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INTERNATIONAL WHALING COMMISSION

Is Iberian harbour porpoise (*Phocoena phocoena*) threatened by interactions with fisheries?

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Abstract

Harbour porpoises in the Iberian Peninsula form a genetically distinct, small (around 2900 animals) and isolated population. Their main prey are commercially important fish, hence overlap between porpoise occurrence and fishing activity is almost inevitable. We compile information on bycatch mortality, mainly collected over the last 15 years, based on on-board and land-based monitoring of fishing activity, analysis of cause of death and mortality rate based on strandings, and interview surveys with fishers. All these sources provide data of questionable reliability, for example due to low and incomplete coverage of fleets by on-board observers (indeed, essentially an absence of such data for the north coast of Spain (ICES area 8e). Nevertheless, all available estimates appear to suggest that the number of porpoises killed annually is likely to be unsustainably high. Despite some apparent incompatibility between abundance data, estimated bycatch mortality rates and genetic data, we suggest that both new mitigation action to reduce bycatch and improved monitoring are needed to secure the future of this population.

Introduction

The Iberian harbour porpoise (*Phocoena phocoena*) population inhabits the cold-water upwelling zone along the Atlantic coasts of Spain and Portugal (and possibly also southwards to north-west Africa), from the south Biscay coast to (at least) the Algarve coast of Portugal, bordering the Gulf of Cádiz (Sequeira, 1996; Castro, 2010). Records are most numerous in the Galician region of Spain and in northern and central Portugal (Donovan and Bjørge, 1995; Sequeira, 1996; Fontaine, 2016; Read, 2016; Hammond et al., 2017). In Galician waters the harbour porpoise is found in shelf waters between 35m and 200m depth, with a median value of around 88m. During 1990 to 1999, the porpoise was the third most frequently stranded cetacean species in Galicia (López et al. 2002).

Morphological and genetic studies indicate the Iberian harbour porpoise constitutes a separate population, probably most closely related to populations in Mauritania and Gambia in North-West Africa. Mitochondrial and nuclear microsatellite data confirm that Iberian porpoises are genetically distinct (Fontaine et al. 2014; Fontaine 2016) and they also morphologically distinct, with unusually large body size (Donovan and Bjørge, 1995). Fontaine et al. (2017) demonstrated an association between body size variation and genetic background. The Iberian and North-West African animals may represent a separate subspecies (the name *P.p. meridionalis* has been proposed) (Fontaine et al., 2007, 2010, 2014; Fontaine, 2016). There appears to be asymmetric mixing of Iberian and Bay of Biscay animals, i.e. migration from the Iberian unit but not into it (Fontaine et al., 2014). In addition to their presence along the French Atlantic coast (Alfonsi et al., 2012), results in Fontaine et al. (2017) indicate that Iberian animals have also contributed to the gene pool of porpoises in the Celtic Sea area, although again, mixing seems to have been asymmetric. Fontaine et al. (2007, 2010, 2014) and Llavona Vallina (2018) found that porpoises from Spain and Portugal had similar genetic diversity at mitochondrial and nuclear microsatellite markers. In both cases, mitochondrial and nuclear microsatellite DNA diversity was much lower than in all the other Atlantic populations, suggesting a very small effective population size (Fontaine et al. 2010; 2014). The most recent data on genetic diversity in Iberian porpoises suggest a sharp decline in abundance over the last 30 years (Fontaine, Pers. Comm., 2018).

Two large-scale abundance surveys, namely SCANS II and SCANS III, covered this area in 2005 and 2016 respectively. The 2005 survey was carried out in shelf waters of the combined Iberian Peninsula and the southern and central Bay of Biscay (SCANS II block W), producing an abundance estimate of 2,357 animals (CV=0.92) (Hammond et al., 2013). During the 2016 SCANS III survey this area was amended to correspond with the Iberian Peninsula Management Unit (IPMU) (ICES, 2009) and further divided into three sub-blocks. The survey generated an abundance estimate of 2,715 individuals (CV=0.31) from Cabo de São Vicente in Portugal northwards to Cape Finisterre in Galicia, which encompasses the core range of the Iberian population. A further 183 animals (CV=1.02) were estimated to be present between Cape Finisterre and Bayonne (France), while no porpoises were seen in the southern sub-block (Straits of Gibraltar to Cabo de São Vicente). The combined abundance estimate for the IPMU was 2,898 animals (CV=0.32). Porpoise densities recorded for the Iberian Peninsula SCANS blocks during the 2005 and 2016 surveys were among the lowest over the entire European continental shelf. Final abundance estimates for porpoises in the IPMU were very similar, 2880 (CV=0.72) and 2900 (CV=0.32) respectively (Hammond et al., 2017).

