MARINE MAMMAL COMMISSION

2 October 2012

Wesley Patrick, Ph.D.
Fishery Policy Analyst
National Marine Fisheries Service
1315 East-West Highway, Room 13436
Silver Spring MD 20910

Re: Revision to National Standard 1 Guidelines

Dear Dr. Patrick:

On 3 May 2012 the National Marine Fisheries Service provided advance notice of, and requested public comment on, potential adjustments to the National Standard 1 Guidelines (77 Fed. Reg. 26239). The Service seeks comments on specific issues described in the *Federal Register* notice or any other issues related to National Standard 1. National Standard 1, as set forth in the Magnuson-Stevens Fishery Conservation and Management Act, requires that "[c]onservation and management measures shall prevent overfishing while achieving, on a continuing basis, the optimal yield from each fishery for the United States fishing industry." The Marine Mammal Commission, in consultation with its Committee of Scientific Advisors on Marine Mammals, has considered the current guidelines, the issues identified in the *Federal Register* notice, and aspects of the Magnuson-Stevens Act and National Standard 1 Guidelines that affect the conservation and protection of marine mammals. The Commission offers the following recommendations and rationale.

RECOMMENDATIONS

The Marine Mammal Commission recommends that the National Marine Fisheries Service modify the National Standard 1 Guidelines to—

- include a more complete range of ecosystem-based fishery management principles, objectives, and practical approaches in the development of fishery management plans and in the determination of optimum yield for each stock being managed, especially those approaches that preserve and restore ecosystem resilience, integrity, and function. Special attention should be given to (1) the risk of management options not only to each stock, but also to the ecosystem, (2) the trade-off between yield and ecosystem impact at different levels of stock depletion, (3) the depletion of top predators and keystone species, and (4) competitive interactions between fisheries and other species such as marine mammals;
- consider more explicitly competition between fisheries and other ecosystem consumers including marine mammals by requiring (1) assessment for each fished stock of the extent and significance of competition between the fishery and the other ecosystems consumers, (2) monitoring and assessment to resolve uncertainties about the ecological effects of such competition, and (3) continuing efforts to develop and validate multi-species models so that

they might be used to explore the potential ecological consequences of fishing on marine ecosystems;

- ensure the protection of forage fish and the species that depend on them by (1) requiring the adoption of precautionary management strategies for any forage fish fisheries and (2) specifying risk-averse guidelines, biological reference points, and yield quotas for those species, as recommended by Pikitch et al. (2012);
- expand the approach to setting optimum yield by (1) requiring the clarification and thorough evaluation of specific economic, social, and ecological factors that might affect the setting of optimal yield, (2) providing options for the quantification of those factors in relation to yield, (3) requiring the setting of optimum yield based on the evaluation and quantification of those factors, (4) integrating the concept and setting of optimum yield with the framework used to set catch limits and targets framework, and (5) providing guidance on the above to achieve consistency among councils and a convergence on a set of best practices; and
- require more realistic assessment and incorporation of uncertainty in stock assessments and fishery management practices by (1) identifying best practices in estimating and incorporating scientific and management uncertainty, (2) fostering greater consistency among councils in following those best practices, (3) requiring the estimation of management uncertainty associated with both controlling catch levels and quantifying true catch, regardless of the accountability measures used, and (4) providing guidance on the adjustment of the acceptable biological catch or annual catch limit to account for pertinent biological and ecological factors not incorporated into the stock assessment model and scientific uncertainty in the overfishing limit.

RATIONALE

Ecosystem-based management

In recent years the National Marine Fisheries Service has made substantial improvements in fishery management to reduce overfishing. In addition, the Service is attempting to incorporate ecosystem-based management principles into its fishery management plans (Phinney and Tromble 2011). Doing so is necessary because the single-species approach to fishery management is flawed in at least two fundamental ways. First, it fails generally to take into account the multiple ways in which ecological conditions can affect a stock's population dynamics. For example, oscillations in oceanographic and atmospheric conditions and resulting effects on productivity can have important consequences for the status of fish stocks and the level of exploitation that they can sustain (e.g., Polovina 2005). Second, it fails to take into account the effect that the stock has on other components of the ecosystem. Numerous studies have demonstrated significant impacts on ecosystem structure precipitated by excessive exploitation of top predators (e.g., Jackson et al. 2001, Frank et al. 2005, Steneck 2012). The Magnuson-Stevens Act declares one of its purposes to be "to promote … fishing under sound conservation and management principles…,"[1] with conservation and management referring to the "rules, regulations, conditions, methods, and other measures … which are required to rebuild, restore, or maintain … any fishery resource *and the marine environment*

[1] 16 USC 1801 Sec 2(b)(3)

[emphasis added]."[2] Although the Service has significantly improved its single-species fishery management performance in recent years, it has yet to address in a comprehensive, rigorous, and forthright manner the maintenance of the integrity, function, and resilience of the ecosystems upon which fished species, non-target fish species, marine mammals, and other protected species depend.

