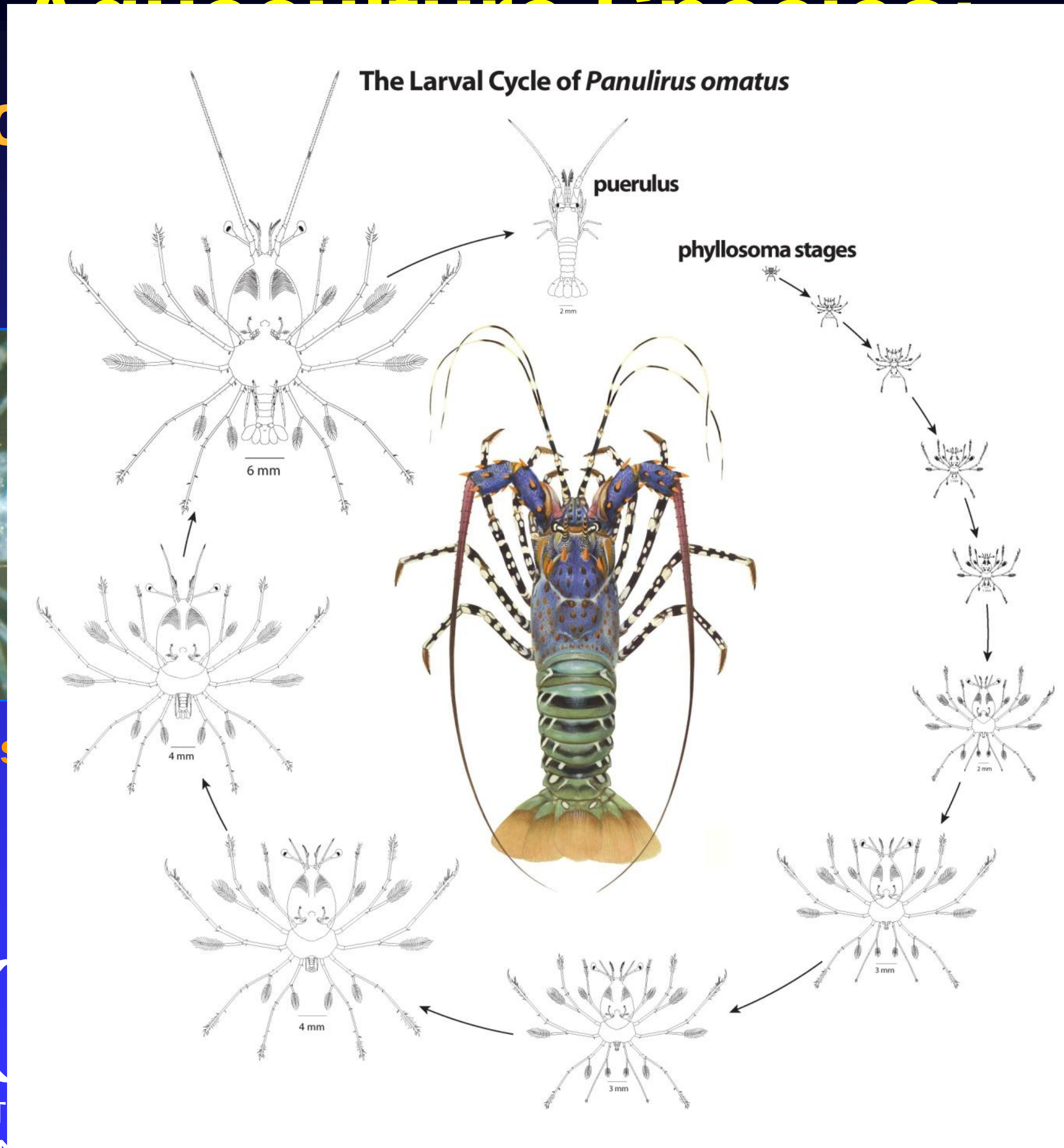
32,000 species of fish globally, <10 domesticated

