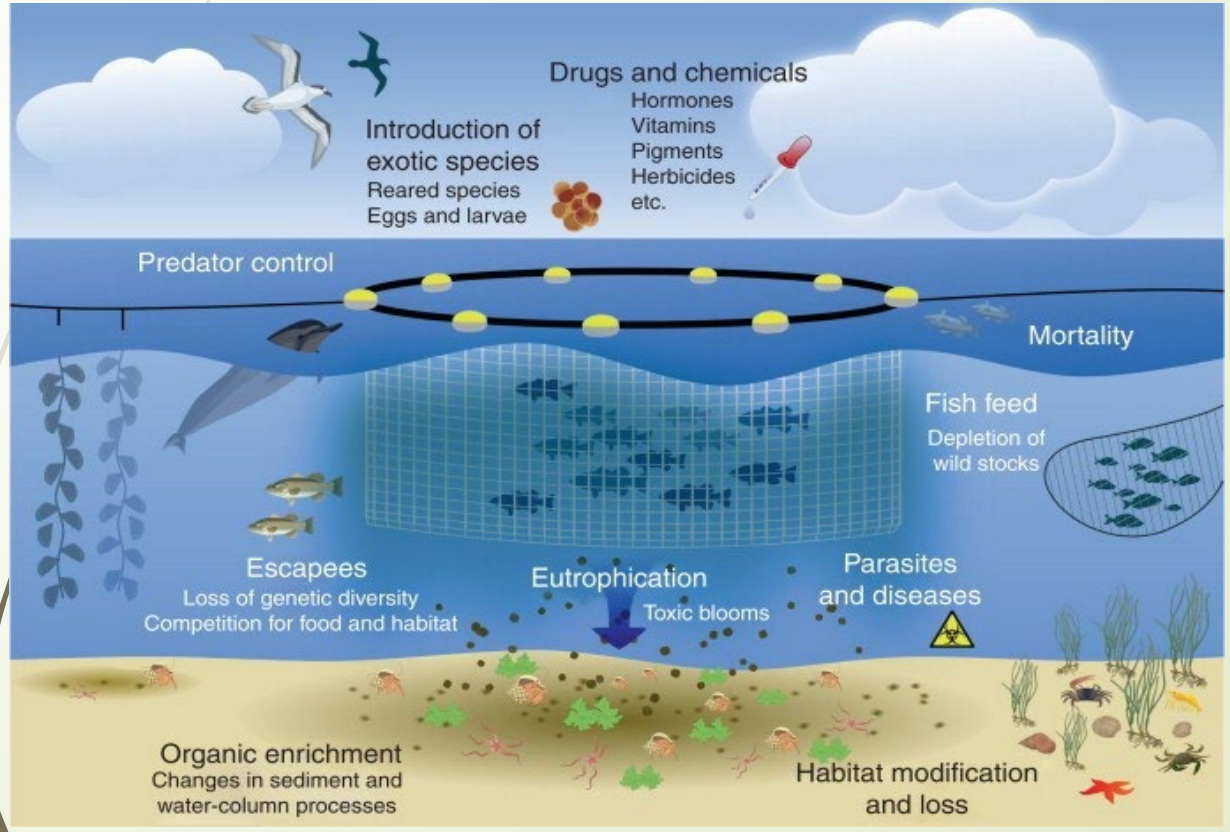
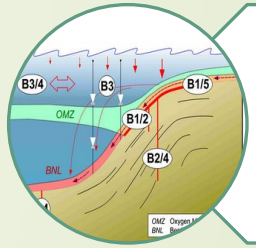
Environmental Improvement Strategies in Aquaculture Production

Manolis Tsapakis , Anastasia Tsiola, Victoria Litsi Mizan, Eugenia Apostolaki

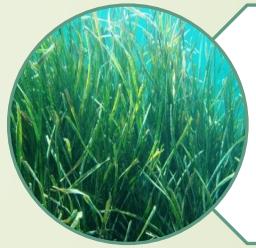
General Concerns

Growth is followed by concerns about environmental and social impacts which include:





Release of effluents into the environment and interference with biogeochemical processes