There have also been numerous local and regional surveys which recorded porpoises and it may be noted that one of these, in Portugal in 2012, suggested an abundance of around 3600 animals in Portuguese waters alone, more than double the estimate from the equivalent survey in 2011 (see ICES 2014a).

Fishery bycatch mortality is generally considered to be the main threat to harbour porpoise in European Atlantic waters. Analysis of life history data derived from strandings in Galicia and Portugal during 1990-2010 suggested that the bycatch mortality rate in the population could be well above limits of 1% or 1.7% suggested for intermediate total anthropogenic mortality in harbour porpoise (ASCOBANS, 2000): the overall annual mortality rate was estimated to be 18%, and around 25% of carcases (60% of those for which a cause of death was diagnosed) showed evidence of fishery interactions. This leads to estimates of annual bycatch mortality of between 4.3% and 11% (Read et al., 2020), equivalent to between approximately 130 and 330 deaths per year. Evidently if bycatch mortality is concentrated in inshore waters, the overall proportion of porpoise which died due to bycatch may be overestimated and it should also be noted that the SCANS survey abundance estimates suggested no population decline between 2005 and 2016.

In December 2018, the North Atlantic Marine Mammal Commission (NAMMCO) and the Norwegian Institute of Marine Research (IMR) held an International Workshop on "the Status of Harbour Porpoises in the North Atlantic". The present paper summarises and updates evidence about fishery bycatch mortality in the Iberian population presented in the workshop report (North Atlantic Marine Mammal Commission and the Norwegian Institute of Marine Research, 2020). Specifically, we examine more recent strandings data and summarise information on bycatch arising from on-board observation under national fishery monitoring programmes and individual projects, as well as briefly mentioning results of interview surveys. Finally, we consider the ecological dimension of bycatch, considering overlap between porpoise diet and fishery catches and the amount of fish likely to be eaten by porpoises.

Update on strandings in Galicia (NW Spain)

Between 1990 and 2019, cetacean strandings in Galicia included 22 species (López, 2017). An average of 205 (st. dev. = 76.82) stranded marine mammals was recorded per year. Harbour porpoise comprised 5.2% of those strandings (N=321) or an average of 11 (st. dev. = 4.67) per year (see Figure 1).

Of the 313 porpoises in the database, 7 were known bycatches handed in by fishermen and should thus not be considered in the calculations here, while 306 were strandings. Among the strandings, 120 animals were in a good state of preservation (decomposition state of 3 or less). Among the strandings, 53 (19.2% of the total) showed some evidence of fisheries interactions. This changes to 41 (34.2%) if we consider only those strandings in good preservation state. The figures are summarised in Table 1. No sex-related difference was seen in the incidence of fisheries interactions.

The estimates of the percentage of mortality due to bycatch are considerably lower than those given by Read et al. (2020) (which may have been slightly inflated if known bycatches were included; see figures in Table 1) but it should be noted that the data series presented here is from Galicia only and does not include data from Portugal. However, assuming that the previously estimated annual mortality rate of 18% is applicable, annual by-catch mortality would thus be between 3.1% and 6.8% of the population. If we further assume a population size of 2900 animals in the Iberian Peninsula and assume that inferences from Galician strandings data can be applied to the entire Iberian Peninsula, this is equivalent to annual bycatch deaths of between 90 and 197 individuals. For comparisons, the mortality rates estimated by Read et al. (2020) lead to an annual bycatch mortality of 125 - 330 porpoises.