New

Tropic



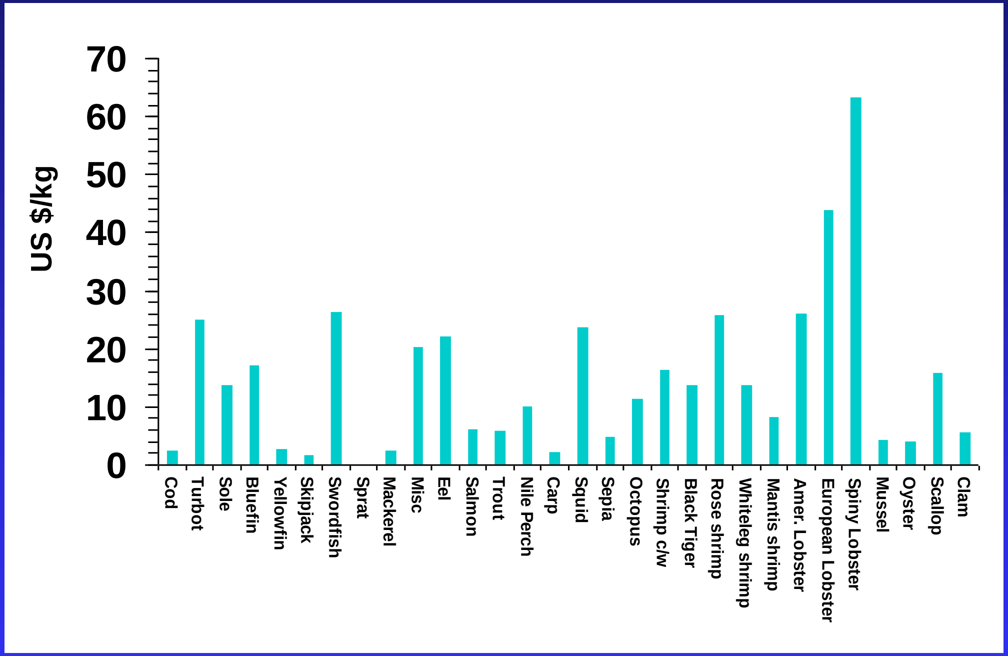
4-6 months



ears

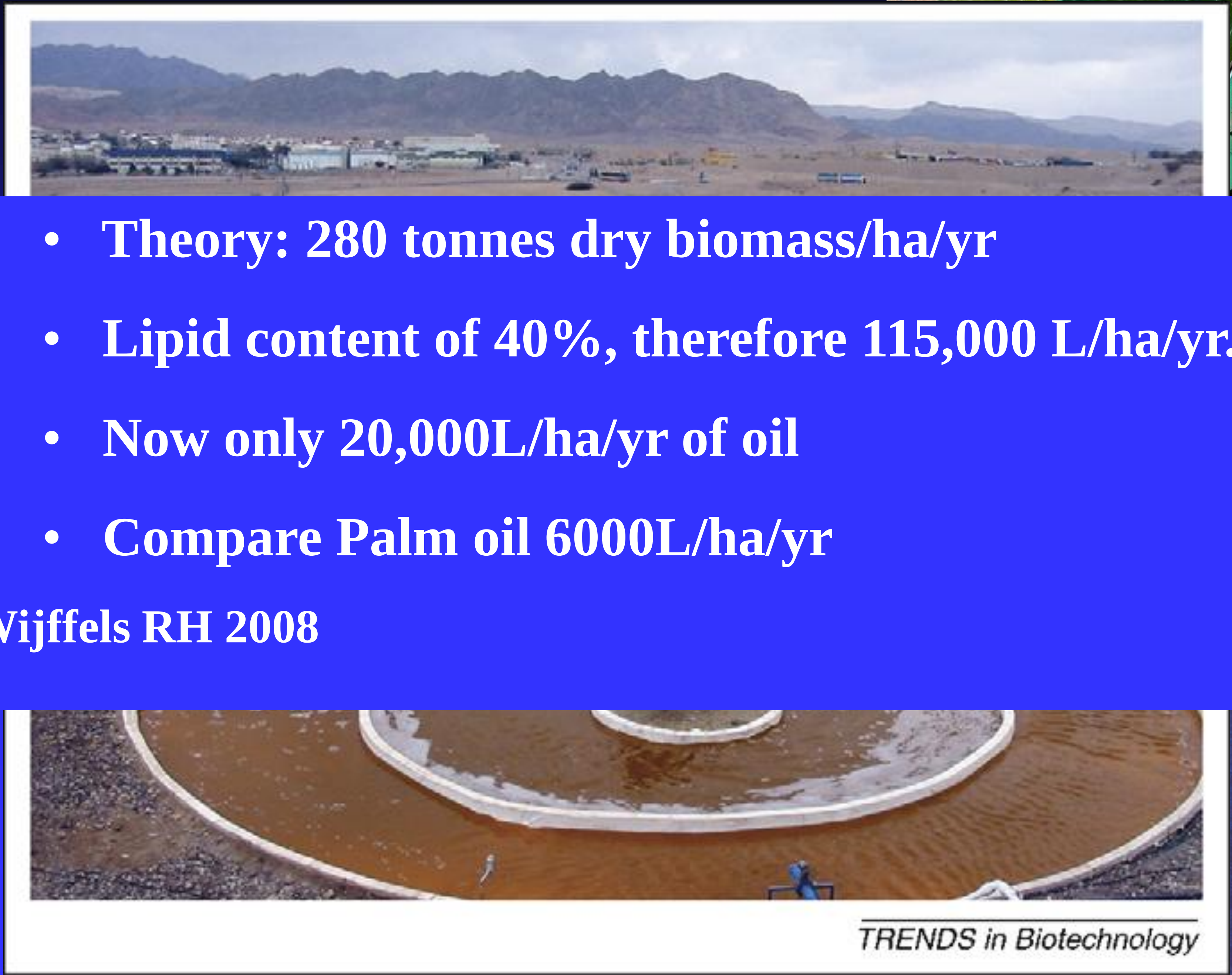
AUSTRALIAN INST
OF MARINE SCIEN

Possible new targets:
High value, ‘domesticatable’, fast economic growout



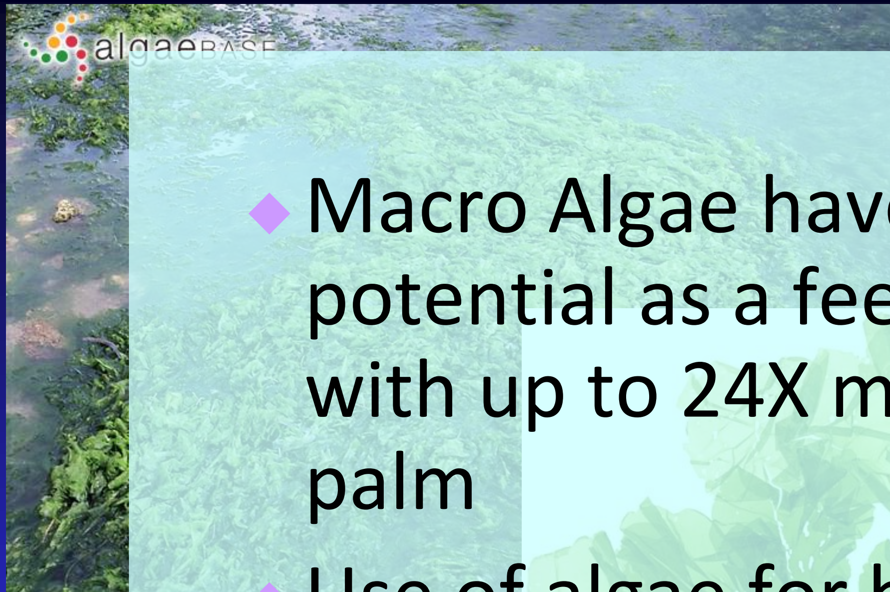