Effects on species that are considered to be of priority for conservation

Conflicts in coastal zone development plans

Competition for and access to common resources

Point of view

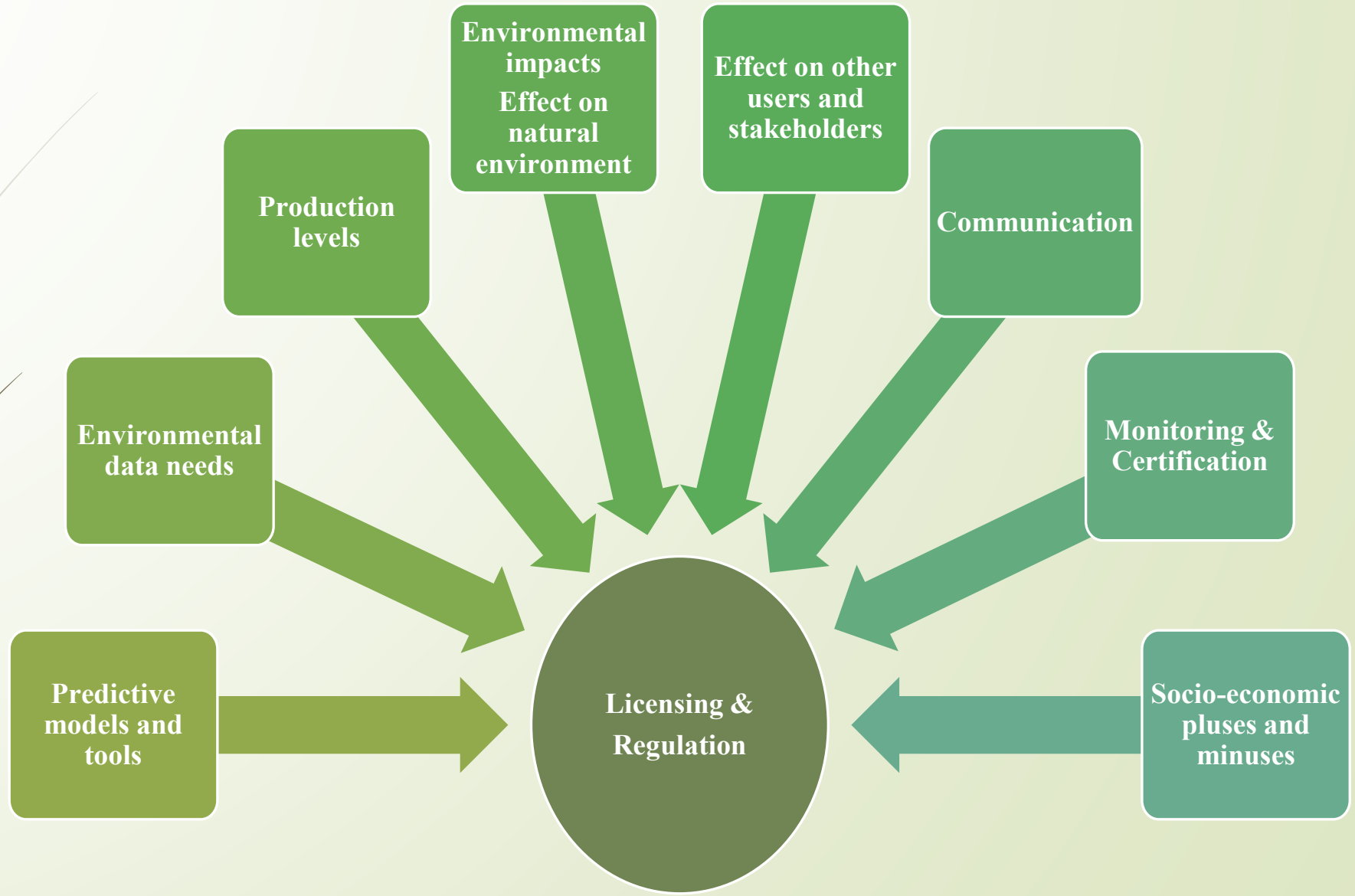
Environmental outlook

- Prediction and evaluation of localized and dispersed effects
- Assessment of mechanisms through which the environment is interacted with the marine aquaculture

Management outlook

- Produce tools for planning and development of aquaculture activities
- Assist with decision on number and size of farms that can be established in a body of water

Requirements for decision making



Improvements that can be implemented in aquaculture sector to reduce environmental footprint

