MareFrame

Scientific Conference
"Advances in Ecosystem-based Fisheries Management"

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This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no. 613571

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Cetacean fishery interactions: A multi-species model for ecosystem management in Atlantic waters of the Iberian Peninsula.

C. Saavedra, S. Cerviño, B. Elvarsson, D. Howell, G. Pierce, B. Santos

CENTRO OCEANOGRÁFICO DE VIGO

100 años en Vigo
una vida en el mar

FECYT

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Starting point:

- Hake is a main species in the area
- Small cetaceans (common and bottlenose dolphin) are known to be main hake predators.
- Aim: to develop a multispecies assessment model for hake fishery and dolphins
- Approach: develop individual GADGET models and link them.
- Problem: existing dolphin information is scarce, incomplete, unknown, …

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Spatial Area and Cetaceans model structure

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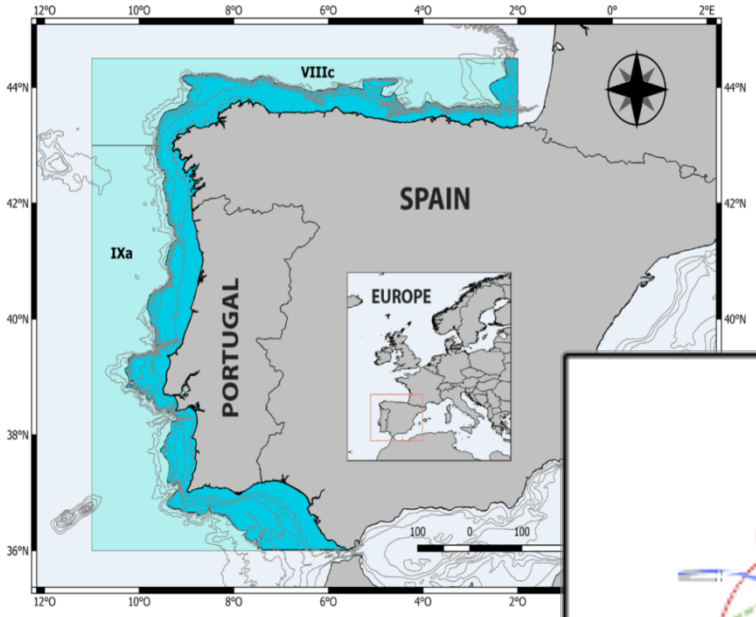

