Universidad De Los Lagos

i~mar MASH CeBiB Centre for Biotechnology and Bioengineering

Development of marine agronomy in Chile: research developments and policy actions towards increasing production, diversification, and value-adding

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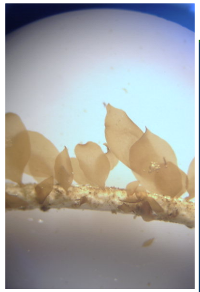
3rd International Seaweed Conference USA
Seagriculture
11 - 12 SEPTEMBER 2024
KETCHIKAN (ALASKA), USA

AIMS



Seaweed Global Development and their Challenges

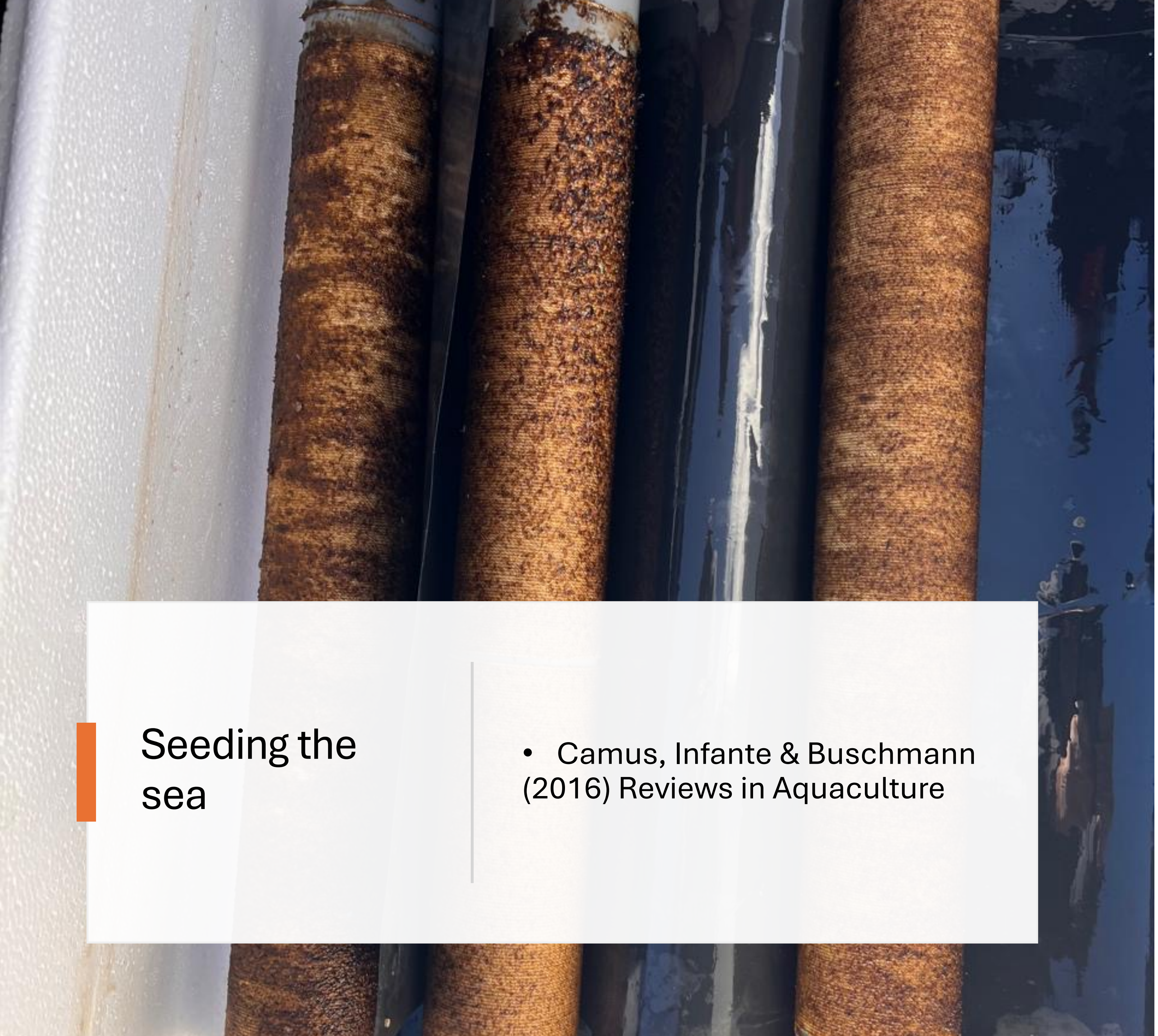
Biological Challenges

Value Added: Potential Products

Conclusions

Hatchery: Kelp seedling production

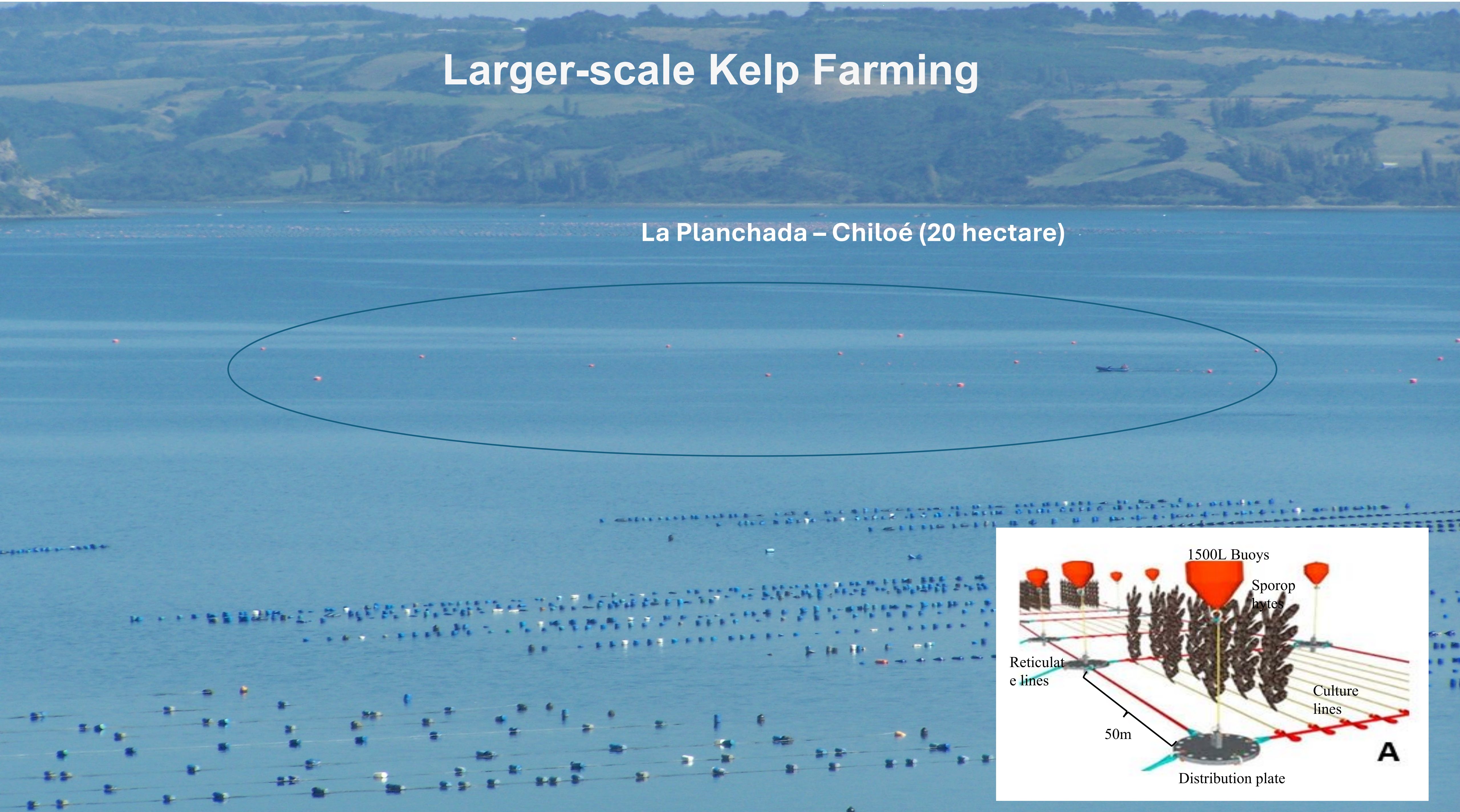
Camus & Buschmann 2017. Aquaculture



Seeding the sea

- Camus, Infante & Buschmann (2016) Reviews in Aquaculture

Larger-scale Kelp Farming



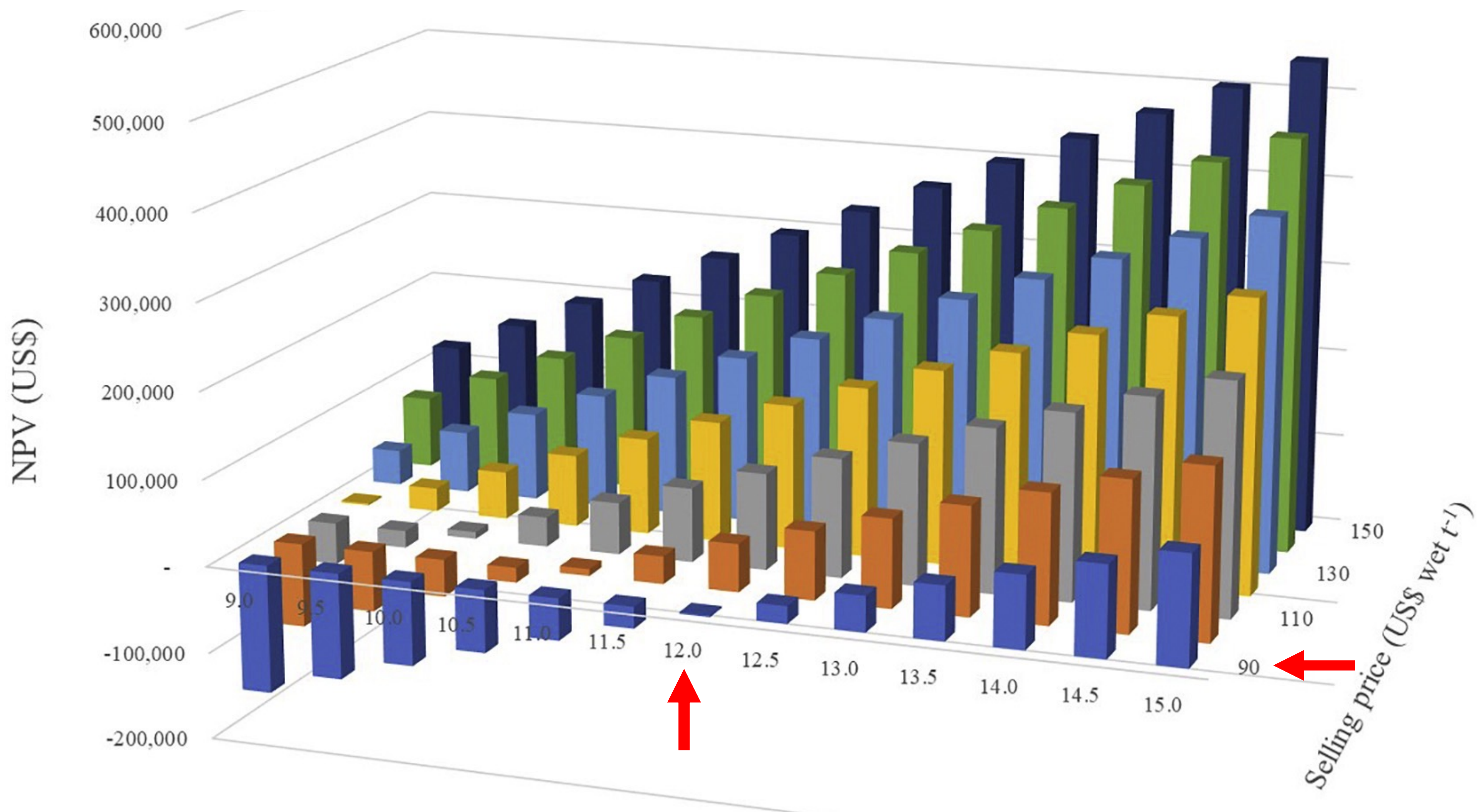
La Planchada – Chiloé (20 hectare)

