

## Dolphin predation pressure on pelagic and demersal fish in the northwestern Mediterranean Sea

Quentin Queiros\*, Jean-Marc Fromentin, Guillelme Astruc, Robert Klaus Bauer, Claire Saraux

\*Corresponding author: quentin.queiros@ifremer.fr

Marine Ecology Progress Series 603: 13–27 (2018)

**Table S1.** Table summarizing all data used in the Monte Carlo simulations, their sources and associated references.

Data	Source	References
Dolphin census	Ifremer aerial surveys	<i>Bauer et al. 2015</i>
Proportion of dolphin species	Aerial survey from literature and PELMED acoustic survey observations	<i>Gannier 2005, Gómez De Segura et al. 2008, Laran et al. 2017</i>
Demographic composition	Mark-and-release captures and stranding individuals (literature)	<i>Wells &amp; Scott 1990, Calzada et al. 1994, 1996, Mcfee &amp; Hopkins-Murphy 2002, Stolen et al. 2002, Reeves &amp; Read 2003, Mattson et al. 2006, Centro Studi Cetacei 2012</i>
Dolphin length	Age-length relationships from literature	<i>See Tab. S2</i>
Dolphin weight	Length-mass relationships from literature	<i>See Tab. S3</i>
Daily energetic requirements	Mass-energetic requirement relationships from literature	<i>Kleiber 1975, Lockyer 1981, Lavigne et al. 1986, Kenney et al. 1997, Sigurjónsson &amp; Víkingsson 1997, Boyd 2002, Pusineri 2005, Leaper &amp; Lavigne 2007, Rechsteiner et al. 2013</i>
Nursing female requirements	Dolphin in captivity (literature)	<i>Kastelein et al. 2002, 2003</i>
Diet	Stomach content analysis	<i>See Tab. S4 and S5</i>
Energetic values of prey	Bomb calorimetry (literature)	<i>See Tab. 1</i>
Sardine and anchovy stocks	MEDITS bottom-trawl survey ( <a href="http://dx.doi.org/10.18142/7">http://dx.doi.org/10.18142/7</a> )	<i>GFCM 2017b</i>
European hake stock	PELMED acoustic survey ( <a href="http://dx.doi.org/10.18142/19">http://dx.doi.org/10.18142/19</a> )	<i>GFCM 2017a</i>

### References

- Bauer RK, Fromentin J-M, Demarcq H, Brisset B, Bonhommeau S (2015) Co-Occurrence and Habitat Use of Fin Whales, Striped Dolphins and Atlantic Bluefin Tuna in the Northwestern Mediterranean Sea (G Tserpes, Ed.). PLoS One 10:e0139218
- Boyd IL (2002) Energetics: consequences for fitness. In: Hoelzel AR (ed) Marine mammal biology: an evolutionary approach. Blackwell Science, Malden, MA, p 247–277
- Calzada N, Aguilar A, Sørensen TB, Lockyer CH (1996) Reproductive biology of female striped dolphin (*Stenella coeruleoalba*) from the western Mediterranean. J Zool 240:581–591

- Calzada N, Lockyer CH, Aguilar A (1994) Age and sex composition of the striped dolphin die-off in the Western Mediterranean. *Mar Mammal Sci* 10:299–310
- Centro Studi Cetacei (2012) Cetacei spiaggiati lungo le coste italiane XXI. Rendiconto 2006-2010. CSC Online Publications No. 129, Pescara
- Gannier A (2005) Summer distribution and relative abundance of delphinids in the Mediterranean Sea. *Rev Ecol Terre Vie* 60:223–238
- GFCM (General Fisheries Commission for the Mediterranean) (2017a) Report of the working group on stock assessment of demersal species. FAO, Rome
- GFCM (2017b) Report of the working group on stock assessment of small pelagic species. FAO, Rome
- Gómez De Segura A, Hammond PS, Raga JA (2008) Influence of environmental factors on small cetacean distribution in the Spanish Mediterranean. *J Mar Biol Assoc United Kingdom* 88:1185–1192
- Kastelein RA, Staal C, Wiepkema PR (2003) Food consumption, food passage time, and body measurements of captive Atlantic bottlenose dolphins (*Tursiops truncatus*). *Aquat Mamm* 29:53–66
- Kastelein RA, Vaughan N, Walton S, Wiepkema PR (2002) Food intake and body measurements of Atlantic bottlenose dolphins (*Tursiops truncatus*) in captivity. *Mar Environ Res* 53:199–218
- Kenney RD, Scott GP, Thompson TJ, Winn HE (1997) Estimates of prey consumption and trophic impacts of cetaceans in the USA northeast continental shelf ecosystem. *J Northwest Atl Fish Sci* 22:155–171
- Kleiber M (1975) Metabolic turnover rate: a physiological meaning of the metabolic rate per unit body weight. *J Theor Biol* 53:199–204
- Laran S, Pettex E, Authier M, Blanck A, David L, Dorémus G, Falchetto H, Monestiez P, Canneyt O Van, Ridoux V (2017) Seasonal distribution and abundance of cetaceans within French waters- Part I: The North-Western Mediterranean, including the Pelagos sanctuary. *Deep Res Part II Top Stud Oceanogr* 141:20–30
- Lavigne DM, Innes S, Worthy GAJ, Kovacs KM, Schmitz OJ, Hickie JP (1986) Metabolic rates of seals and whales. *Can J Zool* 64:279–284
- Leaper R, Lavigne DM (2007) How much do large whales eat? *J Cetacean Res Manag* 9:179–188
- Lockyer CH (1981) Growth and energy budgets of large baleen whales from the Southern Hemisphere. In: *Mammals in the seas*. Vol 3. FAO Fish Ser 5 p 379–487
- Mattson MC, Mullin KD, Ingram GW, Hoggard W (2006) Age structure and growth of the bottlenose dolphin (*Tursiops truncatus*) from strandings in the Mississippi sound region of the north-central Gulf of Mexico from 1986 to 2003. *Mar Mammal Sci* 22:654–666
- Mcfee WE, Hopkins-Murphy SR (2002) Bottlenose dolphin (*Tursiops truncatus*) strandings in South Carolina, 1992-1996. *Fish Bull* 100:258–265
- Pusineri C (2005) Niches alimentaires et partage des ressources: les petits cetacés du golfe de gascogne. PhD thesis, University of La Rochelle