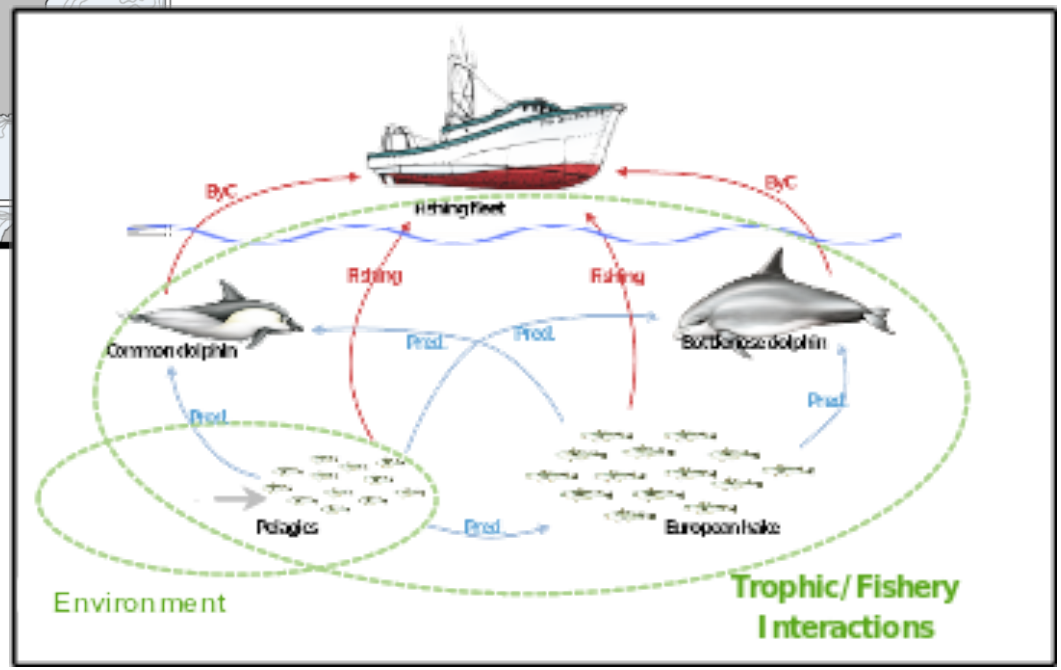

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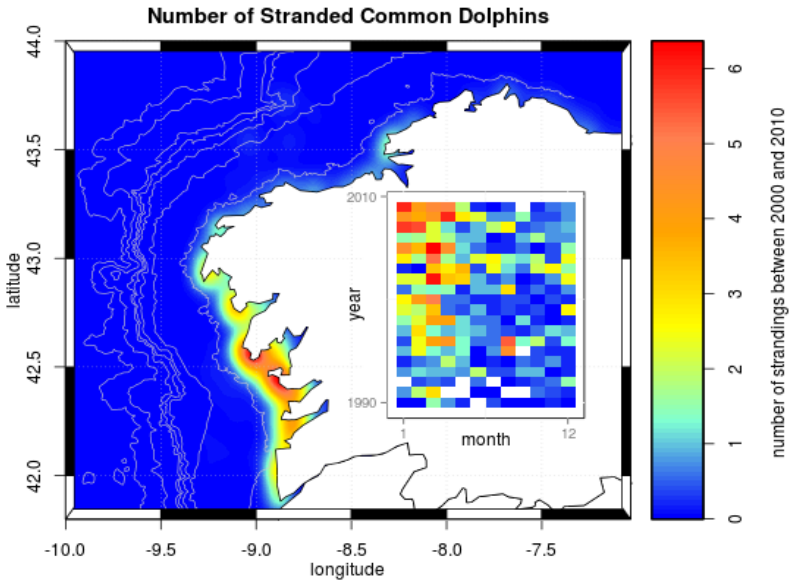
Main original information source:

Strandings

- from 1990 to 2013
- Common dolphin ≈ 2600
- Bottlenose dolphin ≈ 360
- sex
- size and age
- fecundity
- diet
- mortality causes



Saavedra et al. 2017 Factors driving patterns and trends in strandings of small cetacean. Mar. Biol. 164.

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Disentagling Cetacean by-catch and natural mortality

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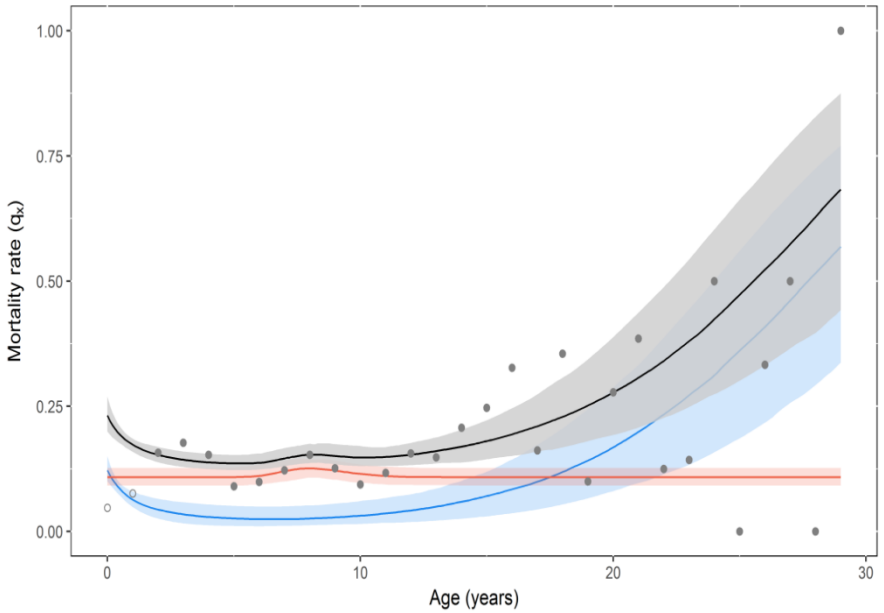
Life tables