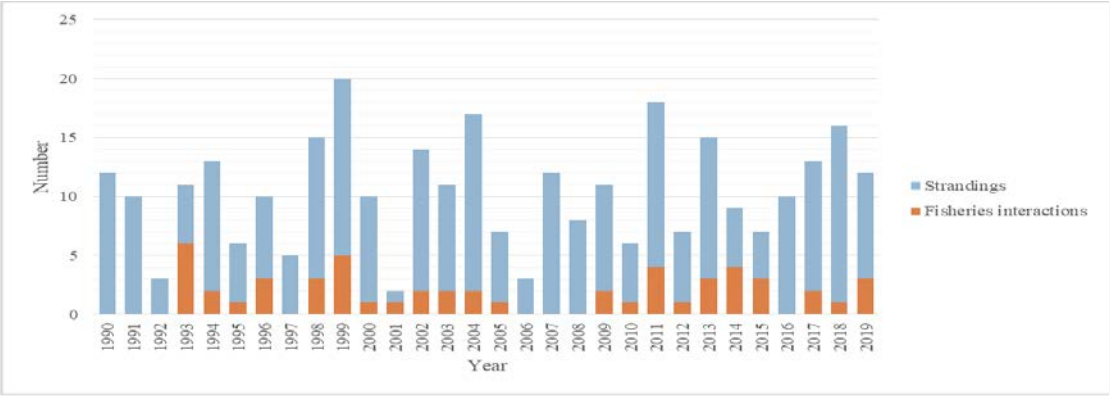

Figure 1. Porpoises stranded and diagnosed as bycaught, per year in Galicia (NW Spain), 1990-2019.

Table 1. Estimation of proportion and rate of bycatch based on porpoises examined in Galicia. Bycatch rates are expressed as the percentage of the population dying due to bycatch per year. A population size of 2900 is assumed (Hammond et al., 2017) and an overall annual mortality rate of 18% (Read et al., 2020).

		All states	Good state
Number of animals	A. All animals	313	127
	B. Known bycatch	7	7
	C. Stranded	306	120
	D. Diagnosed bycatch	53	41
	E. All bycatch	60	48
From all animals	%Bycaught (E/A)	19.2%	37.8%
	Bycatch mortality rate	3.5%	6.8%
	Number bycaught	100	197
From strandings	% Bycaught (D/C)	17.3%	34.2%
	Bycatch mortality rate	3.1%	6.2%
	Number bycaught	90	178

Interview surveys

Two interview-based studies, López et al. (2003) and Goetz et al. (2014) both generated estimates of total annual cetacean bycatch in Galicia of around 1700 animals. Porpoises were not specifically identified in the earlier study. Goetz et al. (2014) reported that Galician fishers operating fixed gillnets caught an average of 2 to 3 porpoises per year, with an estimated total annual bycatch by trawl and set gillnet fleets of approximately 40 porpoises, although almost 1300 of the cetaceans estimated to be bycaught annually were not identified to species.

An interview survey of 1274 fishers during 2009-2011 in northern Spain (Galicia, Asturias, Cantabria and the Basque Country) resulted in a total bycatch estimate of slightly over 3000 cetaceans per year, over 85% of which occurred in Galician waters. It was estimated that around 2% of bycatch mortalities in Galicia were of harbour porpoise (corresponding to 51 animals), compared to 30% in Asturias (75 animals) and none in the other two regions. These results imply a total annual bycatch mortality of 126 porpoises along the northern Atlantic coasts of Spain (Martínez-Cedeira and López, 2018).

In Portugal, interviews with fishers were carried out in 2009-2010 as part of the SafeSea project, to ask them about numbers of cetaceans bycaught over the last year. Mortalities of porpoise were reported by fishers using beach seines (20 interviews representing 50% of the fleet, 4 porpoise deaths) and polyvalent gears (175 interviews representing 35% of the fleet, 4 porpoise deaths). Scaling up gives an annual bycatch estimate of approximately 19 porpoises. Fishers using trawls, purse seines and bottom longlines reported cetacean bycatches but no bycatches of porpoise (Vingada et al., 2011).

On-board observations

Cetacean bycatches recorded by dedicated on-board observers under Regulation 812/2004 until 2019 have been compiled annually by ICES WGBYC in order to permit estimation of total bycatch. For the Iberian porpoise, the relevant ICES fishery divisions are 8e (northern Spanish Atlantic coast) and 9a (western Spanish Atlantic coast, Portuguese coast, southern Spanish Atlantic coast). Here we consider data up to and including 2016 (reported by WGBYC in 2018).