Sustainable Fuel Aquaculture

Future: Marine Biofuels

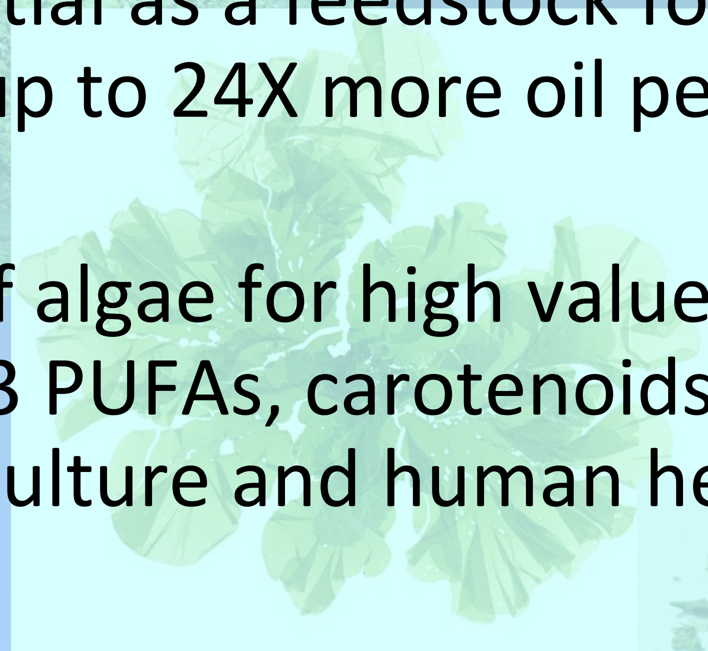


- Theory: 280 tonnes dry biomass/ha/yr
- Lipid content of 40%, therefore 115,000 L/ha/yr.
- Now only 20,000L/ha/yr of oil
- Compare Palm oil 6000L/ha/yr