The current guidelines address two of the numerous factors that should be considered in ecosystem-based fishery management—optimum yield and ecosystem component species. The Magnuson-Stevens Act defines "optimum" with respect to yield as that which "will provide the greatest overall benefit to the Nation, particularly with respect to food production and recreational opportunities and taking into account protection of marine ecosystems …" and that is "prescribed … on the basis of the maximum sustainable yield from the fishery, as reduced by any relevant economic, social, or ecological factor."[3] Although the guidelines suggest economic, social, or ecological factors that could be used to reduce maximum sustainable yield in the determination of optimum yield, fishery management councils have mostly recommended pro forma, default, constant reductions that are not based on an assessment of actual interactions between each fished stock and its ecosystem.

The best place to start this revision of National Standard 1 Guidelines is by defining what the Service means by ecosystem-based fishery management and setting forth the principles, objectives, and means for achieving such management. To that end, <u>the Marine Mammal Commission recommends</u> that the National Marine Fisheries Service modify the National Standard 1 Guidelines to include a more complete range of ecosystem-based fishery management principles, objectives, and practical approaches in the development of fishery management plans and in the determination of optimum yield for each stock being managed, especially those approaches that preserve and restore ecosystem resilience, integrity, and function. Special attention should be given to (1) the risk of management options not only to each stock, but also to the ecosystem, (2) the trade-off between yield and ecosystem impact at different levels of stock depletion, (3) the depletion of top predators and keystone species, and (4) competitive interactions between fisheries and other species such as marine mammals. Although the Service may not be prepared to address all these ecosystem-based concerns in full, it can describe what actions already are being taken to follow its principles and meet its objectives, and what additional actions are needed. Such information should be useful in developing and guiding research and management programs that, in time, will provide the information needed for ecosystem-based management.

Competitive interactions

Marine mammals and fisheries may compete for the same target (prey) species, possibly affecting marine mammal foraging success, condition, reproduction, and survival. Plagányi and Butterworth (2005) list over 50 cases of possible competition between fisheries and baleen whales, toothed whales, dolphins, porpoises, sea lions, fur seals, walrus, or otters. Many cases involve competition for so-called forage fish species (hereafter referred to collectively as forage fish), such as anchovies, sardines, herring, sandlance, sprat, mackerel, and krill, but others involve groundfish such as cod, halibut, hake, and pollock (considered by some to be a forage fish), or salmon (a pelagic

[2] 16 USC 1802 Sec 3(5)(A)
[3] 16 USC 1802 Sec 3(33)(A) and (B)

species). At a very broad scale, Kaschner et al. (2006) estimated the consumption of small pelagic fish worldwide during the 1990s at 20 million tons, or roughly two-thirds of the catch by fisheries. In an earlier analysis, Kaschner et al. (2001) estimated that, in the North Atlantic, marine mammals consume roughly three times as much fish as is caught, with competitive potential being greatest for pinnipeds and baleen whales. Similar patterns have been documented in the Pacific (Trites et al. 1997).

Although scientists have demonstrated more specific competitive effects of fisheries on numerous seabird species and in multiple ecosystems (see Table 1 in Österblom et al. 2008), such specific effects are not as evident for marine mammals, possibly because of the difficulty of studying their vital rates. Österblom et al. (2008) list studies showing effects of prey depletion by fishing on minke whale abundance in the Barents Sea (Haug et al. 2002); Antarctic fur seal abundance, breeding success, and condition at South Georgia (Reid et al. 2005); and harbor porpoise starvation rate in the North Sea (MacLeod et al. 2007). In addition, competition with marine mammals has been a common complaint from fisheries, as evidenced in southeast Alaska where fishermen catching urchins, clams, and other invertebrate species are now voicing concerns about the competitive effects of sea otters. Competition also has been an important concern for managers responsible for marine mammal protection and conservation. As the Service knows, much of the controversy over the Steller sea lion case in Alaska is based on concerns regarding competition between these sea lions and various fisheries including, but not limited to, the groundfish fisheries.