- Rechsteiner EU, Rosen DAS, Trites AW (2013) Energy requirements of Pacific white-sided dolphins ( *Lagenorhynchus obliquidens* ) as predicted by a bioenergetic model. *J Mammal* 94:820–832
- Reeves RR, Read AJ (2003) Bottlenose dolphin, harbor porpoise, sperm whale and other toothed cetaceans. In: Feldhammer GA, Thompson BC, Chapman JA (eds) *Wild mammals of North America: biology, management, and conservation*, 2nd edn. The Johns Hopkins University Press, Baltimore, MD, p 397–424
- Sigurjónsson J, Víkingsson GA (1997) Seasonal abundance of and estimated food consumption by cetaceans in Icelandic and adjacent waters. *J Northwest Atl Fish Sci* 22:271–287
- Stolen MK, Odell DK, Barros NB (2002) Growth of bottlenose dolphins (*Tursiops truncatus*) from the Indian River Lagoon system, Florida, U.S.A. *Mar Mammal Sci* 18:348–357
- Wells RS, Scott MD (1990) Estimating bottlenose dolphin population parameters from individual identification and capture-release techniques. *Rep Int Whal Comm Spec Issue* 12: 407–415

**Table S2.** Age-length relationships for each dolphin species (length in cm, age in year). For each relation, minimal and maximal ages observed and used have been given by the range and number of observations by n.

Publication	Species	Sex	Age-length relationship	Range (year)	n
Mattson et al. 2006	Bottlenose dolphin	Male < 9 years	$L = 221.3 \times \exp(-0.73 \times \exp(-1.15 \times \text{age}))$	[0 ; 27]	69
		Male ≥ 9 years	$L = 254.0 \times \exp(-0.87 \times \exp(-0.38 \times \text{age}))$		
		Female < 9 years	$L = 215.9 \times \exp(-0.74 \times \exp(-1.25 \times \text{age}))$	[1 ; 29]	42
		Female ≥ 9 years	$L = 244.1 \times \exp(-0.87 \times \exp(-0.30 \times \text{age}))$		
Fernandez & Hohn 1998	Bottlenose dolphin	Male	$L = 263.5 \times \exp(-0.785 \times \exp(-0.35 \times \text{age}))$	[0 ; 33]	75
		Female	$L = 244.7 \times \exp(-0.755 \times \exp(-0.50 \times \text{age}))$	[0 ; 41]	78
Read et al. 1993	Bottlenose dolphin	Male	$L = 266.4 \times \exp(-0.422 \times \exp(-0.16 \times \text{age}))$	[0 ; 38]	129
		Female	$L = 249.2 \times \exp(-0.423 \times \exp(-0.31 \times \text{age}))$	[0 ; 48]	170
Stolen et al. 2002	Bottlenose dolphin	Male	$L = 254.9 \times \exp(-0.72 \times \exp(-0.36 \times \text{age}))$	[0 ; 35]	118
		Female	$L = 246.2 \times \exp(-0.78 \times \exp(-0.45 \times \text{age}))$	[0 ; 35]	72
Di-Méglio, Romero-Alvarez, and Collet 1996	Striped dolphin	Male	$L = 191.2 \times \exp(-0.70 \times \exp(-0.65 \times \text{age}))$	[0 ; 25]	22
		Female	$L = 194.8 \times \exp(-0.72 \times \exp(-0.38 \times \text{age}))$	[0 ; 22]	22
Calzada et al. 1997	Striped dolphin	Male	$L = 199.9 \times \exp(-0.51 \times \exp(-0.26 \times \text{age}))$	[0 ; 28]	75
		Female	$L = 194.4 \times \exp(-0.58 \times \exp(-0.38 \times \text{age}))$	[0 ; 32]	77
Gómez-Campos et al. 2011	Striped dolphin	Male	$L = 201.2 \times \exp(-0.64 \times \exp(-0.28 \times \text{age}))$	[0 ; 27]	17
		Female	$L = 195.3 \times \exp(-0.73 \times \exp(-0.37 \times \text{age}))$	[0 ; 34]	

## References

- Calzada N, Aguilar A, Grau E, Lockyer C (1997) Patterns of growth and physical maturity in the western Mediterranean striped dolphin, *Stenella coeruleoalba* (Cetacea: Odontoceti). *Can J Zool* 75:632–637
- Di-Méglio N, Romero-Alvarez R, Collet A (1996) Growth comparison in striped dolphins, *Stenella coeruleoalba*, from the Atlantic and Mediterranean coasts of France. *Aquat Mamm* 22:11–21
- Fernandez S, Hohn AA (1998) Age, growth, and calving season of bottlenose dolphins, *Tursiops truncatus* off coastal Texas. *Fish Bull* 96:357–365
- Gómez-Campos E, Borrell A, Cardona L, Forcada J, Aguilar A (2011) Overfishing of small pelagic fishes increases trophic overlap between immature and mature striped dolphins in the Mediterranean sea. *PLoS One* 6(9): e24554
- Mattson MC, Mullin KD, Ingram GW, Hoggard W (2006) Age structure and growth of the bottlenose dolphin (*Tursiops truncatus*) from strandings in the Mississippi sound

region of the north-central Gulf of Mexico from 1986 to 2003. *Mar Mammal Sci* 22:654–666

Read AJ, Wells RS, Hohn AA, Scott MD (1993) Patterns of growth in wild bottlenose dolphins, *Tursiops truncatus*. *J Zool* 231:107–123

Stolen MK, Odell DK, Barros NB (2002) Growth of bottlenose dolphins (*Tursiops truncatus*) from the Indian River Lagoon system, Florida, U.S.A. *Mar Mammal Sci* 18:348–357

**Table S3.** Length-weight relationships for bottlenose dolphins (length in cm, weight in kg). For each relation, minimal and maximal lengths observed and used have been given by the range and number of observations by n.

