Networks of coordinated video-observatories as step forward in ecosystem monitoring

***Aguzzi J.,* Company J.B., Doya C.**

Instituto de Ciencias del Mar — ICM — CSIC Consejo Superior de Investigaciones Científicas

K. Juniper, De Leo F.

Ocean Networks Canada

Thomsen L., Purser A., Chatzievangelou D.

Jacobs University

ROBEX Robotic Exploration of Extreme Environments

Costa C.

CRA Consiglio per la Ricerca e la Sperimentazione in Agricoltura

Furushima Y., Fujiwara Y.

JAMSTEC

Matabos M.

Ifremer

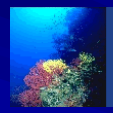
del Río J.

SARTI

Marini S.

CNR National Research Council

Fanelli E.



ENEA Agenzia Nazionale per le Nuove tecnologie, l'Energia e lo Sviluppo economico sostenibile

CENTRO RICERCHE AMBIENTE MARINO S. TERESA

Gomariz S.

UPC Universitat Politècnica de Catalunya BarcelonaTech

Favali P.

european multidisciplinary seafloor & water column observatory — emso

Barkley Canyon Refresh Workshop
Univ. Victoria (BC, Canada) 5-9 October 2015

JACOPO AGUZZI
Departamento de Recursos Marinos Renovables
Instituto de Ciencias del Mar (ICM-CSIC)

Our backgound

Any behaviour
(Feeding, Moving, Mating)

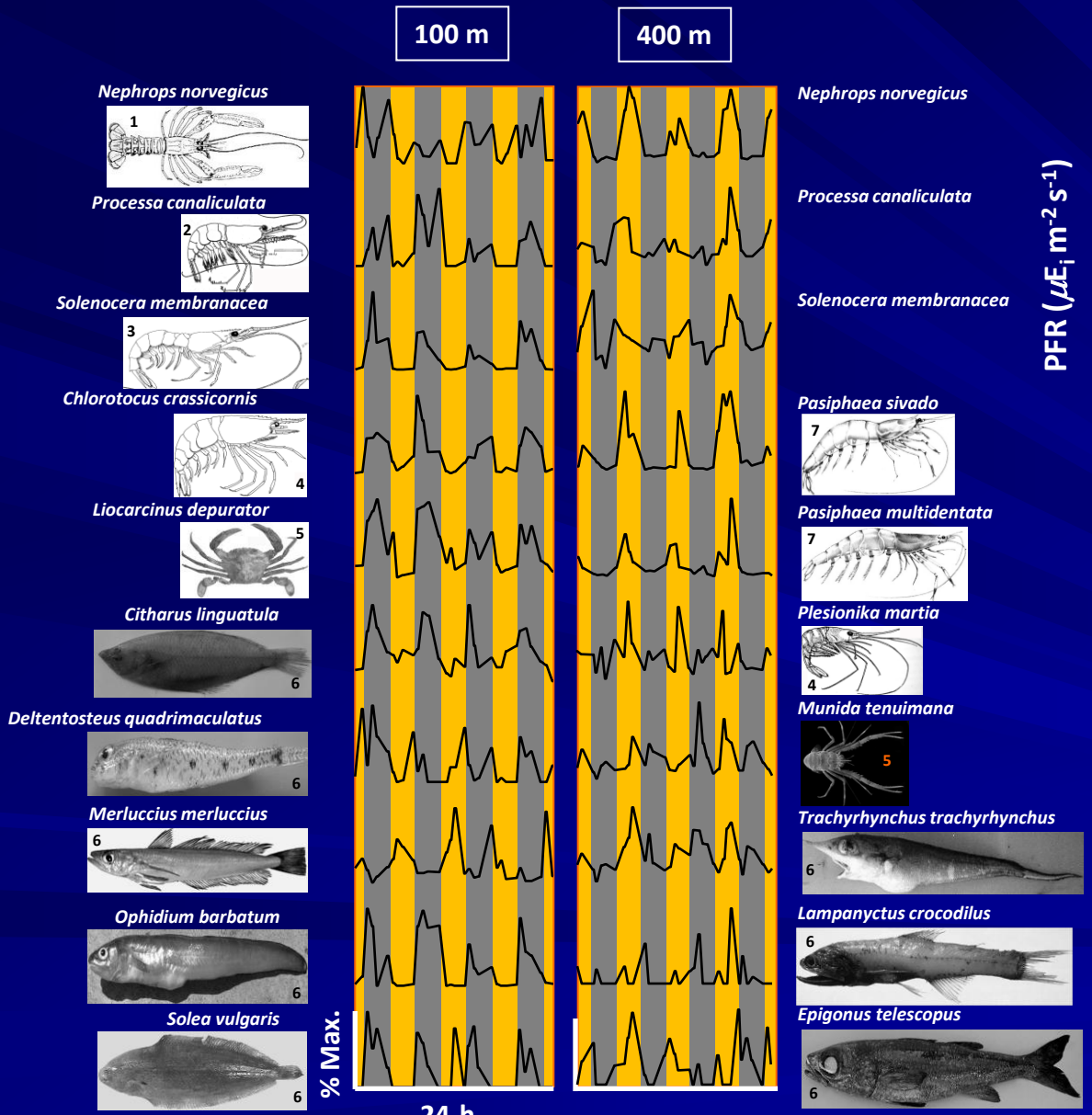
→ Temporal windows for activation → Rhythms in response to geophysical cycles → Biases in stock and biodiversity assessments

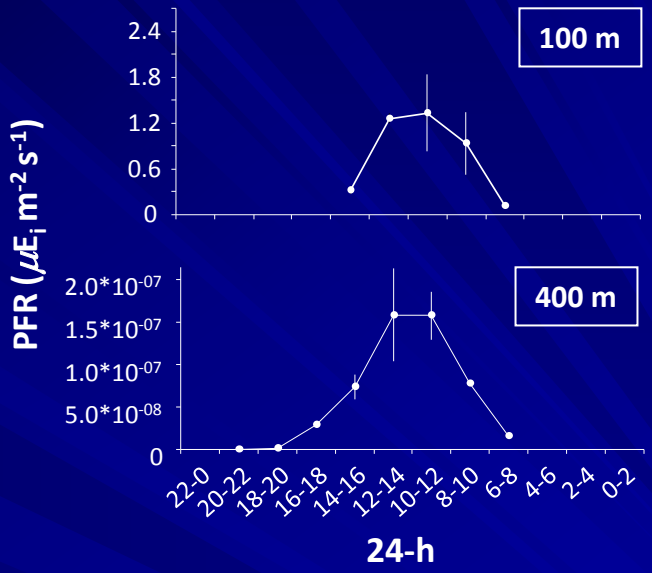
Major Objective:

Scale perceived communities compositions down to species behaviour and its environmental control

Aguzzie and Company 2010. Adv. Mar. Biol. 58: 155-225

Temporal catch patterns produced by rhythmic behaviour (4 days, 1-2 h fr.)

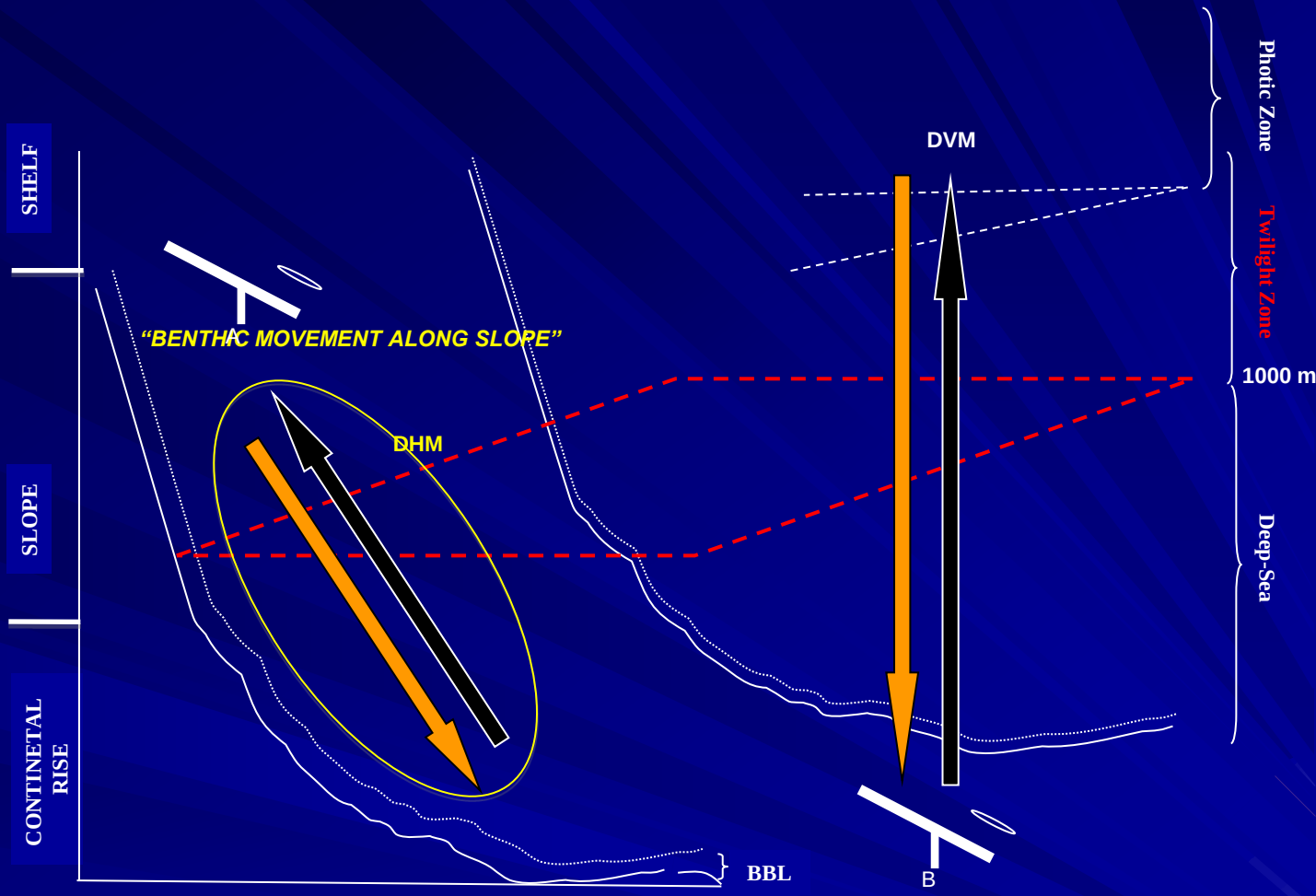


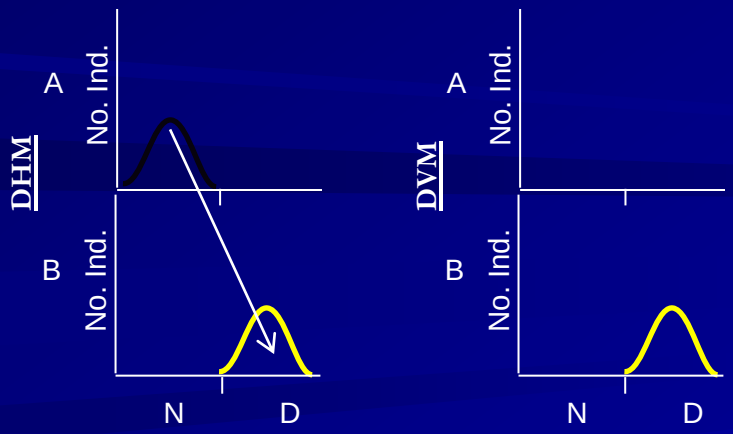


Light intensity is a poorly considered parameter in field studies

1. **Aguzzi** et al. 2003. MEPS 258:201-211
2. **Aguzzi** et al. 2008. Crustaceana 81:1301-1316
3. **Aguzzi** et al. 2008. Crustaceana 81:1301-1316
4. **Aguzzi** et al. 2007. J. Zool. 273:340–349
5. **Aguzzi** et al. 2008. Mar. Ecol. 30:93-105
6. **Aguzzi** et al. Limnol. Oceanogr. Submitted.
7. **Aguzzi** et al. 2007. MEPS 335: 167-174

