

REPORT OF THE NORTH ATLANTIC RIGHT WHALE PROGRAM REVIEW

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Report prepared for the
Marine Mammal Commission by

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This is one of five reports prepared in response to a directive from Congress to the Marine Mammal Commission to assess the effectiveness of protection programs for the most endangered marine mammals in U.S. waters.

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I. OVERVIEW STATEMENT BY THE REVIEW PANEL

The approximately 350 North Atlantic right whales alive today constitute a biologically viable population with potential for recovery. Although calf production has been variable and appears to be lower than in some populations of southern right whales, we believe that reproduction and recruitment in the North Atlantic population are adequate to support a recovery but only if the number of whales killed by ship strikes and entanglement in fishing gear is significantly reduced. In fact, much of the potential recruitment to the population is being lost to such removals, seriously inhibiting population growth. With such a small population, any progress toward recovery could be offset by random processes and events (e.g., inbreeding, a natural catastrophe, or a disease outbreak). The longer the population remains mired in its present state of low numbers because of regularly occurring ship strikes and entanglement, the greater is the danger that such processes and events will drive the population to a level from which it cannot recover.

The last 100 years have seen an unbroken chain of human impact on right whales, marked by a shift in the mid-1930s (when international legal protection, albeit incomplete, was conferred on the whales) from deliberate to non-deliberate “whaling.” From a demographic and biological standpoint, “whaling” on this population has continued uninterrupted and may have intensified in recent decades as its habitat has become increasingly hazardous.

In terms of public investment to remedy this situation, the most cost-effective approach to protection and recovery of North Atlantic right whales would be to eliminate high-speed (>10 knots) vessel traffic and risk-conferring fishing gear (e.g., traps with vertical lines and set or drift gillnets) from the whales’ environment, or at least from areas where the whales occur most frequently. In fact, one way to assess the cost-effectiveness of these measures would be to calculate the public expenditures that would have been saved (i.e., available for reallocation to other priorities) if the mortality from ship strikes and entanglement had been significantly reduced in the 1970s or 1980s when the whale population apparently was increasing. To the best of our knowledge, no such calculation has previously been contemplated, much less undertaken.

From a cost-effectiveness standpoint, comprehensive, science-based management actions that can be scaled back as conditions improve would be greatly preferable to the piecemeal and prolonged process of incremental regulatory expansion that has been pursued over the past 15 years. In effect, many of the accumulated program costs (to say nothing of the costs of legal actions brought against the National Oceanic and Atmospheric Administration [NOAA] and other agencies) can be properly viewed as the costs of past inaction. Protection of right whales has been subjugated to the social and economic expectations of an ever-expanding, increasingly urban human society with which the whale population must co-exist. The compatibility of the two—a healthy, recovered right whale population on one hand and expansive coastal development on the other—cannot be taken for granted.

II. INTRODUCTION AND PROJECT BACKGROUND

As part of the 2004 Omnibus Appropriations Bill, the Senate Appropriations Committee directed the Marine Mammal Commission to “review the biological viability of the most endangered marine mammal populations and make recommendations regarding the cost-effectiveness of current protection programs.” One of the Commission’s activities in response to that directive was to organize and conduct, in close consultation with the National Marine Fisheries Service (NMFS), a review of the federal recovery program for the endangered North Atlantic right whale and the federal and non-federal research in support of it. This species was chosen for a case study because of its degree of endangerment, the large scale of research and recovery efforts related to it, and Congress’s particular awareness of and interest in the species. It was understood from the outset that the review would need to include a workshop where a panel would have opportunities to engage in discussions with relevant experts.

The present report, together with other background papers and the report of a workshop on population viability analysis, was prepared for use by the Commission in developing a report that it will submit to Congress as a response to the congressional directive. The workshop on population viability analysis was held in September 2005 and, among other things, considered natural factors affecting the population dynamics and recovery of very small populations of marine mammals. Workshop participants noted that small populations are particularly vulnerable to demographic and environmental stochasticity and to the loss of genetic variability. As population size is reduced, populations become increasingly vulnerable to such chance factors and, as a result, can be driven to smaller and smaller size in what conservation biologists refer to as an “extinction vortex.” It was also noted, however, that population viability is a vague term that is best stated in terms of the probability of extinction within a specified time frame. The September 2005 workshop concluded that, with possibly one or two exceptions, all marine mammal populations in U.S. waters, including North Atlantic right whales, are viable. In other words, with effective management, even populations that are greatly reduced should be capable of recovery.

The right whale review involved the following steps:

- A steering group, including members of the review panel (Attachment 1), the Commission staff, and SRA International (a consulting firm contracted by the Commission to help organize meetings and draft reports in response to the congressional directive), prepared a draft workshop agenda and a series of questions to be directed at agency representatives, contractors, and others involved in right whale research and management.
- After considering the draft agenda and list of questions, NMFS representatives offered to help organize the workshop and requested that the scope of the review be modified somewhat to meet the agency’s own need for external (independent) review of its right whale science program.

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- In January and February 2006 the steering group met several times with NMFS representatives to develop the workshop format and logistics.
 - In advance of the workshop, and with assistance from NMFS and Commission staff, SRA International prepared extensive background reading materials for the panel. These included explicit written responses to the steering group's list of questions.
 - The workshop was held at the Marine Biological Laboratory, Woods Hole, Massachusetts, on 14–17 March. The agenda and list of participants are provided in Attachments 2 and 3.

The panel prepared this report after the workshop. It consists of two main parts: a review and evaluation of the federal government's North Atlantic right whale research and monitoring program (including university and nongovernmental organization-sponsored research) and a review and evaluation of the federal government's North Atlantic right whale protection and recovery program.

A. EVALUATING EFFECTIVENESS

Any evaluation of cost-effectiveness implicitly assumes that information is available to assess effectiveness, preferably quantitatively but at least qualitatively. To judge effectiveness throughout its report, the panel sought to use the downlisting criteria (i.e., from endangered to threatened status) specified in the 2005 version of the Recovery Plan for the North Atlantic Right Whale (National Marine Fisheries Service 2005). The criteria, paraphrased from the plan, are—

- (1) "Population ecology" (range, distribution, age structure, sex ratios, etc.) and vital rates (age-specific survival, age-specific reproduction, and lifetime reproductive success) indicate an increasing population.
- (2) The population has increased at an annual rate of 2 percent or greater for 35 years.
- (3) None of the five listing factors—habitat degradation, deliberate use, disease or predation, inadequate regulations, and mortality/serious injury from ship strikes and fishery interactions—is known to be limiting the population's growth rate.
- (4) The estimated probability of quasi-extinction in 100 years is no more than 1 percent.

The panel attempted to evaluate the relevance and importance of research and monitoring efforts according to the extent to which they either had addressed these criteria or could be expected to address them in the future. Similarly, it tried to evaluate protection and recovery programs according to whether they had brought the population closer to meeting the downlisting criteria or could reasonably be expected to do so in the future.

Judging effectiveness with reference to the criteria in the recovery plan was complicated by the following:

- Unless it is known whether the population is increasing, decreasing, or at an equilibrium, it is difficult to know whether any particular intervention, or for that matter the entire package of interventions as a whole, is having any positive effect. Because the
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population's rate of increase is not estimated on a regular basis, and indeed because we cannot even assess whether the population is currently increasing or decreasing, there is little or no basis for confirming effectiveness.

- For effectiveness to be assessed in relation to specific management measures, causal connections need to be established between such measures and the desired outcome or outcomes. In other words, it has to be shown, for example, that a reduction in the rate of serious injuries or deaths of right whales (and its concomitant effect on status) was due to a particular fishery management measure or change in shipping traffic. Without a means of associating cause and effect in this way, any judgment about the effectiveness of individual protective measures is highly speculative.
- Compliance with management measures needs to be verified. It has to be shown that prescribed changes in human activities or behavior (e.g., in the types of fishing gear deployed or the speeds and routes of vessel traffic in specified areas or seasons) are actually being made. Otherwise, there is danger that apparent correlations between regulatory actions and trends in the whale population will be misleading.
- Data on the whale population's "performance" in response to management measures, as well as data on compliance by regulated parties, need to be gathered at very large spatial and temporal scales (tens of thousands of square miles and decades). Given the expense and logistics involved, this means that datasets are often incomplete or have low statistical power.

In the view of some NMFS representatives, the effectiveness of the right whale program cannot be judged solely on the basis of the delisting criteria because the agency is bound to adhere to several other relevant mandates. Specifically, Endangered Species Act (ESA) section 7 consultations require that any alternatives to a proposed activity be "reasonable and prudent," and section 118(f) of the Marine Mammal Protection Act (MMPA) specifies that NMFS must take into account the economics of the fishery and the availability of existing technology when seeking to reduce incidental mortality or serious injury of marine mammals. The inadequacy of specific information concerning the dynamics of entanglement, right whale foraging ecology, and right whale behavior, in general, makes it difficult for NMFS to develop measures that are not only effective in protecting right whales but that also meet the "reasonable and prudent alternative" requirement of the ESA and give due consideration to fishery economics and technology as required under the MMPA. The panel acknowledges that these competing components of the ESA and MMPA further complicate the agency's position and hinder progress toward achieving some of the downlisting criteria. Nonetheless, when evaluating the effectiveness of past actions and identifying future actions that might be more effective, the panel did not feel constrained to consider those other mandates. Its conclusions and recommendations are based solely on judgments about what actions are most likely to be effective in achieving the recovery of North Atlantic right whales.

B. EVALUATING COST-EFFECTIVENESS

To aid it in evaluating cost-effectiveness, the panel benefited from a detailed compilation of expenditures on right whale recovery and research by federal and state government agencies and

nongovernmental organizations over the past three fiscal years (FY2003/04 to FY2005/06). That information was compiled by Jeff Benoit of SRA International, who contacted agencies and organizations directly. It was supplemented by workshop presentations in which representatives of federal agencies and certain major contractors attempted to place the expenditures in context.

Determining how to measure and assess cost-effectiveness proved a major challenge for several reasons, including the following:

- Assessing cost-effectiveness depends on the ability to assess effectiveness. As discussed above, that can be very difficult.
- Reliable information on the actual costs of implementing management measures is needed, but such information is seldom available for individual program components. Moreover, because some program components (e.g., aerial surveys) simultaneously serve multiple research and management functions, it can be difficult to partition costs for specific activities or purposes within the overall recovery program.
- A metric of cost-effectiveness is needed that is conceptually coherent and feasible to apply. For example, cost-effectiveness might be measured in terms of right whale deaths prevented per unit of federal funds invested in a given type of intervention. Thus, if a 50 percent reduction in adult female mortality could be achieved with a \$1 million investment in a certain management action, while a \$10 million investment would be required to achieve a similar reduction in mortality with a different management action, the relative cost-effectiveness of the two measures could easily be assessed and compared. However, uncertainty regarding the magnitude and causes of right whale deaths, together with frequent changes in regulations, makes it virtually impossible to devise a practical and appropriate metric for cost-effectiveness in the present context.

Systemic constraints also exist and deserve mention. Among these are the following:

- Inadequacy and uncertainty of funding for critical activities make it difficult for agencies to develop cost-effective programs, which require the ability to plan, introduce measures in a stepwise fashion, monitor and evaluate outcomes, and adapt if necessary.
- The conflicting mandates within and between government agencies inevitably reduce effectiveness of many kinds—biological, economic, and political. For example, the Coast Guard must respond, first and foremost, to demands related to human safety and homeland security, even if in the process it means putting right whales at greater risk of ship strikes. Similarly, the Department of Commerce is responsible for protecting and enhancing the economic interests of U.S. business, industry, and individuals, yet it also is expected to protect right whales from shipping and fishing gear.

Such constraints are to be expected in a modern nation with a large bureaucracy and frequently changing government administrations. What is important here, however, is to acknowledge that cost-effectiveness alone may not be an appropriate guide to the public interest.

The panel was at once mindful of the intrinsic difficulties and limitations summarized above and the desire expressed by Congress for information concerning the effectiveness and cost-effectiveness of the right whale protection program. In the complete absence of rigorous, conclusive studies evaluating the effectiveness of specific measures, the best that the panel can offer is a series of judgments based on the information provided to it. Given their subjective nature, some of these judgments are bound to be controversial. Where doubt has been expressed concerning the effectiveness or cost-effectiveness of a given aspect of the program, the panel would like nothing better than to be proven wrong by an appropriate study.

III. FINDINGS OF THE PANEL:

RESEARCH ON NORTH ATLANTIC RIGHT WHALES AND MONITORING THE WHALE POPULATION

As noted above, the downlisting criteria are framed around the demography of the North Atlantic right whale population. Any assessment of status must provide basic information on the rate of population increase or decrease, parameters controlling that rate (births and deaths), and the ecological factors affecting those parameters. This section of the report reviews the NMFS right whale science program. Research and monitoring efforts related to recovery management are discussed in sections IV and V.

A. RANGE AND DISTRIBUTION

A great deal has been learned over the past 25 years about the distribution of right whales in the western North Atlantic, yet surprisingly large gaps in knowledge remain. The winter distribution of a significant portion of the population is unknown. The routes taken by whales moving between the southeastern U.S. calving grounds and northern feeding areas have been only partially documented. In particular, the extent to which migrating whales remain in coastal waters or travel offshore as they pass the mid-Atlantic states (between the Carolinas and New England) is uncertain. A significant fraction of adult females take their dependent calves somewhere other than to the main summer nursery area in the Bay of Fundy. Paternity analyses of DNA from biopsy samples suggest that the number of males in the population is 16 to 21 percent greater than the number documented through photo-identification and genotyping. Opportunistic sightings of right whales in the Gulf of St. Lawrence, south of Greenland, around Iceland, and in northern Norway show that some individuals occur far beyond the well-known high-use areas in the Gulf of Maine, Bay of Fundy, and Scotian Shelf regions during summer. The boundaries of designated critical habitat do not appear to define all of the areas used intensively by right whales. Improved understanding of right whale distribution and movement patterns should, therefore, remain a research priority, both for better assessing the status of the population and for designing a comprehensive protection regime.

Seasonal (winter and spring) aerial surveys in the Southeast, Cape Cod Bay, and Great South Channel and year-round surveys in the Gulf of Maine have provided some useful information on distribution patterns, although these surveys are not designed solely for that purpose. Instead, the surveys are conducted, in part, to provide information necessary for management (e.g., providing warnings to mariners) and are therefore flown more frequently than would be necessary for population monitoring purposes alone (e.g., annual calf counts). Since 2001 federally funded studies of right whale distribution also have been expanded to include broadscale aerial surveys beyond the well-described habitats in New England, Bay of Fundy, and the calving grounds. For example, these expanded surveys were expected to cover the entire coasts of North and South Carolina in winter/spring of 2005/2006 and 2006/2007.

There is a clear desire on the part of NMFS to reduce the frequency of aerial survey flights in critical habitats and to phase out broadscale aerial surveys for detecting locations where whales occur and to replace them with another method, such as passive acoustic monitoring. The impetus for such a shift is rooted in at least three factors: (1) the emergence of the requisite technology to conduct real-time acoustic monitoring, (2) concerns about human safety in offshore aerial surveys, and (3) the high and rising costs of aircraft use (due, in part, to measures to address safety). The review panel regards all three factors as worthy of consideration and agrees that the Service should continue to support efforts to develop and refine alternative monitoring capabilities. However, any shift away from aerial surveys needs to proceed with due recognition of the potential benefits and drawbacks of new approaches. The panel's thoughts in regard to passive acoustic monitoring are presented here.

Benefits: Once an acoustic monitoring system has been deployed and a system for processing data from it has been set up, this approach offers the potential for continuous, long-term monitoring of an area to detect vocalizing right whales—regardless of visibility, sea conditions, or time of day—at relatively low cost and with little risk to human safety. Preliminary results of studies in Cape Cod Bay, as reported to the workshop by Chris Clark of Cornell University, indicate that when whale densities are low, acoustic detection is more efficient than visual detection. It should be possible to establish acoustic monitoring stations at remote locations where right whales are known or suspected to have occurred in the past but have yet to be adequately surveyed (e.g., the Gulf of St. Lawrence and the eastern margins of the Grand Bank). The availability of real-time acoustic data also offers the possibility of improving the cost-effectiveness of certain aerial (and shipboard) survey efforts by allowing flights (or cruises) to go directly to areas where at least some right whales are known to be present. Finally, the recent inclusion of passive acoustics as part of NOAA's Integrated Ocean Observing System is a welcome development that can be expected to contribute new information on right whale range and distribution.

