MARINE MAMMAL COMMISSION

22 December 2020

Danielle Blacklock, Director
Office of Aquaculture, National Marine Fisheries Service
National Oceanic and Atmospheric Administration
Silver Spring, MD 20910

Re: NOAA–NMFS–2020–0118

Dear Ms. Blacklock:

The Marine Mammal Commission (the Commission) has been closely following the implementation of the 7 May 2020 Executive Order on "Promoting American Seafood Competitiveness and Economic Growth."[1] In consultation with its Committee of Scientific Advisors on Marine Mammals, the Commission has reviewed the National Marine Fisheries Service's (NMFS) 23 October 2020 request for information on the current and future plans for Aquaculture Opportunity Areas (AOAs) in the Gulf of Mexico, Southern California, and nationwide. As a general matter, the Commission is concerned that longline, cage, and other aquaculture gear associated with algae, shellfish, finfish, and combination aquaculture facilities may have impacts on cetaceans, pinnipeds, and sirenians, given uncertainties on whether and how marine mammals respond to or avoid man-made structures in the water. In particular, the critically endangered North Atlantic right whale (*Eubalaena glacialis*) and Gulf of Mexico Bryde's Whale (*Balaenoptera edeni* GOM subspecies) could be severely affected by even a few deaths. The Commission offers the following comments and recommendations in response to NMFS's question (#3 in the FRN) regarding the overlap of aquaculture gear with areas important to protected species.

**Marine Mammals and Aquaculture Interactions**

Marine mammals may interact with or be impacted by aquaculture gear, facilities, and activities in a number of ways, including entanglement and other gear interactions, habitat exclusion and modification, noise disturbance, and vessel strikes (e.g., Würsig et al. 2002, Becker et al. 2011, MMC 2011, Clement 2013, Price et al. 2016, Callier et al. 2017, NMFS 2019, Barrett et al. 2019). A number of attributes of marine aquaculture infrastructure could increase the threat of entanglement and non-lethal injury, including the arrangement of anchor lines, horizontal support longlines, vertical mussel grow lines, and marker buoy lines. The spat collection and surface buoy lines may pose the greatest risk (Moore & Wieting 1999, Lloyd 2003, Keeley et al. 2009, Clement 2013).

[1] Executive Order 13921, 85 Fed. Reg. 28471 (May 12, 2020).

Large whales (baleen whales and sperm whales) are known to become entangled in nets or ropes associated with fishing activities. Entanglements can result in death or sublethal injuries or impairments that affect health and reproduction. Many aquaculture facilities use nets and most, if not all, use ropes to tether the facility to anchors or buoys, interconnect arrays of cages or longlines, and suspend algae or shellfish in the water column. These lines pose an entanglement threat to large whales. In addition, if the netting used for finfish cages is not kept taut, cetaceans or pinnipeds can become entangled. Instances of whales becoming entangled in aquaculture gear have been reported around the world (Kemper & Gibbs 2001, Noke & O'Dell 2003, Allen & Bejder 2003, Kemper et al. 2003, Coughran 2005, Kemper et al. 2008).

Finfish facilities and their cages are often attractive to pinnipeds and small cetaceans that attempt to depredate fish from the cages (Güçlüsoy & Savas 2003, Quick et al. 2004, Díaz López & Bernal-Shirai 2007, Sepúlveda et al. 2015, Callier et al. 2017). These interactions can result in entanglement in cage netting, entrapment within cages, injuries suffered while trying to get into the cages, or harassment by facility employees seeking to deter depredation.[2]

Aquaculture facilities can displace marine mammals from important habitat used for feeding, reproduction, calving, or migration (Olesiuk et al. 2002, Johnston 2002 Markowitz et al. 2004, Pearson et al. 2009, Díaz López & Methion 2017). In addition, vessel activities associated with the operation of aquaculture facilities create the potential for acoustic disturbance and vessel strikes. Although there is little evidence to date that this threat is problem, it warrants monitoring and management to ensure minimal levels.