Wijffels RH 2008

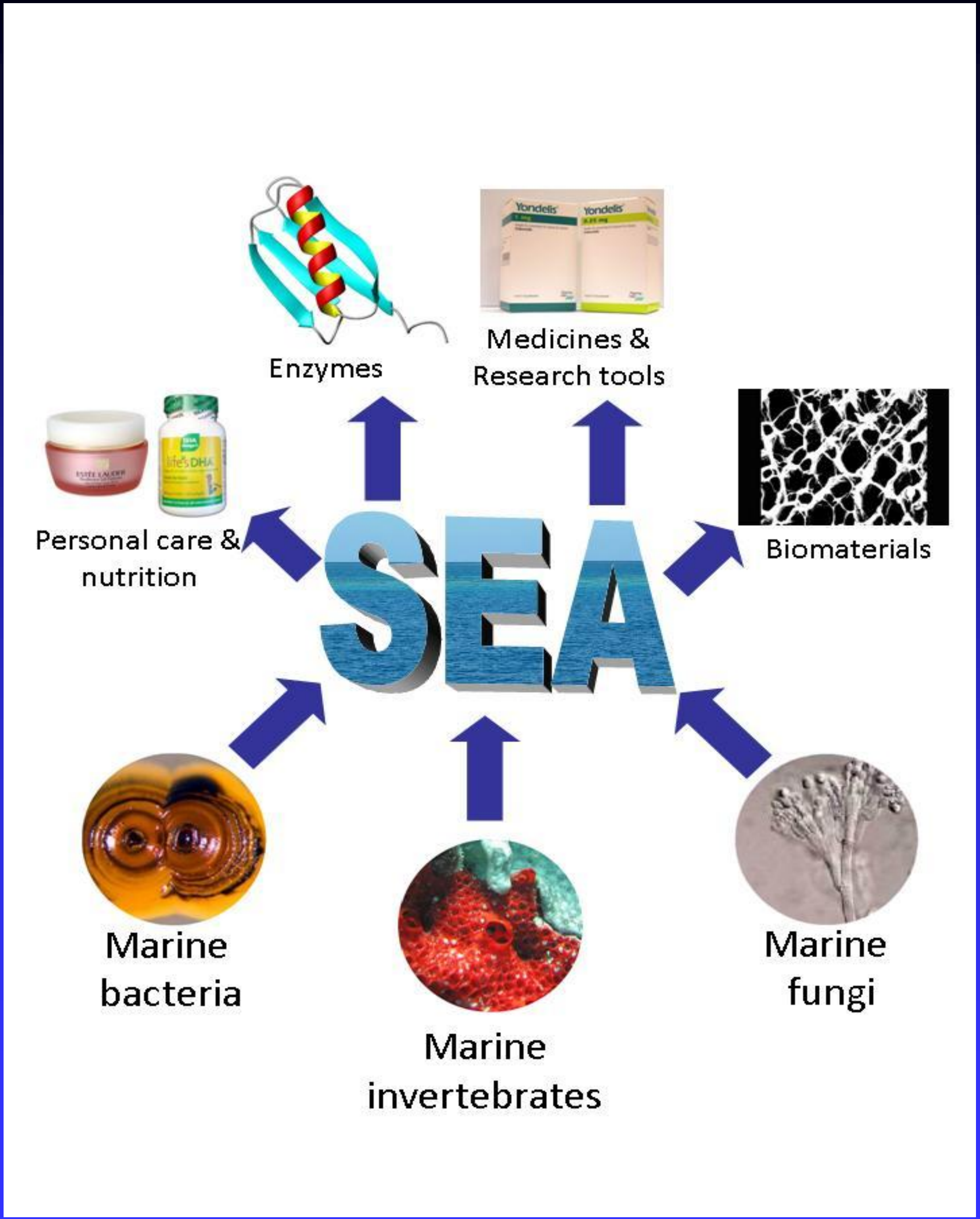


- Macro Algae have the highest potential as a feedstock for biodiesel with up to 24X more oil per acre than palm
- Use of algae for high value products (eg ω3 PUFAs, carotenoids for aquaculture and human health)



MACRO ALGAE!!