Camus et al. Reviews in Aquaculture (2016)

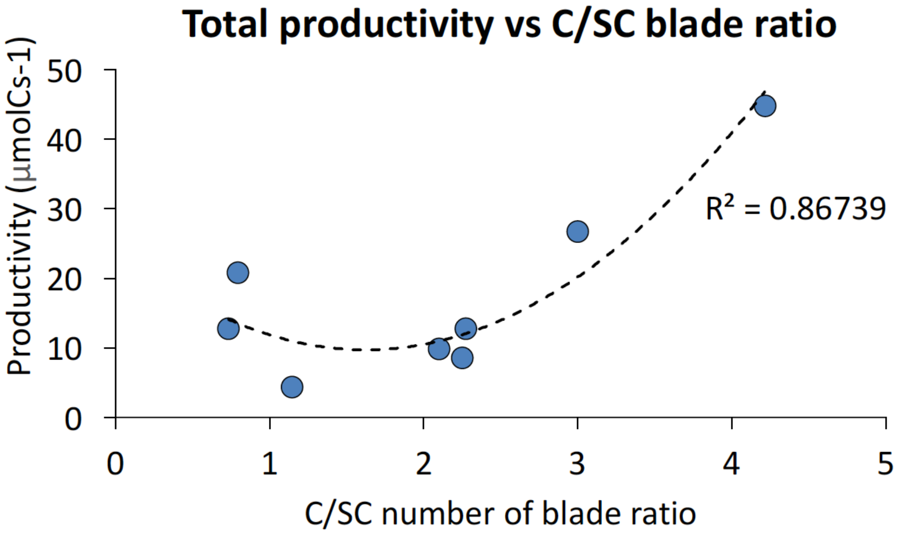
Yield

Economics

Productivity & Biomass Value



Ecophysiological understanding towards improving biomass yield



Measuring productivity by IRGA:

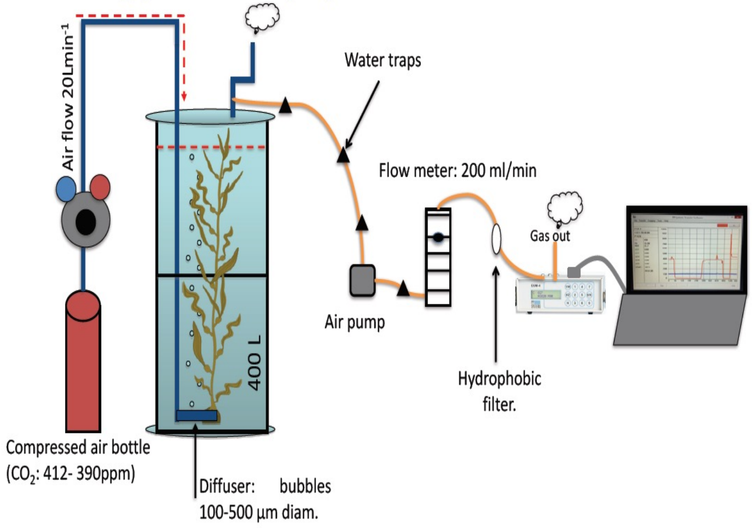


Figure 4: scheme of IRGA experiment set up. With a hole algae.

Measuring productivity through PAM:

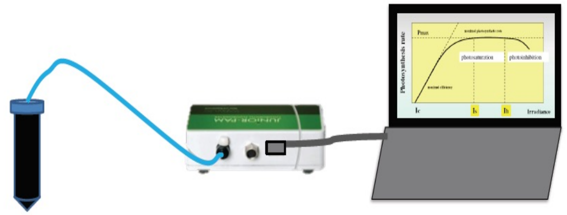


Figure 5: scheme of PAM experiment set up. Prepared for Rapid Light Curves (ETR vs Irradiance).