Drawbacks: Although listening can establish the presence of calling right whales (within a radius of about 5 to 10 nautical miles [nmi] of a buoy in optimal listening conditions using current technology), a lack of detections cannot establish their absence from an area. A failure to detect calls may occur because the whales are not vocalizing or because of acoustic masking by noise from ship traffic or other sources. Further work is required before we understand the factors responsible for variation in calling rates, such as behavioral and reproductive state, time of day, and location, and the effect of this variation on detection probabilities using passive acoustic methods. Call characteristics and rates cannot be used to determine numbers of right whales present or to detect and assess entangled or injured whales, and it is not yet possible to identify individual right whales acoustically. Further development is needed to improve techniques for transmitting detections in real time and for analyzing and interpreting the acoustic data. Another drawback is that reduction or cessation of large-scale aerial surveys will lead to a loss of information critical to population assessment and monitoring. For example, calf counts are obtained from aerial surveys, and many of the detections of whales entangled in fishing gear are made during aerial surveys. Also, a reduction in aerial survey effort will mean fewer photographic records and therefore a loss of data for use in population analyses that involve

photo-identification (e.g., abundance estimation and assessments of individual health). For this reason, aerial surveys cannot be eliminated, but rather the current broadscale surveys should be replaced by a system of focused surveys designed to provide information necessary for demographic assessment. Such focused surveys could be conducted at much less cost (and risk to human life) than the current broadscale system of surveys. The utility of such surveys could be improved by incorporating knowledge gained from predictive modeling based on environmental correlates of right whale presence and absence. There will also be a continuing need for follow-up visual documentation of at least some of the acoustic detections (e.g., for periodic ground-truthing), which can be accomplished from aircraft or boats.

A balance is needed to ensure that, during the transition from aerial surveys to passive acoustic monitoring (or some other monitoring method), data critical to population monitoring continue to be collected and well-justified aerial survey programs are not terminated prematurely. Moreover, there continues to be a need for other tools that will improve knowledge of distribution patterns, perhaps including analyses of isotopic signatures from tissue samples and the deployment of satellite tags on a carefully selected sample of right whales. The panel was not able to reach consensus on the important question of whether satellite-tagging technology has been adequately developed and field-tested to ensure that it can be safely and effectively used on North Atlantic right whales. It does agree, however, that if any such program is initiated, it should include a follow-up monitoring component to assess the health and condition of tagged animals. Development of less invasive, long-term tags also should be encouraged and supported, and close consideration given to the potential of shipboard surveys to provide additional information on range and distribution.

The value of shipboard surveys deserves special consideration. Although not generally as cost-effective as aerial surveys for obtaining large-scale, synoptic views, shipboard surveys have fewer safety issues and provide a much wider array of opportunities for data collection (e.g., photography, biopsy sampling, fecal sampling, visual health assessments, observations of behavior, group size determination, acoustic recording, and measurements of environmental conditions). The photographs from shipboard surveys are the only ones that provide sufficient detail and are of high enough quality to support visual health assessment and, importantly, analyses of wounds and scars from interactions with fisheries. These latter analyses are, at present, the only means available for assessing the effectiveness of management actions to reduce entanglement risk. In part because of those advantages, shipboard surveys can be highly cost-effective in comparison to aerial surveys in some circumstances. For example, the designated right whale critical habitat in Cape Cod Bay was undetected as such during the broadscale aerial surveys conducted by the University of Rhode Island in 1979–1981. The significance of the area as habitat for right whales was, however, recognized from shipboard observations during the late 1970s and 1980s. In Cape Cod Bay, as in some other parts of their range, right whales in scattered groups or individuals making prolonged dives (18 to 25 minutes) are much more likely to be detected by shipboard surveys than by broadscale aerial surveys.

Some of the data on right whale distribution have come from aerial surveys in support of management programs. There has not always been a clear and consistent distinction between

research/monitoring and management functions of the surveys. Although integration can enhance cost-effectiveness, it also can create the potential for data collection and analyses that serve management but are not optimal for addressing key research questions. Therefore, the types of data needed for research and for management (mitigation) should be distinguished when designing and implementing aerial survey programs.

Table 1: Costs of actions to study range and distribution, FY2003/FY2005

Activity/Source	FY 03	FY 04	FY 05
Aerial Surveys	\$2,017,000	\$2,906,544	\$2,984,470
NMFS	1,484,000	1,854,000	2,345,000
Navy	155,000	155,000	155,000
U.S. Coast Guard	237,000	370,544	299,470
U.S. Army Corps of Engineers	141,000	174,000	185,000
National Fish and Wildlife Foundation	0	353,000	0
Massachusetts Environmental Trust	0	0	36,475
Shipboard Surveys	66,815	39,048	32,500
NMFS	N/A*	N/A*	N/A*
New England Aquarium	64,315	36,548	31,000
Provincetown Center for Coastal Studies	2,500	2,500	2,500
Acoustic Monitoring	642,552	416,170	345,324
NMFS	627,552	416,170	285,324
International Fund for Animal Welfare	0	0	60,000
Stellwagen Bank National Marine Sanctuary	15,000	0	0
TOTAL	\$2,726,367	\$3,361,762	\$3,362,294

Note: The costs for aerial surveys and acoustic monitoring summarized in the table represent investments in both management and research, i.e., in both ship strike mitigation (early warning and avoidance systems; see section IV.A) and investigations of right whale range and distribution.

* Costs of ship time provided in-kind by NMFS (i.e., by making NMFS vessels available for dedicated right whale work) were not provided to the panel but were significant in all three years.

Contribution to recovery program

Reliable information on range and distribution is needed to identify critical habitat, facilitate the monitoring of right whales within high-use areas, plan research activities, and trigger or tune management actions. Knowing the entire range and distribution is important to ensure that animals have adequate protection throughout the year and that no large groups of individuals are unaccounted for.

Cost-effectiveness of actions

During FY03/05, a total of \$9.45 million was spent on activities that contributed relevant data. Of that total, \$7.91 million was spent on aerial surveys. The challenge of obtaining detailed information on the range, distribution, and movements of this whale population is formidable. There is no quick, simple, or inexpensive way to do it. The current state of knowledge represents an accumulation of data over many decades and from many different sources, some of it from activities carried out for other purposes. These factors make it impossible to quantify the true cost of studying the species' range and distribution. Clearly, aerial surveys have absorbed a large proportion of the total funding for studying this topic, and the fraction has increased steadily from 74 percent in FY03 to 89 percent in FY05. Although the majority of the funds (72 percent) expended on surveys came from NMFS, other agencies and organizations provided \$2.23 million over the three years.

The review panel accepts the judgment of NMFS scientists that alternative methods (passive acoustic monitoring, satellite tracking, shipboard surveys in unstudied areas, etc.) will ultimately prove more cost-effective and safer than aerial surveys. At the same time, the panel recognizes that some recent aerial surveys have fulfilled multiple, and important, research and management purposes. For example, photo-identification data have been obtained, and many of the detections of entangled right whales have been made during aerial surveys.

Shipboard surveys, in addition to providing data on range and distribution, offer opportunities to collect samples and data of many kinds. Actual expenditures for shipboard surveys during FY03/05 are greatly underrepresented in the foregoing table of costs, which includes only the amounts raised from non-NMFS sources to supplement the support provided in-kind by NMFS. More realistic estimates of the total amounts invested in shipboard surveys are approximately \$300,000 in FY03, \$286,000 in FY04, and \$281,000 in FY05 (S. Kraus, pers. comm., October 2006).

Passive acoustic monitoring is a promising but still not fully developed tool and therefore is at present only potentially cost-effective for improving knowledge of range and distribution. Moreover, its eventual effectiveness might be restricted to areas that are readily accessible and known to be used by right whales. A significant investment has been made in development of passive acoustics methods, with \$1.4 million spent on this topic during FY03/05, the vast majority by NMFS. Although controversial and not without some risk to the health of right whales, satellite tracking is a potentially cost-effective means of completing the inventory of habitat used by North Atlantic right whales. No expenditures to support satellite-tracking studies during FY03/05 were identified.

Recommendations

The apparent intent of NMFS to move away from aerial surveys and toward passive acoustic methods for assessing right whale range and distribution is both prudent and desirable. It is important, however, that the transition occurs gradually and with due regard to the need for

continuity in collecting photo-identification data, especially in the southeast region and in Great South Channel. In the short term, the panel recommends that aerial surveys be continued as needed to supply critical management information, while development, testing, and deployment of passive acoustic technology proceeds. A combined program of focused aerial surveys in areas where small survey vessels are unable to work easily (e.g., offshore in the Great South Channel or on the Northeast Peak of Georges Bank) and dedicated shipboard surveys in predictably used seasonal habitat of right whales would likely be the most cost-effective approach. It would address multiple management and science needs while allowing flexibility to respond to changes in whale distribution as well as the emergence of enhanced acoustic monitoring capabilities. Other approaches, including satellite tagging and isotope analyses, should be explored to determine what role they might play in refining our understanding of right whale range and distribution. In the medium to long term, aerial surveys explicitly for determining range and distribution should be used only in a carefully focused manner as needed to complement alternative methods. A major purpose of range and distribution studies should be to provide data needed to reassess the current designation of critical habitat under the Endangered Species Act.

B. ABUNDANCE AND TRENDS

Databases

Two separate but related databases are supported by NMFS: the North Atlantic Right Whale Identification Catalog (hereafter, the Catalog), maintained at the New England Aquarium and the Right Whale Sightings Database (hereafter, the Sightings Database), maintained at the University of Rhode Island (URI). Both databases play critical roles in right whale conservation.

The Catalog is the cornerstone of right whale research and monitoring. It provides records of individual whale sightings that are used to estimate reproductive parameters, mortality rates, and other input to demographic models. In addition, the Catalog serves to link many other types of samples (e.g., biopsies) and information (e.g., health assessments) to individual whales. Among other services provided by the Catalog team are the provision of real-time data on individual whale identities for researchers engaged in biopsy darting or tagging; information on identity and health assessment of stranded, injured, or entangled right whales; and responses to requests for data to be used in many types of scientific and management analyses.

Ongoing maintenance of the Catalog has two essential aspects: (1) field collection of photographic images and associated data, and (2) photographic analysis, matching, confirmation, integration, and cataloging previously unidentified individuals. Each year, approximately 3,000 sighting records are added to the Catalog. Somewhat paradoxically, the advent of digital photography has increased the workload of the New England Aquarium team as field researchers now contribute many more images every year, creating a backlog in processing and archiving the information. In addition, the rich database of genetic information obtained from biopsy sampling has not yet been fully integrated into the Catalog. Ongoing curation and maintenance of the Catalog requires 4.7 person-years annually. The panel notes that the cost of the Catalog would rise substantially if there were a need to train new personnel for its curation and maintenance.

Maintenance of the Sightings Database involves processing, validating, and integrating survey and sightings datasets. This database, which includes records of species other than right whales (e.g., sea turtles and other marine mammals), serves NMFS and individual researchers by providing tailored subsets of data—e.g., for analyses used in stock assessment reports, environmental impact assessments, plans and designs of protected areas, and analyses of habitat. Like the Catalog, it has experienced rapid growth, doubling in the past three years to more than two million records. Much of the increase is due to expanded aerial survey effort.

The manager of the Sightings Database at URI (R. D. Kenney) has prepared a detailed manual explaining the procedures involved in its upkeep, but the panel is concerned about the extent to which the continuity and function of this database depend on Kenney's continued availability.

Trends in Abundance

Despite the fact that the four primary criteria for downlisting this population pertain directly to its demography, there is no current or recent statistically derived estimate of the number of North Atlantic right whales. The most recent (2005) NMFS Stock Assessment Report notes "...no estimate of abundance with an associated coefficient of variation has been calculated for this population." The primary factor responsible for this situation is not lack of data, as the Catalog provides a rich source of information on individual histories. Instead, the limiting factor is variation in the probability of sighting individual whales. That is, not all whales occur in specific study areas (and are thus available to be photographed) each year.

Mark-recapture and matrix population models applied to the Catalog data by Caswell et al. (1999) and Fujiwara and Caswell (2001) suggest that the population began to decline around 1992 after a period of modest growth. The models incorporated variation in sighting probabilities because estimates of survival and population growth that do not take into account such variation may give spurious and misleading results. The published model results incorporate sightings data only up to 1996.

NMFS scientists suggested at the workshop that the "minimum number of individuals known to be alive" is a potentially useful metric for tracking the population's status, but the panel disagrees. Instead, the panel believes that, as called for in the Recovery Plan, a true estimate of population growth rate, or a reasonable proxy, should be generated on a regular basis, perhaps as part of the NMFS Stock Assessment Report process. Such estimates will become particularly important as specific management measures are implemented to reduce anthropogenic sources of mortality. Without a statistically appropriate demographic metric, it will be difficult or impossible to gauge the success or failure of management measures, let alone their cost-effectiveness.

Demographic metrics other than population growth rate may prove effective for monitoring population status. For example, this population's growth rate is particularly sensitive to changes in the survival rate of adult females. Furthermore, adult females have consistently higher sighting probabilities than other age and sex classes. It might be possible, therefore, to monitor the status

of the North Atlantic right whale population by tracking changes in the survival rate of adult females. Further effort should be put toward the development of such a metric that would allow authoritative assessment on a regular and timely basis (e.g., annually). This would require identifying the data requirements and ensuring that they are met in a timely fashion. To achieve this, maintenance and more frequent updating of the Catalog will be necessary to ensure availability of the data for modeling purposes in a reasonable time frame.

Table 2: Costs of actions to study abundance and trends, FY2003/FY2005

Activity/Source	FY 03	FY 04	FY 05
Right Whale Identification Catalog	\$219,000	\$579,206	\$363,000
NMFS	207,000	215,000	223,848
New England Aquarium	7,000	0	139,152
National Science Foundation	0	359,206	0
International Fund for Animal Welfare	5,000	5,000	0
Right Whale Sightings Database	98,962	117,815	124,949
NMFS	98,962	117,815	124,949
Population Modeling/ Abundance Estimates	238,300	256,919	317,035
NMFS	228,300	229,483	296,128
Woods Hole Oceanographic Institution	0	17,436	10,907
International Fund for Animal Welfare	10,000	10,000	10,000
TOTAL	\$556,262	\$953,940	\$804,984

Note: Also see cost table on page 11; survey and monitoring work carried out for multiple purposes has contributed much of the data used in analyses of abundance and trends.

Contribution to recovery program

(a) *Databases.* Both principal databases—the Catalog and the Sightings Database—are essential to right whale recovery efforts. Many aspects of both research and management depend directly on access to up-to-date information that they contain. This information can be and often is provided very quickly (e.g., in the case of identifying an entangled whale).

(b) *Trends in Abundance.* Demographic analyses of the right whale population should be a high priority for NMFS. Any future assessment of the effectiveness of right whale recovery efforts will depend on an ability to determine whether the population is growing and, if it is, which specific actions are responsible. Also, given continued uncertainty regarding the effectiveness of various management actions, further investigations are warranted into the contribution of demographic processes (e.g., survival of the different age and sex classes, and birth rates) to

population growth rates. Some may argue that the current situation is so dire that detailed demographic analyses are superfluous. The panel rejects such an argument and believes that, given the significant investment of public funds in efforts to promote the recovery of this population, it is essential for managers, stakeholders, and the public to know whether the North Atlantic right whale population is increasing, decreasing, or stable.

Cost-effectiveness of actions

(a) *Databases.* During FY03/05, a total of \$1.5 million was spent on maintenance of the two primary right whale databases (\$1.16 million on the Catalog and \$0.34 million on the Sightings Database). Both databases are essential for right whale recovery and have been diligently maintained in a cost-effective manner. Furthermore, the Sightings Database includes important information on other protected species that is being curated and made available to NMFS and others at no cost to those programs.