Harmful algal blooms are known or suspected causes of marine mammal deaths (e.g., Van Dolah et al. 2003, Flewelling et al. 2005, Torres de la Riva et al. 2009, Häussermann et al. 2017, Broadwater et al. 2018). Because nutrients from feces and excess feed can stimulate the growth of harmful algal blooms, finfish aquaculture operations have the potential to pose a significant threat to marine mammals (Ross Brown et al. 2019).

**Vulnerable Species and Habitats**

NMFS is in the midst of its programmatic evaluation of Aquaculture Opportunity Areas for shellfish, finfish, algae, or a combination of these methods in the Gulf of Mexico, Southern California, and future areas across the U.S. Exclusive Economic Zone (EEZ). In these early stages of the programmatic planning process, the Commission offers the following comments on the range, distribution, and vulnerability of sensitive species in federal waters nationwide.[3]

---

[2] NMFS is developing regulations that will identify allowable deterrence methods, but the potential still exists for facilities to use deterrence methods that are not approved and that could lead to injuries or death of depredating marine mammals.

[3] The Commission assumes that NOAA's lead agency status is currently limited to federal waters, per the Executive Order.

The Gulf of Mexico Bryde's whale (Rosel et al. 2016), as with other large whales, is known to be vulnerable to fatal entanglement in, and non-lethal interactions with, active and derelict fishing gear. Aquaculture facilities would add to the current threats to Bryde's whales and their habitat, which include pelagic and longline fisheries, vessel strikes, and ocean noise associated with energy development. Bryde's whale interactions with mussel aquaculture have been documented in New Zealand and Australia (Würsig & Gailey 2002, Lloyd 2003, Groom & Coughran 2012). In the Gulf of Mexico, habitat vital to the survival and recovery of the Bryde's whale population may be affected by the proposed aquaculture projects.

Anchoring, stabilizing, and buoy lines that are part of aquaculture facilities pose an entanglement risk, which needs to be mitigated through careful site selection and facility design. In considering AOAs in the Gulf of Mexico, the Commission recommends that NOAA ensure that AOAs do not overlap with the habitat of Gulf of Mexico Bryde's whales (Soldevilla et al. 2017), and as a precautionary measure since use of habitats can change over time, implement gear modification, monitoring, and siting practices that prevent, or at least mitigate, the risk of entanglement to these whales.

No information is available on the potential effects of aquaculture on Florida manatees (*Trichechus manatus*). However, this should be considered for future projects within the near-shore habitat occupied by these animals in the Gulf of Mexico (Würsig & Gailey 2002).

As in the Gulf of Mexico, longline or finfish aquaculture facilities sited in Southern California will create entanglement risk to large whales. Several endangered populations of large whales occur in those waters, including blue (*Balaenoptera musculus*), humpback (*Megaptera novaeangliae*; 'Mexico DPS' and 'Central America DPS') and sperm whales (*Physeter macrocephalus*) that forage in, and migrate through, the region. In addition, many gray whales (*Eschrichtius robustus*) migrate through the region twice yearly. The Commission recommends that NMFS, in assessing the suitability of potential AOAs in Southern California, place emphasis on delineating the foraging areas and migratory corridors of these species. Further, as with the Gulf of Mexico Bryde's whale population discussed above, the Commission recommends that NMFS ensure that aquaculture facilities are sited to avoid overlap with foraging areas and migratory corridors of large whales and are designed to minimize the likelihood of entanglements of large whales.

In addition, a number of species of pinnipeds and small cetaceans occur, and some breed, in Southern California, creating the potential for entanglement and for depredation of finfish aquaculture cages. The Commission recommends that NMFS, in assessing the suitability of sites for AOAs in Southern California, identify pinniped rookeries and the core habitat of small cetaceans, take these into account in siting decisions, and ensure that all facilities are constructed and operated in a manner that will minimize the opportunities for entanglement and depredation by pinnipeds and small cetaceans.

AOAs sited in the future in other areas of the EEZ could come into conflict with other populations of marine mammals, including ones listed as threatened or endangered under the Endangered Species Act. As in the Gulf of Mexico and Southern California, NMFS, in evaluating regions for the placement of AOAs, should carefully consider the potential impact on vulnerable marine mammals that use those regions for feeding, breeding, calving and migration.