Breeding

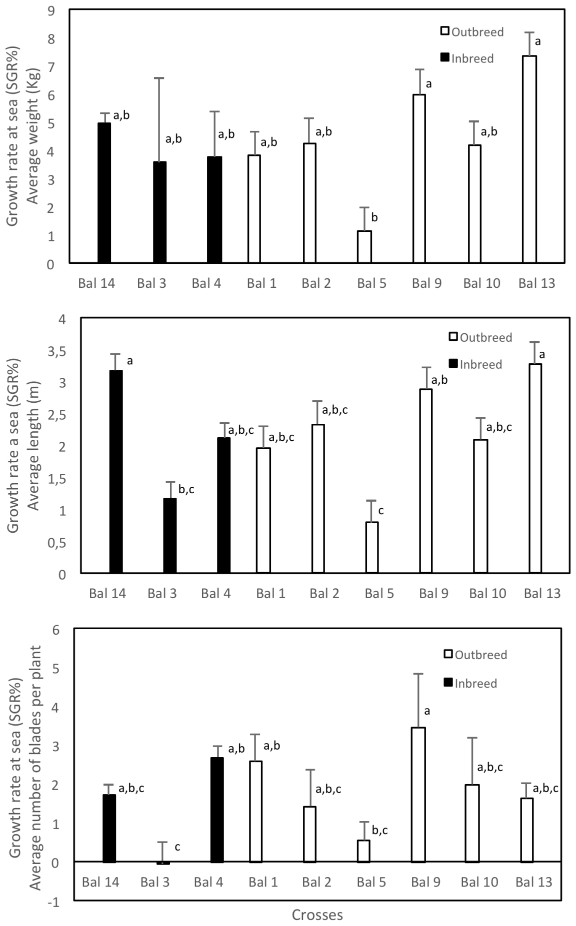


Figure 2

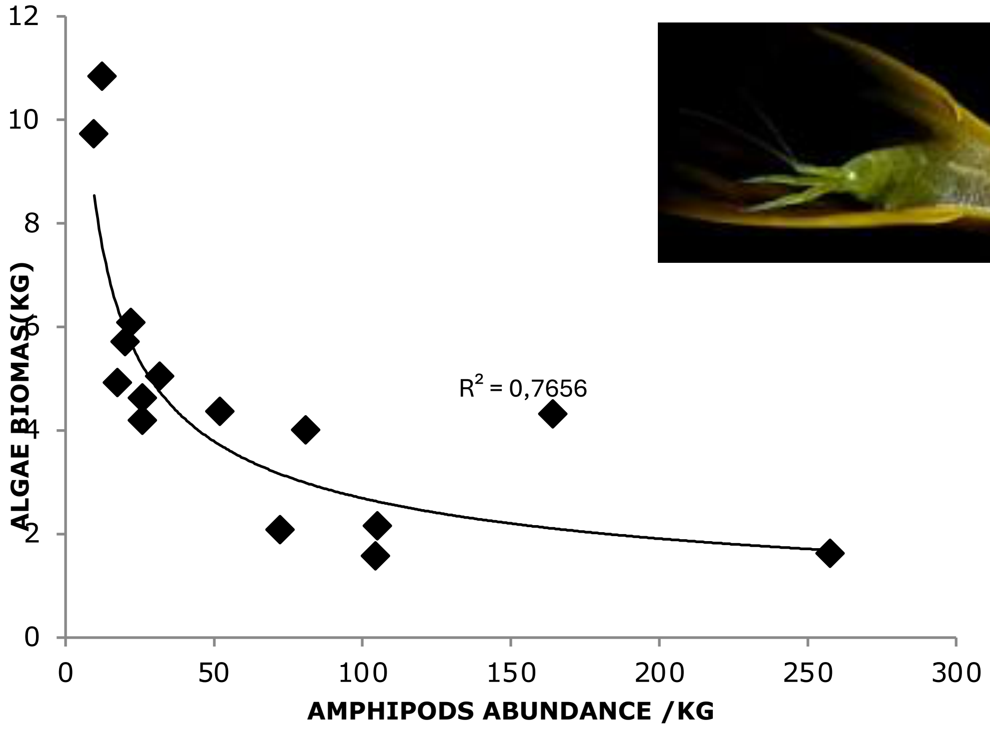
Chemical Composition

Strains	Bal 1	Bal 2	Bal 3*	Bal 4	Bal 5	Bal 11	Bal 14	Bal 16	Bal 17
Carbohydrates (%DW)									
Alginate	33,0 ± 1,2[a]	31,4 ± 14,3 [a]		27,1 ± 9,2 [a,b]	20,0 ± 1,5 [a,b]	9,9 ± 5,2 [b]	10,7 ± 1,4 [b]	11,3 ± 3,3 [b]	14,6 ± 5,5 [a,b]
Mannitol	3,4 ± 0,8 [a,b]	2,6 ± 3,1 [a,b]		7,7 ± 3,1 [a]	3,1 ± 2,6 [a,b]	0,2 ± 0,3 [b]	0,4 ± 0,5 [b]	5,4 ± 1,6 [a,b]	1,0 ± 0,2 [b]
Glucans	4,1 ± 0,3 [a]	4,4 ± 0,7 [a]		3,9 ± 0,2 [a]	4,1 ± 0,1 [a]	1,9 ± 1,6 [b]	2,8 ± 0,3 [a,b]	2,9 ± 0,3 [a,b]	3,2 ± 0,1 [a,b]