Stock assessments rarely model consumption of a target fish stock by fishery competitors such as marine mammals (Townsend et al. 2008). Typically, stock assessment models subsume such consumption within a constant natural-mortality term. In several cases where consumption was modeled explicitly, the constant natural mortality term was thought to have underestimated mortality from marine mammal predation with important implications for fishery management (Hollowed et al. 2000, Moustahfid et al. 2009a,b, Tyrrell et al. 2011). For example, Moustahfid et al. 2009a showed that the biomass of, and fishing mortality rate on, longfin squid in the northwest Atlantic relative to their benchmarks were off by factors of 1.4 and 0.8, respectively, when predation was not considered. Those results indicate the stock was neither overfished nor experiencing overfishing. However, when they explicitly included predation, their benchmarks were off by factors of 0.6 and 1.2, indicating that the stock was overfished by a considerable amount and experiencing overfishing. Basing management actions on the former estimates could lead to excessive catch and thereby further reduce the availability of squid to other ecosystem components such as marine mammals. Such studies indicate that fishery scientists must account for predation accurately when generating biological reference points, whether predation is incorporated into a general mortality term or is modeled explicitly. A constant mortality term likely is not an appropriate approach because it fails to account for variability in predation-related mortality.

To bring clarity to this concern, <u>the Marine Mammal Commission recommends</u> that the National Marine Fisheries Service modify the National Standard 1 Guidelines to consider more explicitly competition between fisheries and other ecosystem consumers including marine mammals by requiring (1) assessment for each fished stock of the extent and significance of competition between the fishery and the other ecosystems consumers, (2) monitoring and assessment to resolve uncertainties about the ecological effects of such competition, and (3) continuing efforts to develop and validate multi-species models so that they might be used to explore the potential ecological consequences of fishing on marine ecosystems.

Forage species

Forage fish, such as those listed above, are generally considered critical components of marine ecosystems. They play an important ecological role in many upwelling systems, transferring a large proportion of secondary production to the higher trophic levels. Ecologically, they may exert top-down influence on plankton and bottom-up influence on top predators, including marine mammals (Cury et al. 2000). Some of the clearest examples of potential competition between marine birds or mammals and fisheries listed in Österblom et al. (2008) or Plagányi and Butterworth (2005) involve forage fish. Many of these species have highly variable population dynamics and experience large fluctuations in population size because of changes in oceanographic conditions as well as excessive removals by fishing (Beverton 1990, Pikitch et al. 2012). An analysis of global fisheries data by Pinsky et al. (2011) found that fisheries for forage fish are just as vulnerable to collapse as other fisheries. The modeling study by Pikitch et al. (2012) found that constant fishing for such species at the rate that would produce the maximum sustainable yield led to fishery collapse 30 percent of the time.

The vulnerability of forage fish to population collapse argues that fishery managers should adopt precautionary exploitation rates. Early efforts to be precautionary, such as not allowing the fishing mortality rate to exceed the natural rate, did not provide a sufficient buffer against failure (Pikitch et al. 2012). More recent measures that set biomass thresholds, below which fishing is curtailed and then prohibited, are showing more promise. For example, the Pacific Fishery Management Council allows fishing on the sardine stock only when its spawning biomass is greater than 150,000 metric tons. This set-aside is intended to protect the stock's spawning potential and account for the needs of other ecosystem consumers. Importantly, it has led to greater stability in the fishery than was the case under previous management approaches. In some cases, management authorities have judged the risks of fishing on forage fish to be so great that they do not allow any fishing (e.g., krill in the California Current, most forage fish in the North Pacific).

Modeling studies indicate that species dependent on forage fish also are likely to be sensitive to the level of fishery-caused depletion of those species. A meta-analysis of the output from a suite of ecosystem models indicated that avoiding declines in predator populations requires that the biomass of forage fish not be lower than 80 percent of the unfished biomass level, which corresponded to a fishing rate one-half that which would produce the maximum sustainable yield (Pikitch et al. 2012). Such a biomass level and fishing rate are considerably more conservative than used previously or at present.