-BIOMASS/CARBON FLUXES
-TROPHIC RELATIONSHIPS
-REPRODUCTIVE MOVEMENTS





Aguzzi et al. 2011. Frontiers in Bioscience-Landmark 16: 131-150

Aguzzi et al., 2015. Deep-Sea Research I 95: 1-11

The PAST

ROI definition

Gray-scale enhancement

Frame subtraction

Area filtering

Profile extraction/ RGB content

apse 5 s, 2 months)

TRAINING SET (manual)

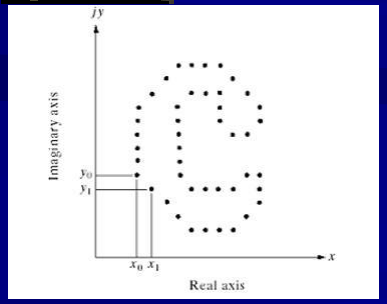
LIBRARY of images

RGB content

Profile extraction

Shape analysis

Morphological models

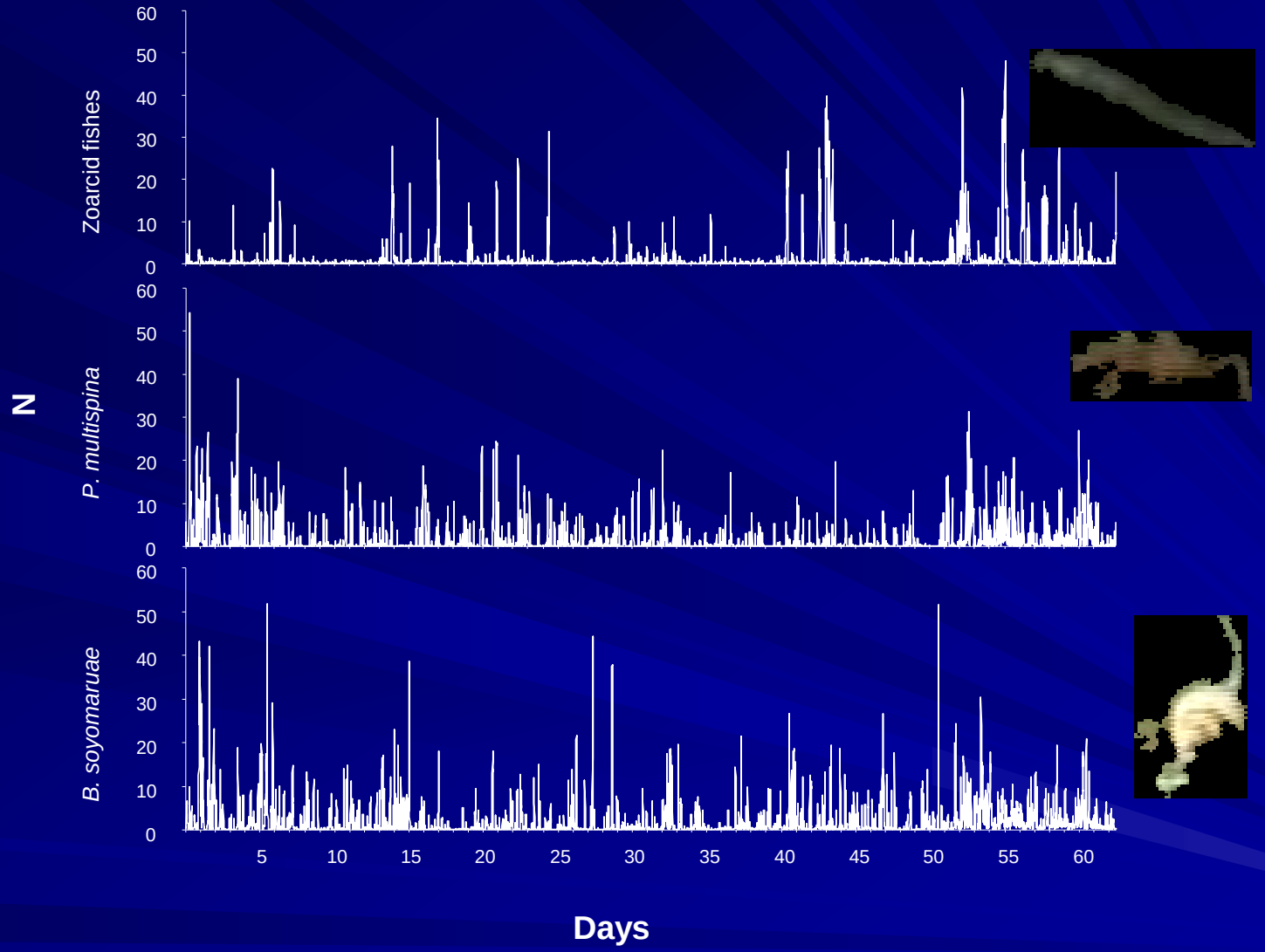


Animal classification

Animals' counting

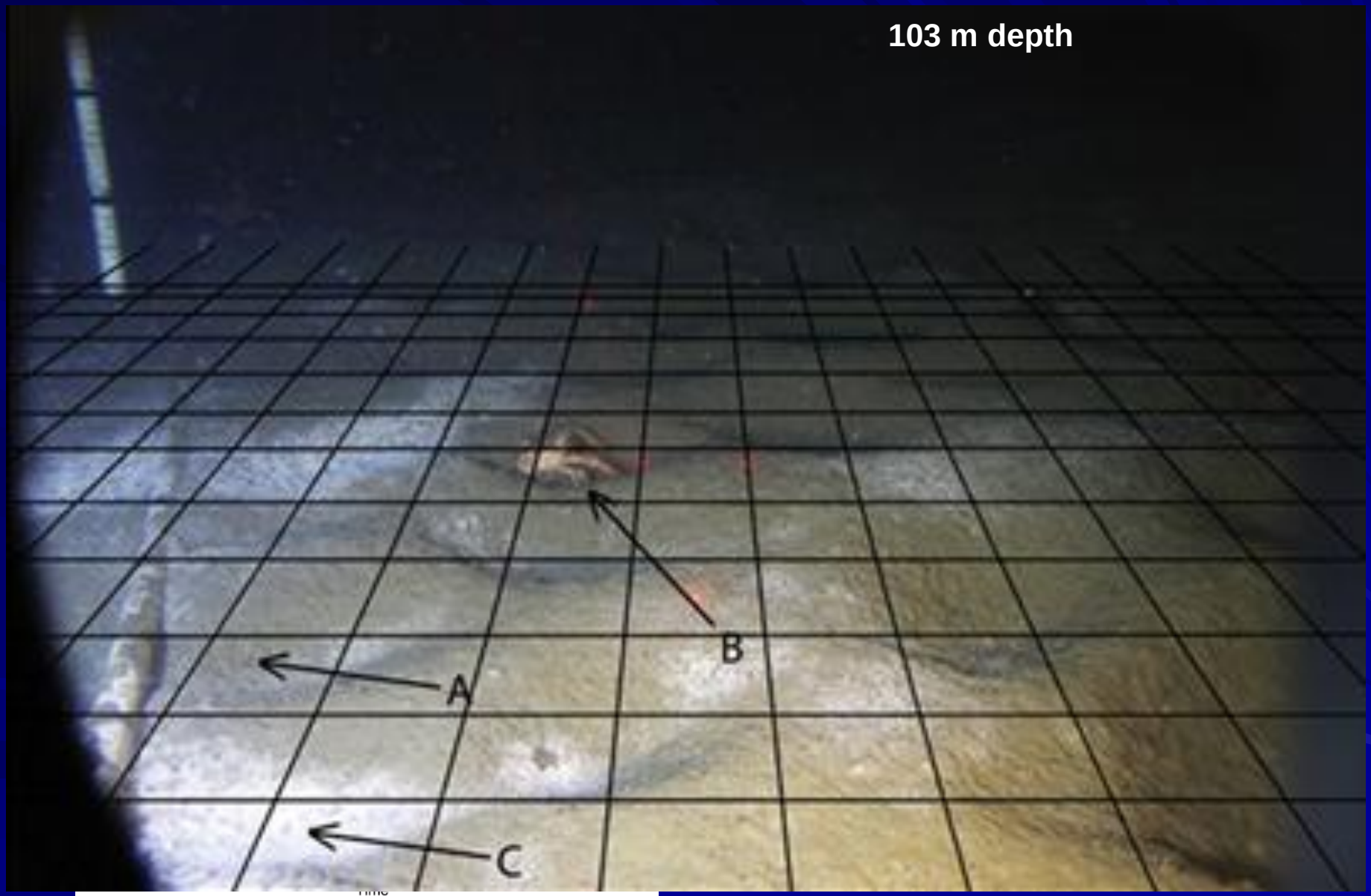
Time Series Analysis

Aguzzi et al. 2009. SENSORS 9: 8438-8455



Aguzzi et al. 2010. MEPS 418: 47-56

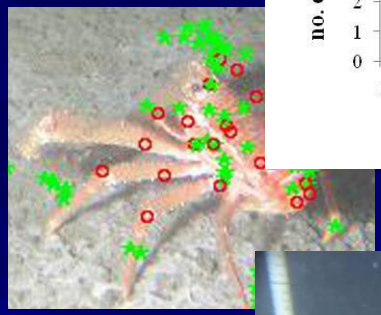
Canada: VENUS
(Saanich Inlet 93 m depth, time-lapse image 30 min, 1 month)

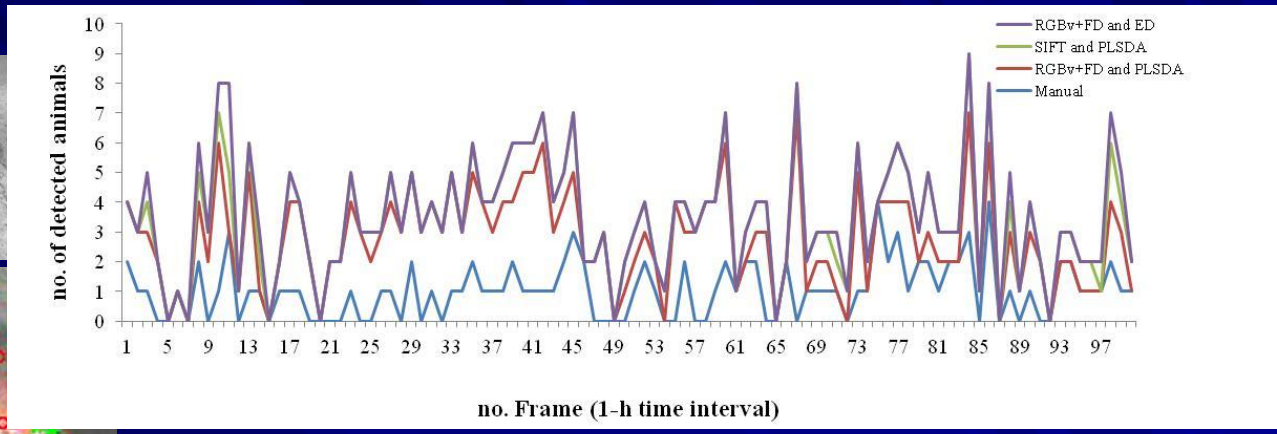


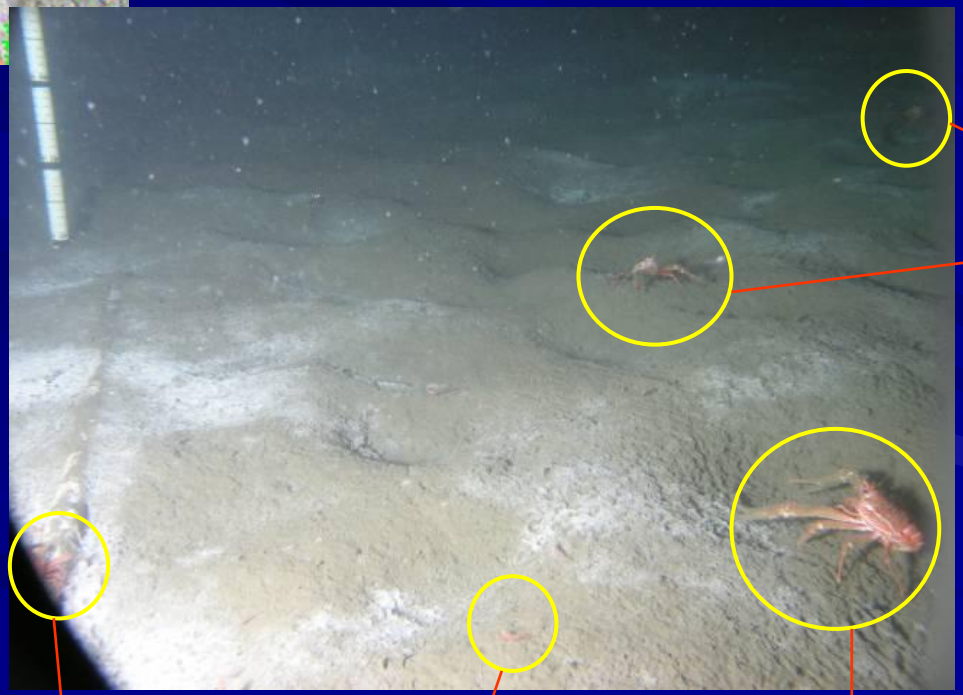
Matabos, Aguzzi et al. 2011. JEMBE 401: 89-96