The Commission draws particular attention to the critically endangered North Atlantic right whale, which calves in the southeastern United States, mainly off South Carolina, Georgia and northern Florida. The whales forage in New England and southeastern Canadian waters, and undertakes a north-south migration each year. Right whales are rapidly declining largely due to entanglements in fishing gear and ship strikes. Any injuries or deaths due to human activities will accelerate the species' decline toward extinction. Therefore, the Commission strongly recommends that for the foreseeable future no aquaculture facilities be sited off the east coast in areas within the known distribution of North Atlantic right whales. NMFS's efforts to reduce the number of vertical lines in the water column associated with fishing activities would be somewhat undermined if it then allows lines associated with aquaculture facilities.

A similar, but less dire, situation exists off the west coast from Point Conception, California, to the Canadian border, where in recent years large and possibly unsustainable numbers of humpback and blue whales have died from entanglement in crab pot lines. The Commission recommends that NMFS take a precautionary approach in assessing the suitability of sites for AOAs on the west coast, given the potential for exacerbating the current entanglement problem affecting the survival of endangered large whales there.

There is currently a NOAA-led and Navy-supported initiative to delineate and score a second round of Biologically Important Areas (BIAs) for cetaceans, focusing on but not limited to, the US EEZ and state waters. BIAs are areas where cetacean species and populations are known to concentrate for feeding, breeding, and migratory purposes, and where small and resident populations occur. The Marine Mammal Commission recommends that the NOAA aquaculture program monitor the progress of the BIA delineations and use the BIAs when assessing the suitability of potential AOAs.

**Management Options**

Since data on open-ocean aquaculture are limited, the Commission recommends the following non-exhaustive management options for fishing gear that are relevant to aquaculture. The anchor and buoy lines associated with fixed fishing gear pose a major risk to endangered and protected species. These lines are similar to those used in the designs of some marine aquaculture farms. Offshore farms tend to use thick metal cables under high tension or high tensile-strength lines (Ögmundarson et al. 2011). While thick, tense lines are less likely to pose an entanglement risk

to small cetaceans, collisions by the animals with such lines could result in non-fatal injuries (Baldwin et al. 2012). High-tension lines could also pose entanglement and injury risks to large whales. By limiting loose, unattended lines, or unnecessary lines, offshore aquaculture farms could limit the risk of entanglement or collision.

One additional mitigation option would be to apply data-informed spatial planning that seeks to avoid overlap between aquaculture facilities and the animals' home ranges, foraging and breeding areas, and migration routes. Aquaculture planning requires quantifying and minimizing the ecosystem footprint of siting, construction, and operation. Appropriate siting and geospatial analyses can limit the impacts of aquaculture. However, there is concern that farms may impede access to foraging or influence movements and habitat use. Spatial or temporal adjustments could reduce the effective overlap of aquaculture operations with the distribution of species of concern (Lindell & Bailey 2015).

Post-siting monitoring is vital to assessing the effectiveness of strategies to reduce the risk of harmful interactions between protected species and marine aquaculture. Quantification of observer program data and cooperative field observation and experimentation have been used in Maine's lobster fisheries. This approach could be instructive for monitoring aquaculture interactions (Soykan et al. 2008, McCarron & Tetreault 2012). Limiting the presence of lines and other entanglement risks is vital to preventing harmful marine-mammal and aquaculture interactions. Gear modifications such as those used to reduce rope strength along the U.S. East Coast and Canada could be instructive for marine aquaculture projects (Knowlton 2015). The Commission recommends that the mitigation measures described above be implemented in tandem with an adaptive management and monitoring approach.