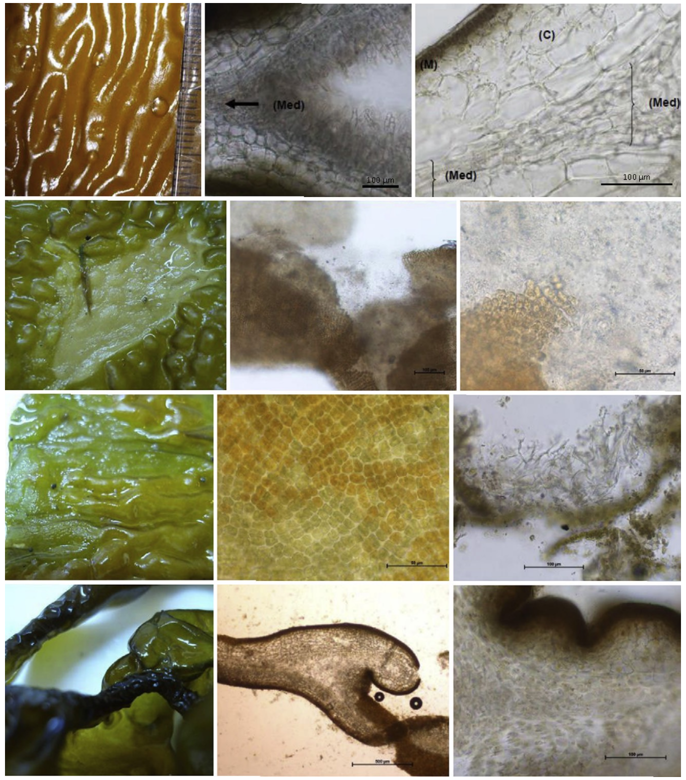
Camus, Faugeron & Buschmann (2017). Algal Research