Publication	Species	Sex	Length-weight relationship	Range (cm)	n
Hart et al., 2013	Bottlenose dolphin	Female	$M=10^{-4.29} \times L^{2.73}$	[180 ; 270]	70
		Male	$M=10^{-5.40} \times L^{3.2}$	[170 ; 280]	86
Cockcroft and Ross, 1989	Bottlenose dolphin	Female	$M=10^{(-4.7 + 2.90 \times \log(L))}$	[100 ; 250]	84
		Male	$M=10^{(-5.1 + 3.06 \times \log(L))}$	[100 ; 260]	88

### References

Cockcroft VG, Ross GJB (1989) Age, growth, and reproduction of bottlenose dolphins *Tursiops truncatus* from the East coast of Southern Africa. *Fish Bull* 88:289–302

Hart LB, Wells RS, Schwacke LH (2013) Reference ranges for body condition in wild bottlenose dolphins *Tursiops truncatus*. *Aquat Biol* 18:63–68

**Table S4.** Abundance (N and %N), weight (W (g) and %W), occurrence (F and %F) and Index of Relative Importance (IRI and %IRI) of identified prey in stomach contents of 43 bottlenose dolphin (*Tursiops truncatus*) in NW Mediterranean Sea. Species with \* have been kept for the study (%IRI > 1)

Family	Species	N	%N	W	%W	F	%F	IRI	%IRI
Sparidae	Sparidae unknown	1	0,1%	514	0,2%	1	2,3%	1	0,0%
	<i>Boops boops</i> *	45	2,9%	5162	1,7%	6	14,0%	9490	21,2%
	<i>Pagellus sp.</i> *	21	1,4%	10500	3,4%	2	4,7%	24	0,1%
	<i>Diplodus puntazzo</i>	7	0,5%	2016	0,7%	1	2,3%	3	0,0%
	<i>Diplodus vulgaris/sargus</i>	4	0,3%	1160	0,4%	1	2,3%	2	0,0%
	<i>Dentex dentex</i> *	4	0,3%	8000	2,6%	1	2,3%	7	0,0%
	<i>Diplodus annularis</i>	5	0,3%	1000	0,3%	2	4,7%	3	0,0%
	<i>Lithognathus mormyrus</i>	2	0,1%	180	0,1%	1	2,3%	0	0,0%
	<i>Pagellus erythrinus</i> *	30	2,0%	22030	7,2%	9	20,9%	4647	10,4%
	<i>Pagellus acarne</i> *	33	2,1%	9900	3,2%	2	4,7%	27	0,1%
	<i>Sparus aurata</i>	2	0,1%	2000	0,7%	2	4,7%	4	0,0%
	<i>Spondylisoma</i>	1	0,1%	100	0,0%	1	2,3%	0	0,0%
Centranchidae	<i>Spicara smaris</i>	30	2,0%	510	0,2%	1	2,3%	5	0,0%
	<i>Spicara sp.</i>	28	1,8%	476	0,2%	1	2,3%	5	0,0%
Clupeidae	Clupeidae unknown	7	0,5%	105	0,0%	1	2,3%	1	0,0%
	<i>Sardina pilchardus</i> *	91	5,9%	2275	0,7%	7	16,3%	117	0,3%
	<i>Sardinella aurita</i>	18	1,2%	954	0,3%	1	2,3%	4	0,0%
Belonidae	<i>Belone belone</i>	4	0,3%	388	0,1%	1	2,3%	1	0,0%
	<i>Belone sp.</i>	1	0,1%	97	0,0%	1	2,3%	0	0,0%
Gadidae	Gadidae unknown *	42	2,7%	3570	1,2%	5	11,6%	49	0,1%
	<i>Trisopterus minutus</i>	22	1,4%	330	0,1%	1	2,3%	4	0,0%
	<i>Micromesistius poutassou</i> *	43	2,8%	4258	1,4%	3	7,0%	3530	7,9%
Lotidae	<i>Gaidropsarus sp.</i>	1	0,1%	70	0,0%	1	2,3%	0	0,0%
	<i>Molva sp.</i> *	44	2,9%	3740	1,2%	4	9,3%	41	0,1%
Phycidae	<i>Phycis blennoides</i>	4	0,3%	224	0,1%	3	7,0%	3	0,0%
Merluccidae	<i>Merluccius merluccius</i> *	489	31,8%	92286	30,2%	19	44,2%	12508	28,0%
Argentinidae	<i>Argentina sphyraena</i>	2	0,1%	24	0,0%	1	2,3%	0	0,0%
Congridae	<i>Conger conger</i> *	103	6,7%	74781	24,5%	12	27,9%	10404	23,3%
Scombridae	<i>Scomber scombrus</i>	5	0,3%	650	0,2%	1	2,3%	1	0,0%
	<i>Scomber sp.</i>	2	0,1%	260	0,1%	1	2,3%	1	0,0%
Carangidae	<i>Trachurus trachurus</i>	4	0,3%	40	0,0%	1	2,3%	1	0,0%
	<i>Trachurus sp.</i>	34	2,2%	340	0,1%	6	14,0%	2013	4,5%
Engraulidae	<i>Engraulis encrasicolus</i> *	93	6,0%	930	0,3%	4	9,3%	64	0,1%
Trichinidae	<i>Lepidopus caudatus</i> *	19	1,2%	10654	3,5%	1	2,3%	12	0,0%
Mugilidae	<i>Liza sp.</i>	4	0,3%	1881	0,6%	1	2,3%	2	0,0%
Moronidae	<i>Dicentrarchus labrax</i>	2	0,1%	880	0,3%	1	2,3%	1	0,0%
Sciaenidae	Sciaenidae unknown	2	0,1%	1	0,0%	1	2,3%	0	0,0%
Triglidae	<i>Chelidonichthys obscurus</i>	1	0,1%	30	0,0%	1	2,3%	0	0,0%
Labridae	<i>Symphodus tinca</i>	1	0,1%	100	0,0%	1	2,3%	0	0,0%
Ophidiidae	<i>Ophidion sp.</i>	62	4,0%	1	0,0%	6	14,0%	61	0,1%
Cepolidae	<i>Cepola macrophthalma</i>	61	4,0%	976	0,3%	7	16,3%	75	0,2%
Histiotteuthidae	<i>Histiotteuthis sp.</i>	1	0,1%	75	0,0%	1	2,3%	0	0,0%
	<i>Histiotteuthis bonnellii</i>	1	0,1%	75	0,0%	1	2,3%	0	0,0%