**Statutory Authority**

Executive Order 13921 designates NOAA as the "lead agency" for aquaculture located in the Exclusive Economic Zone and assigns that agency the primary role in "navigating proposed projects through the Federal environmental review and authorization process." It is unclear whether these decisions were premised on a determination or an assumption that NMFS already has management and regulatory authority over aquaculture activities by virtue of the Magnuson-Stevens Act or simply that the agency has had a role and taken an interest in such matters in the past. If the former is the case, we note that a recent Fifth Circuit Court decision, although perhaps limited in geographic scope, throws such determination or assumption into question. The court ruled that Congress did not confer regulatory authority for aquaculture operations to NMFS under the Magnuson-Stevens Act. Given this uncertainty, the Commission recommends that NOAA, as part of its implementation of the Executive Order, clarify the steps that make up the "Federal environmental review and authorization process" for aquaculture activities, explain whether the requirements of the Magnuson-Stevens Act are relevant to some or all of these activities, and, if not,

describe any other laws and mechanisms it will use to ensure that aquaculture operations are situated and operated in ways that minimize risks to marine mammals and other resources.

**Conclusions**

Many of the potential effects of aquaculture on marine mammals described in this letter are difficult to evaluate because of insufficient data on the interactions between marine mammals and aquaculture. To address the need for adequate scientific information, the Commission recommends that NOAA include in its aquaculture policy a clear description of the existing gaps in the scientific information needed to manage aquaculture with respect to impacts on protected species, the research required to close those gaps, and the funding required to support the research. With regard to marine mammals, the following are examples of topics that warrant further research: (1) facility design and construction standards to minimize damage to and from marine mammals; (2) effects (and mitigation) of facility siting, design, and operation on marine mammal behavior, movements, and health; (3) effects (and mitigation) of facility operations and byproducts on marine ecosystems; (4) impacts on the forage base of marine mammals as forage fish are harvested for aquaculture feed and measures to alleviate those impacts; and (5) effects of the accidental escape of cultivated species.

Some of the most important information to be collected pertains to the nature, frequency, and significance of aquaculture/marine mammal interactions. Over time, the most effective means of evaluating such interactions and identifying possible unforeseen effects is requiring aquaculture operators to monitor and report.

The Commission appreciates the opportunity to submit recommendations during the planning process for current and future AOAs. Thank you for considering the Commission's comments as your agency develops national offshore aquaculture policy. Please do not hesitate to be in contact if you have questions about the Commission's recommendations or comments.

Sincerely,

Peter O. Thomas, Ph.D.,
Executive Director

Cc: Laura K. Engleby, Chief, Marine Mammal Branch, NMFS, Southeast Region
Jessica R. Powell, Biologist, NMFS, Southeast Regional Office
Chris Yates, Assistant Regional Administrator, NMFS, West Coast Region
Diane Windham, Aquaculture Coordinator, NMFS, West Coast Region

**References**

Allen, S, and L Bejder. 2003. Southern Right Whale *Eubalaena australis* sightings on the Australian coast and the increasing potential for entanglement. *Pacific Conservation Biology* 9: 228-233. https://doi.org/10.1071/pc030228

Becker, B, DT Press, and S Allen. 2008. Modeling the effects of El Niño, density-dependence, and disturbance on harbor seal (*Phoca vitulina*) counts in Drakes Estero, California: 1997-2007. *Marine Mammal Science* 25(1): 1-18. https://doi.org/10.1111/j.1748-7692.2008.00234.x

Becker, BH, DT Press, and SG Allen. 2011. Evidence for long-term spatial displacement of breeding and pupping harbour seals by shellfish aquaculture over three decades. *Aquatic Conservations: Marine and Freshwater Ecosystems*, 21(3): 247-260. https://doi.org/10.1002/aqc.1181

Broadwater, MH, FM Van Dolah, and SE Fire. 2018. Vulnerabilities of marine mammals to harmful algal blooms. Pp. 191-222 in: SE Shumway, JM Burkholder, and SL Morton (eds.), Harmful Algal Blooms, John Wiley & Sons, Ltd, Chichester, UK.