(b) *Trends in Abundance.* During FY03/05 a total of \$0.81 million was spent on population monitoring and abundance estimates. The current lack of statistically derived estimates of either abundance or trend means that further investment in this task will be necessary to provide fundamental information needed for effective management.

Recommendations

(a) *Databases.* The Catalog and the Sightings Database are both essential elements of the right whale recovery program and, as such, they should be fully funded on a stable basis. Each database has particular needs that must be met during the next few years to place data processing and analyses in support of the recovery program on a sound footing over the medium to long term. Therefore, in addition to continuation of base support for the Catalog at a level of approximately \$360,000 (actual operating costs in FY 2005), the panel recommends that NMFS provide a one-time funding supplement to the New England Aquarium to cover the costs of clearing the data backlog and integrating genotype information with the photo-identifications.

The panel further recommends that NMFS continue to support the Sightings Database at a level adequate to cope with the growing rate of data input. Because much of the effort being expended on the database is due to sightings of sea turtles and other marine mammals, it would be appropriate for some support to come from programs focused on those species.

The panel also recommends that NMFS consider the need to broaden administrative support, and thus increase funding, for both databases to ensure the long-term continuity of these invaluable resources.

(b) *Trends in Abundance.* The panel recommends that NMFS develop a system for regular assessment of right whale numbers so that trends in abundance can be determined. As noted above, such a system could either estimate a rate of increase directly, or use a surrogate parameter, such as adult female survival, to determine the likely trend of the population. The

panel further recommends that NMFS take advantage of the considerable expertise in demographic modeling in academic institutions to develop the methods for this assessment.

C. MORTALITY

Estimating mortality rates and determining causes of death are both critical components of the right whale research program. Estimates of mortality (or survival) rates are required to understand the demography of the population, as noted earlier. It is essential to know the causes of death in order to understand which, and to what extent, anthropogenic factors are affecting the population.

Estimating mortality rates is not straightforward because perhaps only half, or less than half, of all deaths are discovered and reported (Knowlton and Kraus 2001, Kraus et al. 2005). To account for deaths that are not observed, the Catalog assumes that any whale not resighted within six years has died. Sighting records suggest that this assumption is reasonable in most but not all cases. For example, right whale #1035 was seen 10 times between 1978 and 1986 in waters off New England but was not resighted again until 2002, an interval of 16 years. Conversely, right whale #1102 was the subject of an intensive disentangling operation in 2001 before disappearing in very poor condition. Although this whale almost certainly died, it is still considered a living animal in the Catalog because no carcass has been found. With a longer time series of observations, it may be possible to reevaluate the probability of mortality having occurred after a given period of absence from the Catalog.

The necropsy program ranks alongside the Catalog and the Sightings Database as an indispensable aspect of right whale recovery efforts. Evaluation of the effectiveness of mitigation and protection measures will depend ultimately on an ability to demonstrate a reduction in mortality from ship strikes and entanglements. Therefore, the capability to determine cause of death, which begins with carcass detection and ends only with a definitive necropsy diagnosis, needs to be maintained and enhanced.

During the period from 2000 to 2005, causes of death were determined for about half of the right whales known to have died (12 of 23). Concerted efforts by NMFS, the Coast Guard, and the Navy have been responsible for substantial improvements in the detection, reporting, and recovery of carcasses. Likewise, NMFS, the U.S. Geological Survey, and a few exceptionally committed researchers have greatly improved the quality and standardization of necropsy protocols so that more information is obtained from each carcass. In particular, there have been improvements in the diagnosis of blunt trauma associated with ship strikes. All of these efforts, however, require sustained funding. Appropriate levels of support (salaries and adequate funds for logistical expenses) are needed to keep necropsy team leaders engaged (only three teams are currently in place). Arrangements for sites to perform necropsies are essential, so agreements with the relevant state agencies for access to necropsy sites should be updated and expanded. In addition, further standardization of necropsy protocols and the training of a broader pool of necropsy team leaders are necessary.

The difficulty and complexity of obtaining conclusive results from necropsies and associated pathology and forensic investigations should not be underestimated. Difficult, uncomfortable, and stressful work by a small but dedicated cadre of individuals has provided the critical data presently available on causes of death for right whales. Although the panel recognizes and appreciates that work, it also believes that more effort is needed to investigate causes of death and, importantly, to trace those causes to precise times, localities, and circumstances. As explained by representatives of NMFS, determination of the exact type of fishing gear that was responsible for a given entanglement, and where the entanglement occurred, requires painstaking, careful documentation and can involve substantial logistical and legal complications. Nevertheless, the current long delays between carcass discovery and reporting with regard to the type of entangling gear (many months and, sometimes, years) are unacceptable. Mandatory gear marking (not only buoys, but also line and net material) as a condition for permission to fish with high-risk gear and methods (e.g., lobster traps and gillnets) is certainly desirable, and its feasibility should be evaluated. (For more discussion, see section IV.B. Also, note that much of the gear removed from right whales is obtained during attempts at disentanglement of live animals rather than during necropsies.)

The panel is well aware of how difficult it often is to determine, even approximately, where an entanglement took place or a ship strike occurred without observing the event. Nevertheless, knowing something about the proportions of lethal events that occur inside or outside areas designated as critical habitat, in shipping lanes, or on known migratory routes is essential for assessing effectiveness and improving management measures. This will require continued support for efforts to detect and examine carcasses, investigate the etiology of wounding and scarring on live animals, and determine where whales were killed, injured, or entangled.

Table 3: Costs of actions to study mortality, FY2003/FY2005

Activity/Source	FY 03	FY 04	FY 05
Necropsy Teams	\$0	\$65,000	\$65,000
NMFS	0	65,000	65,000
Logistics	91,596	150,169	231,259
NMFS	70,000	70,000	70,000
U.S. Coast Guard	21,596	80,169	161,259
Diagnostics	11,000	11,000	11,000
NMFS	11,000	11,000	11,000
TOTAL	\$102,596	\$226,169	\$307,259

Contribution to recovery program

Increased efficiency in detecting dead right whales at sea, better coordination among cooperating agencies in responding to carcasses, more consistent necropsy protocols, and new postmortem techniques have allowed the stranding program to play an increasingly important role over the

past decade. The response to stranding events is now an integral part of the right whale recovery program, contributing information on the rates and causes of death that is vital to understanding the population's status and the anthropogenic threats affecting it.

Cost-effectiveness of actions

About \$636,000 was spent during FY03/05 to secure right whale carcasses and examine them. Although NMFS expenditures over that three-year period remained relatively stable, Coast Guard assistance with logistics (principally retrieving floating carcasses) increased substantially. Coast Guard expenditures for logistics accounted for 38 percent of the total amount spent on mortality studies.

The investments by NMFS and the Coast Guard, together with the many hours of volunteer labor contributed by necropsy teams, have yielded significant information on the causes of right whale deaths. Such information is essential to the development of management and conservation actions that will assist in right whale recovery. Considering travel expenses, equipment needs (including rental of heavy construction equipment for moving carcasses), costs for laboratory analyses, volunteer help, and the difficulty of retrieving floating carcasses, this component of the recovery program is judged to have been very cost-effective.

Recommendations

Stranding response is a core responsibility of the recovery program and requires an adequate, ongoing funding base. This funding should be used principally to cover the recurrent but unpredictable costs of travel for necropsy teams. Funds should be made available each year to ensure that these teams are adequately equipped, stranded animals are moved to suitable sites for necropsy, heavy equipment is available for moving carcasses at necropsy sites, and essential laboratory analyses are conducted in a timely manner. The process of establishing cooperative agreements with the Navy, Coast Guard, and others for assistance in towing carcasses and securing shore areas to conduct necropsies appears well under way. Existing agreements should be maintained and others pursued to completion as needed. Finally, although recognizing the need for thoroughness and quality control, the panel believes that the analyses of gear removed from right whale carcasses (and entangled live animals) can and should be completed in a more timely and efficient manner.

D. ASSESSMENT OF HEALTH AND REPRODUCTION

Fecundity rates in the North Atlantic right whale population have shown significantly more inter-annual variation than expected by chance alone, and there have been two multi-year periods of very low calf production in the past two decades. In addition, there have been increases in the inter-birth intervals of individual females during the past two decades, suggesting that reproductive output has declined. Multiple hypotheses have been proposed to explain this variation and the possible decline in births, including long-term fluctuations in ocean conditions that affect copepod production, exposure to toxins and pathogens, and genetic factors. Whether

the observed variation is intrinsic to the species, caused by fluctuations in the environment, a result of human activities, or an artifact of sampling heterogeneity (e.g., caused by annual differences in behavior and habitat choices by individual whales) remains uncertain. It is possible that multiple factors are responsible, acting either additively or synergistically.

The above hypotheses have been examined to some extent, but, regardless of what is causing the variability, it is difficult to conceive of ways to substantially improve the health status of right whales and, in turn, increase their fecundity, by modifying human activities. It is possible that exposure to pathogens would be reduced through elimination (or at least improved management) of sources of contamination (e.g., sewage). Also, to the extent that human activities are responsible for the increased frequency and geographic expansion of harmful algal blooms, and if these are a health threat to right whales, it may be possible to take some kind of preventive action. Removal of entangling debris from adult females could improve their health and increase the likelihood that they will produce a calf. Otherwise, the health of right whales, and therefore their reproductive output, appears largely beyond human influence.

Investigations of right whale health nevertheless may be useful for understanding why this population is not recovering. Poor health of individual right whales could help explain why fecundity in this population is lower than the rates observed in some Southern Hemisphere right whale populations. Refinement of techniques that improve knowledge of animal health can play an important role in risk identification and assessment.

An impressive array of methods for assessing right whale health has been developed, including a visual health assessment protocol (Pettis et al. 2004) and an analysis of skin lesions (Hamilton and Marx 2005) using photographic images; fecal sampling and analyses of reproductive and stress hormones, lipid metabolism, parasites, etc. (e.g., Rolland et al. 2005); measuring blubber thickness with ultrasound (Moore et al. 2001); and efforts to carry out standard necropsies and associated histopathology on dead right whales (Moore et al. 2004). Application of such tools, and the development of new tools for health assessment, will continue through integration with (and at least limited support from) programs other than the NMFS right whale recovery program. It is important to recognize that health assessment, like many other parts of the overall right whale research and monitoring program, is subsidized by these other programs and that, conversely, core elements of the NMFS right whale program (photographic and genetic sampling, database management and maintenance, stranding response, surveys, etc.) provide the foundation that facilitates, and provides a necessary context for, such assessment. Further, the interest, initiative, and inventiveness of individual researchers are what drive much of this work.

Table 4: Costs of actions to assess health and reproduction, FY2003/FY2005

Source	FY 03	FY 04	FY 05
NMFS	\$561,000	\$425,000	\$321,000
Woods Hole Oceanographic Institution/Ocean Life Institute	0	88,044	92,444
TOTAL	\$561,000	\$513,044	\$413,444

Contribution to recovery program

Although various hypotheses have been formulated to explain the observed inter-annual variation in calf production of this population, there is no evidence that the variation is due to any human action. Nor is there evidence that the population's failure to recover is due to poor health or reproductive impairment. More knowledge about individual animal health and reproductive condition will contribute to interpretations of observed trends and inform management planning, but it may not be possible to apply this knowledge directly to improve the population's fecundity or status. Understanding how right whale reproduction might be coupled with broad ocean trends or cycles in productivity would provide an important context for evaluating the effectiveness of actions under human control.

Compromises to health and reproduction can, in some instances, be the result of injuries sustained from ship strikes or encounters with fishing gear. Therefore, in that sense, assessment of health and reproduction is, like the necropsy program, an integral part of the recovery program's effort to improve understanding of threat factors.

Cost-effectiveness of actions

During FY03/05, a total of \$1.49 million was spent on reproduction and health studies, with a steady decline in the level of support over that period. With the exception of support from the Woods Hole Oceanographic Institution's Ocean Life Institute in FY04 and 05, all of the identified funding has been provided by NMFS. However, research on right whale health and reproduction has been funded in diverse and creative ways, making it difficult to assess its true costs. Moreover, some of the most important insights have come from efforts by individual scientists who have, by their own initiative and resources, pursued studies with relatively modest levels of federal funding. Much of what is known about right whale health and reproduction is a direct or indirect product of the Catalog, costs of which were included in Section III.B above. Overall, excellent scientific value has been realized from the federal funds invested in studies of right whale health and reproduction in recent years.

Recommendations

It is important that investigations of health and reproduction continue at some scale and that particular attention (and funding) be directed toward determining how serious injuries from ship strikes and entanglement are affecting the health and reproductive capabilities of individual right whales. Therefore, the panel encourages individual scientists to maintain their investigations in these areas ancillary to other programs and also encourages NMFS to provide them both direct and in-kind support. The panel recommends specifically that NMFS continue to support visual health assessment, which is relatively inexpensive and provides information potentially useful for predicting and explaining inter-annual variation in calf production and for monitoring injuries caused by ship collisions and entanglements.

E. HABITAT

Major advances have been made over the past decade toward understanding habitat features that are important to right whales, especially in the calving and feeding areas off eastern North America. Management can benefit directly from improved understanding of (a) why right whales go where they go, (b) the cues that prompt them to move into or leave a given area, and (c) how they use the different types of habitat that they occupy.

In the southeastern United States, time series of right whale sightings from aerial surveys have been used to develop predictive models and characterize calving habitat for right whales. Among the more significant findings are that warm Gulf Stream waters represent a thermal limit and help define right whale offshore distribution within the calving grounds and that most sightings are in water depths of 10 to 20 m. This work, as well as analyses of sightings per unit of effort and predictive modeling, has led NMFS scientists to conclude that right whale habitat may extend outside the area designated as critical habitat for right whales in the Southeast. The aerial surveys discussed earlier (section III.A), designed to sample all nearshore waters off North and South Carolina, are expected to provide relevant data for further habitat analyses, including reevaluation of critical habitat designations.

In the Northeast, studies of right whale habitat in Cape Cod Bay have been ongoing for the past two decades, led by the Provincetown Center for Coastal Studies and supported by NMFS through contracts with the Massachusetts Department of Marine Fisheries. The studies have shown a tight coupling between high zooplankton abundance at the surface and relatively high-density occurrences of right whales. Right whales apparently come into the bay following an ecological signal of some kind that leads them to encounter large zooplankton concentrations. Why they leave the bay when they do is less clear and may have to do with memory of large copepod concentrations in other feeding areas to the north and east of Cape Cod Bay.

In the lower Bay of Fundy, a major summer feeding area, right whales appear to be closely associated spatially and temporally with dense patches of the copepod *Calanus finmarchicus* that often form just above the bottom-mixed layer in response to tidal movements. Evidence from digital archival tags (D-tags) indicates that the whales typically change their orientation while diving to feed near the bottom so that the dorsal surface of the head sometimes comes into contact with the seafloor. This research seems well justified because of its scientific value and clear relevance in addressing conservation concerns, particularly with regard to why and how right whales become entangled in fishing gear set over sandy bottom habitat. Similar D-tag studies in other types of habitat (e.g., rocky bottom) would likely provide information useful to management.

Major existing gaps in knowledge include (1) factors that determine the timing and routing of right whale movements between the Southeast and the Northeast (essentially as they go from North Carolina to Cape Cod); (2) factors that influence the presence of individuals other than reproductive females on the calving ground (e.g., is there a social component driving habitat selection in winter?); and (3) the large-scale physical processes that determine where and when

concentrations of right whale prey (especially *C. finmarchicus*) will become available. The work mentioned in III.A should provide data to address these knowledge gaps through modeling and other types of analysis.