The only on-board observer-based bycatch estimates collected by Spain under Regulation 812/2004 in area 8 relate to a pilot project to study gillnet catches in 2008 and 2009, and pair trawls in 2008. Coverage in 2008 was in only the last quarter of the year and revealed no bycatches of porpoises (one common dolphin bycatch was recorded in the pair trawls and several in gill nets). These observations appear in reports by Anon. (2009) and Lens & Diaz (2009). A bycatch of around 300 porpoises in gill nets was estimated from the 2009 data. However, breaking the data down by sub-region, the bycatches of porpoises occurred further north in the Bay of Biscay, beyond Iberian waters (i.e., not in area 8e). An earlier study by Fernández-Contreras et al. (2010) carried out observations on-board pair trawlers in Galicia in 2001 and 2002 estimated an annual bycatch of 394 common dolphins but no harbour porpoises. Subsequently, Spain has submitted cetacean bycatch data collected by fishery observers and, at least until 812/2004 was repealed, these data have not been used by WGBYC. However, it appears that no porpoise bycatches were reported.

According to reports submitted to SGBYC and WGBYC (ICES, 2010, 2011), in 2007-2009 Portugal had no fisheries covered by regulation 812/2004 and no observer programme. Data from 2010-2016 are summarised in Table 2. In 2010, Portugal reported on observations of polyvalent and purse seine fisheries in area 9a, reporting 5 bycaught porpoises in the polyvalent fishery in ICES area 9a during 2010 (ICES, 2013a). Scaling up, this results in an estimate of 150 porpoises bycaught. In 2011, Portugal reported on observations of purse seine, polyvalent and demersal trawl fisheries, with 1 reported porpoise bycatch in the purse seine fishery, leading to an estimate of 103 porpoises bycaught (ICES, 2013b). In 2012, Portugal reported on observations from demersal trawl, purse seine and polyvalent (trammel net) fishing (ICES, 2014b). Bycatch of one porpoise was recorded in the polyvalent fleet deploying trammel nets. With 63612 days at sea (possibly the total estimated soak time), of which 71 were observed, the extrapolated bycatch, which ICES (2014b) did not report, would have been 896 porpoises. In 2013 and 2014, Portugal reported on bycatches in polyvalent, seine and bottom trawl fleets, which did not include any porpoises (ICES, 2015, 2016). In 2015, only observations from fisheries using “other gears” (presumably the polyvalent fleet based on the number of days at sea reported) were reported, with a bycatch of 6 porpoises. Extrapolation gives a porpoise bycatch of 1462 animals (ICES, 2017). A small number of trips by boats in the polyvalent fleet and deploying fixed nets was observed in 2016, yielding no bycatches of protected species (ICES, 2018).

Some additional bycatch data arise from research projects (Table 2). A total of 292 beach seine (xávega) hauls monitored (from land) in Portugal between 2008 and 2011 resulted in 5 porpoise

mortalities, i.e. a mortality rate of 0.017 animals per haul (Vingada et al., 2011). The authors state that they observed 3.3% of national fishing activity by this fleet. Based on broad consistency with annual fishing effort data reported in Oliveira et al. (2015), we assume that 292 hauls represented 3.3% of *annual* fishing effort by this fleet. Thus, the annual number of beach seine hauls would be around 8850, implying a total annual bycatch mortality in this gear of around 152 porpoises. While more recent data exist on bycatches in this fishery, these are not presently in the public domain. Observations on-board purse seiners in Portuguese waters in 2010-2011 (163 days at sea) yielded zero bycatch of porpoises, although a porpoise was observed being encircled and subsequently escaping. These results were reported in a paper (Marçalo et al., 2015) and it is not clear whether they were also included within Portugal´s submission to WGBYC.

Table 2. Bycatch data from observations (mainly) on-board Portuguese fishing vessels in area 9a. The main number given in each cell is the extrapolated bycatch mortality. Numbers in parentheses are the number of bycaught porpoises actually seen and the number of days of observation.