Two Critical Points

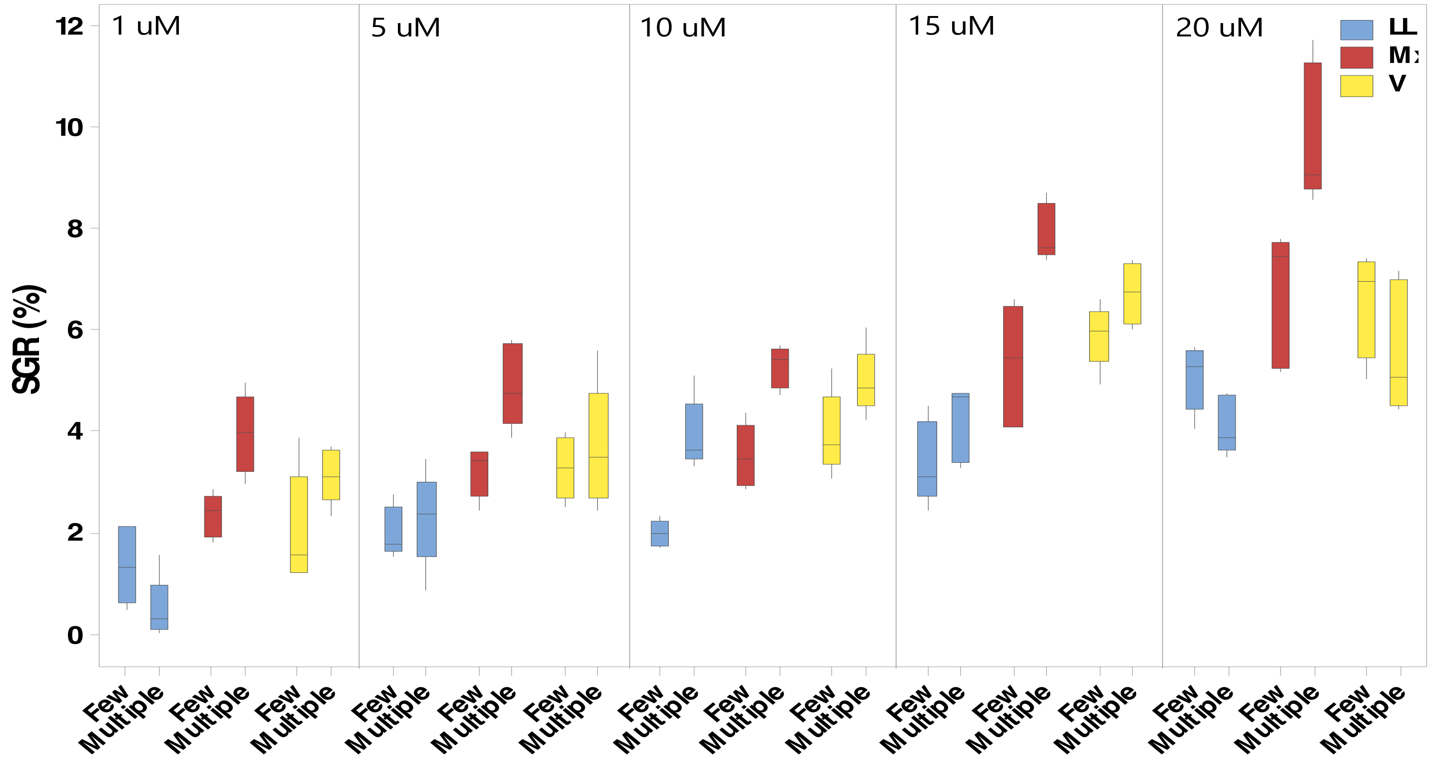
Grazing



Diseases



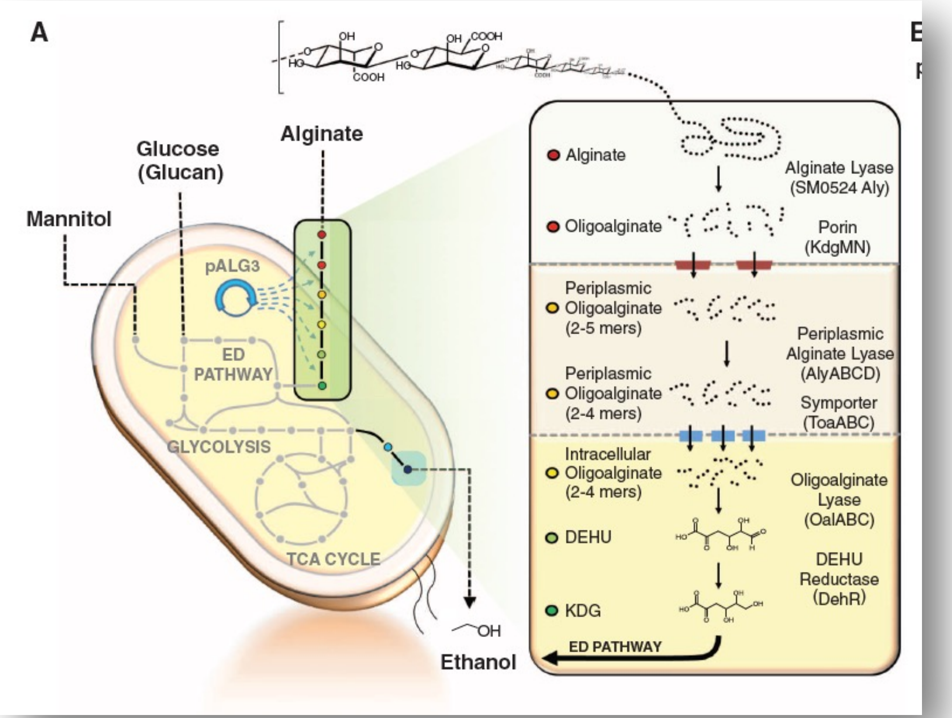
Stress Management



Source	DF	Adj SS	Adj MS	F-Value	P-Value
NO_3* Population* morphotype	8	18,423	2,3028	3,45	0,001

Searching for adding value to kelp biomass

Biorefinary-Bioethanol



In the Field

Biofpr
Biofuels Bioproducts & Biorefining

Scaling up bioethanol production from the farmed brown macroalga *Macrocystis pyrifera* in Chile

Table 2. Biomass growth rates, sugar to biomass yields and sugar to ethanol yields at different alginate:mannitol ratios.

Alginate:mannitol ratio	Growth rate [liter $hour^{-1}$]	Biomass yield [g biomass g^{-1} substrate]	Ethanol yield after 12 h [g ethanol g^{-1} substrate]	Ethanol yield after 48 h [g ethanol g^{-1} substrate]
Pure alginate	0.099 ± 0.068[a]	0.008 ± 0.003[d]	0.000[g]	0.000[i]
10:3	0.478 ± 0.035[b]	0.067 ± 0.008[e]	0.102 ± 0.022[h]	0.146 ± 0.043[j]
8:5	0.527 ± 0.036[b]	0.061 ± 0.008[e]	0.086 ± 0.022[h]	0.173 ± 0.049[j]
5:8	0.480 ± 0.041[b]	0.072 ± 0.009[e]	0.042 ± 0.007[h]	0.304 ± 0.023[k]
3:10	0.470 ± 0.033[b]	0.077 ± 0.006[e]	0.064 ± 0.024[h]	0.177 ± 0.012[j]
Pure mannitol	0.325 ± 0.032[c]	0.041 ± 0.011[f]	0.000[g]	0.000[i]

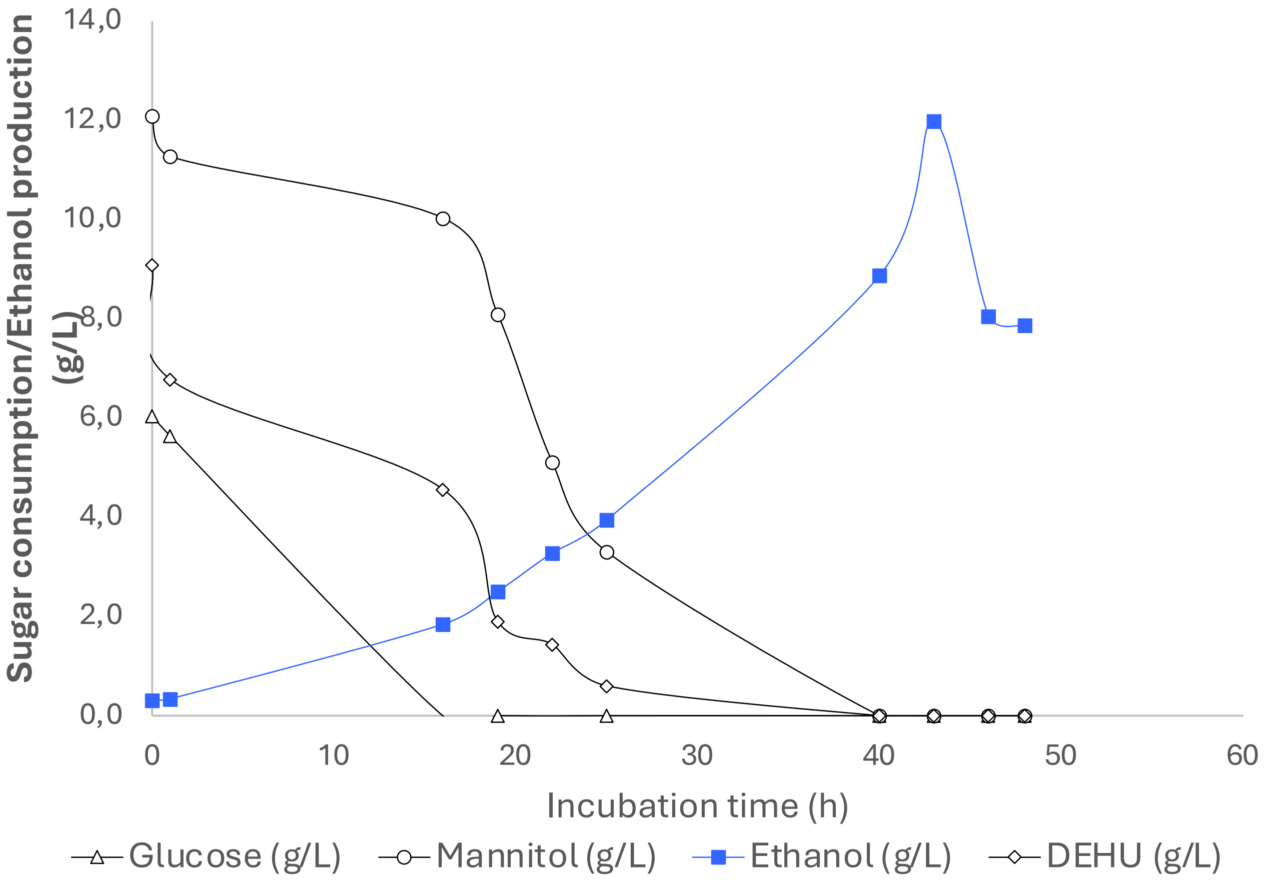
Superindex letters denote statistically different groups.