Sustainable feed ingredients

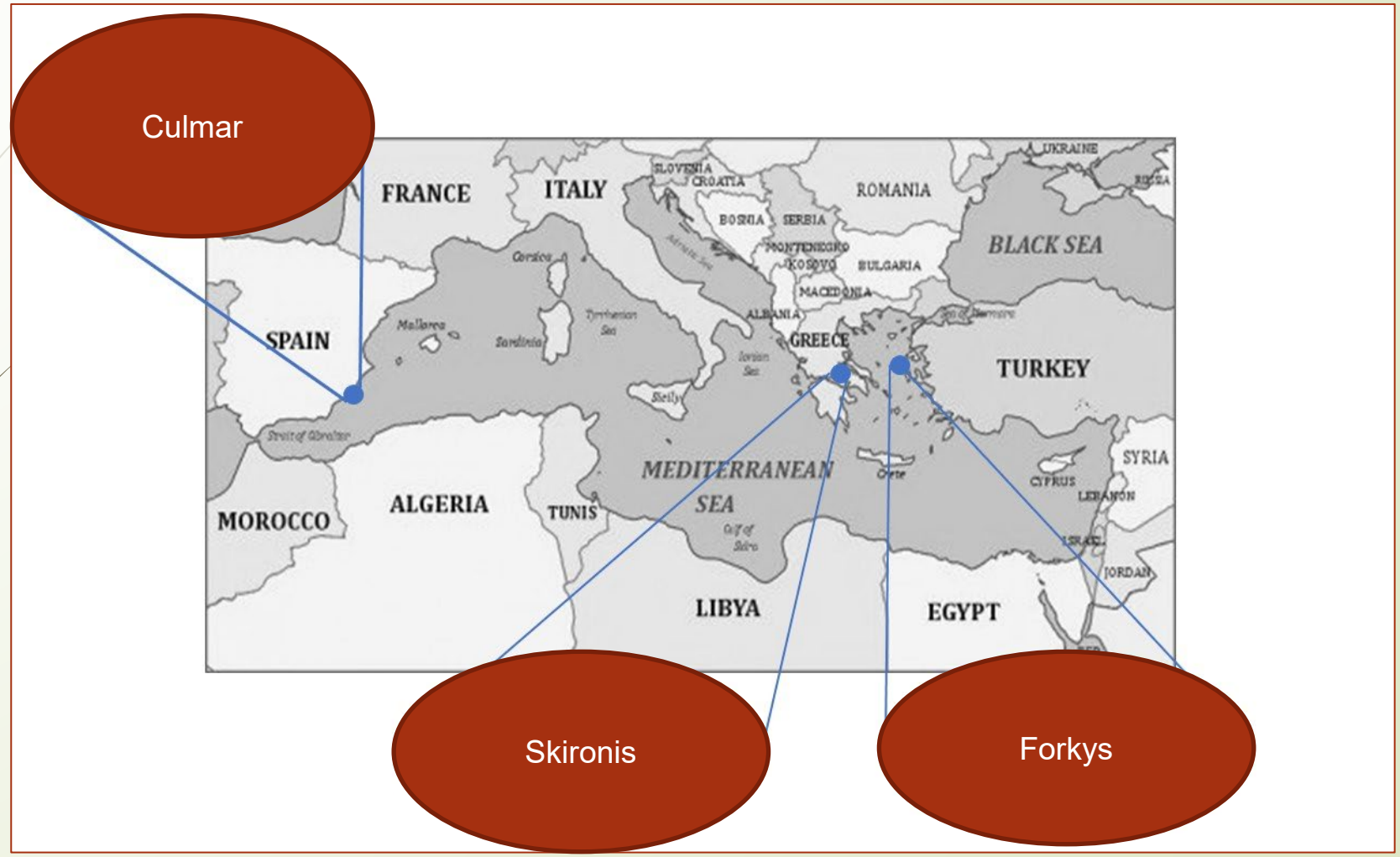
Carrying capacity tools & Site selection approaches

Multitrophic approaches

Novel Management Productions Tools

Genetics tools

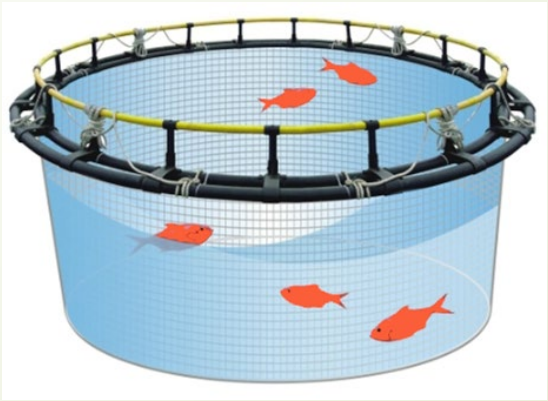
Selected aquaculture facilities where environmental improvements have been examined