Source	Vingada et al. (2011)	Marçalo et al. (2015)	ICES WGBYC reports			
Year	Beach seine*	Purse seine	Purse seine	Polyvalent**	Trawls	Total
2008	152 (5, 149)	-	-	-	-	152
2009		-	-	-	-	152
2010		0 (0, 163)	0 (0, 369)	150 (5, 80) 0 (0, 161)	-	302
2011			103 (1, 110)	0 (0, 64)	0 (0, 78)	255
2012	-	-	0 (0, 94)	896 (1, 71)	0 (0, 144)	896
2013	-	-	0 (0, 114)	0 (0, 118)	0 (0,92)	0
2014	-	-	0 (0, 43)	0 (0, 50)	0 (0,71)	0
2015	-	-	-	1462 (6, 245)	-	1462
2016	-	-	-	0 (0, 13)	-	0
Total	152 (5, 149)	0 (0, 163)	103 (1, 730)	2507 (12, 802)	0 (0, 385)	
Average	152	0	21	358	0	531

* Observation of beach seining took place from the shore over 4 years and observed bycatch numbers are raised to the estimated annual total. ** The 2010 “polyvalent” fleet data were reported separately for boats targeting demersal and pelagic fish. Porpoise bycatches came from boats targeting mackerel, horse mackerel and sardine.

Based on the combined Portuguese data from 2008-2016, as described above, the estimated average annual bycatch across polyvalent, purse seine and beach seine fleets along the Portuguese coast is 531 animals, although there is wide variation between years and monitoring coverage was both low and uneven. It is also striking that only 18 porpoise deaths were observed over this period. Again it should be noted that fishing in Spanish Atlantic coastal waters is effectively excluded, potentially leading to underestimates. In addition, fishing vessels <15m in length would normally not have been included in the sampling under 812/2014. Provided their fishing effort was included in the total, this does not automatically result in bycatch being underestimated, but it could be a source of bias.

Bycatch mortality: summary

The various bycatch mortality estimates are summarised in Table 3. It is worth noting that few bycaught mortalities have been directly observed and the minimum number of porpoise dying due to bycatch is no more than a handful per year on average. However, extrapolations lead to estimates of as many as 700 porpoise deaths per year (combining the highest estimates for Portugal and Spain) and, given the incompleteness of the monitoring coverage, the true figure could be even higher. It should be noted that, due to the prevailing currents, it is likely that many porpoises stranded in southern Galicia may have died in Portuguese waters, although if strandings data were available for the entire Iberian Atlantic coast this would not be an issue.

Table 3. Summary of bycatch mortality data for porpoises in the Iberian Peninsula. The minimum annual number of deaths refers to the number of bycaught porpoises actually observed. The letters in parentheses refer to the region to which the estimates have been extrapolated: G = Galicia, IP = Iberian Peninsula (Atlantic coast), NS = Northern Spain, P = Portugal

Areas sampled	Method	Years	Estimated annual deaths	Minimum annual deaths	Source
Galicia + Portugal	Strandings + life table*	1990-2010	129- 329 (IP)	3.8 (79 over 21 years) (G+P)	Read et al. (2020)
Galicia	Strandings + life table*	1990-2019	90-197 (IP)	2 (60 over 30 years) (G)	This study
Galicia	Interviews	2008-2010	40 (G)	-	Goetz et al. (2014)
Northern Spain	Interviews	2009-2011	126 (NS)	-	Martínez-Cedeira and López, 2018
Portugal	Interviews	2009-2010	19 (P)	-	Vingada et al. (2011)
Portugal	Observation of beach seine fishery	2008-2011	152 (P)	1.2 (5 over 4 years) (P)	Vingada et al. (2011)
Portugal	On-board observation of polyvalent, purse seine and trawl fleets	2010-2016	379 (P)	1.9 (13 over 7 years) (P)	ICES WGBYC reports

* Life table mortality rate from Read et al. (2020); in both studies the minimum number of porpoise deaths includes some carcases handed in by fishermen (a total of 7 in Galicia).

The ecological dimension: porpoise diet and food consumption

Stomach contents were analysed from 72 stranded porpoises during 1991-2018 to quantify diet, investigate seasonal, size- and sex-related variation in diet and to test whether interannual variation in the diet was related to changes in abundance of the main prey species. The most important prey were *Trisopterus* spp., blue whiting (*Micromesistius poutassou*), horse mackerel (*Trachurus trachurus*) and hake (*Merluccius merluccius*). All these main prey, to a greater or lesser extent, are commercially important in Galician waters. Year to year trends in the importance of hake in the diet of harbour porpoises appeared to track trends in hake spawning stock biomass (Hernandez-Gonzalez et al., unpublished). Previous summaries of porpoise diet in Galicia, based on analysis of samples to date, appeared in Pierce et al. (2010), Read et al. (2013) and Santos et al. (2014).