Camus et al. (2016) *Biofuels, Bioprod. Bioref.* Vol. 10

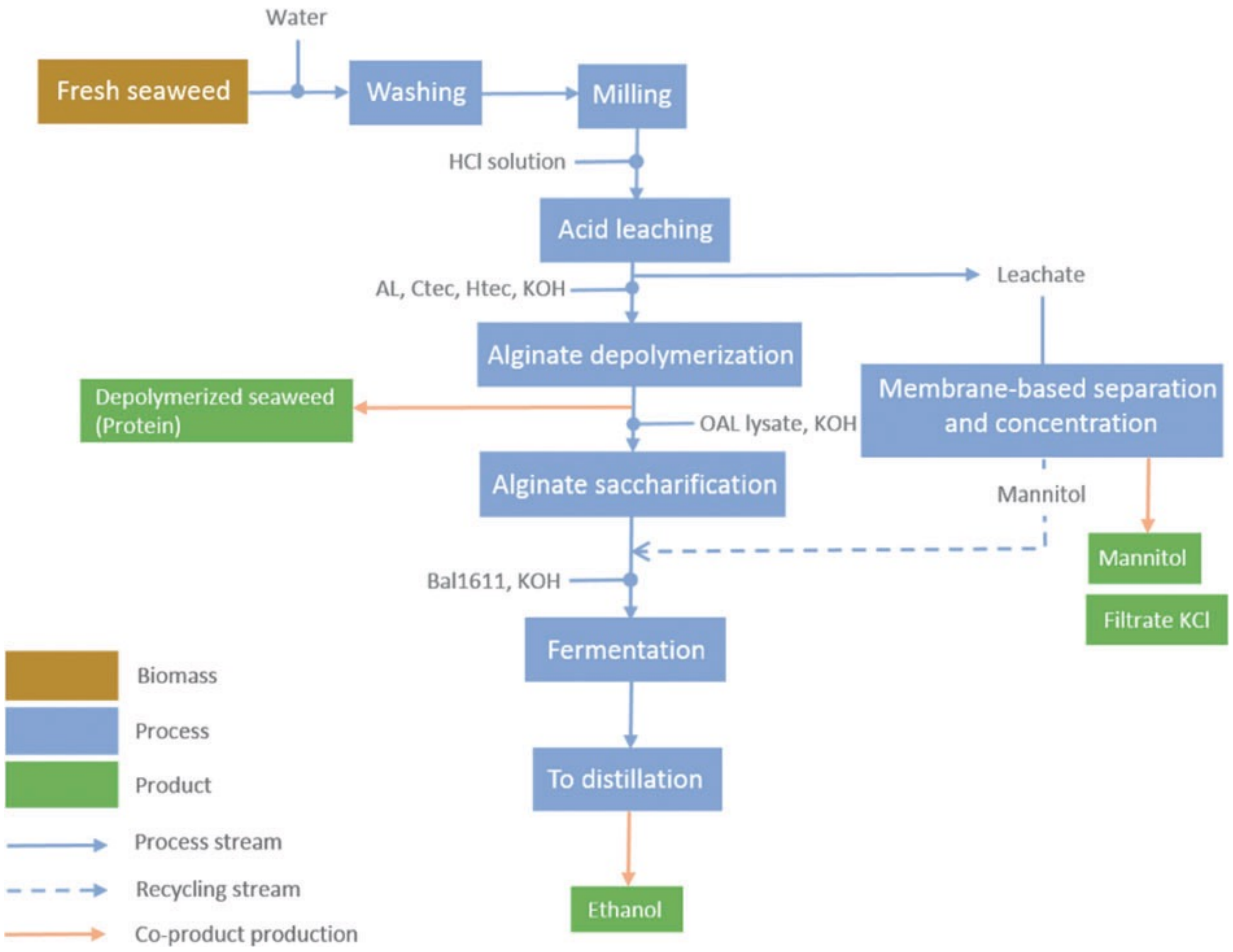
Bioethanol Yield

183L fermented liquid (12 gEtOH/L)