Table 5: Costs of actions to study habitat, FY2003/FY2005

Activity/Source	FY 03	FY 04	FY 05
Habitat Studies in the Northeast			
NMFS	\$0	\$161,200	\$100,100
Predictive Modeling in the Northeast			
NMFS	119,100	198,100	196,100
Modeling in the Southeast			
NMFS	56,000	56,000	56,000
Florida Wildlife Research Institute GIS Analysis			
NMFS	125,000	125,000	125,000
D-TAG Studies			
National Fish and Wildlife Foundation	0	123,924	0
TOTAL	\$300,100	\$664,224	\$477,200

Contribution to recovery program

Understanding the habitat requirements of right whales and the ecological factors driving those requirements is vital for effective management. Such information is necessary for informed decision-making concerning critical habitat designations and to allow prediction of where and when concentrations of whales will occur (e.g., by linking them to prey concentrations) and therefore where and when protective measures should be applied.

Cost-effectiveness of actions

During FY03/05, a total of \$1.44 million was spent on habitat studies. A large portion of the funding for aircraft surveys came directly from NMFS, was directed toward states for the purpose of flying surveys, or, in some instances, was provided through the National Fish and Wildlife Foundation on the advice of NMFS. In addition, many of the analyses of this population's habitat have relied on data from the multi-purpose field and data management activities, costs of which are discussed in sections III.A and III.B. There was no straightforward way for the panel to determine what portion of the costs of multi-purpose data collection and data management should be apportioned to habitat studies. Therefore, the panel was unable to determine the true costs, or the cost-effectiveness, of recent habitat assessment work.

The finescale studies of right whale diving and habitat use (e.g., using D-tags) have delivered high value in relation to the scale of funding (a one-time grant of \$123,924). Importantly, such fine-scale studies often have numerous applications, only one of which is to improve

understanding of habitat requirements and habitat use. Understanding the population's habitat requirements can help focus survey and other research efforts and thereby minimize cost and maximize effectiveness.

Recommendations

Most activities proposed in areas designated as critical habitat are automatically subject to increased scrutiny by ESA section 7 requirements. Also, the boundaries of critical habitat may be used as a basis for various regulatory actions (e.g., some of those currently in place under the Atlantic Large Whale Take Reduction Plan). Longstanding designations of right whale critical habitat have proven well justified, but the panel believes that a reanalysis is needed. It should include reconsideration of the boundaries of currently designated critical habitat areas and evaluation of new areas for possible designation.

The panel also recommends the continuation of localized studies of factors determining habitat use (e.g., triggers for arrival and departure of whales in a given area, threshold plankton concentrations to support right whale feeding, and multivariate predictive modeling of habitat).

F. GENETICS

Genetic analyses of North Atlantic right whales provide important information on the identity, sex, and relatedness of individual whales, the current and historic genetic diversity of this population, the relationship of these right whales to other populations and species, and insight into the potential effects of small population size on vital parameters and health. NMFS has not funded any genetics research on North Atlantic right whales during the last three years. However, genetic analyses have been conducted during this period using biopsy material obtained through NMFS-supported field programs and with the support of sighting histories documented in the Catalog. One of the important findings of this research is that the photo-identification procedures are extremely robust with a very low (less than 1 percent) error rate.

Another important finding from genetic studies is that a significant portion (16 to 21 percent) of the reproductively active males in this population has not been sampled; their existence is known only indirectly by excluding all other males in a paternity analysis. This finding suggests that the population is larger than currently believed, particularly if an equivalent number of females also have not been sampled (although there is no *a priori* reason to believe that this would hold for females).

About 40 percent of the calves born each year are not taken by their mothers to the Bay of Fundy feeding ground. Since callosity patterns on neonates are not sufficiently developed for reliable photo-identification, genetic sampling of calves produced by “non-Fundy” females on the southeastern U.S. calving ground is an important component of population monitoring. This work requires real-time coordination with the New England Aquarium staff to direct biopsy sampling toward new calves that have not yet been sampled. The resulting information helps to refine understanding of the total number of calves produced each year.

The research by scientists at Trent University on mating incompatibility and fetal loss due to genetic characteristics (“inbreeding”) may prove relevant in helping to explain this population’s apparently low fecundity compared to that of some southern right whale populations.

Table 6: Costs of actions to study genetics, FY2003/FY2005

Source	FY 03	FY 04	FY 05
NMFS	\$0	\$0	\$0
National Fish and Wildlife Foundation	0	0	45,135
Woods Hole Oceanographic Institution	0	21,233	78,766
New England Aquarium	3,007	3,869	12,911
TOTAL	\$3,007	\$25,002	\$136,812

Note: The costs involved in collecting tissue samples for genetic analyses (e.g., costs of shipboard surveys, necropsies, and disentanglement attempts) are not reflected in this table. (For such costs, see sections III.A, III.C, and IV.B, respectively.)

Contribution to recovery program

Genetic research adds to understanding of the demography of this population and is interesting scientifically. Like the research on reproduction and health assessment, however, it should not detract from support for surveys of right whales, maintenance of the key databases, studies to document causes of mortality, and habitat assessment.

Cost-effectiveness of actions

During FY03/05 a total of \$164,821, all of it from sources other than federal agencies, was invested in studies of genetics. The panel did not consider it appropriate to make a judgment about cost-effectiveness. Nevertheless, the finding that up to one-fifth of the males in this population has never been sampled is certainly a high-value result.

Recommendations

Further genetics studies should be supported according to the merits of individual proposals (in terms of both conservation relevance and scientific quality) and the availability of funds. This research component is a core element of the recovery program that, from a budgetary and practical standpoint, should be incorporated largely into the activities described in Section III.B.

H. PERMITS

The panel’s review of the right whale research program did not address research permits as a separate issue or in detail. However, this issue was raised by some of the involved scientists during the course of the workshop. It was clear that, as a strategy for litigation avoidance, NMFS has been seeking to comply fully with the requirements of the National Environmental Policy

Act (NEPA) with respect to issuance of research permits. Because North Atlantic right whales are endangered, concerns about the potentially negative effects of research on them (e.g., disturbance from repeated close approaches and physical harm or health impairment associated with tagging) go beyond animal welfare and humane treatment alone; they extend to the potential for effects at the population level that would run counter to the goals of conservation. Without discussing individual cases, the panel is convinced that extremely long delays in permit issuance have sometimes seriously impeded progress on both population monitoring (e.g., biopsy sampling of calves in the Southeast) and the development of effective mitigation (e.g., field experiments with new types of rope to reduce entanglement risks and D-tagging to improve understanding of whale behavior). The process has created serious inefficiencies, increased costs, and delayed research that could guide recovery actions. NMFS has prepared an environmental impact statement to address NEPA-related issues specifically with regard to scientific research. The environmental assessment was intended, in part, to speed up the permit issuance process while at the same time ensuring that NMFS would be in full compliance with its NEPA obligations. The panel nevertheless concludes that the problem of having critical monitoring and mitigation work delayed by the permitting process needs to be addressed as a matter of urgency and not folded into a prolonged, comprehensive process of systemic reform.

IV. FINDINGS OF THE PANEL:

PROTECTION AND RECOVERY

The vast majority of the federal government's effort with regard to protection and recovery has revolved around the twin goals of reducing deaths or serious injury from ship strikes and entanglement in fishing gear (bycatch). That emphasis is entirely appropriate.

A. SHIP STRIKE REDUCTION

On average, one or two ship strike deaths of right whales are documented annually along the East Coast of North America. Given that not all events are reported and not all right whale carcasses are recovered and subjected to a definitive necropsy, these numbers almost certainly underestimate the true mortality caused by ship strikes. The potential biological removal (PBR) level (the number of deaths and serious injuries that the population can withstand in addition to natural mortality as defined in the Marine Mammal Protection Act) has been set at zero for this population, meaning that any ship strike-related mortality or serious injury is unsustainable and should not be permitted.

To date, measures to reduce collision risks have consisted primarily of providing advice to vessel operators and urging them to exercise caution and seek to avoid hitting right whales. The main elements of NOAA's ship strike reduction strategy can be summarized as follows:

- The use of aerial surveys, known as Early Warning System (EWS) flights in the Southeast and Sighting Advisory System (SAS) flights in the Northeast. The surveys have been conducted annually in the Southeast during winter (1 December to 31 March) since 1993 and year-round in New England since 1997. Once right whales have been detected, mariners are alerted via NAVTEX, Notices to Mariners, the Mandatory Ship Reporting (MSR) outgoing message, NOAA weather radio, and other routes, and advised (at least through the "NOAA-mediated" outlets) to reduce speeds (to no more than 10 knots) and increase vigilance in the area(s) of the sighting(s).
- Since 1997 enforcement of a "500-yard no-approach" regulation for all vessels (including whale-watching boats) and aircraft in the vicinity of any right whale.
- MSR systems, jointly funded by NOAA and the Coast Guard, in place since 1999, to provide information, including that obtained from the early warning and advisory system surveys, to mariners entering areas where right whales occur in New England and Florida/Georgia. These systems apply to vessels larger than 300 gross tons.
- Since mid-2005 NOAA advisories specifying that speeds of 10 to 12 knots or less should be maintained in areas of known or expected right whale presence, communicated to mariners via NOAA weather radio and other NOAA outreach mechanisms.
- Consultations under Section 7 of the Endangered Species Act that have led the Army Corps of Engineers, the Coast Guard, and the Navy to modify their operating procedures

in areas where, or at times when, the risks of ship strikes on right whales are considered especially high.

- Interagency collaboration, especially with the Coast Guard, Navy, and Canada's Department of Fisheries and Oceans, on right whale conservation measures.
- Extensive outreach and mariner education efforts.

These measures have not brought an end to ship strikes, nor is there any evidence that they have reduced the incidence of such events. Between September 2001 and February 2006 at least seven right whales, including four adult females, a juvenile female, and a female calf, have died from ship strikes. Those losses to the reproductive potential of the population are alarming by any standard, and even more so considering the likely negative bias in the number of deaths observed. It must be concluded, therefore, that although the ship strike reduction strategy may have prevented some collisions, it has not been successful in addressing this threat to North Atlantic right whales.

Recognizing the need for stronger measures, NMFS has been developing and evaluating a number of initiatives since the late 1990s. The options being considered consist primarily of (a) regulating vessel speeds, (b) changing vessel routing, (c) expanding mariner awareness and education efforts, and (d) developing and testing collision avoidance technology. The primary approach is to separate whales and vessels to the maximum extent feasible. Where such separation cannot be assured, a secondary approach is to reduce vessel speeds. This order of priority is well justified given what is known and not known about ship/whale interactions.

Regulation of vessel speeds

A proposed rule that would establish speed limits of 10 or 12 knots for large vessels (>65 ft) in specified areas is currently working its way through the rulemaking process, with the expectation that final regulations could take effect by mid-2007. Two types of areas would be designated: seasonal management areas (SMAs), where right whales are regularly expected to occur in relatively high densities, and dynamic management areas (DMAs), where right whales occur unpredictably. The first would impose speed restrictions during specified periods each year; the latter would involve temporary (15-day) imposition of speed restrictions.

Although this was not made explicit during the review, DMAs presumably would involve triggering criteria similar, if not identical, to those used for dynamic area management of fisheries (see IV.B). In other words, some threshold density (e.g., 0.4 whales per nmi²) documented by direct observation (aerial or shipboard, but possibly in the future by passive listening devices) would trigger the DMA designation process.

Information presented by NMFS representatives at the workshop indicated that the cost implications of reducing vessel speeds as suggested in the proposed rule are small relative to the total value of East Coast shipping (\$325.1 billion). The direct costs of a 10-knot limit are estimated at \$66.4 million and the overall costs at \$116.1 million (including direct and secondary costs). Corresponding costs of a 12-knot limit are estimated to be \$44.1 million and \$62.4

million. Difficulties of monitoring and enforcing speeds of vessels at sea need to be addressed, bearing in mind evidence that suggests relatively small differences (a few knots) in vessel speed can make a crucial difference in whether a lethal strike on a whale does or does not occur.

NMFS can expect to be challenged to demonstrate quantitatively the conservation benefits of vessel speed regulation. For example, how many fewer ship strike deaths of right whales can be expected if the limit is set at 10 knots rather than 12? There should be no illusions about the feasibility of producing robust calculations of that kind, given the many uncertainties and biases in the data on numbers, locations, and causes of ship strikes, as well as the small sample sizes in the available database (ship strikes on right whales are rare events in absolute terms). Nevertheless, the panel shares the opinion of many other scientists, based on the best data available, that a significant reduction in lethal ship strikes would be achieved if vessel traffic were limited to 10 knots or slower within areas of high right whale density.

The Automated Identification System (AIS) currently used on vessels larger than 300 gross tons provides mariners with information on the location of other similarly equipped vessels within a range of about 60 nmi. Although not intended for such a purpose, AIS transmissions have the potential to monitor point-to-point ship speeds and could be used for enforcement of ship speed limits. To do so, however, would require a shore-based receiving system, which the system is apparently designed to accommodate. The review panel believes that such a system offers considerable promise for future monitoring and enforcement systems.

Regulation of vessel routing

Frequently when a right whale carcass is initially sighted near a shipping lane off a major port, the death proves to have been the result of a collision. (It must be borne in mind, however, that the precise locations of most ship strikes are unknown, and strikes may happen anywhere within the species' range.) Therefore, steps have been taken to adjust some shipping lanes in both Canada and the United States to reduce the risks to right whales.

According to a Canadian official at the workshop, an analysis of data on whale distribution and shipping traffic indicated that shifting the western boundary of the traffic lanes in the Bay of Fundy westward by 3.9 nmi would reduce the probability of ship strikes by 80 to 90 percent. As a result, the traffic separation scheme (or shipping lanes) in the Bay of Fundy was altered in 2003 specifically to achieve such a reduction in risk. This required a formal procedure in which Canadian officials prepared a proposal for submission to, and acceptance by, the International Maritime Organization (IMO).

In the United States, NMFS submitted a proposed change to the port of Boston's shipping lanes to the IMO in April 2006. If approved, this change could be implemented by mid-2007. The proposal includes a 12-degree shift in orientation of the northern leg and a narrowing of the two traffic lanes by approximately one-half mile each. These changes are expected to result in a 58 percent reduction in the risk of ship strikes on right whales and an 81 percent reduction in the risk of strikes on other large whales. Although it is not mandatory that vessels entering and

leaving Boston follow identified traffic lanes, most vessels do adhere to them. The panel commends the Service and the staff of the Stellwagen Bank National Marine Sanctuary for the painstaking work involved in bringing this measure to its present stage.

NMFS also is considering non-regulatory measures to establish recommended routes for ships in Cape Cod Bay and the Southeast, developed collaboratively with the Coast Guard (e.g., using Port Access Route Studies). Such recommended routes would be communicated via navigation charts and other means. The intention of the measures would be to reduce the overlap between whales and ships by minimizing ship transit distances through the highest-use whale habitat and encouraging ships to avoid specific whale aggregation areas. NMFS has indicated that it will monitor adherence to the designated shipping lanes and assess the need for making them mandatory.

The panel was advised by a representative of the Coast Guard that, although shipping lanes are generally non-mandatory, IMO rules do allow them to be made mandatory. Moreover, it was noted that the main purpose of a traffic separation scheme normally is to reduce the risks of collisions between ships or with fixed objects, and of groundings. The panel welcomes and commends the evident willingness of both NOAA and the Coast Guard to proceed with measures involving traffic separation schemes for the unorthodox purpose of reducing risks to right whales.

Finally, NMFS is considering establishment of an Area To Be Avoided in the Great South Channel where right whales congregate to feed in the spring. Such a designation would require IMO approval, and it is anticipated that a formal proposal will be ready for submission by April 2007. There is adequate evidence of this area's importance to right whales to justify at least seasonal regulation of vessel traffic there. In the panel's view, serious consideration should be given to the possibility of complete closure to large vessel traffic during part or all of May and June each year. Regardless of how the area is configured or managed, it will be important to anticipate and allow for unintended consequences, such as the displacement of high-speed traffic and exposure of whales to greater risks in another part of their range (e.g., while they are moving into or out of the restricted area). Although approximately 90 percent of existing Areas To Be Avoided are voluntary, the panel strongly encourages a mandatory approach in this instance for two reasons: (1) the fact that such a high proportion of the population uses the area on a regular basis, and (2) the whales' intensive use of the area is strongly seasonal, so closure could be confined to a relatively small part of the year.