age	M	S	nx	dx	qx	lx
0	20	440	1000	46	0.05	1.00
1	32	420	955	73	0.08	0.95
2	54	388	882	123	0.14	0.88
3	55	334	759	125	0.17	0.76
4	43	279	634	98	0.15	0.63
5	22	236	536	50	0.09	0.54
6	20	214	486	46	0.09	0.49
7	22	194	441	50	0.11	0.44
8	21	172	391	48	0.12	0.39
9	20	151	343	46	0.13	0.34
10	17	131	298	39	0.13	0.30
11	16	114	259	36	0.14	0.26
12	12	98	223	27	0.12	0.22
13	12	86	196	27	0.14	0.20
14	13	74	168	30	0.18	0.17
15	18	61	139	41	0.30	0.14
16	13	43	98	30	0.30	0.10
17	4	30	68	9	0.13	0.07
18	9	26	59	21	0.35	0.06
19	2	17	39	5	0.12	0.04
20	3	15	34	7	0.20	0.03
21	5	12	27	11	0.42	0.03
22	2	7	16	5	0.28	0.02
23	0	5	11	0	0.00	0.01
24	2	5	11	5	0.40	0.01
25	0	3	7	0	0.00	0.01
26	1	3	7	2	0.34	0.01
27	1	2	5	2	0.49	0.00
28	0	1	2	0	0.00	0.00
29	1	1	2	2	1.00	0.00



Mortality at age (Natural and By-caught) estimated fitting the Modified Heligman-Pollard model

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Cetacean model parameters

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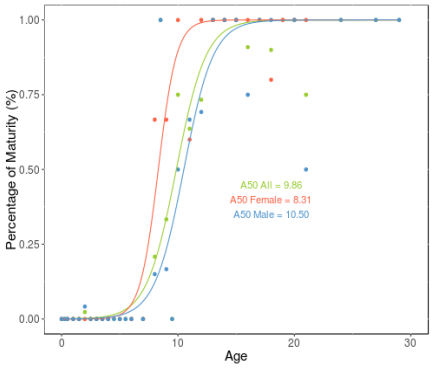
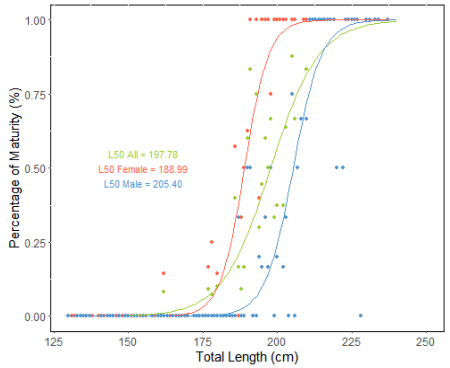
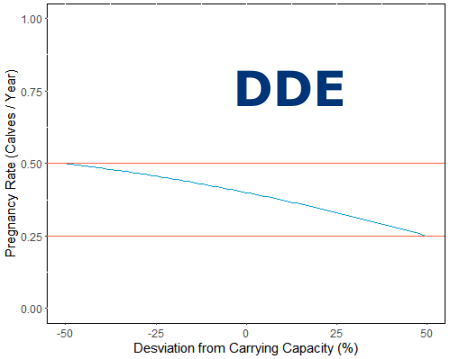
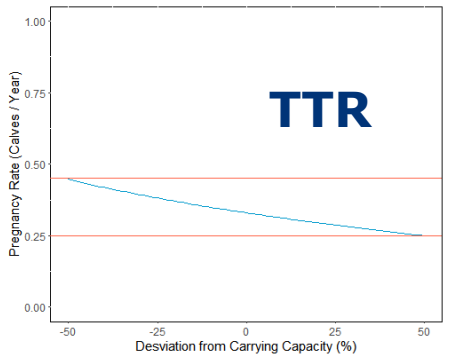