Marine Bioproducts
of the
Future

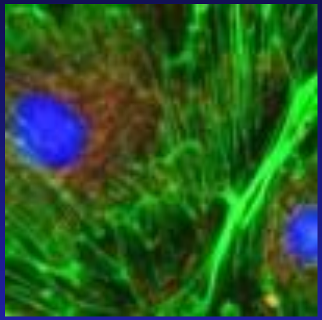

Enzymes
Medicines &
Research tools
Personal care &
nutrition
SEA
Biomaterials
Marine
bacteria
Marine
invertebrates
Marine
fungi

The natural non-drugs

- Functional foods eg fatty acids, carotenoids ($US5b+/yr)
- Food additives eg algal polysaccharides ($US6b+/yr)
- Cosmetic ingredients eg anti-inflamatory, sunscreens ($US 7b+/yr)

- Research tools and lab reagents
- REGULATORY HURDLES ARE LOWER (cf drugs)

Research Tools/Lab reagents



Aequorin – a bioluminescent dye from jelly fish *Aequora victoria*.
SigmaAldrich: 1mg $220

Calyculin A – a polyketide from sponge *Discodermia*.

Used as molecular probe (selective inhibitor of protein phosphatase 1)

SigmaAldrich: 10ug $259

Agriculture Applications of Marine Products

International By-Products Conference 187
April 1990, Anchorage, Alaska

Sponge metabolites insecticidal against Lepidopteran pests:

- upto 95% growth inhibition of fifth instar larvae

2246 J. Agric. Food Chem. 2003, 51, 2246–2252
JOURNAL OF AGRICULTURAL AND FOOD CHEMISTRY

Marine Natural Products as Prototype Agrochemical Agents

Jiangnan Peng, Xiaoyu Shen, Khalid A. El Sayed, D. Charles Dunbar, Tony L. Perry, Scott P. Wilkins, and Mark T. Hamann*
Department of Pharmacognosy and National Center for the Development of Natural Products, School of Pharmacy, The University of Mississippi, University, Mississippi 38677
Steve Bobzin, Joseph Huesing, and Robin Camp
Monsanto Company, 700 Chesterfield North Parkway, St. Louis, Missouri 63198

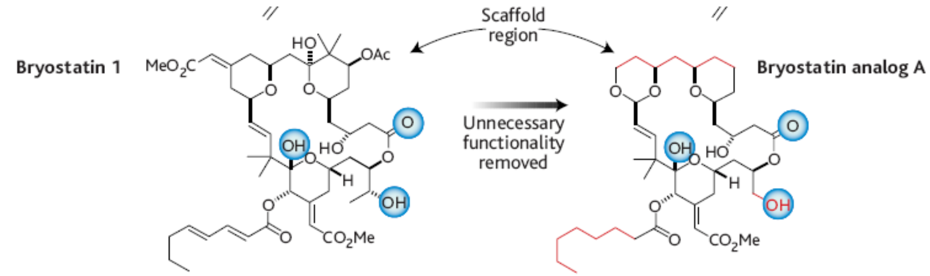
Marine Natural Products with herbicidal and fungicidal activities:

- Novel chemistry
- Biodegradable
- No resistance to marine compounds

10.1021/jf0207880 CCC: $25.00 © 2003 American Chemical Society
Published on Web 03/05/2003

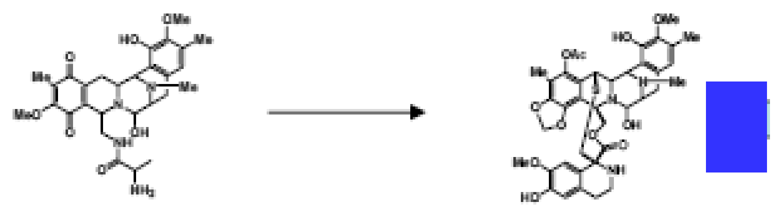
Marine Biotechnology:
Agricultural and Industrial Applications

Aquaculture of drug leads

Taken from Paterson and Anderson, Science 21 October 2005

Bryostatin Analogue A
Total Synthesis

Safracin B, produced by Pseudomonas fluorescens

ET-743 (Yondelis)