232 L EtOH/ton kelp (dry)
30 ton kelp (dry)/ha
7.000 L EtOH/há



DEVELOPMENT OF A BIOREFINARY CONCEPT

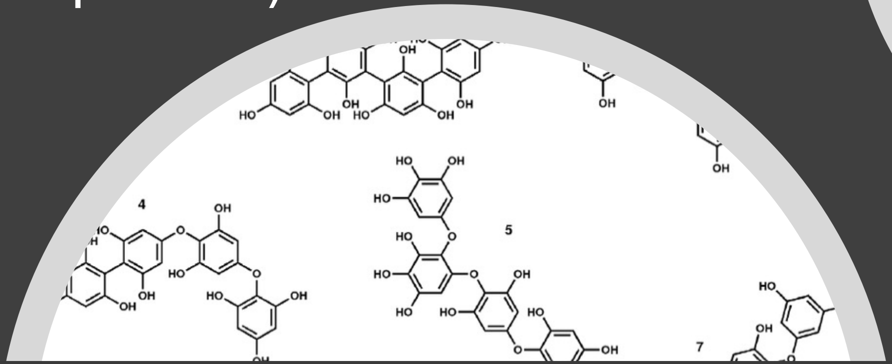


- ETHANOL
- MANNITOL
- MINERALS
- PROTEIN

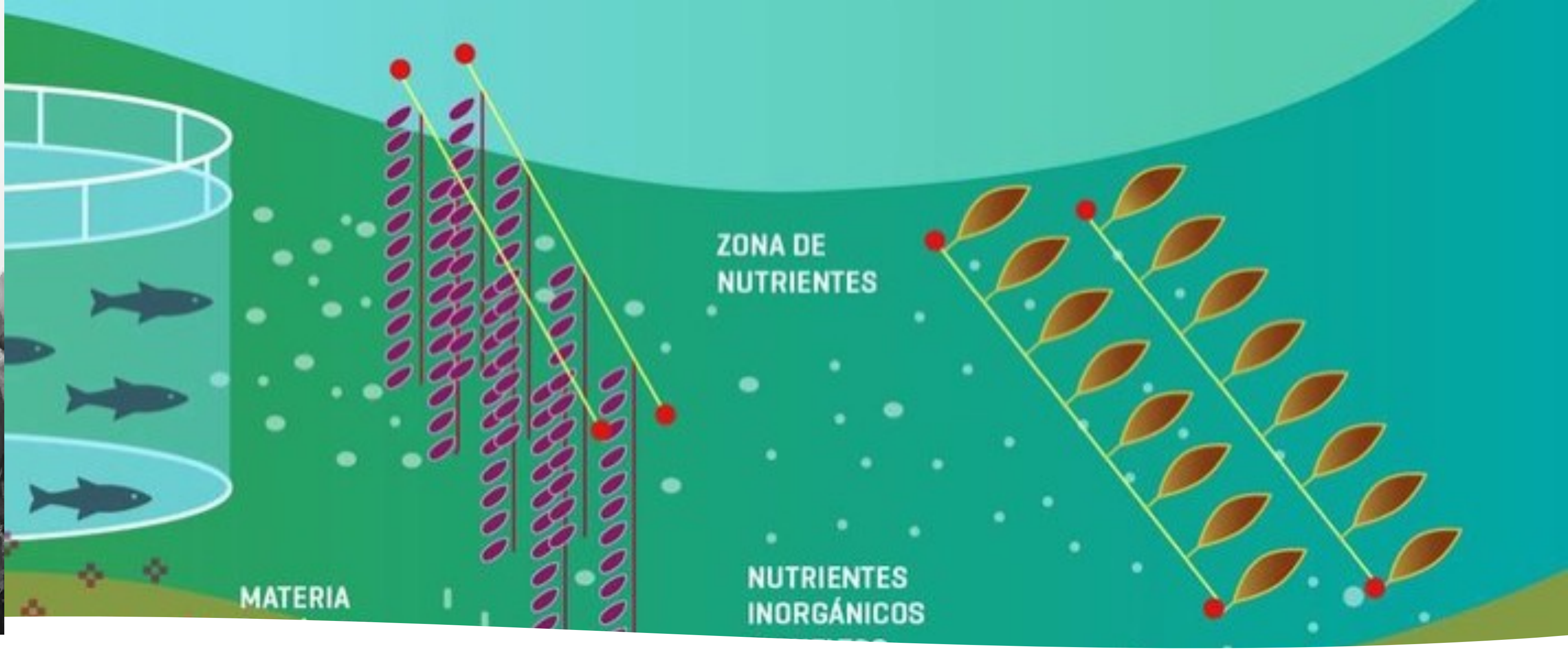
Camus et al. (2016 *Biofuels, Bioprod. Bioref.*

Other Uses

- Food
- Feed
- Plant Growth Promotors
- Valuable Chemicals (Phlorotannins)
- Biofabric (Kelp bioconversion into mycoprotein)



e.g., Gutierrez et al. 2006, JAPH - Leyton et. al. 2016, Algal Research - Sankaranarayanan, et al. (2019). J. Chem. Technol. Biotech. – Landaeta et al. 2024. Foods



- IMTA -
Internalization of Environmental Benefits

- Chopin et al. 2001. J.Phycol. - Buschmann et al. 2001. Cah. Mar. Biol. - Neori et al. 2003. Aquaculture – Chopin & Tacon 2022. Rev Fish. Sci. & Aquac.

CONCLUSIONS

Kelp farming must:

1. Increase productivity
2. Add value to biomass

To achieve sustainable production goals:

1. Added value and market development
2. Science & Technology: breeding and optimization of culture systems
3. Incorporate an understanding of potential bottlenecks
4. Regulations: biosecurity, environmental impact, ...