Santos et al. (2014) estimated annual fish consumption by harbour porpoise in Galicia based on then available diet data, published information on daily food intake and a preliminary population size figure derived from SCANS II results. They estimated that porpoises in the Iberian Peninsula take 39 t of Clupeidae (e.g. sardine), 258 t of Gadidae (e.g. *Trisopterus* spp. and blue whiting), 72 t of Merluccidae (i.e. hake) and 140 t of Carangidae (*Trachurus* spp.). Since the current population estimate for the Iberian Peninsula is around 2900 animals, and Santos et al. (2014) used a figure of 1115 porpoises, the above figures for consumption would be multiplied by 2.6. In comparison with fishery landings (even for the depleted Iberian sardine stock), these values are small. Nevertheless, the overlap between porpoise diet and fishery landings presumably contributes to the occurrence of fishery bycatch mortality.

Discussion

The different sources of data provide different perspectives on the amount of porpoise mortality caused by fishery bycatch in the Iberian Peninsula. We have not put confidence limits of the estimates but they would be wide and there is likely also substantial year-to-year variation.

Evidently, there are data availability and quality are issues. Regulation 812/2004 has now been repealed and superseded by Regulation 2019/1241 concerning the conservation of fisheries resources and the protection of marine ecosystems through technical measures. The new regulation presents some opportunities to improve bycatch monitoring but does not specifically address the main weaknesses of 812/2004, namely the focus on vessels over 15 m in length and the limited number of fleets covered, and indeed it is not clear how similarly incomplete compliance will be avoided. Lastly, by effectively abolishing the dedicated observer programme and integrating the monitoring of protected species bycatch into routine fishery data collection (with no specific funding provision) there is a serious risk that data quality will be degraded. In the context of the Iberian Peninsula, improved monitoring of small-scale fisheries is essential since, for example, most boats which carry gillnets are <15 m in length. It would also be useful if monitoring of strandings on Iberian Atlantic coasts was coordinated and funded at national level, rather than depending on a series of monitoring networks, some with regional funding but all to some extent relying on volunteers.

To put the various estimates, of numbers of porpoises bycaught, in perspective, during the 2018 NAMMCO/IMR workshop, Potential Biological Removal (PBR; Wade, 1998) calculations were carried out for various porpoise stocks (North Atlantic Marine Mammal Commission and the Norwegian Institute of Marine Research, 2020). For the Iberian porpoise, assuming a population size of 2900, application of a Bayesian logistic population growth model (Zerbini et al., 2011), and applying a recovery factor of 0.5, annual PBR was estimated to be 25 animals.

Essentially, every source of fishery bycatch data suggests that annual fishery bycatch mortality of harbour porpoises in the Iberian Peninsula is likely to be higher than PBR. However, as noted in the above-mentioned report, the data on population size and bycatch appear to be incompatible. The population may extend offshore in Portuguese waters beyond the SCANS survey area and also into the Galician rias (which were not surveyed by SCANS), which could have resulted in underestimation of population size. It is also possible that porpoise bycatch is quite localized and extrapolation of bycatch rates to entire Portuguese fleets is in some cases unjustified. There is also contradiction between the apparent stability of population size between 2005 and 2016, according to survey data, and genetic evidence that suggests a marked decline in abundance. What seems to be clear is that a small and genetically distinct population cannot withstand high bycatch mortality and application of a precautionary approach would imply the need for introduction of new mitigation measures (supported by better monitoring).

The precarious status of the Iberian porpoise has been highlighted previously. ICES WGMME (ICES, 2009) recommended that the Iberian population should be given a high priority for conservation, as a consequence of its "presumed small population size, low genetic diversity and likely susceptibility to habitat degradation". Read et al. (2018) submitted a document to the 24th ASCOBANS Advisory Committee requesting that the Iberian harbour porpoise be listed as a separate population and included in Appendices I and II of the Convention on Migratory Species (CMS). The 13th Conference of Parties (COP) of the CMS in February 2020 adopted a Concerted Action for Baltic and Iberian harbour porpoise populations.

In 2019 the European Commission was asked to introduce Fishery Emergency measures to protect common dolphins in the Bay and Biscay and harbour porpoise in the Baltic Sea due to high bycatch mortality. The question is, are such measures needed for Iberian porpoise?

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