Pikitch et al. (2012) argue that precautionary management is necessary to protect forage fish and their predators because (1) forage fish biomass is difficult to estimate, (2) the species are subject to large fluctuations in population size, and (3) single-species assessments that do not account for predation are risk prone. Those authors developed an alternative, precautionary approach to establishing sustainable levels of yield based on the potential biological removal model from the Marine Mammal Protection Act. Accordingly, they recommend that biomass levels be maintained within 80 percent of unfished biomass, exploitation rates be kept below 50 percent of the rate that produces maximum sustainable yield, and yield be set using the potential biological removal analog.

Because of their ecological importance, the Marine Mammal Commission recommends that the National Marine Fisheries Service modify the National Standard 1 Guidelines to ensure the protection of forage fish and the species that depend on them by (1) requiring the adoption of precautionary management strategies for any forage fish fisheries and (2) specifying risk-averse guidelines, biological reference points, and yield quotas for those species, as recommended by Pikitch et al. (2012).

Optimum yield

Although the concepts of surplus production and maximum sustainable yield seem intuitive, and their mathematical underpinnings elegant, the practice of estimating these quantities is inexact and plagued by multiple sources of uncertainty. Fishery scientists learned decades ago that treating maximum sustainable yield as a target is highly risky and too often leads to the overexploitation, and even collapse, of target stocks. The evolution of stock-assessment science and technology has, in one sense, been a trial-and-error search for a yield target that is robust to uncertainty, risk averse, and still acceptably close to the theoretical maximum.

The Magnuson-Stevens Act established the maximum sustainable yield as the foundation for fishery management when it defined optimum yield to be based on "the maximum sustainable yield from the fishery, as reduced by any relevant economic, social, or ecological factor."[4] Thus, optimal yield is conceived as the target that will produce the maximum sustainable yield as a limit. The current guidelines operationalize the setting of catch limits by establishing a framework of biological reference points and catch targets and limits designed to prevent overfishing:

- Overfishing limit (OFL): the product of the current biomass and the fishing mortality rate at maximum sustainable yield
- Acceptable biological catch (ABC): OFL reduced by scientific uncertainty associated with OFL and other considerations
- Annual catch limit (ACL): typically set to equal ABC
- Annual catch target (ACT): ACL reduced by management uncertainty.

Over the last three years the councils have integrated this framework into most fishery management plans.

The current guidelines for setting optimum yield fall short in three ways. First, they do not specify the management options that will "provide the greatest overall benefit to the Nation." Those options and that goal cannot be based solely on economic considerations, for the Act also requires consideration of social and ecological concerns. Second, as discussed earlier, (a) the guidance provided for determining optimum yield is not sufficient, and (b) most councils have not followed the guidelines, except to reduce the fishing mortality rate to 75 percent of that which would produce

[4] 16 U.S.C. 1801 Sec 3(33)(A) and (B)

the maximum sustainable yield. However, such reductions are not explicitly scaled to specific economic, social, or ecological factors, as they should be. Such reliance on a default reduction indicates that the councils have not called for, nor the Service provided, clear descriptions and guidance on the underlying economic, social, and ecological factors to be considered. The default reduction may be adequately protective in some cases, but that cannot be assumed in all cases. Finally, the guidelines do not provide clarity regarding the relationship between optimum yield and the OFL-ACT framework. Because the councils are using the OFL-ACT framework to specify catch targets and limits, and they are required by the Act to specify the optimum yield, they have adopted a variety of approaches, which, for example, equate optimum yield with the—

- annual catch limit (golden crab and dolphin-wahoo fishery management plans),
- maximum sustainable yield (West Coast highly migratory species, and squid, mackerel and butterfish fishery management plans), or
- 75 percent of the maximum sustainable yield (West Coast vulnerable highly migratory species, and Gulf of Mexico reef fish fishery management plans).

Although the maximum-sustainable yield-optimum yield paradigm and OFL-ACT framework provide structure to the setting of catch limits and targets, their value is undermined by the fact that the councils have not recommended and the Service implemented rigorous programs to identify and characterize the economic, social, and ecological concerns to be considered in catch setting, and they have yet to put into practice a requirement for specifying all the many sources of uncertainty involved. The guidelines are not sufficiently explicit on these points. These are not simply issues to be resolved when they become controversial, but must be tackled in a progressive manner if the Service is to develop a rigorous management system based on ecosystem considerations.