SIFT

RGB/FD based







whole animals less and variable illuminated

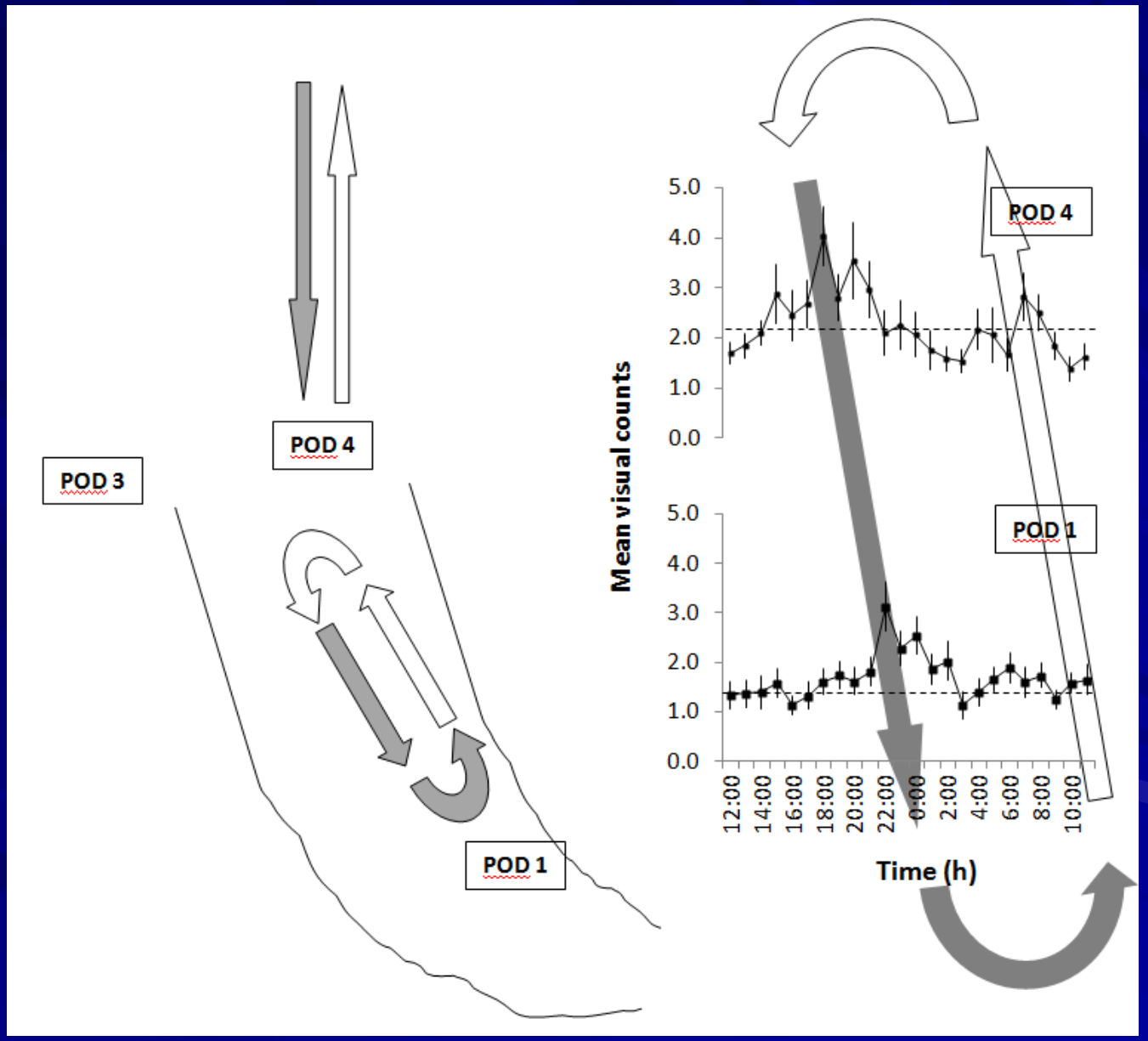
Part of animal

Extraneous specie

whole animal well illuminated

Aguzzi et al. 2011. SENSORS 11: 10534-10556

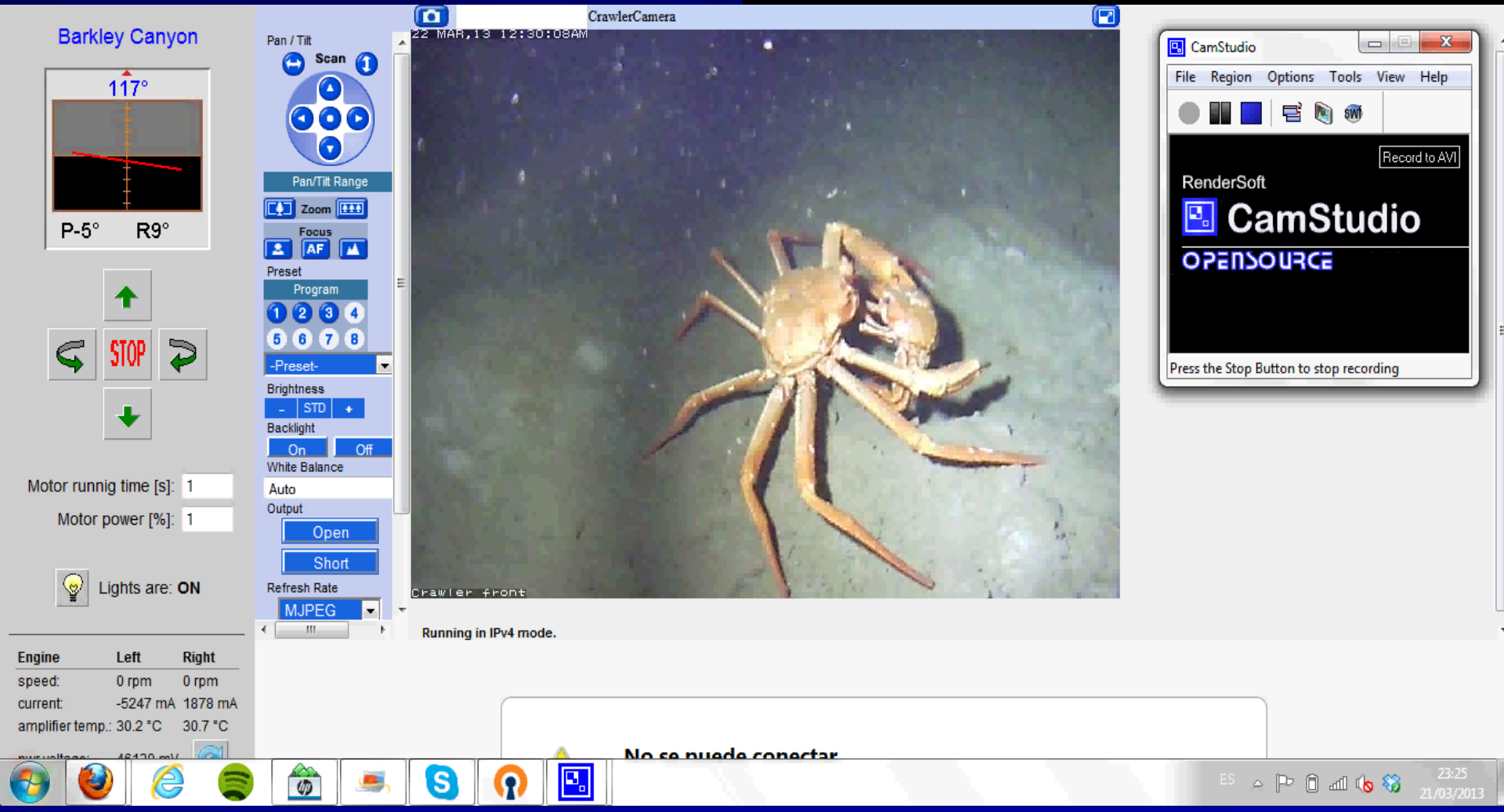
Canada: NEPTUNE
(Barkley Canyon PODS 1-3, ≈1000 m depth, time-lapse videos (30 s), 30 min fr.)

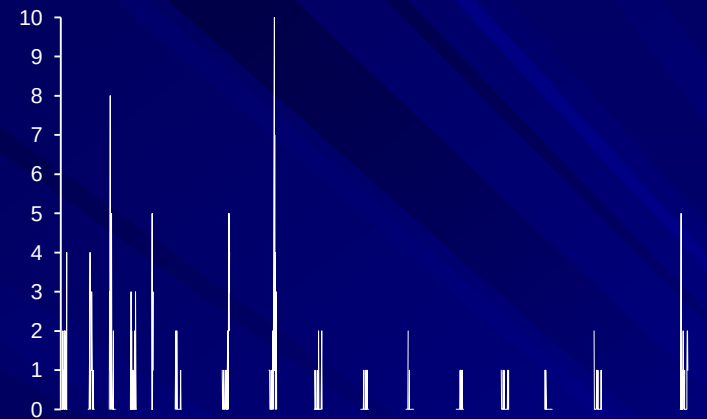


Doya , Aguzziet al. 2013. J. Mar. Syst. 130: 69-78

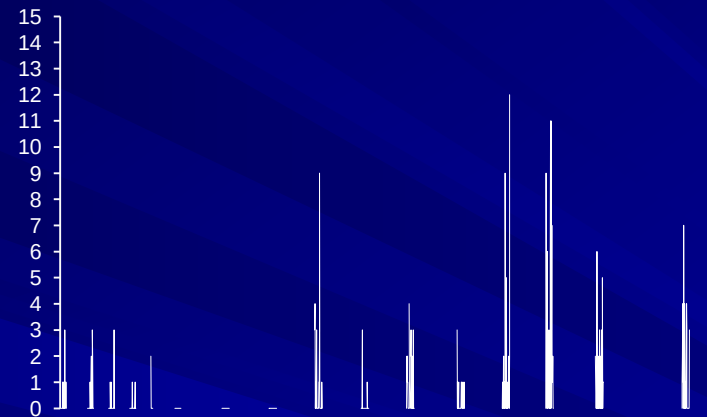
The PRESENT

The Wally spatial/ seasonal monitoring
(2 Ph.D. Theses: C. Doya and D. Chatzievangelou)
892 m depth, sampling by 4-h during 5 days in the 1st week per month-14 months)