Awareness, outreach, and education

The Service has invested significantly in a campaign to make mariners aware of the ship strike problem and to encourage steps on their part to prevent collisions with right whales. Brochures, pamphlets, placards, magazine articles, and videos have been distributed widely; navigational and regulatory charts pertaining to U.S. East Coast shipping are annotated with cautionary notices; and information on right whale collision risks and advice on how to avoid them is posted on relevant Web sites. The campaign has wisely extended beyond the shipping industry to

include enforcement agencies (marine police, Coast Guard, etc.), the military, the cruise ship industry, and the recreational boating community.

Research and development

Representatives of NMFS expressed their intention to continue the search for technologies that would either allow vessel operators to detect whales in advance so that they could steer to avoid collisions or that would alert whales to oncoming vessels and allow them to take evasive action. They regard passive acoustics as a particularly attractive avenue of investigation, hoping that improvements in detecting right whales (in real time) will allow regulations to be fine-tuned with minimal economic impacts. Also, as indicated earlier, it is hoped that passive acoustics will, in time, reduce the need for costly aerial surveys.

There is also a strong impetus within NMFS to improve understanding of the physical dynamics of vessel/whale interactions. Some of this work involves tests in flow tanks using right whale models. Although such tests are potentially informative, the panel was skeptical whether static models and laboratory conditions would provide useful insights justifying the relatively high costs of such studies. That said, it is important to acknowledge the insights gained in the past from laboratory studies of hydrodynamic effects of large vessels (Knowlton et al. 1995) and field studies of right whale behavior and responsiveness (e.g., Nowacek et al. 2001, 2004), both supported by NMFS funding. Both types of studies have revealed specific problems that need to be taken into consideration for a ship strike reduction strategy to be successful.

A pilot project currently underway in the Stellwagen Bank National Marine Sanctuary (with active involvement by NMFS in its design and implementation and with partial funding from NMFS) holds promise for combining data from passive acoustic monitoring with vessel traffic data from AIS transmissions to manage ship/whale interactions on a real-time basis. Ideally, such an approach could facilitate the designation of dynamic management areas (see earlier discussion and section IV.B) and provide a means of monitoring vessel responses to advisories concerning the locations of right whale sightings. Although the panel recognizes the potential value of this approach, it is concerned about possible limitations, both practical and fiscal. For example, a large amount of computing capacity will be required to manage, process, and integrate the massive flow of data coming from both passive acoustic monitoring and the AIS. There also will always be a risk that right whales are present but not heard in a given area, whether because they are not vocalizing or because their sounds are being masked by ship or ambient noise. Although it was pointed out that buoys are already in place for the pilot acoustic monitoring project and therefore the costs of deployment on Stellwagen Bank should be modest, extending the buoy network to cover known or suspected high-use areas throughout the entire range of right whales along the U.S. East Coast will require a huge amount of infrastructure with significant associated cost implications.

Compliance with advisories

Studies of the extent to which vessel operators use EWS/SAS advisories and recommendations are notably lacking, as are studies of how information provided through other awareness and education programs has been used to reduce the risk of ship strikes. Results of a pilot project using AIS to assess voluntary compliance with speed and routing advice in the Great South Channel were not encouraging. Only 2 of 40 monitored ships changed course to avoid right whale aggregations and only 1 reduced its speed measurably (Moller et al. 2005).

Representatives of the Navy and Coast Guard offered the panel assurances that they have protocols onboard their vessels for observing and avoiding right whales. However, no data were provided on, for example, when and where observations had led to avoidance maneuvers or near misses had been noted by the onboard observers. Without such data, it is difficult to judge effectiveness and impossible to generate ideas on how to improve effectiveness. Although data on near misses have been collected opportunistically in a standardized manner since 2001 as part of the EWS aerial survey program in the Southeast, it was unclear if those data had been analyzed and used to refine mitigation measures. Moreover, the panel questioned how meaningful such reports would be, given that they come from surveys that provide no coverage at night or during inclement weather. For enforcement as well as scientific purposes, a priority should be placed on obtaining high-quality photographs or video of vessel interactions with right whales.

NMFS and the Coast Guard appear to be assessing compliance with the MSR systems with rigor and transparency, noting increased compliance rates over time following the initiation of steps to issue citations for non-compliance. Ongoing problems are recognized and efforts are being made to address them. With regard to the EWS program's effectiveness, however, the panel was puzzled to learn that mariners are advised of right whale sightings only as they approach ports and not as they leave. The reason for this asymmetry was said to be that, under the existing IMO-approved arrangement, the Coast Guard is empowered to board vessels and enforce measures as a condition of port entry but not necessarily once a vessel leaves port.

NMFS representatives stated their belief that outgoing mariners almost certainly would receive information about right whales in the normal course of checking NOAA radio and other sources before or as they leave port, although that apparently has not been verified. In the Southeast, harbor pilots are issued pagers that receive real-time information on sightings for their use as they pilot vessels both into and out of port. A NOAA e-mail address is also available for vessel operators to send messages and to receive automated responses giving information on whale locations. In the panel's view, it is important to verify that mariners are aware of right whale locations both when entering and leaving port. If that is not occurring, steps should be taken to correct this deficiency. It is equally important to ensure that individuals who receive right whale advisories respond appropriately. In other words, more studies of the kind mentioned earlier for Great South Channel are needed to assess the extent to which such advisories are heeded by mariners.

The panel also notes that MSR messages sent to vessels by the Coast Guard do not include speed advisories because the Coast Guard considers specification of a speed that is “safe” for whales to be premature. This is despite the fact that NOAA-mediated outlets have begun advising vessels to reduce speeds to 10 to 12 knots or slower in high-risk areas or circumstances. The panel believes that it is very important for specific ship speed advisory information to be included in the MSR and other Coast Guard-generated messages.

Table 7: Costs of actions to reduce ship strikes, FY2003/FY2005

Activity/Source	FY 03	FY 04	FY 05
Development of speed regulations	\$100,000	\$450,000	\$450,000
NMFS	\$100,000	\$450,000	\$450,000
Development of routing measures	269,400	264,400	291,000
NMFS	149,700	204,700	219,000
U.S. Coast Guard	35,000	35,000	35,000
International Fund for Animal Welfare	60,000	0	0
Stellwagen Bank National Marine Sanctuary	24,700	24,700	37,000
Public outreach	9,000	80,000	97,000
NMFS	0	71,000	71,000
International Fund for Animal Welfare	9,000	9,000	26,000
Research on whale avoidance technologies	1,897,800	2,657,713	1,753,825
NMFS	1,874,047	2,611,699	1,685,332
New England Aquarium	23,753	46,014	68,493
Compliance studies	0	0	0
Enforcement	64,668	67,512	87,592
NMFS	0	0	0
U.S. Coast Guard	64,668	67,512	87,592
Whale sighting/advisory systems (i.e., EWS/SAS aerial surveys)	1,114,649	1,124,788	1,607,200
NMFS	617,000	558,000	988,000
U.S. Coast Guard	201,649	237,788	279,200
U.S. Navy	155,000	155,000	155,000
U.S. Army Corps of Engineers	141,000	174,000	185,000
Mandatory ship reporting systems	266,876	284,379	296,353
NMFS	110,000	110,000	110,000
U.S. Coast Guard	156,876	174,379	186,353
TOTAL	\$3,722,393	\$4,928,792	\$4,582,970

Note: The values shown for “whale sighting/advisory systems” are redundant with (for Navy and Army Corps of Engineers) or subsumed within (for NOAA and Coast Guard) those given for aerial surveys in section III.A.

Contribution to recovery program

Rulemaking

Management of vessel traffic to reduce the frequency and severity of ship strikes is vital to the recovery of North Atlantic right whales. The panel questions the effectiveness of the mitigation program currently in place, which consists primarily of encouraging voluntary action on the part of vessel operators to avoid collisions with whales. Ship strikes have continued to occur with no evidence of a reduction in their frequency or severity. The recent strategy proposed by NMFS, which includes mandatory speed restrictions and new routing measures, however, offers considerable promise.

Awareness, Outreach, and Education

The belief that these efforts will contribute to recovery qualifies as common sense, but there is no evidence that complete reliance on them to encourage voluntary action has made a significant difference with regard to reducing ship collisions thus far. Little information was provided to the panel that could be used to evaluate whether the work carried out to date has contributed to recovery or has been well directed. Further, there is little basis for determining the relative value of the different types of awareness, outreach, and education products.

Research and Development

Valuable insights have been gained from studies of ship hydrodynamics and the behavior and responsiveness of right whales when approached by ships. Overall, the results point to two major conclusions: (1) it is unrealistic to expect a technological solution to this problem in the near term, and probably even the medium term; and (2) the only available solution is to separate ships from right whales in space and time. Although data are limited, the best evidence available confirms that ship speed affects the risk of collisions with whales and therefore that the imposition of speed limits is an appropriate measure.

Cost-effectiveness of actions

During FY03/05 a total of \$13.23 million was spent on actions to reduce ship strikes on right whales. Of that total, NMFS provided \$10.38 million.

Rulemaking

The total cost during FY03/05 to develop speed regulations and routing measures as part of ship strike reduction strategies was \$1.82 million. The large investment in this aspect of the recovery program is consistent with its importance. Although the new ship strike reduction strategy currently being proposed appears carefully developed and sensible, the biological costs of the slow pace of development, in terms of dead right whales, have been substantial. Such high financial costs and the long development time must be evaluated in the context of procedural

rulemaking requirements—environmental impact statement preparation, economic impact analyses, scoping processes, port access route studies, etc. Assuming that the various elements of the strategy are implemented during the coming months as anticipated, the program may well be judged cost-effective. However, this will depend on the specific provisions of the various elements, particularly those related to speed limits and routing measures, and the extent to which vessel operators comply with them.

The slowness of rulemaking is largely systemic and therefore not necessarily a reflection of inattention on the part of NMFS. Although not rapid, the work of NMFS scientists and managers in this regard appears to have been thorough and conscientious.

The present early warning system consists of detection of right whales via dedicated aerial surveys and platforms of opportunity (e.g., Coast Guard aircraft and vessels, research vessels, and whale-watching vessels), followed by notification of vessel operators, with the expectation that they will respond appropriately to avoid collisions with right whales. During FY03/05 a total of \$4.7 million was spent to gather data and operate the system. The effectiveness (and thus cost-effectiveness) of the system, in terms of preventing ship strikes, is difficult to evaluate with the information available. The panel acknowledges that useful data on whale distribution, entanglements, and individual identification have been gathered by the aerial surveys.

Studies of ship traffic volume and routing have been accomplished in a rigorous, thorough manner and have been effective in providing support for rulemaking. A great deal of valuable information on traffic volumes and patterns has been obtained and is being analyzed through the MSR system. The continued collection and analysis of such data are warranted, particularly for assessing compliance with, and cost-effectiveness of, new vessel routing measures.

Awareness, Outreach, and Education

During FY03/05, \$187,000 was spent specifically on public awareness, outreach, and education, with \$142,000 allocated by NMFS and the remainder by the International Fund for Animal Welfare. Without an empirical analysis of some kind to evaluate the effectiveness of different mechanisms or media (e.g., brochures, posters, radio broadcasts, training films, etc.) for bringing about changes in vessel operations in right whale high-use habitat (e.g., posting watches, adjusting speeds, or changing routes), it is impossible to determine whether this program has been cost-effective.

Research and Development

During FY03/05, \$6.31 million was spent on research related to whale avoidance technology (e.g., whale detection devices, acoustic alarms, ship hydrodynamics, and the behavior and responsiveness of right whales when approached by ships). This accounted for 48 percent of the total amount spent during that period for ship strike reduction. As indicated earlier, those expenditures have failed to produce a technological solution that would allow ship traffic to operate without restraint (e.g., a vessel-mounted acoustic device that would detect whales or

cause them to move away as the vessel approached). Further investment of federal funds in efforts to develop or test such devices is not likely to be cost-effective.

Recommendations

Rulemaking

The situation with ship strikes of right whales is well past the point at which precautionary action became justified; such action is long overdue. Therefore, regulatory action should be taken with all possible haste. If further delays arise in the rulemaking schedule presented at the workshop (i.e., final action by early 2007), the panel recommends that emergency rulemaking authority be used. Ongoing research will improve our understanding of whale behavior, ship hydrodynamics, the role of speed, and other factors potentially relevant to incidence and severity of ship strikes, and it may be possible to revise or scale back regulations accordingly. The panel recommends that NMFS proceed as rapidly as possible to implement a speed limit of 10 knots for seasonal and dynamic management areas, with the understanding that this precautionary approach (i.e., 10 knots rather than some faster speed) is appropriate for addressing one of the two most serious threats to North Atlantic right whales. In addition, the panel recommends that the proposed changes in the Boston shipping lanes and in the recommended routes for Cape Cod Bay and ports in the Southeast, as outlined during the review, be implemented without delay, accompanied in each case by rigorous monitoring to assess the extent to which the new routes are being used. Finally, in view of the Great South Channel's clear, consistent importance as a seasonal feeding ground for right whales, the panel urges establishing this area as a mandatory Area To Be Avoided for periods when right whales are present.

The panel urges NMFS to consider using the presence of a single mother/calf pair as a sufficient basis for triggering the dynamic management process because of (a) their exceptional vulnerability as they spend more time at the surface than other whales, (b) the mother's relatively high reproductive value to the population, and (c) the fact that six of the seven right whales known to have been killed by ship strikes between 2001 and 2006 were females. Depending on expert judgment with regard to the animals' likely mobility in a given context (e.g., whether they are likely to be passing through or instead remain for a long period), dynamic management areas triggered by this criterion may be designated for a shorter or longer period than is usual.

The panel also recommends that MSR messages be sent to vessels on their reported departure dates so that right whale advisories are available to ships when leaving port, as well as when entering.

Awareness, Outreach, and Education

It may be true that more public awareness, outreach, and education will always be useful. However, the panel has two specific recommendations in this regard. First, there needs to be a sharper focus on mechanisms to ensure that accurate, relevant messages reach specific target audiences (e.g., the people responsible for bridge operations of ships). The effectiveness of

measures taken, whether they are mandatory or voluntary, ultimately depends on their comprehension and acceptance by vessel operators. Therefore, it is important that NMFS solicit the views of vessel operators, harbor pilots, and ship captains concerning the types of information they would find useful and how that information would be most effectively communicated. Second, evaluation is needed of the effectiveness of the awareness, outreach, and education efforts to justify continuation, much less expansion, of this program. To date, there appears to have been no effort to evaluate effectiveness, despite the availability of simple techniques for doing so (e.g., interviews with harbor pilots and ship captains).

There will always be a need to educate new generations of vessel operators and reinforce messages with seasoned mariners, which means that ship strike avoidance procedures and awareness of right whales and their plight must be institutionalized as part of ongoing training and certification processes. Although doing so may be straightforward in the North American context, there is an increasing need to extend such awareness and training to foreign operators. Therefore, more attention should be given to the non-U.S. component of the shipping industry, i.e., mariners from foreign countries who operate in the international maritime trade and regularly call at U.S. East Coast ports. The panel believes that NMFS should increase its work with other agencies and organizations (e.g., the Department of State and the IMO) to make foreign mariners aware of the ship strike problem and of the applicable U.S. guidelines and regulations. This will become even more important as new rules are adopted and implemented.

The panel recognizes and accepts that the contents of brochures and other materials might need to include certain types of information that are somewhat peripheral to mitigation, *per se*. For example, providing basic information on how to identify right whales and on their natural history and conservation status is justified simply because of the inherent value of raising awareness of the animals' existence and basic traits. However, the panel is concerned that certain other key messages that are directly relevant to mitigation may not be being communicated effectively at present. For example, advice on specific speeds that are "safe" for whales generally have not been included in outreach materials in the past, although some steps have been taken recently to correct this deficiency. In particular, given the responses received from representatives of the various agencies at the workshop, it is unclear what, if any, penalties would apply for deviations from designated ship channels. If there are consequences, it is essential that these be clearly stated and that the relevant mariners be made aware of them. Similarly, if there are incentives for voluntary compliance with guidelines or advisories, these should be explained clearly and disseminated widely.

Research and Development

The panel reiterates its recommendation to continue development of passive acoustic monitoring as an alternative or supplement to other types of monitoring, especially aerial surveys.