Callier, MD, CJ Byron, DA Bengtson, PJ Cranford, SF Cross, U Focken, et al. 2017. Attraction and repulsion of mobile wild organisms to finfish and shellfish aquaculture: a review. *Reviews in Aquaculture* 10(4): 924-949. https://doi.org/10.1111/raq.12208

Clement, D. 2013. Effects on Marine Mammals. Chapter 4 in: Ministry for Primary Industries. Literature Review of Ecological Effects of Aquaculture. Report prepared by Cawthorn Institute, Nelson, New Zealand. *Available at*: www.fish.govt.nz/en-nz/Commercial/Aquaculture/Marine-based+Aquaculture/Aquaculture+Ecological+Guidance.htm

Corkeron, P, R Reeves, and PE Rosel. 2017. *Balaenoptera edeni* (Gulf of Mexico subpopulation). The IUCN Red List of Threatened Species 2017: e.T117636167A117636174.

Coughran, D. 2005. Two entangled humpback whales, Western Australia. A report to the Department of Conservation and Land Management (CALM) Western Australia. No URL available.

De La Riva, GT, CK Johnson, FM Gulland, GW Langlois, JE Heyning, TK Rowles, T.K. and JA Mazet, 2009. Association of an unusual marine mammal mortality event with *Pseudo-nitzschia* spp. blooms along the southern California coastline. *Journal of wildlife diseases* 45(1): 109-121. https://doi.org/10.7589/0090-3558-45.1.109

Díaz López, B, and JA Bernal-Shirai. 2007. Bottlenose dolphin (*Tursiops truncatus*) presence and incidental capture in a marine fish farm on the north-eastern coast of Sardinia (Italy). *Journal of the Marine Biological Association of the UK* 87: 113–117. https://doi.org/10.1017/s0025315407054215

Díaz López, B, and S Methion. (2017) The impact of shellfish farming on common bottlenose dolphins' use of habitat. *Marine Biology* 164: 83. https://doi.org/10.1007/s00227-017-3125-x

Flewelling, LJ, JP Naar, JP Abbott, DG Baden, NB Barros, GD Bossart, M-YD Bottein, DG Hammond, EM haubold, CA Heil, MS Henry, HM Jacocks, TA Leightfield, RH Pierce, TD Pitchford, SA Rommel, PS Scott, Ka Steidinger, EW Truby, FM Van Dolah, and JH landsberg. Red tides and marine mammal mortalities. *Nature* 435: 755–756. https://doi.org/10.1038/nature435755a

Groom, CJ, and DK Coughran. 2012. Entanglements of baleen whales off the coast of Western Australia between 1982 and 2010: patterns of occurrence, outcomes and management responses. *Pacific Conservation Biology* 18(3): 203-214. https://doi.org/10.1071/PC130203

Güçlüsoy, H, and Y Savas. 2003. Interaction between monk seals *Monachus monachus* (Hermann 1779) and marine fish farms in the Turkish Aegean and management of the problem. *Aquaculture Research* 34: 777–783. https://doi.org/10.1046/j.1365-2109.2003.00884.x

Häussermann, V, Carolina, S Gutstein, M Bedington, D Cassis, C Olavarria, AC Dale, AM Valenzuela-Toro, MJ Perez-Alvarez, HH Sepúlveda, KM McConnell, FE Horwitz, and Günter Försterra. 2017. Largest baleen whale mass mortality during strong El Niño related to harmful toxic algal bloom. *PeerJ* 5:e3123. https://doi.org/10.7717/peerj.3123

Johnston, DW. 2002. The effect of acoustic harassment devices on harbour porpoises (Phocoena phocoena) in the Bay of Fundy, Canada. *Biological Conservation* 108:113-118. https://doi.org/10.1016/S0006-3207(02)00099-X

Keeley, N, B Forrest, G Hopkins, P Gillespie, B Knight, S Webb, D Clement, and J Gardner. 2009. Review of the ecological effects of farming shellfish and other non-finfish species in New Zealand. Cawthron Report. *Available at*: fs.fish.govt.nz/Page.aspx?pk=113&dk=22056

Kemper, CM, and SE Gibbs. 2001. Dolphin interactions with tuna feedlots at Port Lincoln, SA and recommendations for minimising entanglements. *Journal of Cetacean Research and Management* 3: 283-292.
*Available at*: https://archive.iwc.int/pages/search.php?search=%21collection15&k=#

Kemper, CM, D Pemberton, M Cawthorn, S Heinrich, J Mann, B Würsig, P Shaughnessy, and R Gales. 2003. Aquaculture and marine mammals: co-existence or conflict? Pp 208-224 in: N Gales, M Hindell, and R Kirkwood (eds). Marine Mammals: Fisheries, Tourism and Management Issues, CSIRO Publishing.