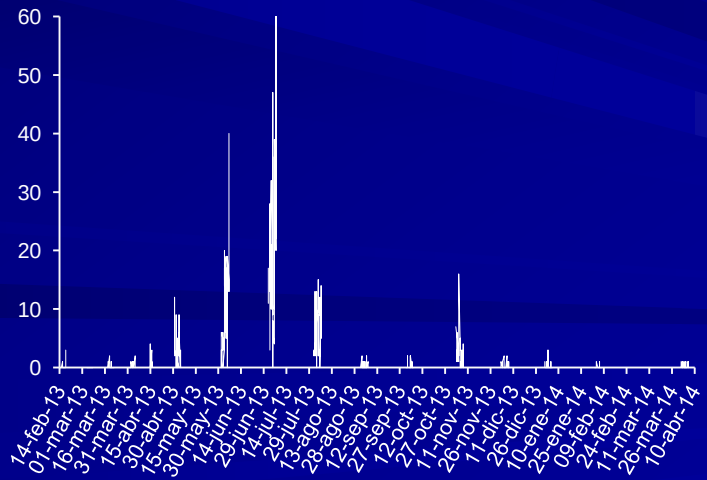




Grooved tanner crab (*Chionoecetes tanneri*)



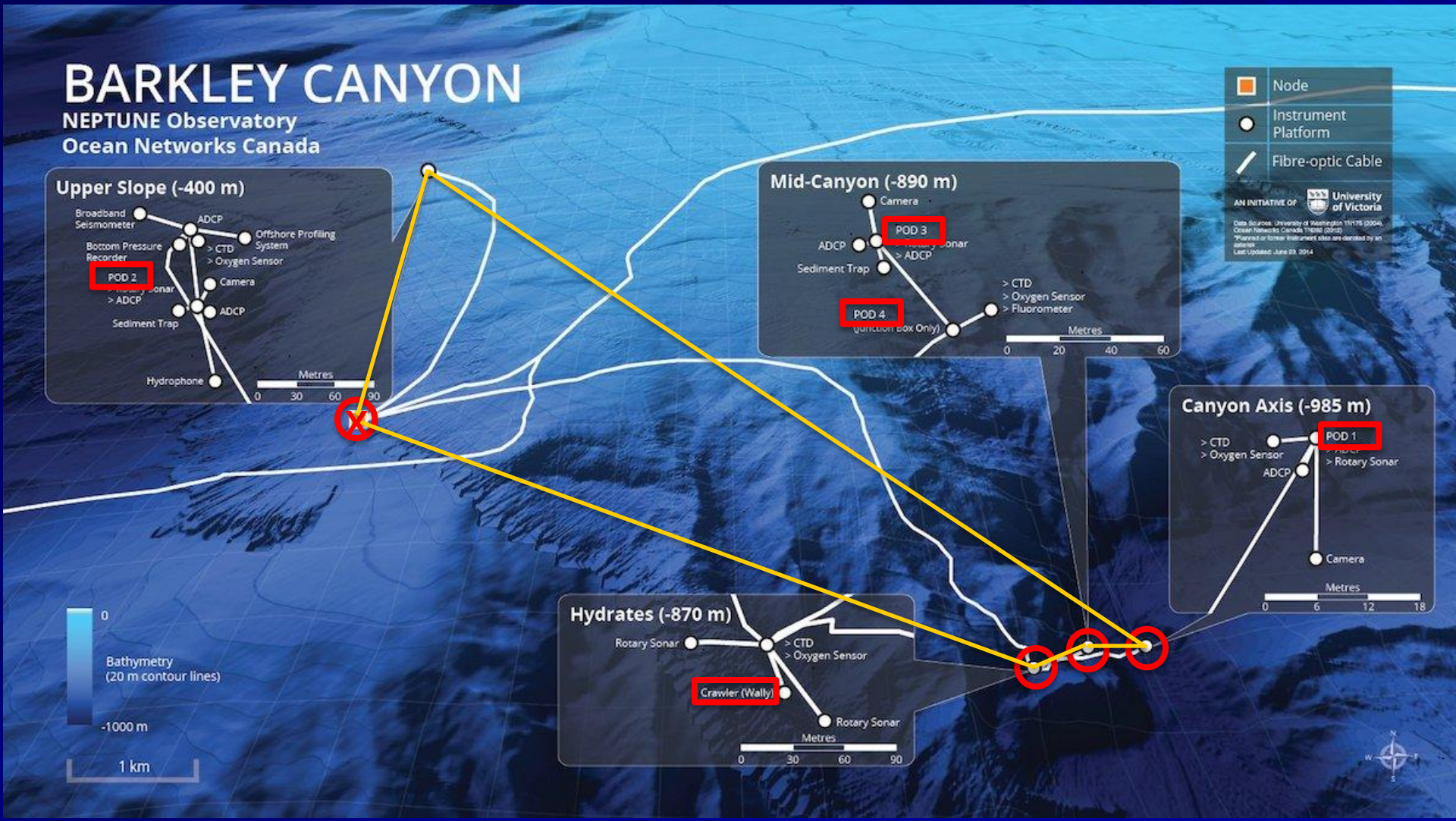
Small crabs



Sablefish (*Anaplopoma fimbria*)

….and the FUTURE: 3 different scenarios

Long-term planning: Cabled video-observatory networks as viable technology for fishery-independent assessment and activity rhythms monitoring



1. Acoustic cameras: large penetrability into the water column “above (fishery-independent assessment)

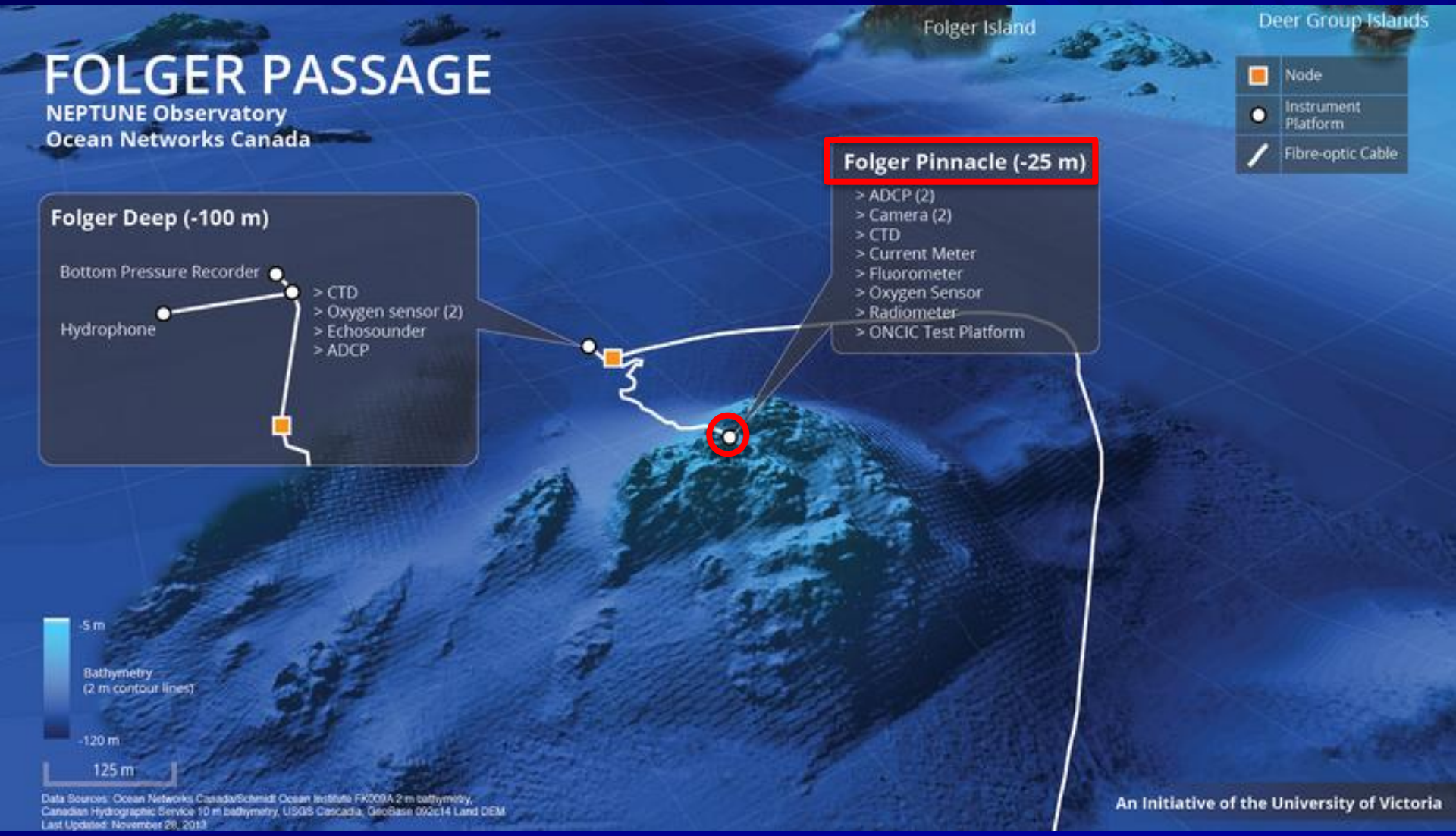
2. Monochromatic blue-light emitters: Deep-sea macrofauna attraction (to implement discovery on poorly characterized pelagic components such as large cephalopods)

3. Low-light cameras: Bioluminescence (benthopelagic coupling as factor controlling benthic rhythms)

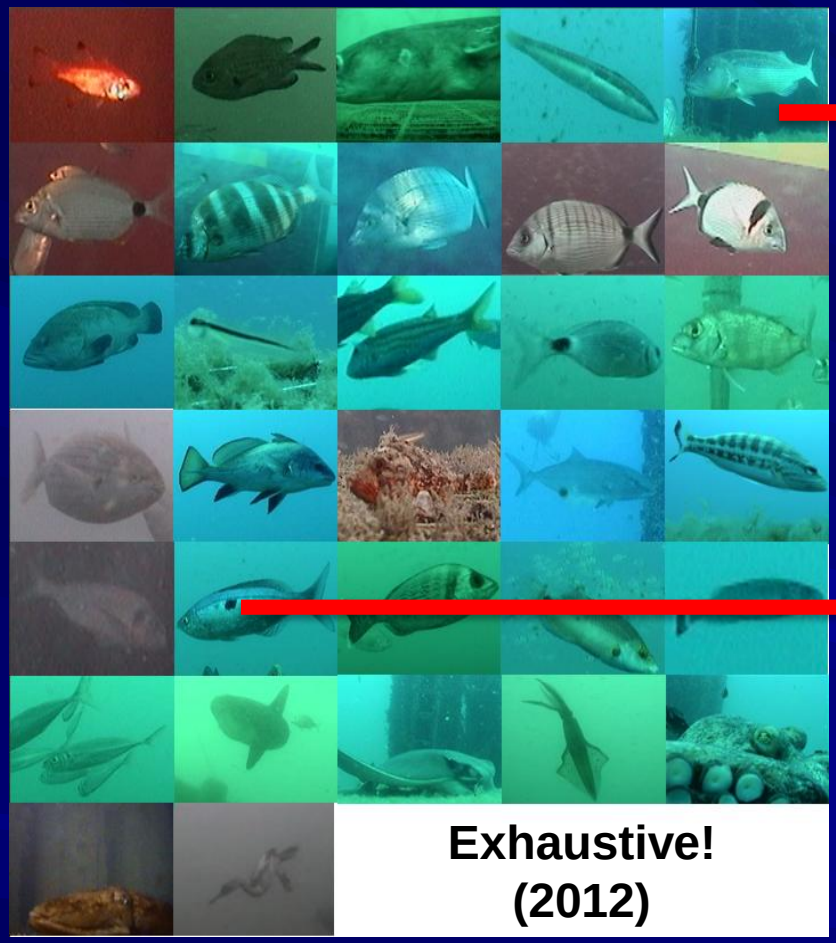
…and finally, 4. Artificial Video-Intelligence: Automated counting of “morfospecies” and their sizing (to implement activity rhythms studies…and else…)