Further studies of compliance should be conducted to evaluate the effectiveness of voluntary approaches to mitigation. Such studies must remain a high priority even as new measures are taken, whether they are voluntary or mandatory (recognizing that, in the latter case, evaluation

may be tantamount to enforcement). AIS seems to offer an excellent tool for these kinds of studies as well as for monitoring and research. Therefore, infrastructure needed to make AIS useful for these purposes should be developed.

The panel recommends that carefully planned field studies to investigate right whale behavior in relation to vessel approaches should be accorded higher priority for funding than work in flow tanks with right whale models. Both types of studies should be considered for funding on their merits and as discretionary funds become available.

All available information on ship strikes of right whales along the East Coast of North America needs to be compiled and analyzed in the context of proposed ship routing changes. For example, it would be useful to know what proportion of the strikes occurred, or might have occurred, within the 30 nmi radii of the nine U.S. ports planned for speed restrictions under the current ship strike reduction strategy. Also, further analyses to compare ship traffic to right whale distribution, including predictive modeling, should continue as needed to support refinement and reevaluation of the ship strike avoidance strategy.

A major data gap is knowing where, when, and under what circumstances (e.g., vessel speed, visibility conditions) ship strikes occur. The most obvious source of such data is the vessel operators themselves. The panel therefore recommends that a regulatory mechanism be devised that would require operators of vessels that strike whales to report the incident and describe the circumstances. Only by increasing the size and quality of the ship strike database will it become feasible to design cost-effective measures that both reduce whale mortality and minimize disruption to shipping.

B. FISHERY BYCATCH REDUCTION

Entanglement in fishing gear (bycatch) is the second primary anthropogenic source of mortality for North Atlantic right whales. There have been 61 confirmed cases of right whales carrying fishing gear since 1986 (Kraus et al. 2005). It is often difficult to determine which fishery is responsible for an entanglement, but when the entangling gear on right and humpback whales in the western North Atlantic has been identified, it has usually (89 percent of the time) been either sink gillnet gear or trap (pot) gear set for lobsters (Johnson et al. 2005). Both types of gear are set on the sea bottom, with vertical lines that extend to floats at the surface to mark the location of the gear. Right whales can become entangled in any part of the gear, but most entanglements in which the part of the gear could be identified involved the buoy lines or the ground lines used to connect adjacent traps or nets (Johnson et al. 2005). At least five recent right whale entanglements have been linked to Canadian lobster or gillnet gear.

Entanglement is seldom immediately lethal to right whales. Instead, entangled whales usually swim off with part or all of the gear, which they may carry for periods of months or years. It can take some time before a whale is sighted and reported as carrying gear, a factor that frustrates most efforts to determine exactly where the entanglement occurred. Depending on the severity of the entanglement, the animal may become emaciated and weakened as a result of an inability to

feed, or it may succumb to infections or other trauma. Death may occur months or even years after the initial entanglement. Entanglements also may reduce the reproductive success of affected animals, which may, in turn, have an effect on the population's recruitment rate.

The NMFS strategy to reduce and eliminate entanglement is two-tiered: a long-term program to develop gear modifications that will reduce the risk of entanglement in these fisheries, and, in the meantime, restricting the use of potentially dangerous fishing gear in times and areas where right whales occur. The ultimate goal is to design "whale-safe" fishing gear that will not entangle right whales and to require that this gear be used throughout areas where right whales occur. This goal is to be achieved by working cooperatively with the fishing industry and other stakeholders to design and test gear modifications that will reduce the risk of entanglement at reasonable cost to the fishing industry. In the meantime, while whale-safe gear is being developed (implicitly recognizing that this may take considerable time), NMFS is identifying times and areas where whales co-occur with high-risk fisheries and restricting the use of potentially risky gears through the dynamic area management (DAM) and seasonal area management (SAM) programs as well as in designated critical habitat. In most cases, conservation actions within DAM and SAM areas require, or encourage, the use of fishing gear that has been modified to reduce the likelihood of life-threatening entanglement.

While working toward the eventual reduction or elimination of entanglements, NMFS also is supporting efforts to disentangle whales observed carrying fishing gear. As explained below, those efforts do not contribute to a solution of the entanglement problem, and they carry a unique set of inherent risks, but they do at least prevent the deaths of a few entangled whales. The disentanglement program is reviewed in this section of the report.

As noted earlier, the PBR level for this whale population has been set at zero, meaning that any fishing-related mortality or serious injury is unsustainable and should not be permitted. Nevertheless, it will be extremely difficult to eliminate entanglement as a source of mortality for right whales without significant changes (and economic costs) to affected fisheries. These fisheries are important to the economies of coastal states. For example, the panel was informed that, under the Atlantic Large Whale Take Reduction Plan (ALWTRP), NMFS currently manages about 6,000 lobster fishermen who set more than 2 million traps.

Complicating efforts to resolve the entanglement issue is the fact that NMFS has a dual charge—on one hand to promote and manage fisheries and on the other to protect right whales and encourage their recovery. These often-conflicting mandates are administered by separate programs within the agency. The role of the federal regional fishery management councils and the various state fishery management agencies in developing management plans complicates matters further. To overcome these complications, the entanglement problem needs to be recognized as a fishery management crisis that requires decisive action at the highest levels of government. The extinction of North Atlantic right whales would represent a fundamental failure in both fishery management and the conservation of protected resources in the United States.

Modifications to fishing gear and practices

Since its establishment in 1996 the ALWTRT has been working with NMFS to reduce mortality and serious injury of right whales in commercial fishing gear through the large whale plan. The major focus has been to develop modifications to existing fishing gear and practices to make it less likely that right whales will become entangled. The plan has been amended several times to reflect new modifications or to extend modifications to new times, areas, or fisheries. It also includes seasonal and temporal restrictions under the SAM and DAM programs.

The following provisions currently apply to lobster trap and anchored gillnet fisheries managed under the ALWTRP throughout the U.S. Exclusive Economic Zone (out to 200 nmi from shore):

- No buoy lines floating at the surface;
- All gear must be hauled from the water at least once every 30 days; and
- Fishermen are encouraged, but not required, to maintain knot-free buoy lines.

Specific requirements for lobster trap and gillnet fisheries (e.g. sinking groundlines, net panel and buoy line weak links, gear marking) vary by management area. In addition, a number of specific modifications are required for lobster trap and anchored gillnet fisheries in areas managed under the SAM and DAM programs, including the following:

- Prohibition on the use of floating ground lines and/or buoy lines;
- Weak links required at buoys and net panels; and
- Limits on the number of buoy lines per trap (pot) trawl or net string.

Despite a decade-long period of development, the suite of regulations implemented to date has not been successful in reducing the observed entanglement rate of right whales in commercial fishing gear. There is good evidence that in some circumstances (e.g., when the line is wrapped around the tail stock) weak links do not work. For example, two lines with intact weak links have been recovered from entangled right whales since 2002. Knowlton et al. (2005) noted that “Entanglements are frequent and the annual rate has remained high and is increasing.” Thus, it is clear that the management program to date has failed to eliminate entanglements. The situation is dire, and more effective actions are urgently required.

In June 2003 NMFS published a Notice of Intent to prepare an environmental impact statement (EIS) to analyze alternatives for further amending the ALWTRP to increase its effectiveness in reducing the entanglement rates of right and other large whales. The draft EIS was issued in February 2005, followed by a proposed rule and request for comment in June of that year. The two preferred alternatives (and all other alternatives) in the amended plan focus on further modification and extension of current techniques, including, but not limited to, the following:

- Expansion of the use of weak links;
 - Requirement to use neutrally buoyant or sinking ground line; and
 - Inclusion of several other fisheries under the plan.
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It is difficult to imagine any scenario in which the limited suite of modifications described in the draft EIS will significantly reduce the frequency with which right whales become entangled in fixed fishing gear. For example, a large proportion of well-documented entanglements have involved buoy and surface lines (although in many cases, just pieces of line are found on whales, and these cannot be attributed to a particular part of the gear), which would not be changed by the proposed regulations. The panel learned that some individuals within the fishing industry oppose efforts to address the problem of buoy lines, citing technical, economic, and safety issues associated with any modification of end lines. Further, according to NMFS, it has proven extremely difficult to modify vertical lines in a way that makes them less risky for whales but still feasible for use by the fishermen. This is plainly evident from the detailed information provided in the NMFS Working Draft of a Strategy to Reduce Large Whale Entanglement Risk Associated with Vertical Line. Nevertheless, without addressing the risk of entanglement in vertical lines, it will not be possible to solve the entanglement problem. It is critical to remember that the goal of this program is not simply to reduce current rates of entanglement but to eliminate serious injury and mortality due to entanglement altogether.

The panel acknowledges that some modifications to fishing practices are currently in place under the ALWTRP, and others are being considered. Nevertheless, the panel concludes that the measures implemented to date, as well as those in the proposed modifications to the ALWTRP, are inadequate. They also may prove more costly than necessary in the long run. The provisions may result in greater long-term economic costs to the fisheries involved than would be the case if effective regulations were implemented immediately to eliminate the risk of entanglement. In particular, regulations should be put into place as quickly as possible to prohibit the use of vertical lines in all areas where right whale aggregations may be expected (i.e., critical habitat and DAM and SAM areas). This prohibition should remain in place until gear modifications are developed that can provide reasonable assurance that entanglement will not occur. Such a prohibition would do two things: (1) place the burden of proof on the fishing industry to demonstrate that it has developed whale-safe gear, and (2) harness the vast creative energy of fishermen to develop ways to catch lobsters and finfish without using gear that has the potential to entangle whales.

Finally, there is a pressing need for improvement in the processes for developing, evaluating, and testing potential gear modifications. NMFS has implemented a competitive grants program, administered through a cooperative agreement with the National Fish and Wildlife Foundation (NFWF) and designed to provide funding opportunities to fishermen, academic researchers, and other interested parties. Once a gear research project has been completed, the researcher may request that NMFS consider the gear modification as a potential management tool for incorporation into the ALWTRP. The panel is concerned that this arrangement has not delivered innovative, effective gear modifications in a timely manner. As noted by participants at the 2004 Workshop on Modification of Fishing Gear to Reduce Large Whale Entanglements, there is an urgent need for a dedicated, coordinated research program that combines gear research with research on whale behavior. For such a program to be effective, there also needs to be a change in the process of issuing scientific research permits to make it easier to evaluate and field-test promising approaches.

Area management

Since 2002 NMFS has employed spatially explicit SAM and DAM approaches to reduce right whale interactions with commercial fishing gear. The SAM program was intended to protect right whales in two areas where predictable seasonal aggregations occur in and adjacent to the currently designated critical habitat areas of Cape Cod Bay and the Great South Channel. The DAM program allows NMFS to impose temporary gear specifications or restrictions on the deployment of lobster trap and anchored gillnet fishing gear in areas north of 40° N where aggregations of right whales are reported. A DAM action is triggered by a reliable report of right whales that meets a certain density threshold (0.04 whales per nmi²). Once a DAM action has been triggered, NMFS may temporarily restrict or request the use of certain types of gear within an area buffered around the original sighting location.

As is the case with the other components of the NMFS fishery interactions strategy, no evidence is available to evaluate effectiveness of the area management approach in reducing right whale entanglements. The panel recognizes the rationale behind the SAM and DAM measures (i.e., to encourage wider use of gear thought to be safer for whales) but concludes that area management, as conceived and implemented to date, is unlikely to enhance right whale conservation unless more stringent restrictions are placed on fisheries operating within prescribed areas.

NMFS has been unwilling to implement conservation actions in either DAM or SAM areas that would eliminate the risk of entanglement. Currently, a series of regulatory measures (e.g., required use of weak links, limits on the number of buoy lines) apply to each SAM area, but these have not eliminated entanglements. NMFS can take several actions in DAM zones, including the following:

- require removal of gear for a 15-day period;
- request voluntary removal of gear in the area for a 15-day period; and/or
- require gear modifications for a 15-day period.

Before implementing a DAM zone, NMFS is required to follow certain steps, including intra-agency documentation and public notification through the *Federal Register*. DAM zones can be extended beyond 15 days if warranted.

With very few exceptions, NMFS has not required the removal of fishing gear in DAM areas. Instead, DAM designations have consistently recommended or required that fishermen incorporate certain modifications in their gear. In addition, internal processing, approval, and publication procedures result in a two-week (or longer) delay in implementing DAM measures after the initial sighting triggers for management action have been met. Obviously, some whales may become entangled and many or all of them may leave the area during this delay interval.

Until truly whale-safe fishing gear is developed, the DAM approach likely will be effective only if fishermen are required to remove lobster and gillnet gear quickly from areas with aggregations of right whales. This poses a potential safety problem for fishermen, who could be required to

remove large quantities of fixed gear on short notice in poor weather. This, together with the frequency and unpredictability of DAM events, hampers the approach's effectiveness.

The DAM approach also requires ongoing aerial surveys to ensure that aggregations of whales are detected outside SAM and critical habitat areas. As noted elsewhere in this report, those surveys are useful for analysis of habitat use, provide important sighting information to the Catalog and Sightings Database and give valuable support to the disentanglement program. However, there are questions about their cost-effectiveness as a management measure, particularly given the delays in implementation, and concerns about their safety.

In addition to the problems outlined earlier, effective implementation of DAM and SAM programs requires enforcement. (Note that if the measures were voluntary, as they sometimes have been, the issue of enforcement would be moot.) Enforcement of fishery management regulations in these areas is primarily the responsibility of the Coast Guard working with the NMFS Office for Law Enforcement. The cost of this enforcement is difficult to estimate due to the multiple tasks addressed in most Coast Guard missions. Relatively few patrols are dedicated to enforcing provisions of the ALWTRP or other right whale conservation measures although such work may be performed while addressing other primary tasks. The panel was advised that enforcement patrols do not remove gear from the water for inspection, which means that an assessment of compliance with gear modification rules or recommendations is possible only if fishermen are encountered while actively hauling their gear.

NOAA holds joint enforcement agreements with the states of Maine, Massachusetts, Rhode Island, and Virginia. The panel was informed that 22 cases of alleged violations of ALWTRP gear requirements had been investigated, resulting in five cases being forwarded for further action to the NOAA Office of General Counsel. Overall, however, no information was readily available on the level of enforcement effort or the proportion of the total deployed gear that had been inspected.

Finally, the panel is concerned about the evident inability of NMFS to prevent the continuation and even proliferation of fisheries that pose risks to right whales within existing management areas. For example, a right whale calf was entangled and killed in a gillnet set in the Southeast Restricted Area in January 2006. The use of gillnets in this Restricted Area is managed under provisions of the ALWTRP. A new gillnet fishery for whiting (southern kingfish) recently emerged inside the Restricted Area, evidently without having been preceded by a determination that it was "safe" for right whales. The panel notes that failures to anticipate and mitigate the potential impact of allowing new fisheries to develop in right whale habitat can worsen the problem of entanglement, as happened in this case.

Disentanglement

The disentanglement program involves dangerous, costly work that is only marginally effective. People involved in the program risk their lives to help compensate for the fact that the entanglement problem has not been solved. Demographic models suggest that preventing the

deaths of even a few females could shift the population trend from a slow decline to a slow increase, which makes abandonment of the disentanglement program unthinkable. From another perspective, a response of some kind to alleviate the suffering imposed on entangled animals is also an important consideration. Almost three-quarters of living right whales in the western North Atlantic show evidence of past entanglements (e.g., scars, wounds, or bits of gear still attached), and perhaps 10 to 30 percent of the population interacts with fishing gear each year. During the period from January 2000 through the end of 2005 the disentanglement network received 25 reports of entangled North Atlantic right whales (Marine Mammal Commission 2006). Network responders were able to remove some of the gear from seven of those animals and all or most of the gear from four others. A few of those 11 animals likely died or were seriously injured. For the other 14 animals, either there was no opportunity to remove the gear or attempts to do so were unsuccessful. The panel commends the people involved in the disentanglement effort for their dedication and commitment.