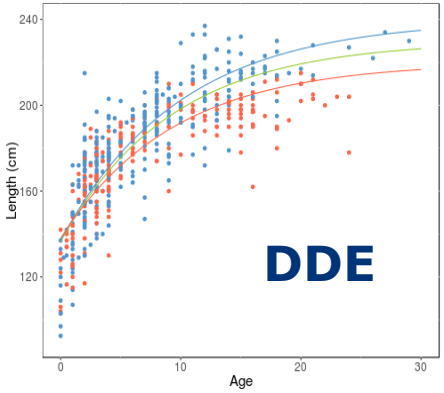


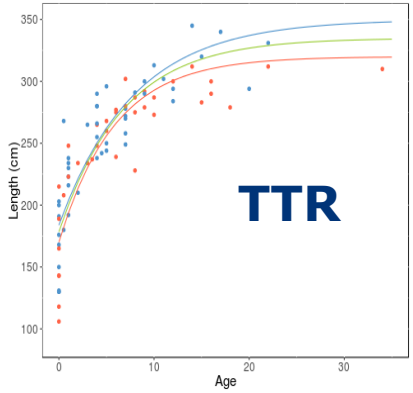
Maturity ogives Males (blue), females (red) and both sexes together (green).





Density-dependence fecundity (annual pregnancy rate)





von Bertlanffy growth models Males (blue), females (red) and both sexes together (green).

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Cetacean abundance

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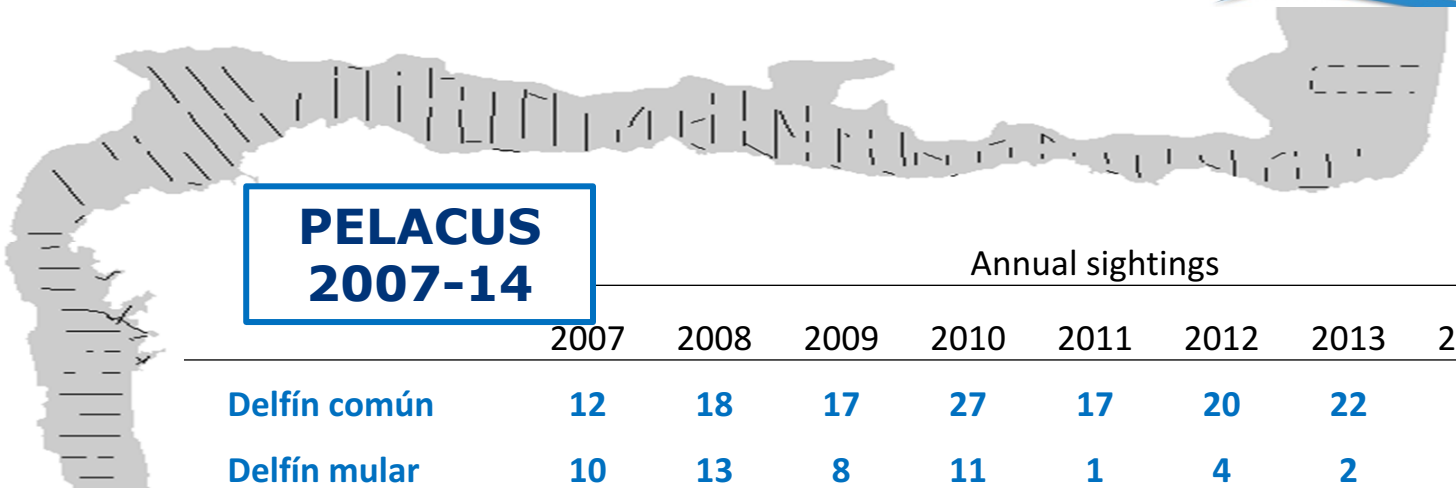