Short-term planning: Coastal diel and seasonal rhythms at OBSEA (20 m depth) and Folger Pinnacle (25 m depth)

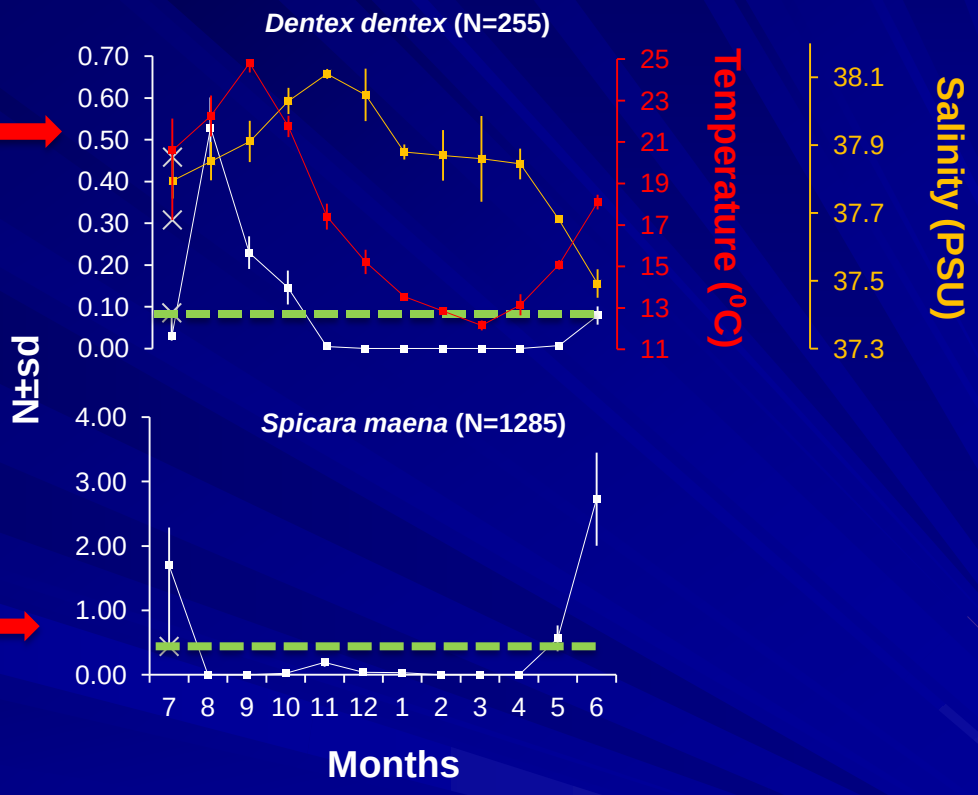
Data treatment as procedural proxy for NEPTUNE surveys



Species list (30 min, 1 year)

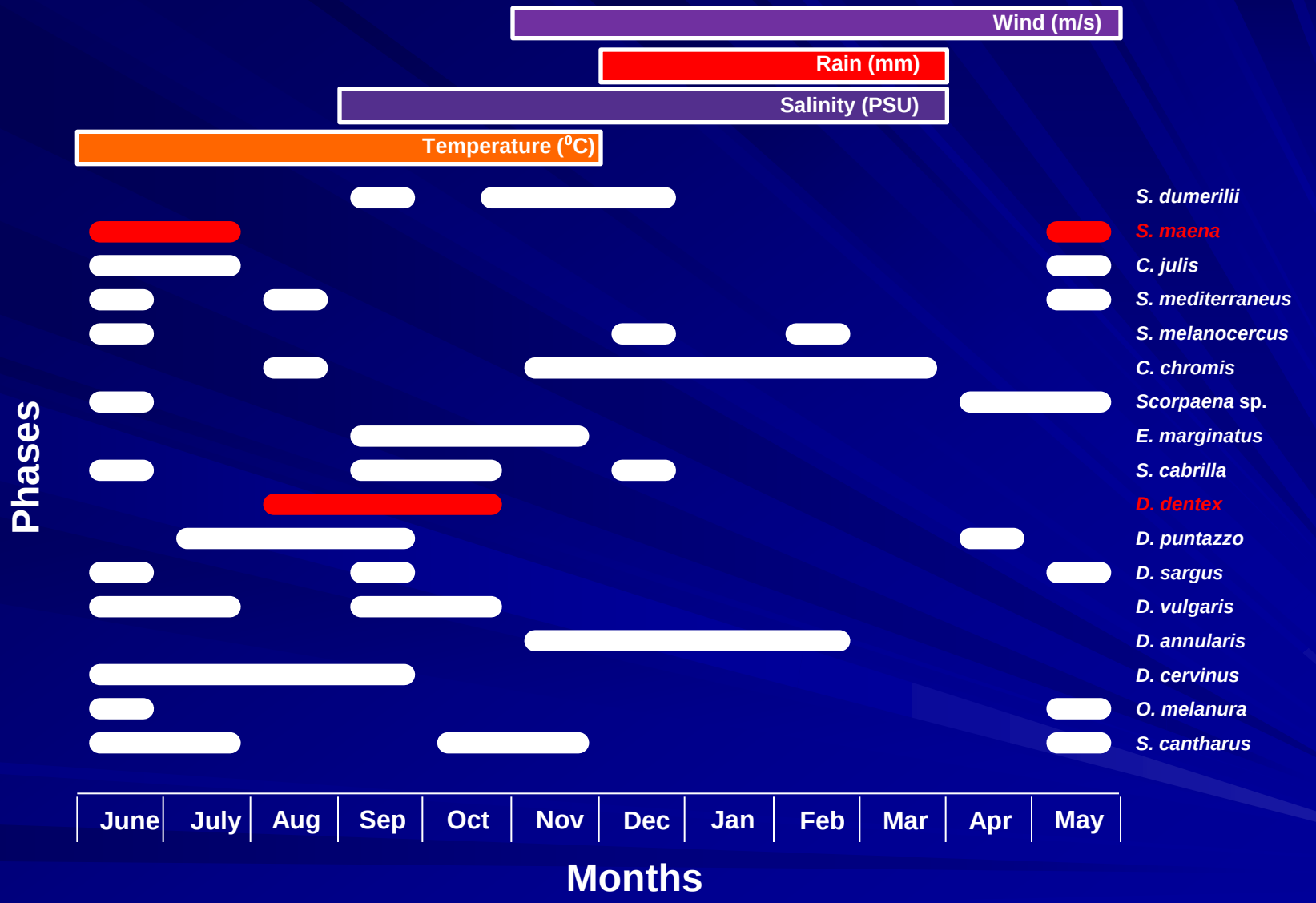


Exhaustive!
(2012)