The following elements of the disentanglement effort are germane to this review:

- At present, only three individuals on the U.S. East Coast are authorized by NMFS (based on training and experience levels) to lead disentanglement attempts on right whales; two others are authorized to lead attempts involving other whale species.
- Aerial surveys have been responsible for many of the detections of entangled right whales, and aircraft have also been used to direct the disentanglement teams to whale locations and provide images helpful for planning disentanglement strategies.
- The success rate for disentangling right whales is much lower than for other species because right whales are comparatively difficult to deal with. For example, it typically takes one attempt to disentangle a humpback whale whereas it can take as many as six or eight attempts to remove the gear from a right whale.
- Outcomes of disentanglement attempts are difficult to predict. Some whales that experts believed would survive after disentanglement have not while others with a poor prognosis have survived and reproduced.
- A major frustration for the disentanglement teams is that entanglements posing the greatest danger to the animal, such as those involving line wrapped around the head, mouth, or flipper, are the most difficult to resolve successfully.
- To date, no attempt to disentangle a right whale has been stopped on the basis of poor survival prospects, nor has any attempt been made to euthanize a right whale because of its condition. It is not clear how humane euthanasia could be accomplished with this species.
- The disentanglement program responds to events involving humpback and minke whales as well as right whales, although the entire federal contribution to funding comes directly out of the right whale program's budget.

Further investment in the disentanglement program is clearly needed to make it safer and more effective. Among the immediate priorities are the following:

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- development of a method to chemically sedate or restrain entangled whales;
 - development of a more effective telemetry system that can be securely attached to trailing gear and provide real-time monitoring data; and
 - establishment of reliable, long-term cooperative agreements with state agencies and the Coast Guard, especially in the Southeast, to ensure that vessels and aircraft are available when and as needed to support disentanglement efforts.

Consideration also should be given to novel approaches that would facilitate disentanglement and reduce the risks to human health and safety. These might include some unusual ideas, for example, the employment of remotely operated robotic devices or trained marine mammals (e.g., sea lions).

Finally, the panel stresses that the costs of disentanglement, including the personal risks faced by members of the disentanglement network, should be incorporated explicitly into fishery management decisions and cost-benefit assessments. In other words, rather than these costs being accounted against the right whale recovery program and borne quietly by a few dedicated individuals, they should be considered a responsibility and a funding obligation of fishery management. Requirements to modify fishing methods or equipment are matters of concern not only for the purpose of right whale conservation but also for the purpose of human safety. The highest priority should be given to methods, such as those described earlier, that will eliminate entanglement and thus eliminate the need for the disentanglement program.

Take reduction process

The ALWTRT has been ineffective as a mechanism for developing mitigation strategies to deal with right whale entanglement. A number of presenters at the workshop described the ALWTRT as unique in several respects. It is the longest serving take reduction team, having existed for more than a decade. The team is very large, with 58 members (including three from NMFS) divided into two regional sub-teams. It is by far the largest take reduction team to date. Not surprisingly, the ALWTRT has been unable to reach consensus on most important issues and, instead, has usually delivered majority and minority opinions to NMFS. Management options leading to the proposed rule currently under consideration were discussed by the ALWTRT in 2003. In the panel's view, the take reduction team process was never intended to operate in such a prolonged, open-ended fashion. In fact, it appears that those who crafted the 1994 amendments to the Marine Mammal Protection Act intended exactly the opposite.

The panel believes that other mechanisms would be more effective for developing mitigation strategies and for combining those strategies with other conservation approaches. For example, a small recovery team, consisting of individuals with direct experience in addressing right whale biology and whale bycatch issues, itself advised on technical aspects of gear modification by a group of gear specialists and fishing industry experts, might be much more effective than the current take reduction team approach (see section V later in this report). Such a team also might be able to interact in a more efficient manner with regional fishery management councils and other bodies.

Table 8: Costs of actions to reduce fishery bycatch, FY2003/FY2005

Activity	FY 03	FY 04	FY 05
Administration (e.g., public hearings, convening TRTs, preparing EIS, labor, etc)	\$168,000	\$1,057,000	\$729,000
NMFS	168,000	1,057,000	729,000
Development of gear modifications and buyback	1,129,400	1,713,605	1,839,405
NMFS	1,129,400	1,713,605	1,614,405
New England Aquarium	0	0	200,000
Provincetown Center for Coastal Studies	0	0	25,000
Atlantic Large Whale Take Reduction Plan	2,101,714	2,648,400	2,216,586
NMFS	2,101,714	2,648,400	2,216,586
Disentanglement	1,175,933	808,691	836,438
NMFS	1,088,000	613,400	608,000
U.S. Coast Guard	37,933	95,291	153,438
Provincetown Center for Coastal Studies	50,000	100,000	75,000
Enforcement	394,034	1,456,770	595,966
NMFS (Joint Enforcement Agreements with Maine, Massachusetts, Rhode Island, and Virginia)	60,000	162,000	200,000
U.S. Coast Guard	334,034	1,294,770	395,966
TOTAL	\$4,969,078	\$7,684,466	\$ 6,217,395

Note: Coast Guard costs do not include staff time dedicated to policy development, drafting regulations, training, and providing enforcement guidance to personnel in the field.

Contribution to Recovery

Modifications to fishing gear and practices

The current suite of gear modifications has not succeeded in eliminating entanglements, nor is there any evidence that it has reduced the frequency with which right whales become entangled in fixed gear. Further, the panel was given no reason to believe that the gear modifications in recently proposed amendments to the ALWTRP will meet take reduction goals, given the insufficiency of attention to resolving entanglement risks from vertical (i.e., buoy) lines. In some areas of Massachusetts, NMFS has funded a buyback program to encourage fishermen to switch from sinking to neutrally buoyant ground lines. However, participation has been voluntary and limited in geographic scope. The panel commends the agency's efforts to reduce the profile of ground lines and to include some measures addressing vertical line, as described and discussed in the Working Draft of a Strategy to Reduce Large Whale Entanglement Risk Associated with Vertical Line, and included in the currently proposed rulemaking. Nonetheless, it concludes that past and planned efforts at gear modification are unlikely to be adequate for solving the right whale entanglement problem.

Area Management

No evidence was presented during the review to indicate that the DAM and SAM programs have been effective in reducing serious injury and mortality of right whales in fixed fishing gear. A fundamental problem with both approaches is that critical aspects of the fishing gear (especially vertical lines) have not been addressed adequately in either past or currently proposed regulations. In addition, the DAM approach takes too long to implement due to the bureaucratic requirements of the current regulatory process. The panel concludes, therefore, that neither program, in its present form, is likely to contribute significantly to population recovery.

Disentanglement

With numbers so low, even a few successful disentanglements of right whales are potentially significant. The panel emphasizes, however, that the same could be said of other measures (e.g., gear modifications, fishery closures) where it is likely that one or more whales have been “saved” even though there is no direct evidence to prove it. The important point is that disentanglement and the other measures, taken together, have not solved the bycatch problem.

Also, it is necessary to acknowledge the possibility that the very existence of the disentanglement program makes the prevention of entanglement seem less urgent. Such a perception could deflect resources away from necessary restrictions on fisheries and allow public officials to delay difficult but necessary measures to eliminate the use of fishing gear that entangles whales. In other words, there is a danger that the program could function as an indirect subsidy to fisheries by compensating (or attempting to compensate) for a major flaw in how they operate. At the same time, the panel recognizes that removal of gear from entangled right whales has been a primary source of information for the identification of gear types and fisheries that pose a risk to right whales; this information is critical to the development of appropriate mitigation measures.

Take reduction process

The take reduction process has been ineffective at providing solutions to the entanglement problem. The process is slow, cumbersome, and often divisive. Even when incremental steps have been agreed to by the ALWTRT, very long delays have ensued in the rulemaking process required for implementation. This slow pace of change has resulted in frequent and costly litigation and rulemaking actions. As noted earlier with regard to ship strike reduction (section IV.A), much of the slow pace of rulemaking is systemic and unavoidable. Despite the agency’s continuing failure to resolve this critical issue, many individual NMFS scientists and managers have been working diligently and conscientiously to do so. Many members of the ALWTRT have expressed skepticism that the take reduction process will be able to deliver meaningful conservation recommendations. Decisive actions are required to conserve right whales, and the take reduction process is not the vehicle to deliver them.

Cost-effectiveness of actions

Expenditures to develop and implement actions that address the entanglement problem totaled \$18.87 million during FY03/05. Of that amount, NMFS provided \$16.10 million.

Modifications to fishing gear and practices

During FY03/05 a total of \$4.67 million was spent on gear modifications and buybacks. Much of the funding for gear development has focused on gear modifications with questionable prospects for reducing entanglement risks (e.g., weak links, line cutters, and new buoy designs) although some investment has been made in more promising approaches involving the elimination of line from the water column (e.g., pop-up buoys). Funding to reimburse fishermen willing to switch from floating to sinking or neutrally buoyant ground lines (buyback programs) may have been helpful. According to NMFS, state and industry representatives report that the buyback programs funded by NMFS and administered through various state agencies, together with the DAM program, have raised awareness and encouraged fishermen to switch over their lines prior to any implementation of requirements mandating such change. The panel is concerned, however, that the use of presumably safer types of line has not yet become sufficiently widespread. The current suite of modifications in the ALWTRP apparently has not succeeded in significantly reducing or eliminating entanglement of right whales in fishing gear. Those proposed in the latest amendments to the plan appear to have the potential to reduce entanglement, but on present evidence it is difficult to assess how significant such a reduction might be. The panel contends that more stringent measures, such as the elimination of all fixed gear with vertical lines in areas of right whale aggregations, would be more cost-effective in the long term. Such measures would have immediate economic consequences for affected fisheries, but the panel believes that those costs would be overcome by the ingenuity of fishermen if they had the needed incentive to develop whale-safe gear rapidly. Furthermore, the longer the delay in implementing such effective measures, the greater will the need become for even more draconian action.

Area Management

It is difficult to estimate the total cost of the area management approach. Cost accounting is confounded by the fact that aerial surveys have multiple purposes, only one of which is to detect concentrations of right whales for establishing DAMs (see section III.A). Much has been learned about the distribution of right whales, and the surveys have been important to the disentanglement program. However, the primary goal of reducing or eliminating the entanglement of right whales in fishing gear has not been achieved. As noted, protection measures in the DAM and SAM areas, as implemented to date, have not been adequate.

Disentanglement

During FY03/05 the investment in disentanglement efforts totaled \$2.82 million, not including some expenditure by the Coast Guard. As a protection measure, *per se*, disentanglement is not cost-effective. Moreover, it entails considerable risks to human safety for the small returns in

terms of numbers of right whales saved from serious injury or death. In assessing cost-effectiveness, it is necessary to recognize that a substantial part of the disentanglement effort, and therefore its cost, has been devoted to species other than right whales. This confounds any analysis of the cost-effectiveness of right whale disentanglement efforts. Although disentangling other whales may provide training opportunities and lead to improved techniques, such efforts do not contribute directly to right whale conservation. The panel did not attempt to evaluate cost-effectiveness from the perspective of all disentanglement efforts for all whale species.

Take reduction process

During FY03/05 expenditures by NMFS related to the ALWTRP totaled \$6.96 million, which represents 37 percent of all funds spent on the bycatch issue. (The ALWTRP and ALWTRT address humpback and fin whales, as well as right whales.) The take reduction process has been neither efficient nor cost-effective in reducing or eliminating the entanglement of right whales in fishing gear. Costs specifically for support of ALWTRT meetings were not provided for this review, but considering travel by members, the number of members, meeting facilitation, printing of background documents, etc., the total cost of each meeting of the full team likely exceeds \$200,000. The funds used to convene the current TRT and its regional subteams to discuss and develop management advice that has proven to be ineffective could have been, and should have been, invested in better means of dealing with this pressing problem.

Recommendations

Modifications to fishing gear and practices

The panel recommends that all fisheries using fixed gear in areas where right whale aggregations occur be required to demonstrate that the gear is whale-safe before its use is approved. At present, this would require a prohibition on the use of vertical lines, in addition to the measures currently required or being contemplated as part of the ALWTRP. Such restrictive measures could be relaxed once gear modifications are developed, tested, and shown to be whale-safe. The panel is confident that the East Coast fishing community could meet the challenge posed by such a restriction. Without such measures, right whales will continue to die in lobster and gillnet gear, leading to more lawsuits, additional costs to fishermen, and expensive rulemaking and administrative expenses. The panel also recommends modification to the scientific research permit system to allow more expeditious testing of whale-safe fishing gear and associated concepts.

Area management

The current approach to area management has not reduced the frequency of right whale entanglements. In its stead, the panel recommends a reevaluation of right whale critical habitat, guided by a recovery team (see section V). Critical habitat should include all areas in which right whales occur frequently in both the feeding and breeding grounds. In those areas, management measures should include elimination of the use of fishing gear that could entangle

right whales. To be clear, the panel recommends that all designated critical habitat should be closed to the use of fishing gear that poses a risk to right whales. Trap fisheries should be limited to gear with no fixed vertical lines and no floating ground lines. It should be possible to implement such measures within critical habitat through a combination of ESA section 7 provisions and the take reduction and recovery mandates that apply to right whales under both the ESA and MMPA.

At present, the panel cannot envision a whale-safe gillnet. No new fisheries should be authorized in right whale critical habitat until the gear to be used has been demonstrated to be whale-safe.

Disentanglement

The occasional success of disentanglement in saving a right whale justifies continuation of this program until actions are taken to reduce entanglements to close to zero or eliminate them entirely. The panel recommends that the right whale recovery program's budget not be used to support efforts to disentangle other species or to expand such efforts outside eastern North America, even though it agrees that such expansion may be desirable for conservation generally. The panel also recommends that an independent review be conducted to assess the risks and benefits of the disentanglement program. The review should explicitly consider (1) the probability of serious injury or death to humans involved; (2) the record of success and failure in attempts to disentangle right whales; (3) the merits of, and alternatives to, disentangling some right whales, particularly those individuals in such poor condition that they are likely to die and whales that are entangled in such a way that the probability of safe or successful disentanglement is very low; and (4) the indirect benefits of disentanglement, including knowledge gained concerning which fisheries are involved, increased public awareness, and research opportunities to sample, track, and study the behavior and movements of entangled (and disentangled) individuals.

Take reduction process

The panel recommends that the current ALWTRT, including the two regional sub-teams, be disbanded. The take reduction team should be replaced by a recovery team (see section V) that would guide NMFS in the development and implementation of management strategies to eliminate the entanglement of right whales in fishing gear. Such a team would be able to act in a more efficient, cost-effective manner, without the constraints and dysfunctional history of the ALWTRT. A group of gear specialists and fishing industry experts could advise the team in technical aspects of gear modification. The current approach simply will not result in effective conservation and represents a waste of limited resources that should be invested in more productive ways. In reaching this conclusion, the panel was mindful of the fact that disbanding the ALWTRT would have implications for humpback whales and fin whales as well as right whales. However, reducing the mortality of right whales is of transcendent importance as a conservation priority, and therefore the panel considers the implications for the other two species to be far less critical. Furthermore, it is not clear that the efforts of the ALWTRT are reducing the frequency or severity of entanglements for these other two species.

V. FINDINGS OF THE PANEL: CROSS-CUTTING AND GENERAL

Coordination

The panel recommends that NMFS create a North Atlantic right whale recovery team as provided for in the Endangered Species Act. The team should be constituted for the purpose of helping NMFS promote recovery of this whale population to the point where it satisfies the downlisting criteria in the current recovery plan. Two immediate functions of the team would be to assist with a reevaluation of critical habitat designations and an evaluation of management options for eliminating right whale entanglement.

In addition, there is a need to bring regional fisheries management councils into the take-reduction process to a much greater extent than has been the case to date. This may require amendment of the Marine Mammal Protection Act and/or the Magnuson-Stevens Fisheries Conservation and Management Act to mandate a direct link between right whale bycatch reduction measures and the fishery management process. It may also require an additional oversight mechanism to ensure that councils do not veto, alter, or override essential protection measures.