PELACUS 2007-14

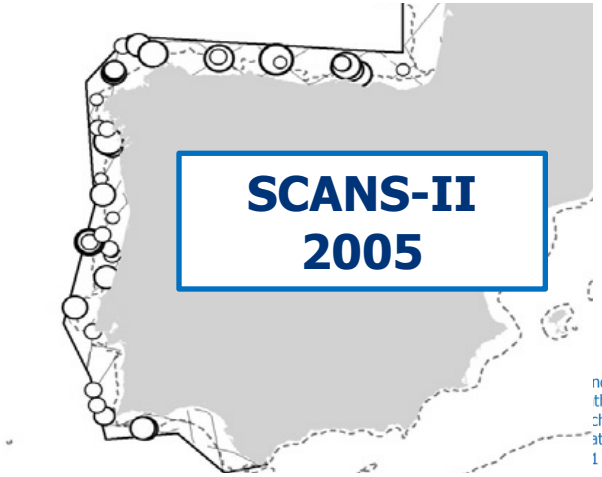
Annual sightings

	2007	2008	2009	2010	2011	2012	2013	2014	Total
Delfín común	**12**	**18**	**17**	**27**	**17**	**20**	**22**	**25**	**158**
Delfín mular	**10**	**13**	**8**	**11**	**1**	**4**	**2**	**30**	**79**

Saavedra, et al. *2017.* Assessing the Environmental Status of the short-beaked common dolphin (*Delphinus delphis*) in North-western Spanish waters using abundance trends and safe removal limits. Progress in Oceanography

Common dolphin (*Delphinus delphis*) **11 471 (CV = 0.22)**

Bottlenose dolphin (*Tursiops truncatus*) **2 617 (CV = 0.38)**



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Linking Cetaceans and hake

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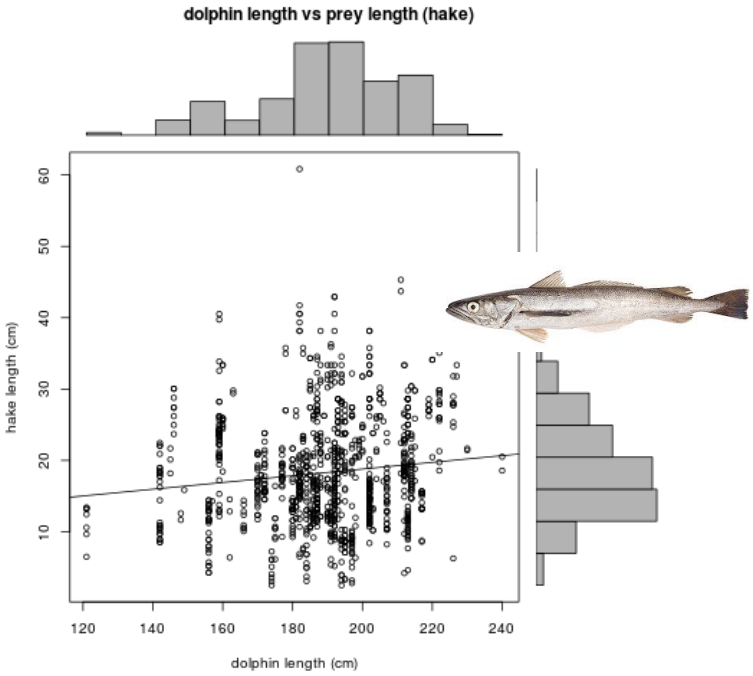
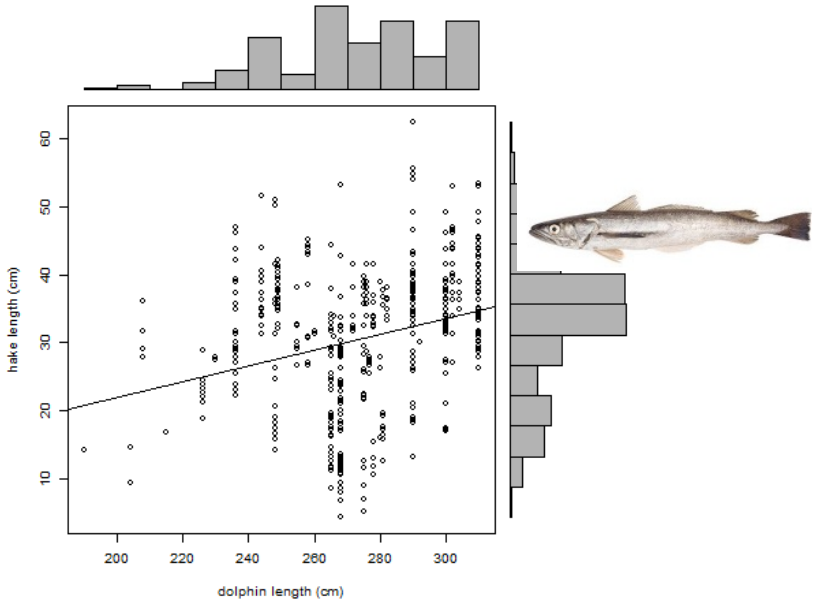