Conventional Versus Sustainable feed

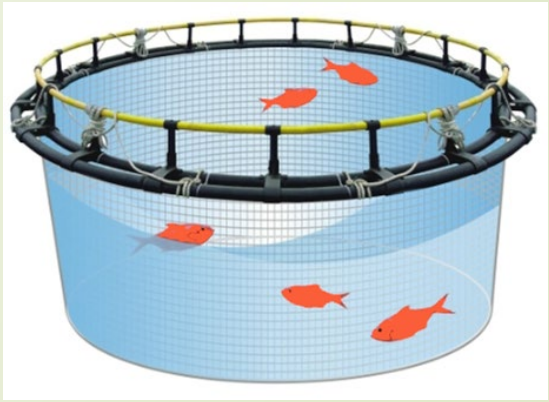
Guardarmar del Segura, Alicante, Spain

Conventional feed



Versus

Sustainable feed



***Aim** : Reduction of discharges to the sea*

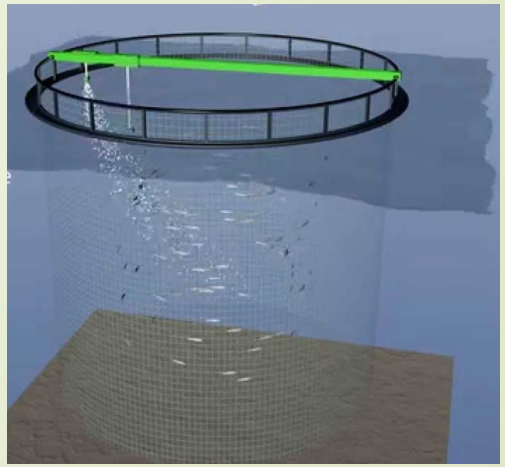
Automatic Vs Handfeeding

Chios, Greece

Manual feeding

Versus

Automatic feeders



Aim: *PEF reduction in different impact categories (e.g acidification, marine eutrophication)*