Family	Species	N	%N	W	%W	F	%F	IRI	%IRI
Ommastrephidae	<i>Todarodes sagittatus</i> *	33	2,1%	8920	2,9%	9	20,9%	114	0,3%
	<i>Todaropsis eblanae</i>	1	0,1%	157	0,1%	1	2,3%	0	0,0%
	<i>Illex coindetii</i>	7	0,5%	858	0,3%	2	4,7%	4	0,0%
Onychoteuthidae	<i>Ancistroteuthis lichtensteinii</i>	5	0,3%	183	0,1%	1	2,3%	1	0,0%
	<i>Onychoteuthis banksii</i>	1	0,1%	20	0,0%	1	2,3%	0	0,0%
Enoploteuthidae	<i>Abralia veranyi</i>	1	0,1%	2	0,0%	1	2,3%	0	0,0%
Loliginidae	<i>Loligo vulgaris</i> *	52	3,4%	17089	5,6%	11	25,6%	1305	2,9%
	<i>Loligo forbesii</i>	1	0,1%	350	0,1%	1	2,3%	0	0,0%
Sepiolidae	<i>Rondeletiola minor</i>	1	0,1%	3	0,0%	1	2,3%	0	0,0%
Sepiidae	<i>Sepia officinalis</i>	3	0,2%	62	0,0%	2	4,7%	1	0,0%
	<i>Sepia elegans</i>	1	0,1%	33	0,0%	1	2,3%	0	0,0%
Branchioteuthidae	Branchioteuthidae unknown	1	0,1%	7	0,0%	1	2,3%	0	0,0%
Octopodidae	<i>Eledone cirrhosa</i> *	24	1,6%	3081	1,0%	2	4,7%	13	0,0%
	<i>Eledone moschata</i>	4	0,3%	144	0,0%	3	7,0%	2	0,0%
	<i>Octopus vulgaris</i> *	16	1,0%	10907	3,6%	9	20,9%	104	0,2%
Euphausiidae	<i>Meganyctiphanes norvegica</i>	1	0,1%	1	0,0%	1	2,3%	0	0,0%
Alpheidae	<i>Alpheus glaber</i>	5	0,3%	50	0,0%	2	4,7%	2	0,0%
Solenoceridae	<i>Solenocera membranacea</i>	3	0,2%	30	0,0%	3	7,0%	2	0,0%
Goneplacidae	<i>Goneplax rhomboides</i>	1	0,1%	1	0,0%	1	2,3%	0	0,0%
Grapsidae	Grapsidae unknown	1	0,1%	1	0,0%	1	2,3%	0	0,0%

### References

- Astruc G (2005) Exploitation des chaînes trophiques marines de Méditerranée par les populations de cétacés. EPHE (Ecole Pratique des Hautes Etudes) dissertation, Laboratoire de Biogéographie et Ecologie des Vertébrés, Montpellier
- Dhermain F and Réseau Echouage Méditerranéen (2012) Suivi des échouages sur les côtes méditerranéennes françaises. Années 2009-2012. Rapport GECM / GIS3M, contrat 10-64 058-83400 pour le Parc National de Port-Cros, 140 p.
- Miokovic D, Kovacic D, Pribanic S (1997) Stomach content analysis of a bottlenose dolphin (*Tursiops truncatus*) from the Adriatic Sea. Eur Res Cetaceans 11:149

**Table S5.** Abundance (N and %N), weight (W (g) and %W), occurrence (F and %F) and Index of Relative Importance (IRI and %IRI) of identified prey in stomach contents of 147 striped dolphin (*Stenella coeruleoalba*) in NW Mediterranean Sea. Species with \* have been kept for the study (%IRI > 1)