To address these shortcomings, <u>the Marine Mammal Commission recommends</u> that the National Marine Fisheries Service modify the National Standard 1 Guidelines to expand the approach to setting optimum yield by (1) requiring the clarification and thorough evaluation of specific economic, social, and ecological factors that might affect the setting of optimal yield, (2) providing options for the quantification of those factors in relation to yield, (3) requiring the setting of optimum yield based on the evaluation and quantification of those factors, (4) integrating the concept and setting of optimum yield with the framework used to set catch limits and targets, and (5) providing guidance on the above to achieve consistency among councils and a convergence on a set of best practices.

Scientific and management uncertainty

Creation of the OFL-ACT framework has improved U.S. federal fishery management significantly. Because it requires the councils and the Service to explicitly estimate and incorporate scientific uncertainty into the setting of acceptable biological catch targets and limits, the process is more transparent and it will be easier to diagnose problems when performance is not as expected. The annual catch target, which is the annual catch limit reduced by an estimate of management uncertainty, is intended to achieve the desired catch while minimizing the likelihood of exceeding the annual catch limit because of management errors or misjudgments. However, the guidelines do not require the setting of an annual catch target, and, instead, identify it as one of many possible accountability measures that can be used to address management uncertainty and avoid exceeding the catch limit. Although other accountability measures, such as in-season adjustments, may be just as, or even more, effective at keeping catch below the annual catch limit, they do not promote transparency and insight into the factors that lead to excessive catch.

The current guidelines state that "acceptable biological catch (ABC) is a level of … annual catch that accounts for the scientific uncertainty in the estimate of OFL and any other scientific uncertainty."[5] However, the guidelines are silent on what other sources of scientific uncertainty should be considered. Consequently, councils and the Service have largely focused on estimating uncertainty in the overfishing limit. However, the methods for estimating uncertainty, and the comprehensiveness of that process, have varied considerably among councils. More importantly, stock assessment models generally do not capture all sources of biological or ecological uncertainty. For example some aspects of a stock's life history or ecosystem interactions are not described and considered. If all the elements of competition between the fishery and a marine mammal are present, but have not been quantified in the assessment model, where and how would the interaction be incorporated into the assessment?

To address these concerns, the Marine Mammal Commission recommends that the National Marine Fisheries Service modify the National Standard 1 Guidelines to require more realistic assessment and incorporation of uncertainty in stock assessments and fishery management practices by (1) identifying best practices in estimating and incorporating scientific and management uncertainty, (2) fostering greater consistency among councils in following those best practices, (3) requiring the estimation of management uncertainty associated with both controlling catch levels and quantifying true catch, regardless of the accountability measures used, and (4) providing guidance on the adjustment of the acceptable biological catch or annual catch limit to account for pertinent biological and ecological factors not incorporated into the stock assessment model and scientific uncertainty in the overfishing limit.

The Commission hopes these recommendations and rationale are helpful. Please contact me if you have any questions about them.

Sincerely,

Timothy J. Ragen

Timothy J. Ragen, Ph.D.
Executive Director

References

Beverton, R.J.H. 1990. Small marine pelagic fish and the threat of fishing; are they endangered? Journal of Fish Biology 37(Suppl. A):6-16.

[5] 50 CFR § 600.310 (f)(2)(ii)

Cury, P., A. Bakun, R.J.M. Crawford, A. Jarre, R.A. Quiñones, L.J. Shannon, and H.M. Verheye. 2000. Small pelagics in upwelling systems: patterns of interaction and structural changes in "wasp-waist" ecosystems. ICES Journal of Marine Science 57:603-618.

Frank, K.T., B. Petrie, J.S. Choi, and W.C. Leggett. 2005. Trophic cascades in a formerly cod-dominated ecosystem. Science 308:1621-1623.

Haug, T., U. Lindstrøm, and K.T. Nilssen. 2002. Variation in minke whale (*Balaenoptera acutorostrata*) diet and body condition in response to ecosystem changes in the Barents Sea. Sarsia 87(6):263-278.

Hollowed, A.B., J.N. Ianelli, and P.A. Livingston. 2000. Including predation mortality in stock assessments: a case study for Gulf of Alaska walleye pollock. ICES Journal of Marine Science 57:279-293.

Jackson, J.B.C., M.X. Kirby, W.H. Berger, and K.A. Bjorndal. 2001. Historical overfishing and the recent collapse of coastal ecosystems. Science 293:629-637.

Kaschner, K., V. Karpouzi, R. Watson, and D. Pauly. 2006. Forage fish consumption by marine mammals and seabirds. Pages 33-46 *in* J. Alder and D. Pauly (eds), On the Multiple Uses of Forage Fish: From Ecosystems to Markets. Fisheries Centre Research reports 14(3), Fisheries Centre, University of British Columbia, Vancouver.