Implications of mitigation measures

Two important aspects of mitigation need to be considered at all stages. First, some of the measures may offer ancillary benefits in addition to preventing harm to right whales. For example, slowing ship traffic may reduce the risks of collisions with other whales or between vessels. Restrictions on the use of gillnets and traps could be part of management plans designed to reduce fishing pressure on target and other non-target species, leading to better overall fishery management. Also, the process of developing whale-safe measures to harvest lobsters and finfish could lead to the development of safer or more efficient methods for capturing the target species. Second, proposed measures should be evaluated for unintended negative consequences, whether direct or indirect. For example, a fishery closure in a right whale feeding area could lead to a shift of fishing effort into a migration path. Similarly, a change in traffic routing could lead to a higher incidence of collisions with another valued species (e.g., humpback whales). Even though such a change might be tolerable from a conservation standpoint, it would be important to anticipate it and be prepared to respond.

Feasibility of enforcement

A great deal of momentum has developed in the direction of using passive acoustic monitoring to track the presence of right whales in different areas. The scientific approach is appealing, and the idea of dependence on remote sensing is attractive because it promises to be more cost-effective and safer. A premise of investing in and pursuing such an approach is that it will facilitate real-time measures to reduce risks to right whales (principally via dynamic management). Although

the panel is not opposed to the concept, it is concerned about the ability of enforcement agencies to deliver such protective measures in a timely and effective way. The poor record to date in this regard must be considered the best guide to what can be expected in the future. Total closures of sensitive areas to high-speed ship traffic, risk-prone fishing gear, or both, on a seasonal or permanent basis, may be the only truly enforceable (and thus effective) approach to protecting right whales from the two most important risk factors impeding their recovery.

Fundamental importance of certain core program elements

A commitment to predictable, long-term funding for core recovery-related work, including development and implementation of take reduction and threat mitigation measures, maintaining and updating key databases, and investigating causes of right whale deaths and serious injuries, is of paramount importance. In particular, the Catalog is indispensable. Any major change in how the photo-identification data are collected and managed could have serious implications for population monitoring and, in turn, the ability to assess the effectiveness of recovery efforts. For example, if funding cuts were to limit field efforts and allow sampling at only two- or three-year intervals instead of annually, this would affect the ability to monitor critical demographic parameters, such as survival and fecundity. Given the present state of North Atlantic right whales, it is essential to continue collecting the field data needed to monitor the population with maximum possible resolution.

Where and with whom does responsibility for right whale recovery lie?

The Secretary of Commerce has ultimate responsibility to ensure that the goals of the Recovery Plan for the North Atlantic Right Whale are met. Pursuit of those goals can be driven by one of three approaches: (1) develop and implement ineffective measures that will likely result in lawsuits and judicial decisions to direct actions by federal agencies; (2) rely on public awareness and education efforts to motivate and guide voluntary actions by fishermen, vessel operators, etc.; or (3) take the initiative to restrict activities known to be harmful to right whales and cope with the negative response from some stakeholders. All three options promise to be costly. However, from the standpoint of meeting recovery plan goals, the third is most likely to be effective on an acceptable time scale.

The language in the recovery plan does not adequately reflect that human-caused mortality for this whale population should be reduced to zero. Rather, the plan refers to significant reductions as the most that can be expected. The panel believes that NMFS should be pursuing the goal of zero human-caused mortality and serious injury of right whales, as clearly expressed by the setting of a PBR level of zero and as stated in the required goals of take reduction plans. The same goal appears not to have been carried forward with regard to ship strikes and general recovery planning. Obviously, working toward such a goal will require a number of different steps that are not likely to be taken simultaneously. Nevertheless, recovery planning needs to be geared toward elimination, not just reduction, of anthropogenic mortality and serious injury. With regard to reducing the number of right whales killed by fishing gear, the panel believes that responsibility for addressing this issue has been misplaced and a major change is needed. The

little progress that has been made to date has been due to efforts of conservationists, scientists, and Office of Protected Species staff in NMFS who have tried to use legislation, such as the Endangered Species Act and the Marine Mammal Protection Act, to force fishery managers to take action to reduce whale entanglements. Unlike some other interactions between marine mammals and fisheries, right whales are not attempting to deplete catches or competing with fishermen for resources. Rather, they are simply using their habitat as they have for hundreds of thousands of years. From the whales' perspective, fisheries have developed in some of the same areas very recently, and some of those fisheries are now taking whales as a bycatch. The Department of Commerce, acting through NMFS, is required by law to regulate bycatch as part of fishery management plans developed under the Magnuson-Stevens Fishery Conservation and Management Act. They do this routinely for non-target species of shellfish, finfish, sea birds, sea turtles, and other taxa. NMFS has clearly recognized that there should be no fishery bycatch of North Atlantic right whales as it has set the PBR level for this population at zero. Therefore, fishery managers have the responsibility to modify management plans as necessary to eliminate right whale bycatch, and the panel strongly recommends that they be instructed to recognize and meet this responsibility.

Relations with Canada

A significant proportion of the known present-day feeding habitat of North Atlantic right whales lies in Canadian waters. Also, some of the deaths from ship strikes and entanglements occur in Canada. Therefore, bilateral efforts are essential to achieve coordination and consistency in measures to protect right whales and their critical habitat. Also, conducting research and monitoring to assess the population's status, investigating factors limiting population recovery, and developing and testing mitigation methods cannot be carried out efficiently without the cooperation of Canadian authorities.

The panel was pleased to learn that cabinet-level discussions are underway to negotiate a bilateral right whale conservation agreement between Canada and the United States. Although Canada's reconfiguration of the Bay of Fundy shipping lanes is deservedly regarded as a signal achievement, the Canadian government's approach to right whale conservation has been otherwise passive in comparison to that of the U.S. government. The whale-watching industry in Canada is unregulated, there is no Canadian equivalent to the critical habitat designations for right whales under the U.S. Endangered Species Act, and no substantive measures have been taken in Canada to address the right whale entanglement problem. Entanglement is one area where bilateral dialogue is essential, but it is important to avoid letting U.S. fishing interests transfer responsibility for the entanglement problem to Canadian fisheries. Fisheries in both countries need to be managed to address this problem.

Another issue that should be high on the bilateral agenda concerns U.S. plans to construct a liquid natural gas (LNG) tanker terminal in Maine. Such a development will create a major new threat to the right whale population. A proposal for an oil tanker terminal at Eastport in the late 1970s provided the impetus for surveys of right whales in the lower Bay of Fundy and Quoddy region. Those surveys led directly to the right whale research and monitoring program in this

area by the New England Aquarium. Impact assessment and site selection for the LNG tanker terminal need to be addressed immediately by authorities in both countries. Also, the high-speed ferry that operates between Yarmouth, N.S., and Bar Harbor, ME, making two trips per day (including one at night), represents a potentially serious hazard for right whales. Its operations are currently not regulated to avoid whale collisions and it is exempt from the traffic separation scheme in the Bay of Fundy. Moreover, plans are underway for the ferry to serve additional sites in Maine, which would almost certainly imply additional risks to right whales.

Funding

Although the data available for this review are not comprehensive, they indicate that a total of \$45.6 million was spent by all U.S. agencies and groups involved in implementing the right whale recovery program during the three fiscal years 2003/04 through 2005/06. Of that amount, 95.5 percent came from federal agencies, 3.8 percent from nongovernmental organizations, and less than 1 percent from state agencies. The National Marine Fisheries Service was the greatest single source of funding (\$35.3 million).

Table 9: Costs of all actions to promote recovery of western North Atlantic right whales, FY2003/FY2005

Source	FY 03	FY 04	FY 05
Federal Agencies	\$12,639,287	\$16,200,810	\$14,707,144
NMFS	10,127,897	12,798,559	12,353,725
NOS (National Marine Sanctuaries)	67,000	89,900	124,300
Navy	165,267	218,427	399,216
Coast Guard	809,525	2,075,569	1,208,268
Army Corps of Engineers	147,000	180,000	191,000
National Fish and Wildlife Foundation	1,322,598	497,149	192,953
State Agencies	102,600	72,800	134,442
Florida	76,000	72,800	73,250
Massachusetts	21,600	0	61,292
Rhode Island	5,000	0	0
Nongovernmental Organizations	379,678	456,227	907,926
International Fund for Animal Welfare	140,000	104,000	257,418
New England Aquarium	98,075	86,431	312,404
Provincetown Center for Coastal Studies	62,500	112,500	92,500
Woods Hole Oceanographic Institution/Ocean Life Institute	54,103	127,296	220,604
Whale Center of New England	25,000	25,000	25,000
TOTAL ALL SOURCES	\$13,121,565	\$16,729,837	\$15,749,512

The objective of this review was not simply to document how much money had been invested in right whale recovery efforts or to project how much should be spent in the future. Rather, the objective was to evaluate whether the funds invested had been used in a cost-effective manner. The panel's conclusions in that regard are explained in sections III and IV of this report. After a surge in federal funding for right whale research and conservation beginning in 2000, the trend of financial support has reversed direction and is now on a downward trajectory. Overall funding peaked in FY04 at more than \$16.7 million but declined by almost \$1 million in FY05, due largely to a reduction of support from NMFS. During the review, the panel was advised that NMFS funding for FY06 was expected to decline to \$7.8 million, a reduction of 53 percent from the FY2004 level.

The panel has concluded that some parts of the recovery program do not appear to have been cost-effective and that significant improvements in cost-effectiveness may be possible in some areas (e.g., aerial surveys, bycatch reduction). However, the panel also has identified a number of essential tasks that are currently underfunded or that should be expanded (e.g., catalog and database management, passive acoustic monitoring, studies of effectiveness of management actions, compliance assessment). Overall, the needs for additional funding appear much greater than any savings that might be realized by paring down program elements that currently are not considered cost-effective. Therefore, any reduction in the overall federal commitment to right whale protection will mean that some high-priority work is not carried out. This, in turn, is likely to increase the risk that recovery of this population will never be achieved.

Overall strategy and implementation

Although the objectives of the North Atlantic right whale recovery program are appropriate, overall strategy and implementation are not adequately accountable. Federal actions have not reflected a sense of urgency about reducing right whale mortality that is consistent with the gravity of the species' peril. The current approach is not precautionary but rather is one of waiting for conclusive evidence and/or industry acceptance before moving ahead with protective actions. This is particularly true of attempts to reduce interactions between right whales and fishing gear. Therefore, the panel recommends that NMFS and other agencies act more aggressively to prevent right whale mortality. In general, they should set higher standards of protection and place greater reliance on the ability of industry to adapt to those standards, rather than continuing to depend on a complex, shifting, inefficient, and ineffective network of regulatory measures to protect the whales. The guiding principle should be to separate high-risk human activities from right whales, in both space and time, to the maximum extent feasible.

VI. Acknowledgments

The panel acknowledges the support and cooperation of everyone who contributed to the planning and execution of the review. This includes staff at SRA International, the Marine Mammal Commission, and the National Marine Fisheries Service (headquarters and regional offices). Two individuals deserve special mention. Wilhelmina Innes at the Commission provided a remarkably clear, detailed set of meeting minutes that facilitated report preparation. David Laist, also at the Commission, contributed in many ways. Most importantly, the panel benefited from his longstanding involvement with right whale conservation and his attention to details that otherwise would have escaped notice. Finally, the panel acknowledges the constructive, detailed reviews of a draft of this report provided by NMFS staff at its headquarters office, the Northeast and Southeast Fisheries Science Centers, and the Northeast and Southeast Regional Offices. The collegial spirit they maintained while watching their programs undergo detailed scrutiny was exemplary. Also, the panel appreciates the helpful review received from Scott Kraus of the New England Aquarium.

VII. References

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APPENDIX I

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APPENDIX II

AGENDA

NORTH ATLANTIC RIGHT WHALE PROGRAM REVIEW

Marine Biological Laboratory
Woods Hole, MA
14–17 March 2006

TUESDAY, 14 MARCH

- 8:00 – 8:30 COFFEE AND DANISH
- 8:30 – 8:45 OPENING REMARKS
David Laist, Marine Mammal Commission
Linda Manning, SRA International
Lloyd Lowry, Marine Mammal Commission
- 8:45 – 9:45 OVERVIEW OF RECOVERY PROGRAM
Michael Payne, NOAA
Richard Merrick, NOAA
Jerry Conway, Department of Fisheries and Oceans, Canada
- 9:45 – 10:45 MONITOR STATUS AND TRENDS OF ABUNDANCE
Richard Pace, NOAA
- 10:45 – 11:00 BREAK
- 11:00 – 12:00 RIGHT WHALE DISTRIBUTIONAL STUDIES
Lance Garrison, NOAA
- 12:00 – 1:15 LUNCH
- 1:15 – 2:15 MAJOR RIGHT WHALE DATABASES
Philip Hamilton, New England Aquarium
Robert Kenney, University of Rhode Island
- 2:15 – 3:15 STOCK STRUCTURE AND INDIVIDUAL IDENTIFICATION – GENETICS
Richard Pace, NOAA
- 3:15 – 3:30 BREAK
- 3:30 – 4:30 REPRODUCTION AND HEALTH ASSESSMENTS
Teri Rowles, NOAA
- 4:30 – 5:30 RESPONSE TO STRANDINGS
Teri Rowles, NOAA

WEDNESDAY, 15 MARCH

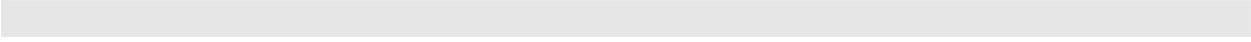
- 8:30 – 9:15 HABITAT STUDIES AND ASSESSMENTS
Lance Garrison, NOAA
- 9:15 – 10:30 OVERVIEW OF FISHERY INTERACTIONS
David Gouveia, NOAA
- 10:30 – 10:45 BREAK
- 10:45 – 11:45 OVERVIEW OF TAKE REDUCTION EFFORT
David Gouveia, NOAA
- 11:45 – 1:00 LUNCH
- 1:00 – 3:00 IMPLEMENTATION OF SPECIAL MANAGEMENT AREAS
David Gouveia, NOAA
- 3:00 – 3:15 BREAK
- 3:15 – 5:15 IMPLEMENTATION OF GEAR MODIFICATIONS AND GEAR RESEARCH
Diane Borggaard, NOAA
Glen Salvador, NOAA

THURSDAY, 16 MARCH

- 8:30 – 9:00 FISHERIES OUTREACH AND EDUCATION
Diane Borggaard, NOAA
- 9:00 – 9:45 DISENTANGLEMENT EFFORTS
Teri Rowles
- 9:45 – 10:00 BREAK
- 10:00 – 10:30 OVERVIEW ON VESSEL INTERACTIONS
Gregory Silber, NOAA
Jerry Conway, Department of Fisheries and Oceans, Canada
- 10:30 – 12:00 INTRODUCITON TO SHIP STRIKE MITIGATION PROGRAM
Gregory Silber
Barbara Zoodsma, NOAA
- 12:00 – 1:15 LUNCH
- 1:15 – 2:15 VESSEL TRAFFIC MANAGEMENT
Gregory Silber, NOAA
Jerry Conway, Department of Fisheries and Oceans, Canada

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- 2:15 – 3:15 MANDATORY SHIP REPORTING SYSTEM
Gregory Silber, NOAA
- 3:15 – 3:30 BREAK
- 3:30 – 4:15 NORTHEAST AND SOUTHEAST RIGHT WHALE SIGHTING AND
REPORTING SYSTEMS
Tim Cole, NOAA
Barbara Zoodsma, NOAA
- 4:15 – 5:15 MARINER OUTREACH, EDUCATION AND TRAINING
Barbara Zoodsma, NOAA
Kristen Koyama, NOAA

FRIDAY, 17 MARCH

- 8:30 – 9:30 RESEARCH TO IMPROVE UNDERSTANDING OF HOW WHALES AND
VESSELS INTERACT
Gregory Silber, NOAA
- 9:30 – 10:30 RESEARCH TO IMPROVE MITIGATION TOOLS FOR REDUCING
VESSEL INTERACTIONS
Gregory Silber, NOAA
Richard Merrick, NOAA
- 10:30 – 10:45 BREAK
- 10:45 – 11:45 REVIEW AND DISCUSSION OF INFORMATION PRESENTED
- 12:00 ADJOURN
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