Family	Species	N	%N	W	%W	F	%F	IRI	%IRI
Loliginidae	<i>Loligo vulgaris</i> *	125	1,92%	13050	7,24%	16	10,88%	1134	10,58%
	<i>Loligo forbesii</i>	16	0,25%	1368	0,76%	3	2,04%	3	0,03%
	<i>Alloteuthis media</i>	22	0,34%	195	0,11%	3	2,04%	4	0,03%
	<i>Alloteuthis sp.</i>	9	0,14%	162	0,09%	2	1,36%	<1	<0.01%
	<i>Loligo sp.</i>	3	0,05%	661	0,37%	3	2,04%	2	0,01%
Sepiidae	<i>Sepia officinalis</i> *	29	0,45%	1809	1,00%	8	5,44%	16	0,15%
Enoploteuthidae	<i>Abralia veranyi</i>	30	0,46%	287	0,16%	10	6,80%	10	0,09%
	<i>Abraliopsis morisii</i>	129	1,98%	1335	0,74%	13	8,84%	57	0,53%
Onychoteuthidae	<i>Onychoteuthis banksii</i> *	304	4,67%	7904	4,38%	29	19,73%	379	3,54%
	<i>Ancistroteuthis lichtensteinii</i> *	145	2,23%	7512	4,17%	39	26,53%	511	4,76%
	<i>Onychoteuthis sp.</i>	1	0,02%	10	0,01%	1	0,68%	<1	<0.01%
Ommastrephidae	<i>Todarodes sagittatus</i> *	260	4,00%	33915	18,81%	63	42,86%	2573	24,00%
	<i>Todaropsis eblanae</i> *	40	0,61%	4548	2,52%	18	12,24%	70	0,66%
	<i>Illex coindetii</i> *	113	1,74%	11026	6,11%	18	12,24%	173	1,61%
	Ommastrephidae unknown	7	0,11%	826	0,46%	3	2,04%	2	0,02%
Octopoteuthidae	<i>Octopoteuthis sicula</i>	40	0,61%	1087	0,60%	4	2,72%	7	0,07%
Sepiolidae	<i>Heteroteuthis dispar</i>	235	3,61%	836	0,46%	29	19,73%	174	1,62%
	<i>Sepiola sp.</i>	18	0,28%	116	0,06%	13	8,84%	6	0,06%
	<i>Sepietta oweniana</i>	36	0,55%	183	0,10%	14	9,52%	18	0,16%
	<i>Neorossia caroli</i>	5	0,08%	704	0,39%	4	2,72%	2	0,02%
	<i>Rossia macrosoma</i>	1	0,02%	14	0,01%	1	0,68%	<1	<0.01%
	<i>Sepietta sp.</i>	3	0,05%	15	0,01%	3	2,04%	<1	<0.01%
	<i>Rossia sp.</i>	3	0,05%	42	0,02%	1	0,68%	<1	<0.01%
Chiroteuthidae	<i>Chiroteuthis veranii</i> *	149	2,29%	2611	1,45%	22	14,97%	173	1,61%
Histiototeuthidae	<i>Histiototeuthis bonnellii</i> *	67	1,03%	6204	3,44%	18	12,24%	139	1,29%
	<i>Histiototeuthis reversa</i> *	173	2,66%	18568	10,30%	26	17,69%	483	4,51%
	<i>Histiototeuthis sp.</i>	10	0,15%	1310	0,73%	5	3,40%	6	0,05%
Ancistrocheiridae	<i>Ancistrocheirus lesueurii</i> *	14	0,22%	1885	1,05%	8	5,44%	13	0,12%
Ocythoideae	<i>Ocythoe tuberculata</i>	1	0,02%	42	0,02%	1	0,68%	<1	<0.01%
Octopodidae	<i>Eledone cirrhosa</i>	4	0,06%	512	0,28%	3	2,04%	1	0,01%
	<i>Scaevargus unicolor</i>	1	0,02%	19	0,01%	1	0,68%	<1	<0.01%
Branchioteuthidae	<i>Brachioteuthis riisei</i>	115	1,77%	785	0,44%	10	6,80%	36	0,34%
Cranchiidae	Cranchiidae unknown	4	0,06%	140	0,08%	3	2,04%	<1	<0.01%
Argonautidae	<i>Argonauta argo</i>	1	0,02%	20	0,01%	1	0,68%	3	0,03%
Clupeidae	<i>Sardina pilchardus</i> *	363	5,58%	9075	5,03%	10	6,80%	703	6,55%
	<i>Sardinella aurita</i>	30	0,46%	1590	0,88%	2	1,36%	4	0,04%
Engraulidae	<i>Engraulis encrasicolus</i> *	208	3,20%	1538	0,85%	7	4,76%	58	0,54%
Merlucciidae	<i>Merluccius merluccius</i> *	172	2,64%	11809	6,55%	20	13,61%	684	6,38%
Gadidae	<i>Micromesistius poutassou</i> *	1133	17,41%	9922	5,50%	14	9,52%	1181	11,01%
	Gadidae unknowns	1	0,02%	11	0,01%	1	0,68%	<1	<0.01%
Belonidae	<i>Belone belone</i>	8	0,12%	1113	0,62%	1	0,68%	15	0,14%
Sparidae	<i>Boops boops</i> *	259	3,98%	16492	9,15%	16	10,88%	695	6,48%
	Sparidae unknown	13	0,20%	886	0,49%	2	1,36%	2	0,02%



Family	Species	N	%N	W	%W	F	%F	IRI	%IRI	
Scombridae	<i>Scomber scombrus</i>	1	0,02%	130	0,07%	1	0,68%	<1	<0.01%	
Stomiidae	<i>Stomias boa</i>	385	5,92%	1516	0,84%	8	5,44%	268	2,50%	
Chauliodontidae	<i>Chauliodus sloani</i> *	49	0,75%	1958	1,09%	3	2,04%	11	0,10%	
Sternoptychidae	<i>Maurolicus muelleri</i>	649	9,97%	464	0,26%	2	1,36%	221	2,06%	
Myctophidae	<i>Hygophum sp.</i>	37	0,57%	13	0,01%	5	3,40%	6	0,06%	
	<i>Diaphus sp.</i>	201	3,09%	109	0,06%	9	6,12%	88	0,82%	
	<i>Diaphus rafinesquii</i>	258	3,96%	228	0,13%	1	0,68%	44	0,41%	
	<i>Lobianchia gemellarii</i>	39	0,60%	233	0,13%	4	2,72%	12	0,11%	
	<i>Lampanyctus crocodilus</i>	28	0,43%	855	0,47%	3	2,04%	3	0,03%	
	<i>Lampanyctus sp.</i>	13	0,20%	88	0,05%	1	0,68%	3	0,03%	
	<i>Ceratoscopelus maderensis</i>	39	0,60%	8	0,00%	5	3,40%	93	0,86%	
	<i>Notoscopelus sp.</i>	102	1,57%	600	0,33%	5	3,40%	456	4,26%	
	Myctophidae unknown		85	1,31%	499	0,28%	5	3,40%	12	0,12%
	<i>Symbolophorus veranyi</i>	6	0,09%	72	0,04%	2	1,36%	28	0,26%	
Argentinidae	<i>Argentina sphyraena</i>	5	0,08%	60	0,03%	1	0,68%	12	0,11%	
Atherinidae	<i>Atherina sp.</i>	30	0,46%	300	0,17%	1	0,68%	66	0,62%	
Pasiphaeidae	<i>Pasiphaea multidentata</i>	122	1,87%	737	0,41%	8	5,44%	36	0,34%	
	<i>Pasiphaea sivado</i>	18	0,28%	165	0,09%	5	3,40%	6	0,06%	
Oplophoridae	<i>Acanthephyra pelagica</i>	13	0,20%	27	0,01%	3	2,04%	1	0,01%	
Sergestidae	<i>Sergia robusta</i>	103	1,58%	94	0,05%	5	3,40%	11	0,11%	
Aristeidae	Aristeidae unknown	4	0,06%	8	0,00%	1	0,68%	<1	<0.01%	
Alphaeidae	<i>Alpheus dentipes</i>	3	0,05%	6	0,00%	1	0,68%	<1	<0.01%	
	<i>Alpheus glaber</i>	2	0,03%	4	0,00%	1	0,68%	3	0,03%	
Pandalidae	<i>Plesionika heterocarpus</i>	5	0,08%	10	0,01%	1	0,68%	<1	<0.01%	
	<i>Chlorotocus sp.</i>	2	0,03%	4	0,00%	1	0,68%	<1	<0.01%	
Penaeidae	<i>Parapenaeus longirostris</i>	7	0,11%	14	0,01%	1	0,68%	<1	<0.01%	
	<i>Funchalia woodward</i>	1	0,02%	2	0,00%	1	0,68%	<1	<0.01%	