Knowlton, AR, J Robbins, S Landry, HA McKenna, SD Kraus, and T Werner. 2015. Effects of fishing rope strength on the severity of large whale entanglements. *Conservation Biology* 30(2): 318-328. https://doi.org/10.1111/cobi.12590

Lindell, S., and Bailey, D. (2015). What Can We Learn From Entanglement Cases of Whales and Turtles in Mussel Farming Gear? Presentation at the Northeast Aquaculture Conference and Exposition in Portland ME, January 16th, 2015. No URL available.

Lloyd, B. 2003. Potential Effects of Mussel Farming on New Zealand's Marine Mammals and Seabirds: A Discussion Paper. Wellington, N.Z. Dept. of Conservation.
*Available at*: https://catalogue.nla.gov.au/Record/3255706

Markowitz, TM, AD Harlin, B Würsig, and CJ McFadden. 2004. Dusky dolphin foraging habitat: overlap with aquaculture in New Zealand. *Aquatic Conservation: Marine and Freshwater Ecosystems* 14: 133–149. https://doi.org/10.1002/aqc.602

McCarron P, Tetreault H (2012) Lobster pot gear configurations in the Gulf of Maine. Consortium for Wildlife Bycatch Reduction.
*Available at*: www.bycatch.org/news/lobster-pot-gearconfigurations-gulf-maine.

MMC (Marine Mammal Commission). 2010. Development of a national aquaculture policy.
*Available at*: https://www.mmc.gov/wp-content/uploads/aquaculture_policy_51410.pdf

MMC (Marine Mammal Commission). 2011. Mariculture and Harbor Seals in Drakes Estero, California.
*Available at*: https://www.mmc.gov/wp-content/uploads/drakes_estero_report.pdf

Moore, K, and D Wieting. (1999) Marine Aquaculture, Marine Mammals, and Marine Turtles Interactions Workshop Held in Silver Spring, Maryland, 12– 13 January, 1999. NOAA Technical Memorandum NMFS-OPR-16, Silver Spring, Maryland.
*Available at*: www.nmfs.noaa.gov/pr/pdfs/interactions/workshop1999.pdf.

Nash, CE, RN Iwamoto, and CVW Mahnken. 2000. Aquaculture risk management and marine mammal interactions in the Pacific Northwest. *Aquaculture* 183(3): 307-323. https://doi.org/10.1016/S0044-8486(99)00300-2

NMFS (National Marine Fisheries Service). 2019. Southern California Offshore Aquaculture and Protected Species Interactions Workshop Summary. West Coast Regional Office. No URL available.

Noke, WD, and DK Odell. 2002. Interactions between the Indian River Lagoon blue crab fishery and bottlenose dolphin *Tursiops truncatus*. *Marine Mammal Science* 18: 819–832. https://doi.org/10.1111/j.1748-7692.2002.tb01075.x

Olesiuk, PF, LM Nichol, MJ Sowden, and JKB Ford. 2002. Effect of the sound generated by an acoustic harassment device on the relative abundance and distribution of harbor porpoises (Phocoena phocoena) in Retreat Passage, British Columbia. *Marine Mammal Science* 18: 843-862.