Sensors and Cameras

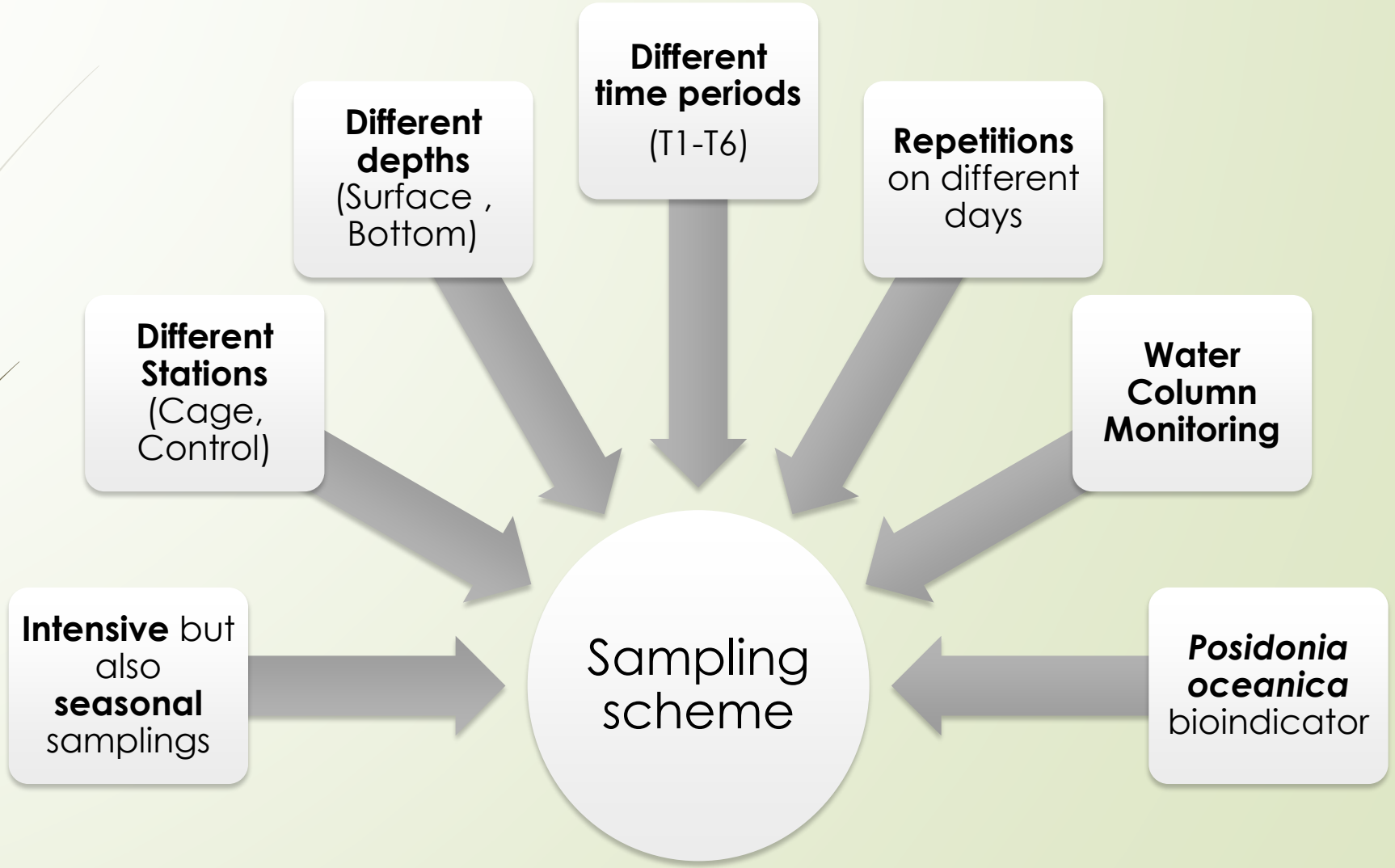
Megara, Greece

SKIRONIS has installed **sensors and cameras** in pilot fish cage aiming to monitor online the behavior of fish. Based on:

- The **observation of uneaten food pellets**
  - The highly accurate monitoring of **fish behavior** (e.g., hunger, anxiety, stop feeding etc.)
- The **high-speed transfer** (5G technology) of the above-mentioned **data** between fish cages and computers that control the feeders

Feeding is accomplished automatically based on real-time data regarding the fish behavior

Field campaigns



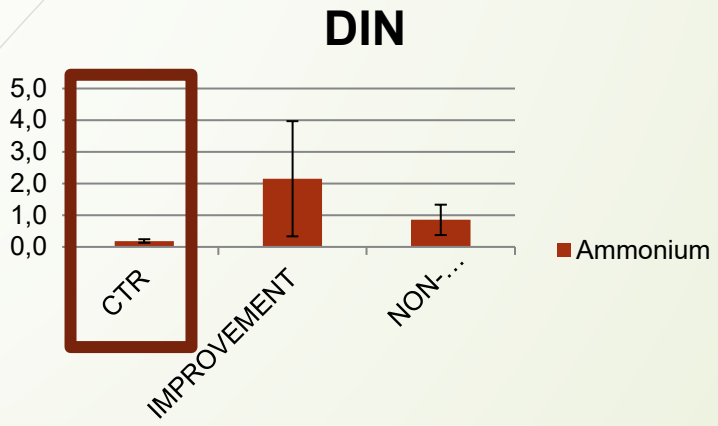
Field campaigns

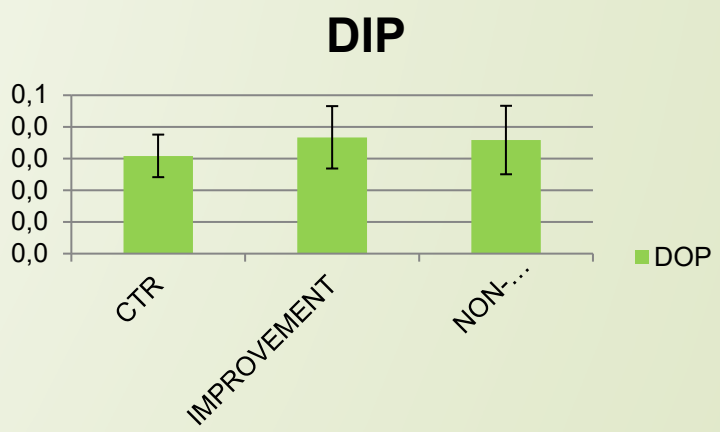
Water column monitoring
Particulate nutrient concentration (P, N, C)
CO_2 concentration
Dissolved nutrient concentration (nitrate, nitrite, ammonium, phosphate, silicate)
Dissolved oxygen concentration
Total **suspended matter**
Chl-a concentration
Water temp., salinity, pH, Secchi depth, turbidity