## References

- Astruc G (2005) Exploitation des chaînes trophiques marines de Méditerranée par les populations de cétacés. EPHE (Ecole Pratique des Hautes Etudes) dissertation, Laboratoire de Biogéographie et Ecologie des Vertébrés, Montpellier
- Dhermain F and Réseau Echouage Méditerranéen (2012) Suivi des échouages sur les côtes 96 méditerranéennes françaises. Années 2009-2012. Rapport GECM / GIS3M, contrat 10-97 058-83400 pour le Parc National de Port-Cros, 140 p. 98
- Würtz M, Marrale D (1993) Food of striped dolphin, *Stenella coeruleoalba*, in the Ligurian 99 Sea. J Mar Biol Assoc UK 73:571

**Table S6.** Mean, coefficient of variation (CV) and taxonomic level of energetic values used for the 27 dolphin prey. Energetic value of each prey species was estimated from the different bibliographic sources listed in the last column, using a normal distribution  $N(\mu, \sigma)$ , in which  $\mu$  is the mean energetic value found at the lowest phylogenetic level of the prey and  $\sigma = \text{mean} \times \text{CV}$  of the energetic values obtained at this phylogenetic level. Note that the CV depends on the taxonomic level at which the information was available, being the lowest when the CV was provided at the species level and the highest when it was only provided at the order level.

Species	Mean (kJ g <sup>-1</sup> )	CV (%)	Taxonomic level	Source(s)
<i>Ancistrocheirus lesueurii</i>	4.5	35%	Order	Montevecchi et al. 1984, Steimle et Terranova 1985, Clarke et al, 1985, Steimle et Terranova 1988, Lawson et al. 1998, Eder et Lewis 2005, Pusineri 2005, Ciancio et al. 2007, Cherel et Ridoux 2008, Einoder 2009, Spitz et al. 2010
<i>Ancistroteuthis lichtensteini</i>	4.6	26%	Family	Clarke et al. 1985, Perez 1994, Eder et Lewis 2005, Cherel et Ridoux, 2008
<i>Boops boops</i>	8.0	18%	Species	Spitz et al. 2010
<i>Chauliodus sloanii</i>	5.1	18%	Species	Steimle et Terranova 1988
<i>Chiroteuthis veranyi</i>	4.5	35%	Order	Montevecchi et al. 1984, Steimle et Terranova 1985, Clarke et al, 1985, Steimle et Terranova 1988, Lawson et al. 1998, Eder et Lewis 2005, Pusineri 2005, Ciancio et al. 2007, Cherel et Ridoux 2008, Einoder 2009, Spitz et al. 2010
<i>Conger conger</i>	6.9	18%	Species	Spitz et al. 2010
<i>Dentex dentex</i>	7.6	26%	Family	Steimle et Terranova 1985, Spitz et al. 2010
<i>Eledone cirrhosa</i>	4.7	18%	Species	Spitz et al. 2010
<i>Engraulis encrasicolus</i>	7.0	18%	Species	Pusineri 2005, Tirelli et al. 2006, Dubreuil et Petitgas 2009, Spitz et al. 2010, Harmelin-Vivien et al. 2012, Spitz et Jouma's 2013
Gadidae unkown	4.9	26%	Family	Steimle et Terranova 1985, Perez 1994, Lawson et al. 1998, Eder et Lewis 2005, Pusineri 2005, Ciancio et al. 2007, Spitz et al. 2010, Harmelin-Vivien et al. 2012, Spitz et Jouma's 2013
<i>Histioteuthis bonnellii</i>	2.7	20%	Genus	Clarke et al, 1985
<i>Histioteuthis reversa</i>	2.7	20%	Genus	Clarke et al, 1985
<i>Illex coindetii</i>	4.3	18%	Species	Spitz et al. 2010,
<i>Lepidopus caudatus</i>	5.2	26%	Family	Steimle et Terranova 1985
<i>Loligo vulgaris</i>	4.9	18%	Species	Pusineri 2005, Spitz et al. 2010, Cardona et al. 2012
<i>Merluccius merluccius</i>	3.9	18%	Species	Pusineri 2005, Spitz et al. 2010, Spitz et Jouma's 2013
<i>Micromesistius poutassou</i>	4.6	18%	Species	Pusineri 2005, Spitz et al. 2010, Spitz et Jouma's 2013
<i>Molva sp.</i>	3.6	26%	Family	Steimle et Terranova 1985
<i>Octopus vulgaris</i>	3.3	35%	Order	Steimle et Terranova 1988, Spitz et al. 2010
<i>Onychoteuthis banksii</i>	5.0	20%	Genus	Clarke et al. 1985, Perez 1994
<i>Pagellus acarne</i>	9.4	18%	Species	Spitz et al. 2010
<i>Pagellus erythrinus</i>	9.4	20%	Genus	Spitz et al. 2010
<i>Pagellus sp.</i>	9.4	20%	Genus	Spitz et al. 2010
<i>Sardina pilchardus</i>	10.2	18%	Species	Pusineri 2005, Spitz et al. 2010, Harmelin-Vivien et al. 2012, Spitz et Jouma's 2013
<i>Sepia officinalis</i>	3.8	18%	Species	Spitz et al. 2010