Pearson HC (2009) Influences on dusky dolphin (*Lagenorhynchus obscurus*) fission-fusion dynamics in Admiralty Bay, New Zealand. *Behavioral Ecology and Sociobiology* 63: 1437– 1446. https://doi.org/10.1007/s00265-009-0821-7

Price, CS, E Keane, D Morin, C Vaccaro, D Bean, and JA Morris, Jr. 2016. Protected Species & Longline Mussel Aquaculture Interactions. NOAA Technical Memorandum NOS NCCOS 211. 85 pp. *Available at:* http://venturashellfishenterprise.com/pdf/2017_Protected_Species_and_Marine_Aquaculture_Interactions.pdf

Quick, NJ, SJ Middlemas, and JD Armstrong. 2004. A survey of antipredator controls at marine salmon farms in Scotland. *Aquaculture* 230: 169–180. https://doi.org/10.1016/S0044-8486(03)00428-9

Rosel, PE, P Corkeron, L Engleby, D Epperson, KD Mullin, MS Soldevilla, and BL Taylor. 2016. Status Review of Bryde's Whales (*Balaenoptera edeni*) in the Gulf of Mexico under the Endangered Species Act. U.S. Department of Commerce. NOAA Technical Memorandum MFS-SEFSC-692. *Available at*: https://repository.library.noaa.gov/view/noaa/14180

Ross Brown, A, M Lilley, J Shutler, C Lowe, Y Artioli, R Torres, E Berdalet, and CR Tyler. Assessing risks and mitigating impacts of harmful algal blooms on mariculture and marine fisheries. *Reviews in Aquaculture* 12(3): 1663-1668. https://doi-org.weblib.lib.umt.edu:2443/10.1111/raq.12403

Sepúlveda, M, SD Newsome, G Pavez, D Oliva, DP Costa, and LA Hueckstaedt. 2015. Using satellite tracking and isotopic information to characterize the impact of South American sea lions on salmonid aquaculture in southern Chile. *PLoS One* 10: e0134926. https://doi.org/10.1371/journal.pone.0134926

Soldevilla MS, JA Hildebrand, KE Frasier, LA Dias, A Martinez, KD Mullin, PE Rosel, and LP Garrison. 2017. Spatial distribution and dive behavior of Gulf of Mexico Bryde's whales: Potential risk of vessel strikes and fisheries interactions. *Endangered Species Research* 32: 533– 550. https://doi.org/10.3354/esr00834

Soykan CU, Moore JE, Zydelis R, Crowder LB, Safina C, Lewison RL (2008) Why study bycatch? An introduction to the theme section on fisheries bycatch. *Endangered Species Research* 5: 91– 102. https://doi.org/10.3354/esr00175

Van Dolah, FM, CJ Doucette, FM Gulland, TL Rowles, and GD Bossart. 2003. Impacts of algal toxins on marine mammals. Pp. 247-269 in: Toxicology of Marine Mammals.

Waring GT, E Josephson, K Maze-Foley, PE Rosel, K Barry, B Byrd, TVN Cole, L Engleby, C Fairfield, LP Garrison, A Henry, L Hansen, J Litz, C Orphanides, RM Pace, DL Palka, MC Rossman, C Sinclair, and FW Wenzel. 2012. U. S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2011. NOAA Technical Memorandum NMFS-NE-22. Available at: www.nmfs.noaa.gov/pr/pdfs/sars/ao2011.pdf

Waring, GT, E Josephson, K Maze-Foley, PE Rosel, B Byrd, TVN Cole, L Engleby, LP Garrison, J Hatch, A Henry, SC Horstman, J Litz, KD Mullin, C Orphanides, RM Pace, DL Palka, M Lyssikatos, and FW Wenzel. 2015. Trends in Selected U. S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2014. NOAA Technical Memorandum NMFS-NE-23. Available at: www.nmfs.noaa.gov/pr/sars/pdf/ao2013_tm228.pdf.

Werner T, S Kraus, A Read, and E Zollett. 2006. Fishing techniques to reduce the bycatch of threatened marine animals. *Marine Technology Society Journal* 40: 50– 68. https://doi.org/10.4031/002533206787353204

Würsig B, and GA Gailey. 2002. Marine mammals and aquaculture: conflicts and potential resolutions. Pp. 45-59 in: RR Stickney and JP McVey (eds), Responsible Marine Aquaculture. CAB Publishing, New York.