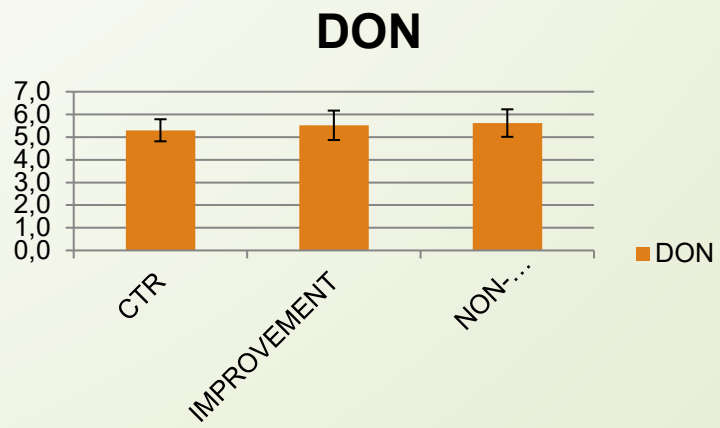
Data acquired from field campaigns

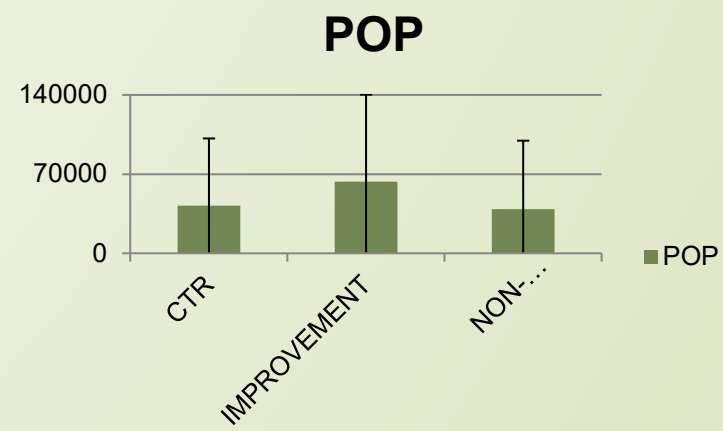
				Inorganic nutrient concentrations					
FISH FARM	STATION	PERIOD	Depth	Nitrate.nitrite (μmol/L)	Nitrite (μmol/L)	Nitrate (μmol/kg)	Silicate (μmol/L)	Phosphate (μmol/L)	Ammonium (μmol/L)
FORKYS	Control	T1		0.180	0.012	0.167	0.693	0.010	0.190
FORKYS	Control	T1	Surface	0.040	0.008	0.030	0.580	0.010	0.177
FORKYS	Control	T2	Bottom	0.040	0.007	0.030	0.643	0.010	0.217
FORKYS	Control	T2	Surface	0.110	0.008	0.100	0.613	0.013	0.163
FORKYS	Control	T3	Bottom	0.043	0.007	0.033	0.723	0.010	0.150
FORKYS	Control	T3	Surface	0.073	0.007	0.070	0.610	0.013	0.210
FORKYS	Control	T4	Bottom	0.063	0.007	0.057	0.757	0.010	0.090
FORKYS	Control	T4	Surface	0.067	0.007	0.030	0.600	0.010	0.207
FORKYS	Cage1	T1	Bottom	0.137	0.050	0.080	1.483	0.050	0.177
FORKYS	Cage1	T1	Surface	0.043	0.009	0.030	0.597	0.010	0.733
FORKYS	Cage1	T2	Bottom	0.173	0.047	0.127	1.357	0.077	0.227
FORKYS	Cage1	T2	Surface	0.047	0.008	0.037	0.583	0.013	0.983
FORKYS	Cage1	T3	Bottom	0.147	0.066	0.080	1.680	0.153	0.380
FORKYS	Cage1	T3	Surface	0.047	0.007	0.040	0.670	0.013	0.757
FORKYS	Cage1	T4	Bottom	0.087	0.029	0.053	1.397	0.083	0.190
FORKYS	Cage1	T4	Surface	0.097	0.007	0.093	0.637	0.010	0.950
FORKYS	Cage2	T1	Bottom	0.050	0.010	0.037	1.137	0.217	0.427
FORKYS	Cage2	T1	Surface	0.103	0.017	0.090	0.740	0.023	2.053
FORKYS	Cage2	T2	Bottom	0.060	0.012	0.047	1.130	0.083	0.260
FORKYS	Cage2	T2	Surface	0.050	0.015	0.033	0.670	0.027	2.393
FORKYS	Cage2	T3	Bottom	0.097	0.012	0.090	1.137	0.110	0.210
FORKYS	Cage2	T3	Surface	0.100	0.010	0.090	0.723	0.030	1.780
FORKYS	Cage2	T4	Bottom	0.107	0.032	0.073	1.603	0.120	0.257
FORKYS	Cage2	T4	Surface	0.067	0.009	0.057	0.703	0.033	2.377
SKIRONIS	Control	T1	Bottom	0.4	0.1435	0.255	1.795	0.105	0.16
SKIRONIS	Control	T1	Surface	0.045	0.007	0.035	0.93	0.01	0.155
SKIRONIS	Control	T2	Bottom	0.15	0.0685	0.08	1.275	0.025	0.315