Condal, Aguzzi et al. 2012. Mar. Biol. 159: 2809-2817

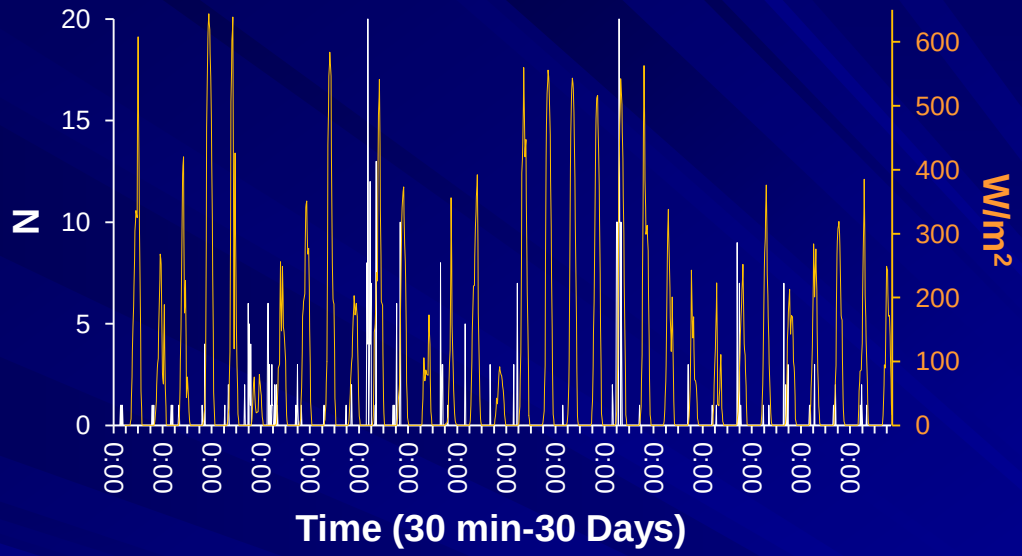
Seasonal Rhythms

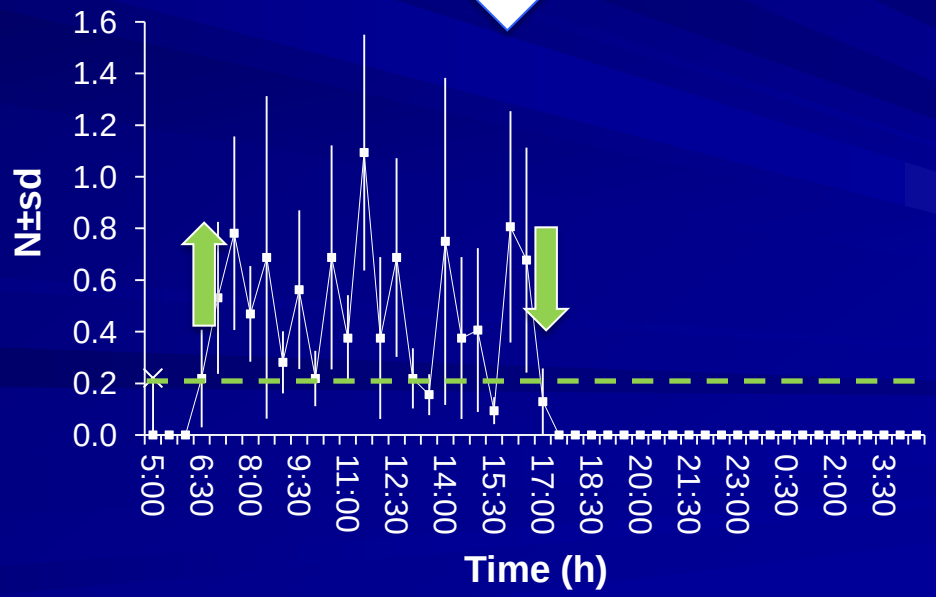


Aguzzi et al. 2015. Rev. Fish. Biol. Fisher. 25: 463-483

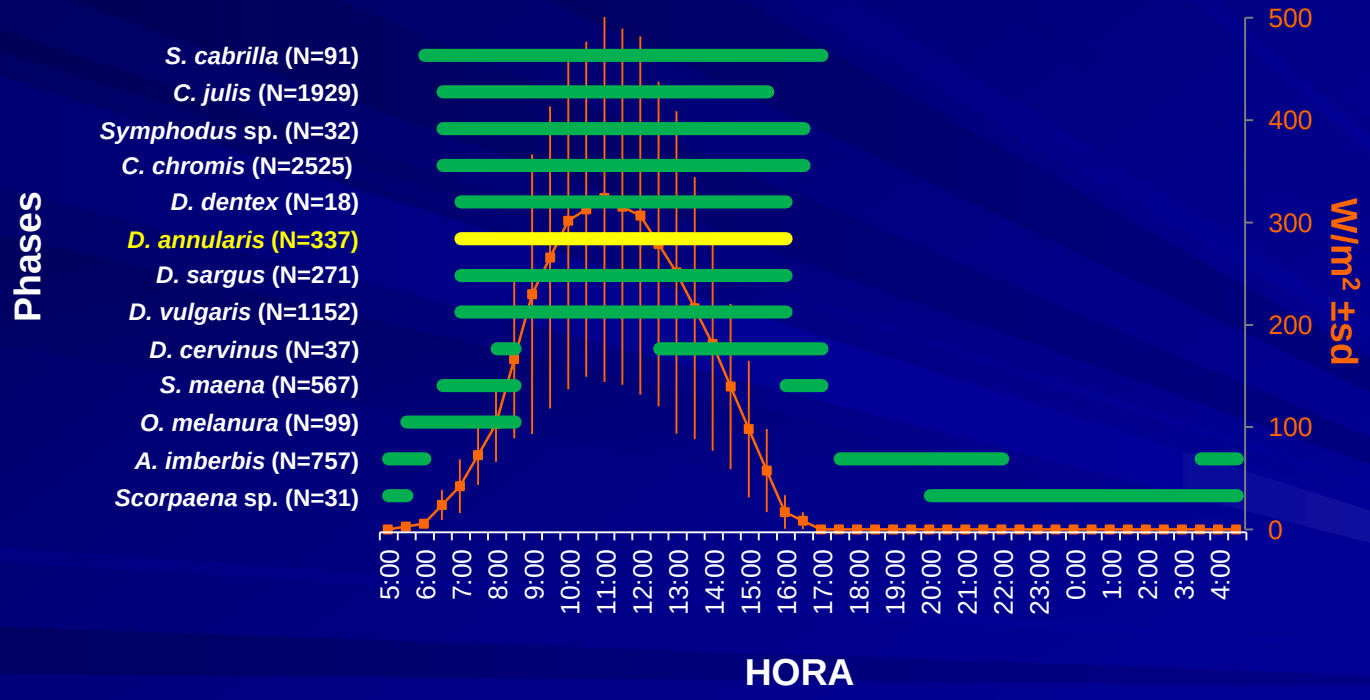
Diel Rhythms

Diplodus annularis



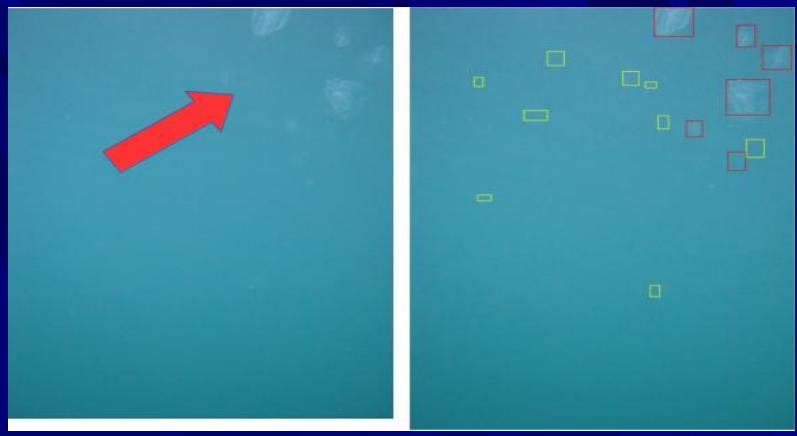


Aguzzi et al. 2013. MEPS 486: 223-236


Phases
S. cabrilla (N=91)
C. julis (N=1929)
Symphodus sp. (N=32)
C. chromis (N=2525)
D. dentex (N=18)
D. annularis (N=337)
D. sargus (N=271)
D. vulgaris (N=1152)
D. cervinus (N=37)
S. maena (N=567)
O. melanura (N=99)
A. imberbis (N=757)
Scorpaena sp. (N=31)
500
400
300
200
100
0
W/m² ±sd
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
1:00
2:00
3:00
4:00
HORA

Automatic Image Content Recognition and Classification

- Fishes and jellies (macro- & mega- gelatinous zooplankton) recognition and classification
- Supervised Machine Learning approach and image features extraction

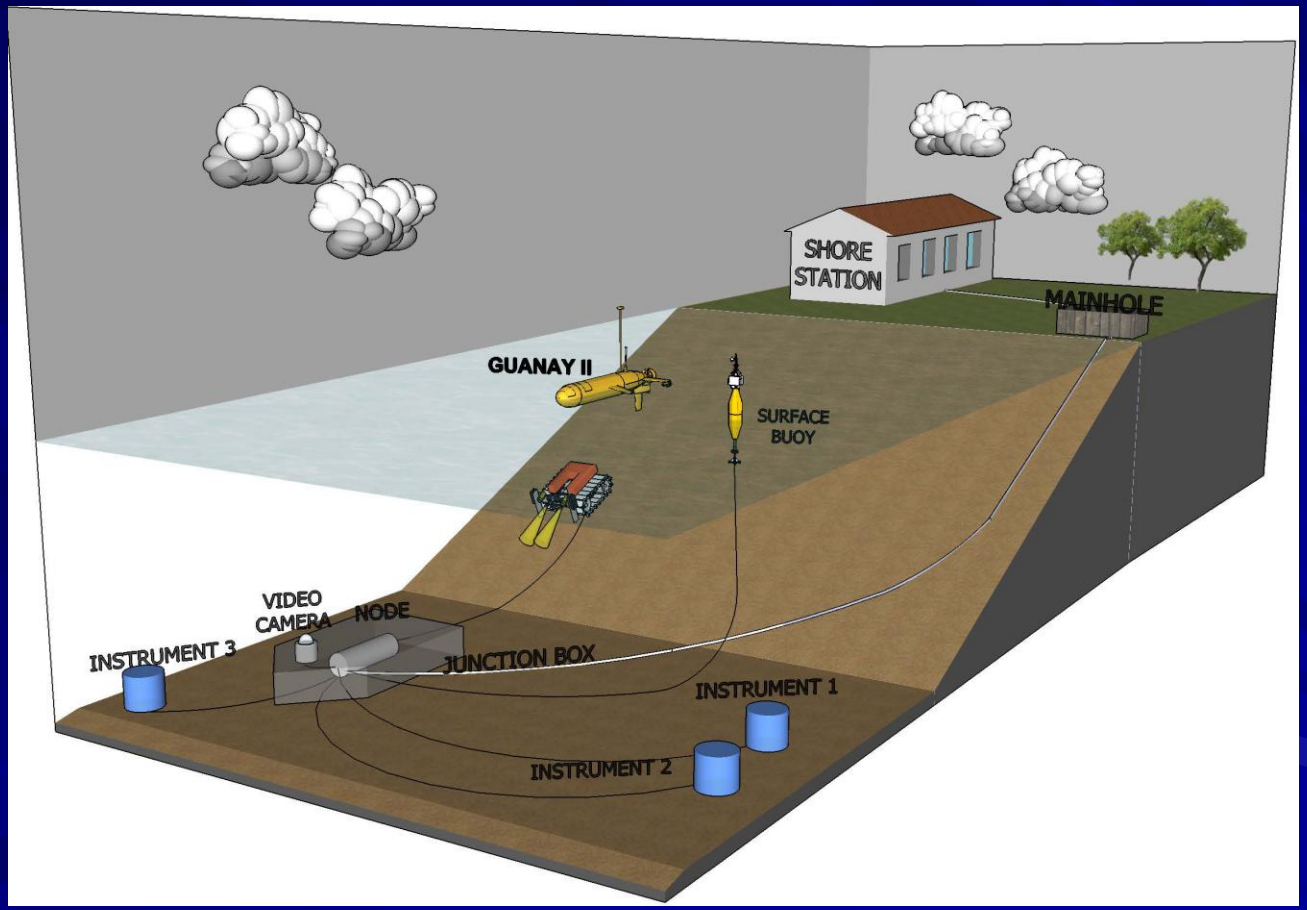


Bio-luminescence event recognition and labelling

- Event identification and labelling
- Event tracking (events change in time)

Spanish National Research Project (Plan Nacional)

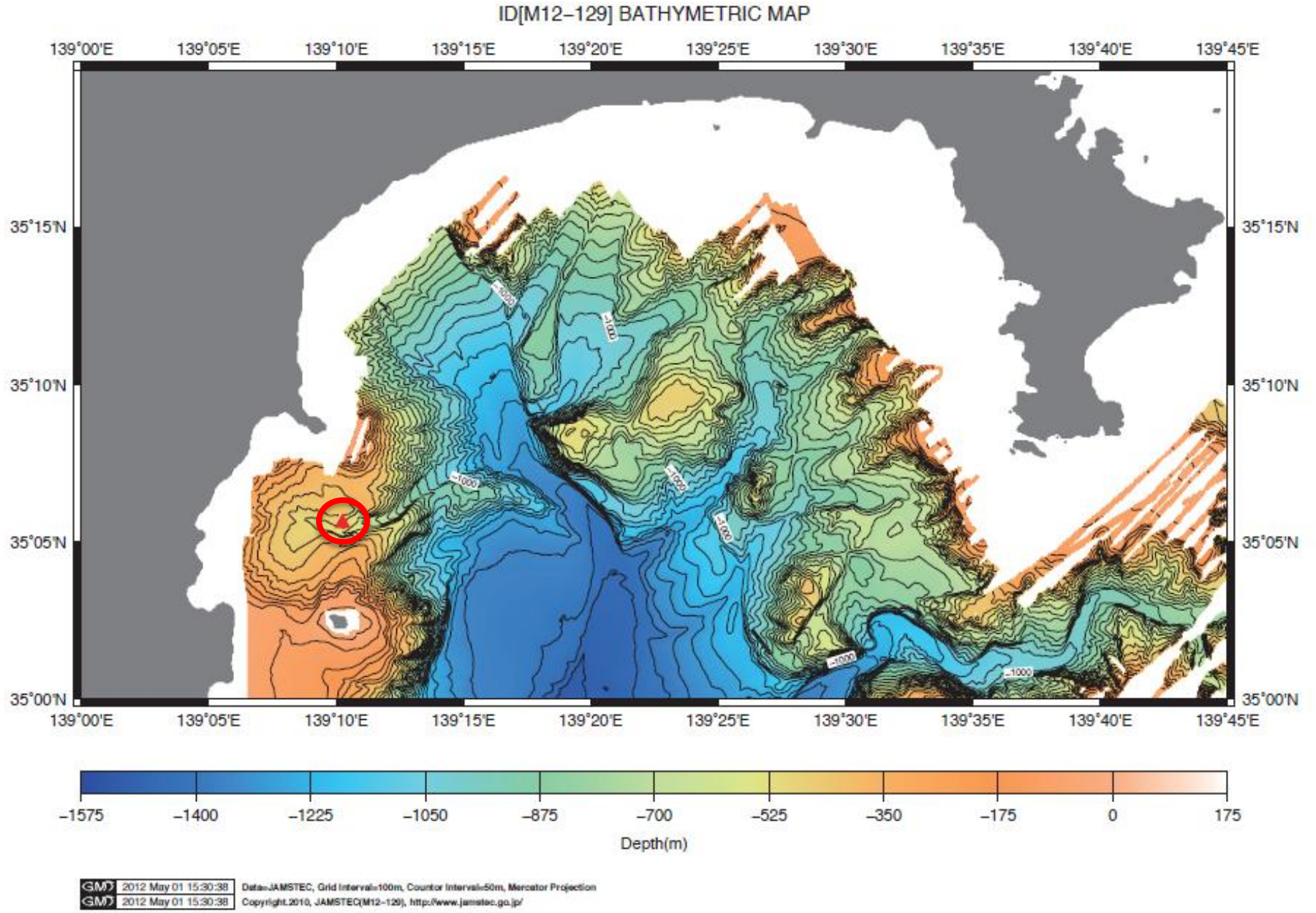
Methodological comparison by expanding the OBSEA platform into a *small-scale network* according to the ONC nodes as model