~ 11 471 common dolphins consuming ~5% hake



~ 2 617 bottlenose dolphins consuming ~30 % hake

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GADGET multispecies model settings

- 1982-2014 (by quarter)
- Cetaceans model parameters fixed with constant abundance
- Hake models parameters as in ICES assessment model
- Cetacean – hake link based on diet proportion (constant on time) and length distribution
- Sardine and other food
- Hake M-at-age (M1+M2) estimation

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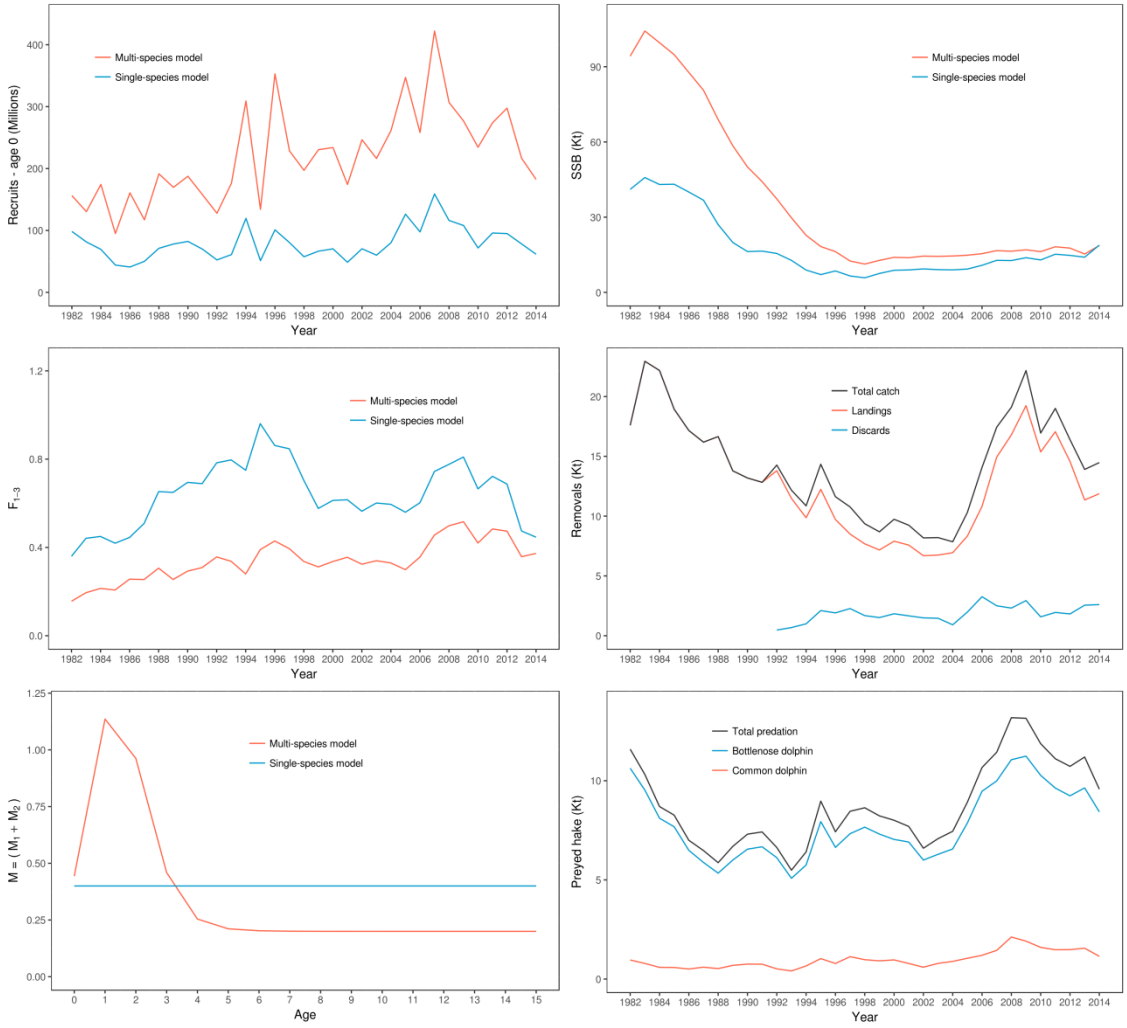
GADGET multispecies model results vs single hake model