SKIRONIS	Control	T2	Surface	0.04	0.0085	0.03	0.875	0.01	0.15
SKIRONIS	Control	T3	Bottom	0.15	0.03	0.115	1.21	0.015	0.275
SKIRONIS	Control	T3	Surface	0.065	0.0135	0.055	0.8	0.01	0.165
SKIRONIS	Control	T4	Bottom	0.04	0.02	0.03	1.035	0.01	0.13
SKIRONIS	Control	T4	Surface	0.04	0.015	0.03	0.855	0.01	0.23
SKIRONIS	Control	T5	Bottom	0.04	0.04	0.03	1.12	0.01	0.21
SKIRONIS	Control	T5	Surface	0.04	0.01	0.03	0.85	0.01	0.09
SKIRONIS	Control	T6	Bottom	0.04	0.02	0.03	0.93	0.01	0.15
SKIRONIS	Control	T6	Surface	0.04	0.007	0.03	0.83	0.01	0.09
SKIRONIS	Cage1	T1	Bottom	0.15	0.06	0.09	1.4	0.025	0.175
SKIRONIS	Cage1	T1	Surface	0.085	0.007	0.08	0.965	0.015	0.885
SKIRONIS	Cage1	T2	Bottom	0.365	0.15	0.215	1.675	0.125	0.285
SKIRONIS	Cage1	T2	Surface	0.045	0.007	0.035	0.9	0.015	0.925
SKIRONIS	Cage1	T3	Bottom	0.525	0.205	0.325	1.92	0.15	0.205
SKIRONIS	Cage1	T3	Surface	0.04	0.015	0.03	0.88	0.01	0.46
SKIRONIS	Cage1	T4	Bottom	0.04	0.015	0.03	0.9	0.01	0.15
SKIRONIS	Cage1	T4	Surface	0.04	0.015	0.03	0.97	0.01	1.065
SKIRONIS	Cage1	T5	Bottom	0.04	0.02	0.03	1.14	0.01	0.15
SKIRONIS	Cage1	T5	Surface	0.04	0.02	0.03	0.94	0.01	1.44
SKIRONIS	Cage1	T6	Bottom	0.04	0.02	0.03	1.15	0.01	0.16
SKIRONIS	Cage1	T6	Surface	0.04	0.02	0.03	0.84	0.01	0.66
SKIRONIS	Cage2	T1	Bottom	0.535	0.18	0.355	2.23	0.245	0.34
SKIRONIS	Cage2	T1	Surface	0.075	0.007	0.075	0.935	0.015	0.81
SKIRONIS	Cage2	T2	Bottom	0.785	0.2	0.585	2.865	0.33	0.395
SKIRONIS	Cage2	T2	Surface	0.04	0.0235	0.03	0.92	0.01	0.68
SKIRONIS	Cage2	T3	Bottom	0.65	0.18	0.465	2.025	0.18	0.885
SKIRONIS	Cage2	T3	Surface	0.04	0.0135	0.03	0.845	0.015	1.24
SKIRONIS	Cage2	T4	Bottom	0.07	0.04	0.04	1.21	0.015	0.25
SKIRONIS	Cage2	T4	Surface	0.055	0.02	0.04	0.9	0.02	3.435
SKIRONIS	Cage2	T5	Bottom	0.04	0.03	0.03	0.99	0.01	0.19
SKIRONIS	Cage2	T5	Surface	0.04	0.02	0.03	0.83	0.01	1.3
SKIRONIS	Cage2	T6	Bottom	0.04	0.02	0.03	1.09	0.01	0.19
SKIRONIS	Cage2	T6	Surface	0.04	0.01	0.03	0.88	0.01	0.5