<i>Todarodes sagittatus</i>	4.0	18%	Species	Clarke et al. 1985
<i>Todaropsis eblanae</i>	4.4	18%	Species	Spitz et al. 2010

---

### References

- Cardona L, Álvarez de Quevedo I, Borrell A, Aguilar A (2012) Massive Consumption of Gelatinous Plankton by Mediterranean Apex Predators (Y Ropert-Coudert, Ed.). PLoS One 7(3): e31329
- Cherel Y, Ridoux V (2008) Prey species and nutritive value of food fed during summer to King Penguin *Aptenodytes patagonica* chicks at Possession Island, Crozet Archipelago. Ibis (Lond 1859) 134:118–127
- Ciancio JE, Pascual MA, Beauchamp DA (2007) Energy Density of Patagonian Aquatic Organisms and Empirical Predictions Based on Water Content. Trans Am Fish Soc 136:1415–1422
- Clarke A, Clarke MR, Holmes LJ, Waters TD (1985) Calorific Values and Elemental Analysis of Eleven Species of Oceanic Squids (Mollusca:Cephalopoda). J Mar Biol Assoc United Kingdom 65:983–986
- Dubreuil J, Petitgas P (2009) Energy density of anchovy *Engraulis encrasicolus* in the Bay of Biscay. J Fish Biol 74:521–534
- Eder EB, Lewis MN (2005) Proximate composition and energetic value of demersal and pelagic prey species from the Southwestern Atlantic Ocean. Mar Ecol Prog Ser 291:43–52
- Einoder LD (2009) The foraging ecology of the Short Tailed Shearwater *Puffinus tenuirostris*. PhD thesis, Adelaide University
- Harmelin-Vivien M, Mahé K, Bodiguel X, Mellon-Duval C (2012) Possible link between prey quality, condition and growth of juvenile hake (*Merluccius merluccius*) in the Gulf of Lions (NW Mediterranean). Cybium 36:335–348
- Lawson JW, Magalhães AM, Miller EH (1998) Important prey species of marine vertebrate predators in the northwest Atlantic: proximate composition and energy density. Mar Ecol Prog Ser 164:13–20
- Montevecchi WA, Ricklefs RE, Kirkham IR, Gabaldon D (1984) Growth energetics of Nestling Northern Gannets (*Sula bassanus*). Auk 101:334–341
- Perez MA (1994) Calorimetry Measurements of Energy Value of some Alaskan Fishes and Squids. U.S. Dep. Commer., NOAA Tech.Memo. NMFS-AFSC-32, 32 p.
- Pusineri C (2005) Niches alimentaires et partage des ressources: les petits cétacés du golfe de gascogne. PhD thesis, University of La Rochelle
- Spitz J, Jouma'a J (2013) Variability in energy density of forage fishes from the Bay of Biscay (north-east Atlantic Ocean): reliability of functional grouping based on prey quality. J Fish Biol 82:2147–2152
- Spitz J, Mourocq E, Schoen V, Ridoux V (2010) Proximate composition and energy content

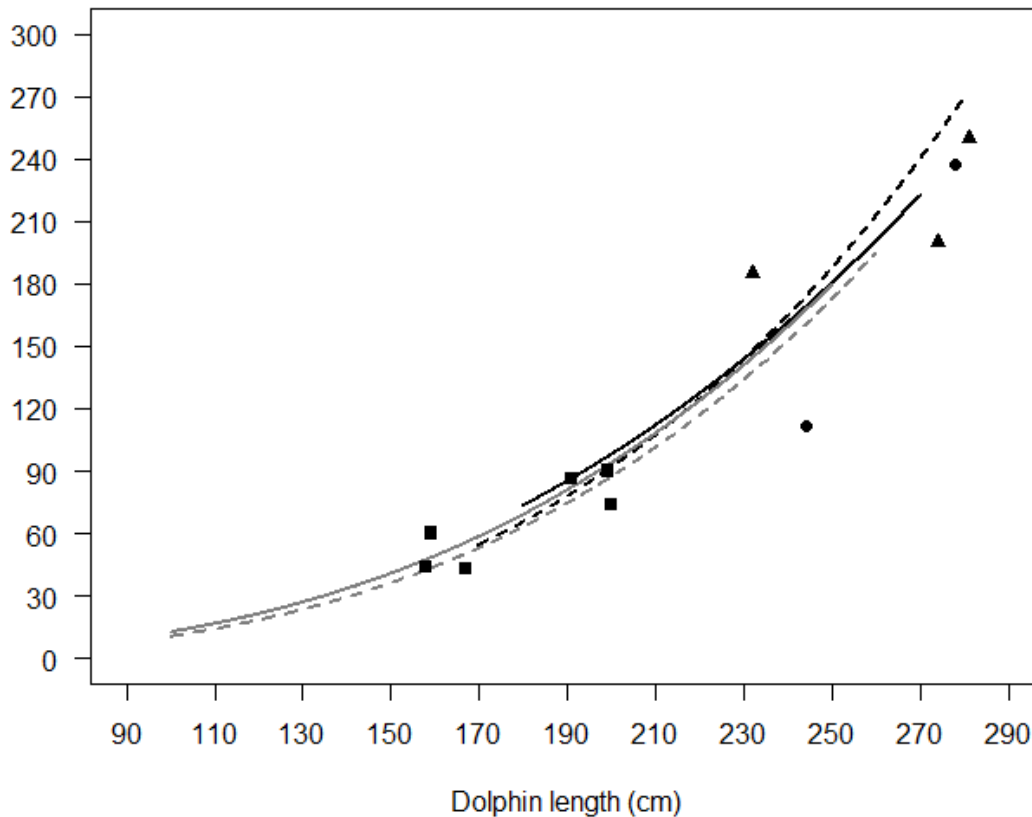
of forage species from the Bay of Biscay: high- or low-quality food? ICES J Mar Sci 67:909–915