Methodological comparison among fixed and mobile benthic and pelagic tools

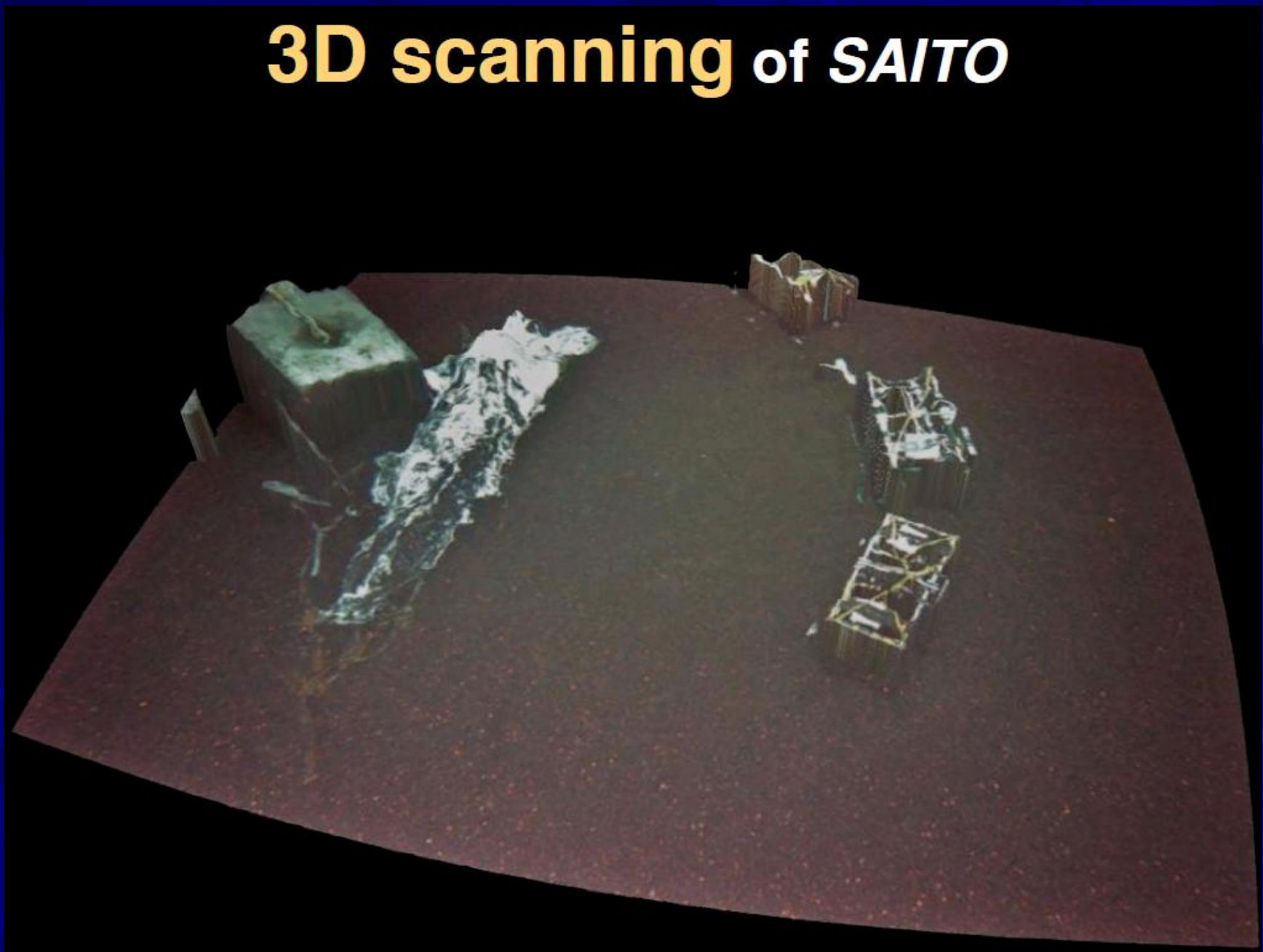
Aguzzi et al. 2015. Rev. Fish. Biol. Fisher. 25: 463-483

The “wish list”: The “Whale fall”
[inspired by SAITO- Exp., 500 m depth; 2-h Time-Lapse, 71 days]



Total length: 464 cm, ♂

3D scanning of *SAITO*



Hexanchus griseus??????

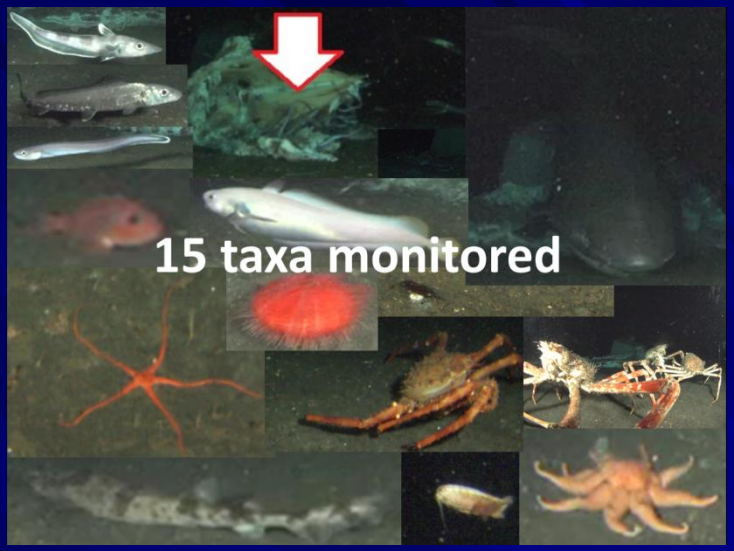
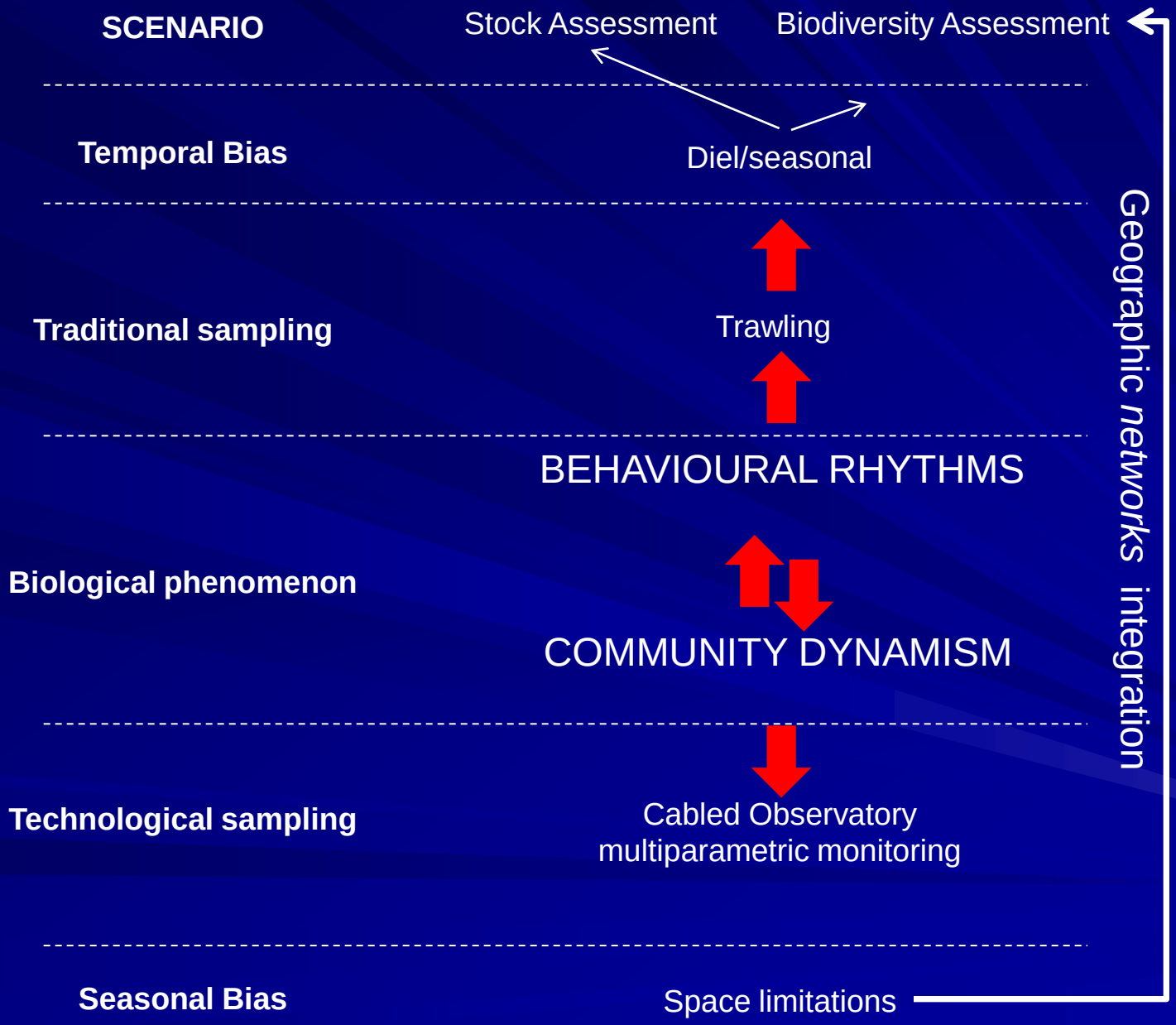