Phar ma Mar
Soft Tissue Carcinoma active
Licensed Europe, September 2007

Yondelis (ET-743)
Hemi-Synthesis

Total world seaweed production 8.5 million tonnes

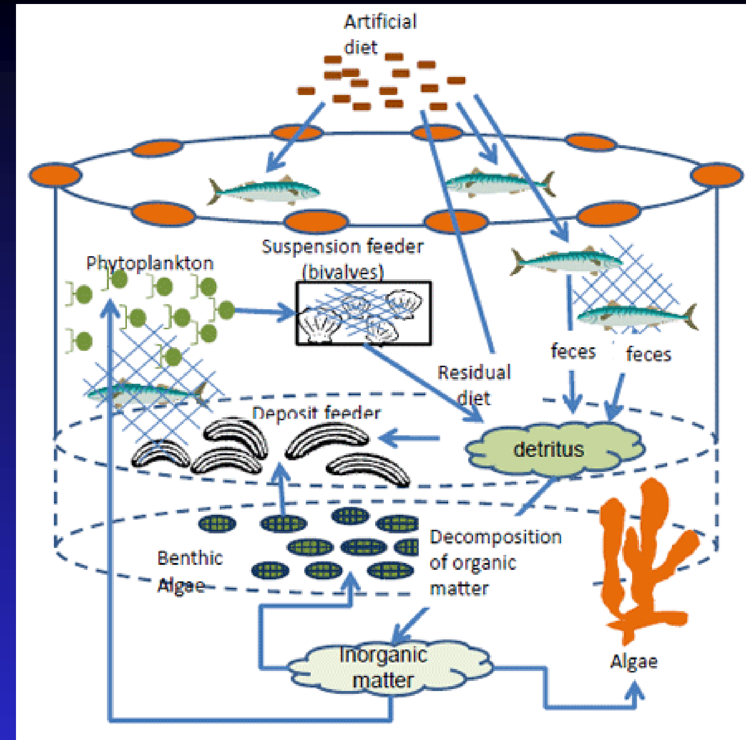
Sea Weed Industry uses 7.5-8 mill mt of wet sea weed /yr ($US5-6b FAO 2004).

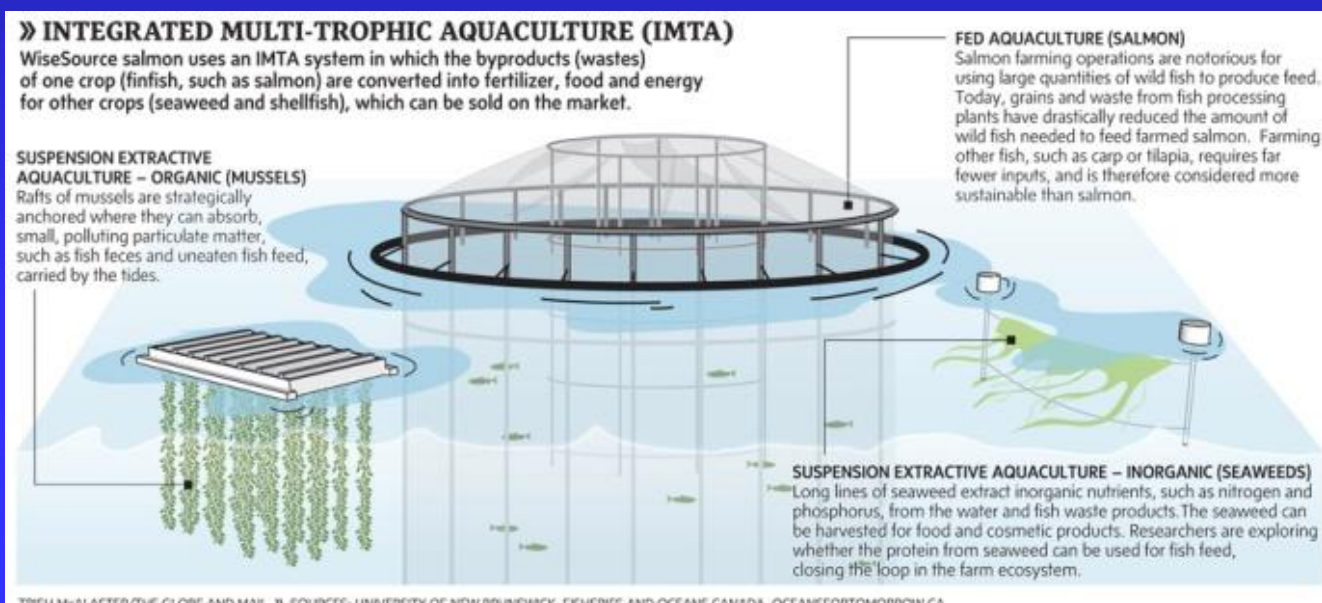
3 Important Phycocolloides:

- **Alginates $US213m/yr, only *Laminaria japonica* grown in China.**
- **Carrageenan production depends on wild *Chondrus crispus*.**
- **Agar-Agar from Gelidium $US132m/yr.**

PLATE 45. *Cystophora distenta* (p.123) with detached, fertile portion (above); *C. congesta* (p.123) — a small plant; *C. scalaris* (p.123) — basal portion of a larger plant.