Kaschner, K., R. Watson, V. Christensen, A.W. Trites, and D. Pauly. 2001. Modeling and mapping trophic overlap between marine mammals and commercial fisheries in the North Atlantic. Pages 33-45 *in* Fisheries Impacts on North Atlantic Ecosystems: Catch, Effort and National/Regional Data Sets. Fisheries Centre Research Reports 9(3), Fisheries Centre, University of British Columbia, Vancouver.

MacLeod, C.D., M.B. Santos, R.J. Reid, B.E. Scott, and G.J.Pierce. 2007. Linking sandeel consumption and the likelihood of starvation in harbour porpoises in the Scottish North Sea: could climate change mean more starving porpoises? Biology Letters 3(2):185-188.

Moustahfid, J.S., M.C. Tyrrell, and J.S. Link. 2009a. Accounting explicitly for predation mortality in surplus production models: an application to longfin inshore squid. North American Journal of Fisheries Management 29:1555-1566.

Moustahfid, J.S., J.S. Link, W.J. Overholtz, and M.C. Tyrrell. 2009b. The advantage of explicitly incorporating predation mortality into age-structured stock assessment models: an application for Atlantic mackerel. ICES Journal of Marine Science 66(3):445-454.

Österblom, H., O. Olsson, T. Blenckner, and R.W. Furness. 2008. Junk-food in marine ecosystems. Oikos 117(7): 967-977.

Österblom, H., O. Olsson, T. Blenckner, and R.W. Furness. 2008. Junk-food in marine ecosystems. Oikos 117(7):967-977.

Phinney, J., and G. Tromble. 2011. Implementing Ecosystem Based Fisheries Management (EBFM): A Review of Existing NMFS Activities in the Regional Fisheries Management Councils. Presentation available online at www.nmfs.noaa.gov/sfa/reg_svcs/Councils/Training 2010/EcosystemFisheriesMgmt.pdf

Pikitch, E., P.D. Boersma, I.L. Boyd, D.O. Conover, P. Cury, T. Essington, S.S. Heppell, E.D. Houde, M. Mangel, D. Pauly, É. Plagányi, K. Sainsbury, and R.S. Steneck. 2012. Little Fish, Big Impact: Managing a Crucial Link in Ocean Food Webs. Lenfest Ocean Program. Washington, DC.

Pinsky, M.L., O.P. Jensen, D. Ricard, and S.R. Palumbi. 2011. Unexpected patterns of fisheries collapse in the world's oceans. Proceedings of the National Academy of Sciences of the United States of America 108(20):8317-8322.

Plagányi, E.E., and D.S. Butterworth. 2005. Chapter 3. Indirect fishery interactions. Pages 19-44 *in* J.E. Reynolds III, W.F. Perrin, R.R. Reeves, S. Montgomery and T.J. Ragen (eds.), Marine Mammal Research—Conservation Beyond Crises. The John Hopkins University Press.

Polovina, J.J. 2005. Climate variation, regime shifts, and implications for sustainable fisheries. Bulletin of Marine Science 76(2):233-244.

Reid, K., J.P. Croxall, D.R. Briggs, and E.J. Murphy. 2005. Antarctic ecosystem monitoring: quantifying the response of ecosystem indicators to variability in Antarctic krill. ICES Journal of Marine Science 62:366-373.

Steneck, R.S. 2012. Apex predators and trophic cascades in large marine ecosystems: learning from serendipity. Proceedings of the National Academy of Sciences 109:7953-7954.

Townsend, H.M., J.S. Link, K.E. Osgood, T. Gedamke, G.M. Watters, J.J. Polovina, P.S. Levin, N. Cyr, and K. Aydin (eds.). 2008. Report of the National Ecosystem Modeling Workshop (NEMoW). National Marine Fisheries Service, National Oceanic and Atmospheric Administration Technical Memorandum NMFS-F/SPO-87, 93 pages.

Trites, A.W., V. Christensen, and D. Pauly. 1997. Competition between fisheries and marine mammals for prey and primary production in the Pacific Ocean. Journal of Northwest Atlantic Fishery Science 22:173-187.

Tyrrell, M.C., J.S. Link, and H. Moustahfid. 2011. The importance of including predation in fish population models: implications for biological reference points. Fisheries Research 108(2011):1-8.