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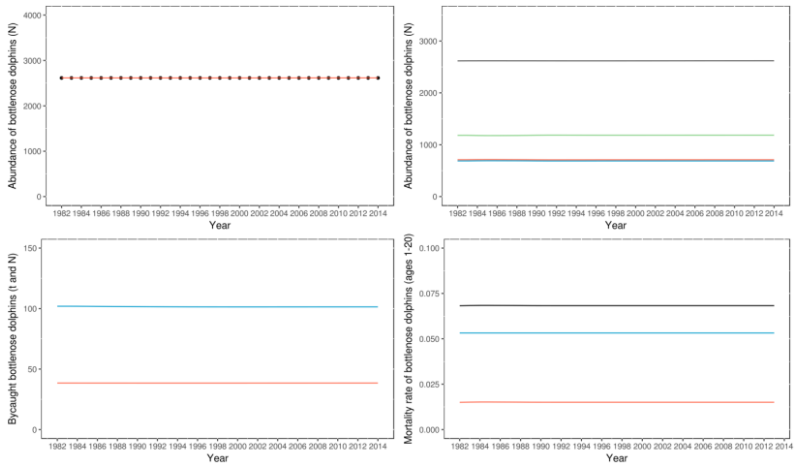
Result 1: Cetacean by-catch level



- Cetacean abundance Forced to keep stable on time since there is not clear temporal signals.
- Proposed management reference level for cetacean GES in MSFD
  - By-catch mortality estimated by the model:
    - 1.406%, [0.7-2.1] for Common dolphin
    - 1.423% [0.9-2.0] for bottlenose dolphin
  - Decreasing abundance level 0.7% and 0.6%