Results - Water Column Monitoring

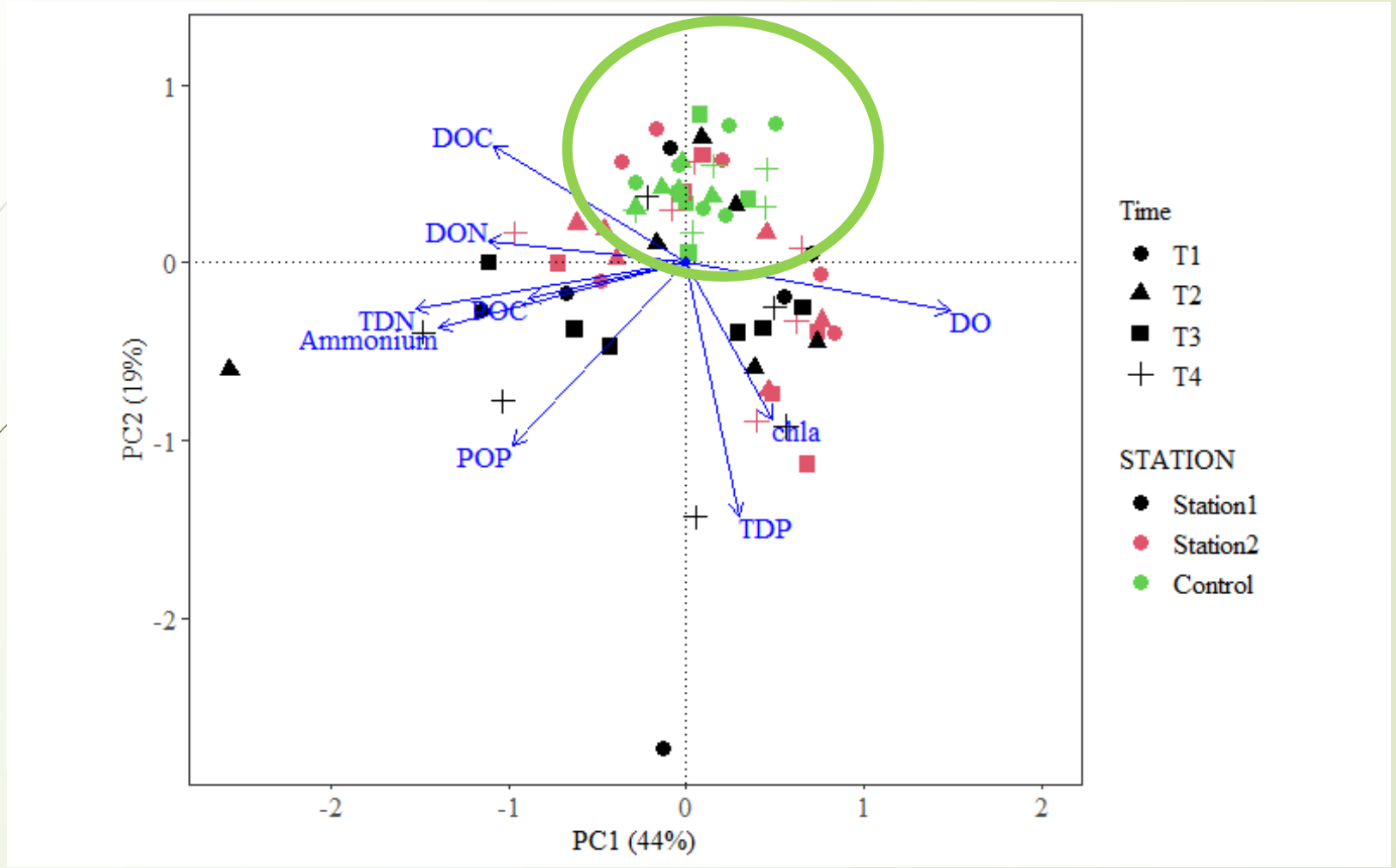








Results -Water Column Monitoring



Incorporation of results in AquaPEF tool

- Use of most relevant indices into ecological eutrophication indicators such as **trophic index TRIX** (Vollemweider *et al.* 1998) and **eutrophication index E.I** (Primpas *et al.* 2010) that show the highest potential of incorporation in the current LCA approaches.

$$\textbf{TRIX} = [\log10(C_{PO4} * C_{DIN} * C_{chla} * D\ \%\ O2) + 1.5]/1.2$$

$$\textbf{E.I} = 0.279*C_{PO4} + 0.261*C_{NO3+} 0.296*C_{NO2} + 0.2975*C_{NH4} + 0.261*C_{Chla}$$

- These parameters can complement the PEF calculation in relation to the impact in **marine eutrophication**

- Assess the contribution of implemented ecological improvements to its reduction.

Looking forward

- The **demand** for fish and fish products is now higher than ever.
- **Sustainable** aquaculture production is crucial for further develpoment
- **Improvement strategies** could reduce significantly environmental footprint
- **AQUAPEF tool** could promote the calculation and improvement of environmental behavior of the aquaculture products

THANK YOU

For any further questions please email me at
tsapakis@hcmr.gr

DELIVERABLES
B.3.1. Review of the environmental improvements in aquaculture facilities
B.3.2. List of aquaculture facilities that environmental improvements have been undertaken
B.3.3. Field campaign and data report from ecological quality monitoring