Integrated Multi-Trophic Aquaculture (IMTA)

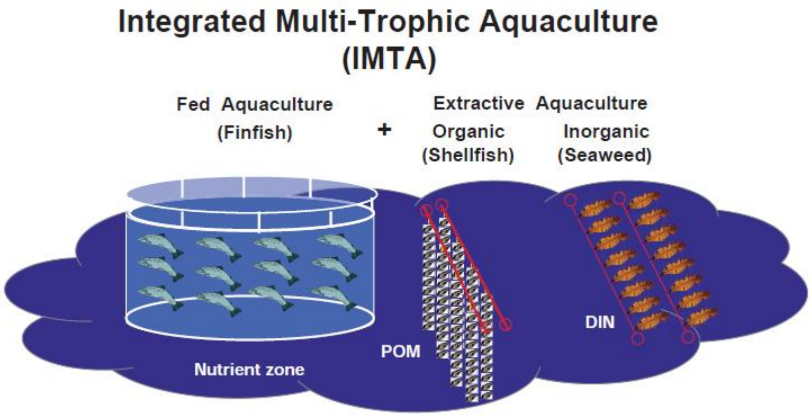




Bay of Fundy IMTA

FIGURE 1
Salmon (left), mussels (right foreground) and seaweeds (right background) integrated multi-trophic aquaculture (IMTA) in the Bay of Fundy, Canada

FIGURE 2
Conceptual diagram of an integrated multi-trophic aquaculture (IMTA) operation combining fed aquaculture (finfish) with organic extractive aquaculture (shellfish), taking advantage of the enrichment in particulate organic matter (POM), and inorganic extractive aquaculture (seaweeds), taking advantage of the enrichment in dissolved inorganic nutrients (DIN)



Source: Chopin (2006).

Benefits:

- Enhanced growth of all species
- Lower Environmental Impact
- Better use of 'sunk' costs
- Diversity of Industry Targets
- Diversity of Value add potential

Risks:

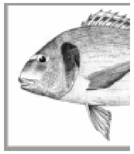
- Introduction of fouling species
- Parasite/pathogen cross contamination