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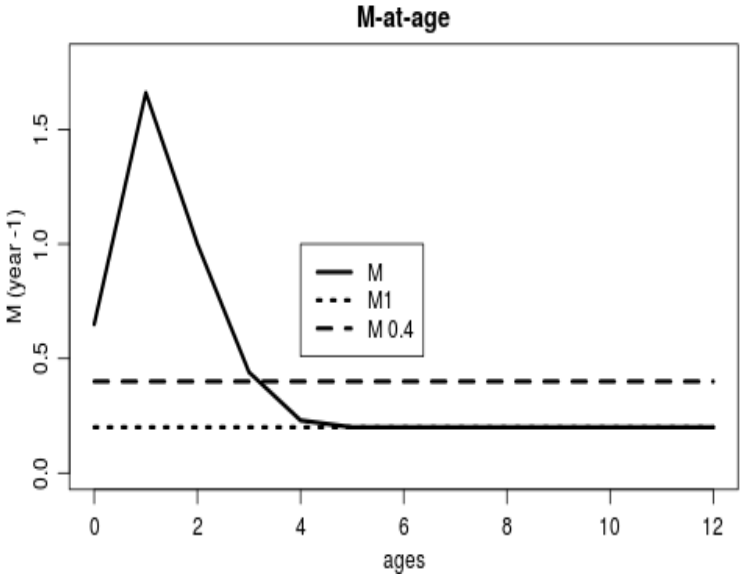
Result 2: New hake natural mortality at age

M1	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40
Likelihood	1105	1020	1052	1001	971	970	980	960
Mean M=M1+M2	0.40	0.39	0.43	0.45	0.49	0.52	0.56	0.60
T max	10.5	10.8	9.8	9.3	8.6	8.1	7.5	7.0

- **Combining model Likelihood and hake longevity (tmax) to estimate M1**



- Comparison of single species models with 2016 data update :
  - M=0.4 (likelihood = 1137)
  - Variable M (likelihood = 1003)

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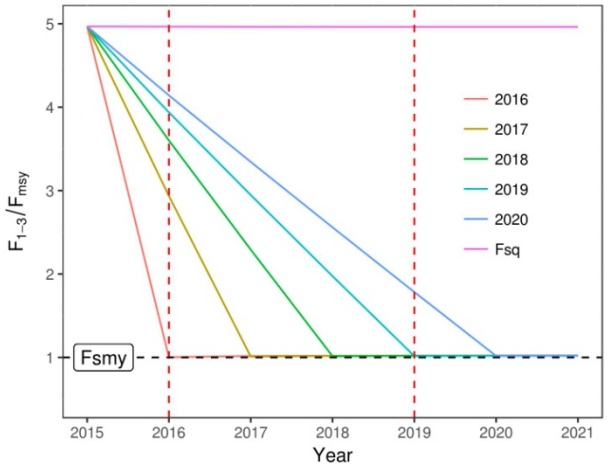
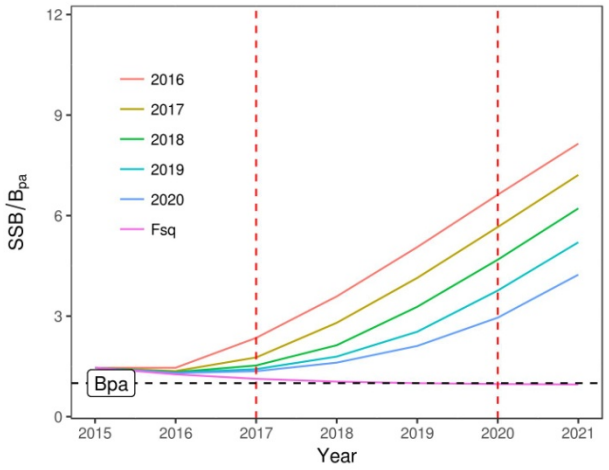
Result 3: Multispecies model to test management scenarios. Reaching hake Fmsy in different time periods.





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Conclusions

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- **It was possible to build a dynamic model with the available information but there are still some work to do.**
  - **Implementation of dolphin variable abundance.**
  - **Sensitivity analysis for more uncertain parameters (abundance, dense-dependent fecundity, M-at-age, etc)**
- **Cetaceans models allow definition of cetacean by-catch level (GES-MSFD)**
- **Multispecies model**
  - **improves Likelihood compared with hake model**
  - **Hake consumption amount at similar scale than hake catches.**
  - **Set a more rational M-at-age for hake**
  - **Useful as operating model in design of future multiannual plans**

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