IMAGE NAME	Image	Date	Time (by 2-h)	Time (by 2-h)		DATE AND TIME	VISIBILITY	OBSERVATIONS	Caelorinchus sp.	Pterothrissus gissu	Meadia (abyssalis	Helicolenus hilgendo	Phaloscyllium umbra	Lysiosicyus japonic	Lysmata moselepy	Scrocheira haempfe	Z	Coelorinchus sp.	Pterothrissus gissu	Meadia (abyssalis	Helicolenus hilgendo	Phaloscyllium umbra	Lysiosicyus japonic	Lysmata moselepy	Scrocheira haempfe	Z
P6140044	1	14/06/2012	16:30	0.6875	930	14-6-12 16:30			0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
P6140045	2	14/06/2012	18:30	0.7708	1110	14-6-12 18:30			1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
P6140046	3	14/06/2012	20:30	0.8542	1230	14-6-12 20:30			1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
P6150047	4	14/06/2012	22:30	0.9375	1350	14-6-12 22:30							0	0	0	0	0	2	0			0	0	0	0	0
P6150048	5	15/06/2012	0:30	1.0208	1470	15-6-12 0:30							0	0	0	0	0	0	0			0	0	0	0	0
P6150049	6	15/06/2012	2:30	1.1042	1590	15-6-12 2:30							0	0	0	0	0	0	0			0	0	0	0	0
P6150050	7	15/06/2012	4:30	1.1875	1710	15-6-12 4:30							0	0	0	0	0	0	0			0	0	0	0	0
P6150051	8	15/06/2012	6:30	1.2708	1830	15-6-12 6:30		whale has moved					0	0	0	0	0	2	0			0	0	0	0	0
P6150052	9	15/06/2012	8:30	1.3542	1950	15-6-12 8:30			0	0	0	0	0	0	0	0	0	23	0			0	0	0	0	0
P6150053	10	15/06/2012	10:30	1.4375	2070	15-6-12 10:30			0	0	0	0	0	0	0	0	0	10	0			0	0	0	0	0
P6150054	11	15/06/2012	12:30	1.5208	2190	15-6-12 12:30			0	0	0	0	0	0	0	0	0	5	0			0	0	0	0	0
P6150055	12	15/06/2012	14:30	1.6042	2310	15-6-12 14:30			0	0	0	0	0	0	0	0	1	8	0			0	0	0	0	0
P6150056	13	15/06/2012	16:30	1.6875	2430	15-6-12 16:30			0	0	0	0	0	0	0	0	2	3	0			0	0	0	0	0
P6150057	14	15/06/2012	18:30	1.7708	2550	15-6-12 18:30			0	0	0	0	0	0	0	0	1	2	0			0	0	0	0	0
P6150058	15	15/06/2012	20:30	1.8542	2670	15-6-12 20:30			0	0	0	0	0	0	0	0	0	4	0			0	0	0	0	0
P6150059	16	15/06/2012	22:30	1.9375	2790	15-6-12 22:30			0	0	0	0	0	0	0	0	0	6	0			0	0	0	0	0
P6160060	17	16/06/2012	0:30	2.0208	2910	16-6-12 0:30			0	0	0	0	0	0	0	1	0	19	0			0	0	0	0	0
P6160061	18	16/06/2012	2:30	1.1042	1590	16-6-12 2:30			0	0	0	1	0	0	1	0	0	21	0			0	0	0	0	0
P6160062	19	16/06/2012	4:30	1.1875	1710	16-6-12 4:30			0	0	1	0	0	0	0	2	0	27	0			0	0	0	0	0
P6160063	20	16/06/2012	6:30	1.2708	1830	16-6-12 6:30			0	0	0	0	0	0	0	3	0	16	0			0	0	0	0	0
P6160064	21	16/06/2012	8:30	1.3542	1950	16-6-12 8:30			0	0	0	0	0	0	0	4	0	9	0			0	0	0	0	0
P6160065	22	16/06/2012	10:30	1.4375	2070	16-6-12 10:30			0	0	0	0	0	0	0	0	0	2	0			0	0	0	0	0
P6160066	23	16/06/2012	12:30	1.5208	2190	16-6-12 12:30			0	0	0	0	0	0	0	0	0	4	0			0	0	0	0	0
P6160067	24	16/06/2012	14:30	1.6042	2310	16-6-12 14:30			0	0	0	0	0	0	0	0	0	3	0			0	0	0	0	0
P6160068	25	16/06/2012	16:30	1.6875	2430	16-6-12 16:30			0	0	0	0	0	0	0	0	0	2	0			0	0	0	0	0
P6160069	26	16/06/2012	18:30	1.7708	2550	16-6-12 18:30			0	0	0	0	0	0	0	0	0	1	0			0	0	0	0	0
P6160070	27	16/06/2012	20:30	1.8542	2670	16-6-12 20:30			0	0	0	0	0	0	0	0	0	3	0			0	0	0	0	0
P6160071	28	16/06/2012	22:30	1.9375	2790	16-6-12 22:30			0	0	0	0	0	0	0	0	0	2	0			0	0	0	0	0
P6170072	29	17/06/2012	0:30	2.0208	2910	17-6-12 0:30			0	0	0	0	0	0	0	0	0	3	0			0	0	0	0	0
P6170073	30	17/06/2012	2:30	1.1042	1590	17-6-12 2:30			0	0	0	0	0	0	0	0	0	4	0			0	0	0	0	0
P6170074	31	17/06/2012	4:30	1.1875	1710	17-6-12 4:30			0	0	0	0	0	0	0	0	0	10	0			0	0	0	0	0
P6170075	32	17/06/2012	6:30	1.2708	1830	17-6-12 6:30			0	0	0	0	0	0	0	2	0	10	0			0	0	0	0	0
P6170076	33	17/06/2012	8:30	1.3542	1950	17-6-12 8:30			0	0	0	0	0	0	0	1	0	27	0			0	0	0	0	0
P6170077	34	17/06/2012	10:30	1.4375	2070	17-6-12 10:30			0	0	0	1	0	0	0	1	0	21	0			0	0	0	0	0
P6170078	35	17/06/2012	12:30	1.5208	2190	17-6-12 12:30			0	0	0	0	0	0	0	1	0	1	0			0	0	0	0	0
P6170079	36	17/06/2012	14:30	1.6042	2310	17-6-12 14:30			0	0	0	0	0	0	0	2	0	3	0			0	0	0	0	0
P6170080	37	17/06/2012	16:30	1.6875	2430	17-6-12 16:30			0	0	0	0	0	0	0	1	0	3	0			0	0	0	0	0
P6170081	38	17/06/2012	18:30	1.7708	2550	17-6-12 18:30			0	0	0	0	0	0	0	0	0		0			0	0	0	0	0
P6170082	39	17/06/2012	20:30	1.8542	2670	17-6-12 20:30			0	0	0	0	0	0	0	0	1	1	0			0	0	0	0	0
P6170083	40	17/06/2012	22:30	1.9375	2790	17-6-12 22:30			0	0	0	0	0	0	0	0	1	4	0			0	0	0	0	0
P6180084	41	18/06/2012	0:30	2.0208	2910	18-6-12 0:30			0	0	0	0	0	0	0	0	1	1	0			0	0	0	0	0
P6180085	42	18/06/2012	2:30	1.1042	1590	18-6-12 2:30			0	0	0	1	0	0	0	0	1	2	0			0	0	0	0	0
P6180086	43	18/06/2012	4:30	1.1875	1710	18-6-12 4:30			0	0	0	0	0	0	0	0	1	17	0			0	0	0	0	0
P6180087	44	18/06/2012	6:30	1.2708	1830	18-6-12 6:30			0	0	0	0	0	0	0	0	1	6	0			0	0	0	0	0
P6180088	45	18/06/2012	8:30	1.3542	1950	18-6-12 8:30			0	1	0	1	0	0	0	0	1	7	0			0	0	0	0	0
P6180089	46	18/06/2012	10:30	1.4375	2070	18-6-12 10:30			0	1	0	0	0	0	1	1	1	4	0			0	0	0	0	0
P6180090	47	18/06/2012	12:30	1.5208	2190	18-6-12 12:30			0	0	0	0	0	0	0	0	1	1	0			0	0	0	0	0
P6180091	48	18/06/2012	14:30	1.6042	2310	18-6-12 14:30			0	1	0	0	0	0	1	0	1	3	0			0	0	0	0	0
P6180092	49	18/06/2012	16:30	1.6875	2430	18-6-12 16:30			0	1	0	0	0	0	1	0	1	9	0			0	0	0	0	0
P6180093	50	18/06/2012	18:30	1.7708	2550	18-6-12 18:30			0	0	0	1	0	0	0	0	1	12	0			0	0	0	0	0
P6180094	51	18/06/2012	20:30	1.8542	2670	18-6-12 20:30			0	0	0	0	0	0	0	0	1	3	0			0	0	0	0	0
P6180095	52	18/06/2012	22:30	1.9375	2790	18-6-12 22:30			0	0	0	0	0	0	0	0	1	4	0			0	0	0	0	0
P6190096	53	19/06/2012	0:30	2.0208	2910	19-6-12 0:30			0	0	0	0	0	0	0	0	0	14	0			0	0	0	0	0
P6190097	54	19/06/2012	2:30	1.1042	1590	19-6-12 2:30			0	1	0	0	0	0	1	0	0	4	0			0	0	0	0	0
P6190098	55	19/06/2012	4:30	1.1875	1710	19-6-12 4:30			0	0	0	0	0	0	1	0	0	6	0			0	0	0	0	0
P6190099	56	19/06/2012	6:30	1.2708	1830	19-6-12 6:30			0	0	0	0	0	0	0	0	1	4	0			0	0	0	0	0
P6190100	57	19/06/2012	8:30	1.3542	1950	19-6-12 8:30			0	0	0	0	0	0	0	3	0	7	0			0	0	0	0	0
P6190101	58	19/06/2012	10:30	1.4375	2070	19-6-12 10:30			0	0	0	0	0	0	0	2	0	1	0			0	0	0	0	0
P6190102	59	19/06/2012	12:30	1.5208	2190	19-6-12 12:30			0	0	0	0	0	0	1	0	0	2	0			0	0	0	0	0
P6190103	60	19/06/2012	14:30	1.6042	2310	19-6-12 14:30			0	0	0	0	0	0	1	1	0	1	0			0	0	0	0	0

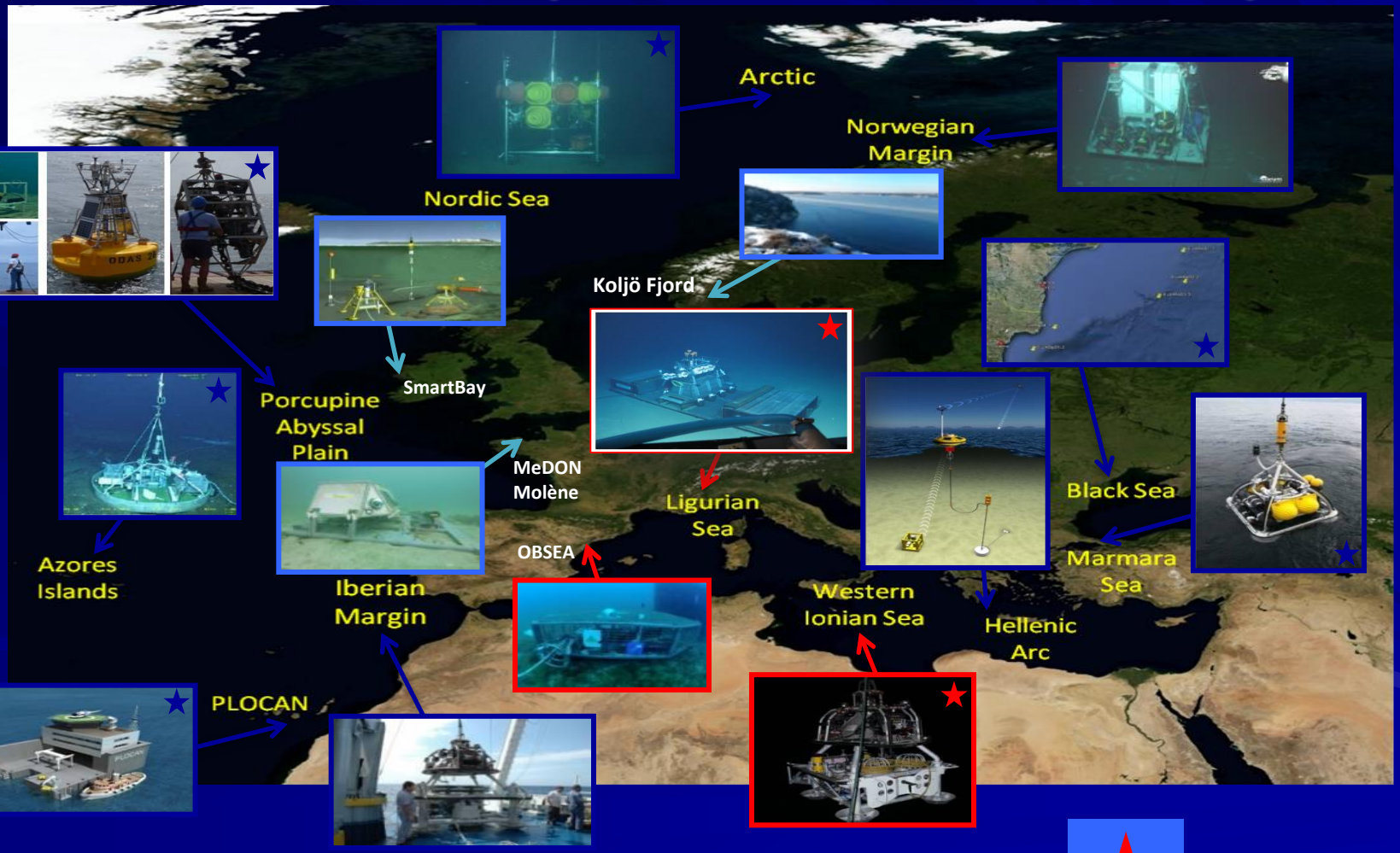
To conclude



Aguzzi et al. 2015. Rev. Fish. Biol. Fisher. 25: 463-483

A new operative framework with ONC experiences *as referent* for ecological development of EMSO

EMSO Nodes (11 nodes & 4 test sites)



Canada-Europe Working Session on Oceans Nov. 4-6, 2015
Marine Science Institute (ICM-CSIC, www.icm.csic.es) Barcelona (Spain)

HORIZON 2020 MARINE AND ATLANTIC ACTION PLAN: OCEAN COOPERATION BETWEEN EUROPE AND CANADA RELATED TO OCEAN OBSERVATORY SCIENCE, TECHNOLOGY, AND INNOVATION.

The Canada Foundation for Innovation www.innovation.ca
Spanish Institute of Oceanography www.ieo.es
Ocean Networks Canada www.oceannetworks.ca
Institute de Ciències del Mar www.icm.csic.es
Trade Commissioner Service, Embassy of Canada to Spain: www.espana.gc.ca