Integrated aquaculture

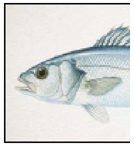
Selecting the

nation

Species selection criteria for tank cultivation



Seabream (S



Seabass (*Dicent*

Wate

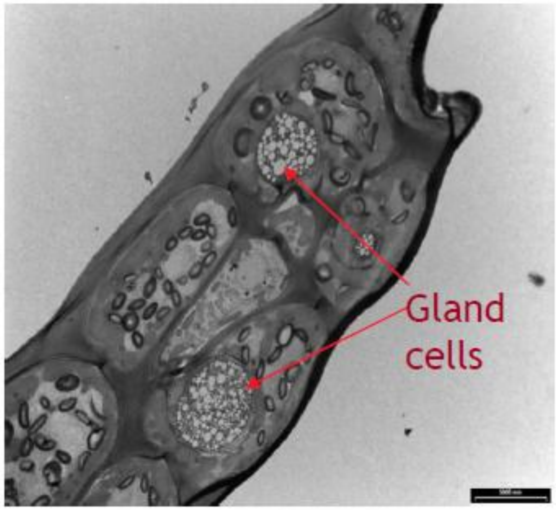
Leon

- High rat
- Low sus
- Morphol
- **High v**

establis

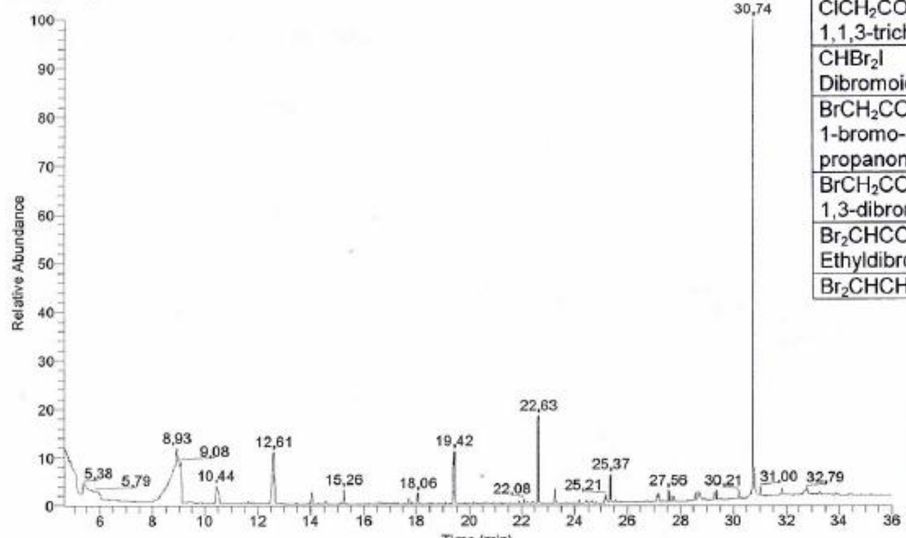
Aspar

Halogenated compounds



Extracto CH_2Cl_2 FALK 1 (21/01/2005)

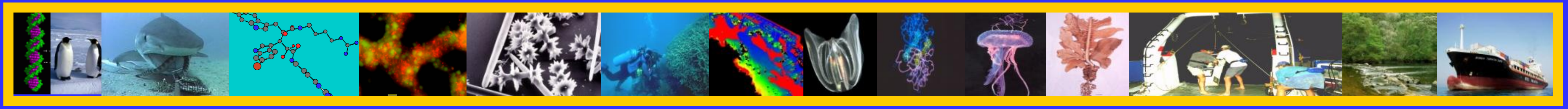
RT: 4,60 - 36,00



Composés	Temps de Rétention en mn	Indice de similitude
CH_2BrCl Bromochlorométhane	3 : 13	680
$BrCH_2CHO$ 2-bromoéthanal	4 : 62	-
CH_2ICl Chloroiodométhane	6 : 56	-
$BrCH_2COCH_3$ 1-bromo-propanone	10 : 26	802
Br_2CHCHO 2,2-dibromoéthanal	12 : 42	-
Br_3CH Bromoforme	15 :15	677
$Br_2CHCOCH_3$ 1,1-dibromo-propanone	15 : 66	-
$ClCH_2COCHCl_2$ 1,1,3-trichloro-2-propanone	17 : 19	558
$CHBr_2I$ Dibromoiodométhane	18 : 79	-
$BrCH_2COCHCl_2$ 1-bromo-3,3-dichloro-2-propanone	18 : 90	-
$BrCH_2COCH_2Br$ 1,3-dibromo-2- propanone	19 : 02	559
$Br_2CHCOOC_2H_5$ Ethyldibromoacétate	19 : 18	407
$Br_2CHCH(OH)CHBr_2$	26 : 53	-

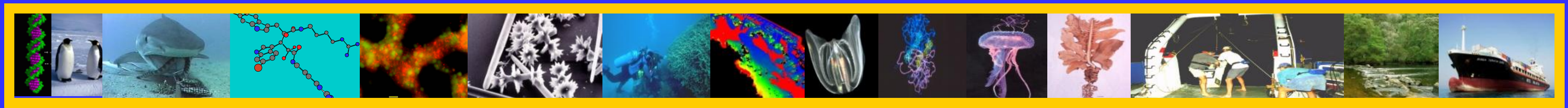
- More than 100 halogenated compunds were identified for *Asparagopsis*

Thank you

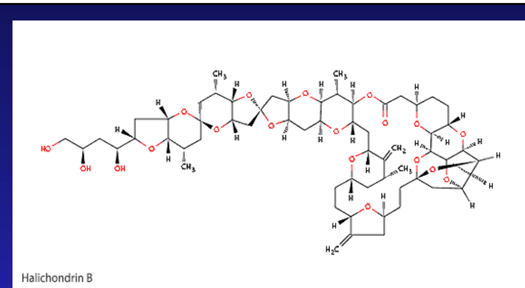


Acknowledgments

- Bay of Plenty Regional Council
- Priority One
- Tauranga Port Authority
- Bay of Plenty Polytechnic
- Awanuiarangi



Relative Economics



	Harvest	In Sea	exSitu	Synth
Avarol	$.30/mg	$.45/mg	$.60/mg	$.50/mg*
Hali B#	No	$100/mg	$300/mg	$1,000+/mg
Hali B spiked (100x)		$1/mg		

(Sipkema et al 2005, Battershill and Page 1996, Munro et al 1998)

- Estimated
- # 80 farms natural yield, 8 farms enhanced yield (10 longlines/farm inside existing!)