Steimle FW, Terranova RJ (1985) Energy equivalents of marine organisms from the continental shelf of the temperate northwest Atlantic. J Northw Atl Fish Sci 6:117–124

Steimle FW, Terranova RJ (1988) Energy contents of northwest Atlantic continental slope organisms. Deep Sea Res Part A Oceanogr Res Pap 35:415–423

Tirelli V, Borme D, Tulli F, Cigar M, Fonda Umani S, Brandt SB (2006) Energy density of anchovy *Engraulis encrasicolus* L. in the Adriatic Sea. J Fish Biol 68:982–989

Dolphin mass (kg)

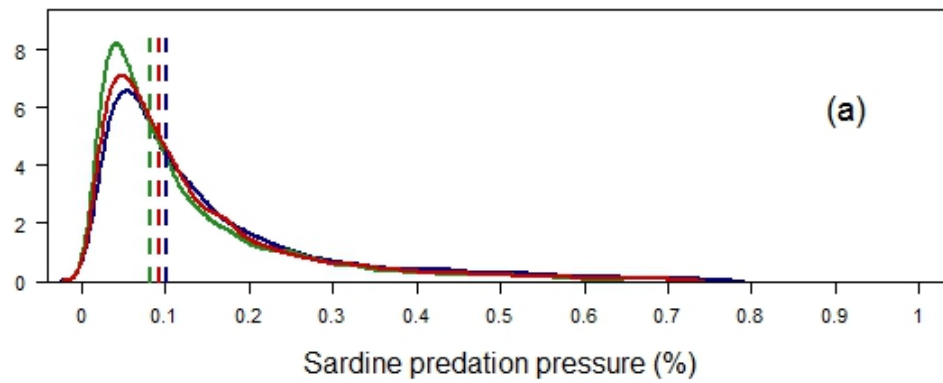


**Fig. S1.** Length-mass relationships found for bottlenose dolphins (black: Hart et al, 2013; grey: Cockcroft and Ross, 1989) for male (dashed lines) and female (solid lines). Stranded individuals found in the Mediterranean Sea are plotted (Orsi Relini et al., 1994; Miokovic et al., 1997; Wurtz and Marrale, 1993) (triangle: female bottlenose dolphins; circle: male bottlenose dolphin; square: male striped dolphin)

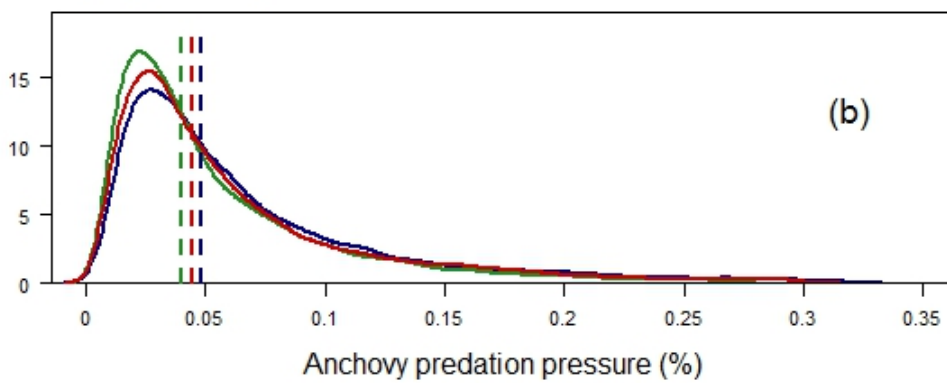
### References

- Cockcroft VG, Ross GJB (1989) Age, growth, and reproduction of bottlenose dolphins *Tursiops truncatus* from the East coast of Southern Africa. *Fish Bull* 88:289–302
- Hart LB, Wells RS, Schwacke LH (2013) Reference ranges for body condition in wild bottlenose dolphins *Tursiops truncatus*. *Aquat Biol* 18:63–68
- Orsi Relini L, Cappello M, Poggi R (1994) The stomach content of some bottlenose dolphins (*Tursiops truncatus*) from the Ligurian Sea. *Proc eighth Annu Conf Eur Cetacean Soc* 8:192–195
- Miokovic D, Kovacic D, Pribanic S (1997) Stomach content analysis of a bottlenose dolphin (*Tursiops truncatus*) from the Adriatic Sea. *Eur Res Cetaceans* 11:149
- Wurtz M, Marrale D (1993) Food of striped dolphin, *Stenella coeruleoalba*, in the Ligurian Sea. *J Mar Biol Assoc U K* 73:571

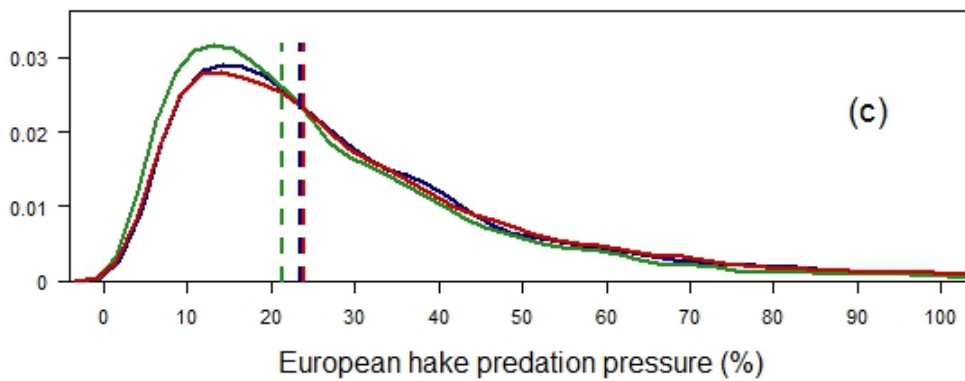
Density of predation pressure



Density of predation pressure



Density of predation pressure



**Fig. S2.** Density plots of the estimation of the predation pressure (95% CI) by dolphins on sardine (a), anchovy (b) and European hake (c) using the 3 energy relationships separately (equation [1]:blue ; equation [2]: green ; equation [3]: red). Median predation pressures are plotted (dashed lines).