# DEVELOPMENT OF A PROCESS FOR THE LONG-TERM MONITORING OF MMPA CATEGORY I AND II COMMERCIAL FISHERIES: PROCEEDINGS OF A WORKSHOP HELD IN SILVER SPRING, MARYLAND, June 15-16, 1998

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# EXECUTIVE SUMMARY

A workshop to discuss the development of a process for the long term monitoring of Marine Mammal Protection Act (MMPA) Category I and II commercial fisheries, and to evaluate the utility of rotational scheduling in that process, was held on June 15-16, 1998 in Silver Spring, Maryland. The MMPA requires that all U.S. commercial fisheries be categorized according to their level of marine mammal mortality and serious injury. The lack of information on the level of mortality/serious injury associated with the 24 Category II fisheries makes it difficult to verify whether the current categorization of these fisheries is correct. Rotational scheduling may make the necessary funding available to monitor the large number of Category II fisheries that are not currently being observed.

Workshop participants reviewed presentations describing the regulatory and funding environment for MMPA observer programs, statistical considerations in the design of monitoring programs, and alternative monitoring strategies. Case histories of programs in New England, California, Hawaii, and Alaska were also presented. The discussions which followed these presentations considered the structure and design of monitoring programs, classification of fisheries and their priority for observation, the utility of and design considerations for pilot observer programs, logistical barriers to rotational observer programs, sampling concerns at low coverage levels, and alternatives to traditional at-sea observer programs.

Workshop participants developed a framework process for long term fishery monitoring. All unobserved Category I and II fisheries would form the selection pool for future observer programs. A one-year pilot program may be considered if basic information about the fishery is required. This would be followed by a two- to three-year Operational Program designed to obtain a reliable estimate of mortality and serious injury. During a (minimum) one-year Take Reduction Plan phase, the program would determine whether the plan has reduced the take of marine mammals below the Potential Biological Removal (PBR) level. This would be followed by a two-to three-year Compliance/Monitoring phase designed to verify that takes remain below PBR. The final Long Term Monitoring phase would last for an indefinite period, until take reduction to insignificant levels approaching a zero mortality and serious injury rate (the Zero Mortality Rate Goal, or ZMRG) has been achieved. The workshop participants described sampling frequencies and strategies at each of these stages. Under ideal conditions, a fishery could progress through the stages of this monitoring process in six to eight years. Rotational scheduling was deemed applicable only at the Long Term Monitoring phase of this process. A rotational schedule was not proposed, since no fisheries currently being monitored are expected to reach that phase for two or three years.

There are currently Category I and II fisheries at various stages in this process. Participants identified stages for each of these fisheries, and viewed fisheries in the Take Reduction Plan phase as the agency's highest priority. They encouraged policy makers to consider unobserved Category II fisheries of equal priority with those in the Compliance/Monitoring phase, so the agency can begin to examine some fisheries with unknown take levels. Fisheries in the Long Term Monitoring phase followed these in priority ranking. Participants began but were unable to complete prioritization and decision criteria for determining which unobserved fisheries are the first to be monitored. They recommended that the agency: (1) task a small working group with developing these criteria for all stages in the monitoring process; (2) develop a draft schedule for observing fisheries based on funding projections and likely budget scenarios; and (3) identify options for alternative monitoring programs and determine when their use may be appropriate.

# INTRODUCTION

A National Marine Fisheries Service (NMFS) workshop to discuss the development of a process for the long term monitoring of Marine Mammal Protection Act (MMPA) Category I and II commercial fisheries, and to evaluate the utility of rotational scheduling in that process, was held on June 15-16, 1998 in Silver Spring, Maryland. The workshop was hosted by the NMFS Office of Protected Resources (OPR), and chaired by Victoria Cornish, OPR. Al Didier, Pacific States Marine Fisheries Commission, was the rapporteur. Appendix A lists the workshop participants.

The MMPA requires that all U.S. commercial fisheries be categorized according to their level of marine mammal mortality and serious injury. Mortality and serious injury estimates are obtained by fishery-specific monitoring programs such as observer programs. Because agency funds are limited, Category I fisheries have received priority for monitoring to date. Observer programs developed for these fisheries have either confirmed their status as Category I fisheries, or have been the basis for recategorizing them as either Category II or III fisheries. Currently, four of the six Category I fisheries have an observer program to monitor take levels and collect data to aid in the development of take reduction plans.

The lack of information on the level of mortality/serious injury associated with the majority of the 24 Category II fisheries makes it difficult to verify whether the current categorization of these fisheries is correct. Observer programs are currently MMPA-funded for only four Category II fisheries. Funds have been proposed for two other Category II fisheries in Alaska. The cost of monitoring all Category II fisheries at the same time is cost prohibitive; the agency's marine mammal review panel recommended at their May 1997 planning meeting that OPR, in conjunction with NMFS regions and centers, develop a process and rotation schedule for monitoring all Category II fisheries.

Because even low level monitoring of Category II fisheries would be resource intensive, efforts should also be made to examine whether a rotation schedule is appropriate for Category I fisheries so that funding might be made available to effectively monitor the large number of Category II fisheries that are not currently being observed.

OPR Deputy Director Patricia Montanio welcomed workshop participants, noting that this meeting is another milestone in the agency's marine mammal planning efforts. She hoped that the workshop would accomplish several objectives. The agency needs to make the best use of limited funds, while still keeping in mind its ultimate goal of bycatch reduction. NMFS also needs to document and justify those areas where additional funding is necessary. Finally, the workshop will assist in the management of protected species by helping to prioritize monitoring needs so that each fishery's progress towards achieving the goal of reducing serious injury and mortality of marine mammals to insignificant levels approaching a zero rate can be assessed.

## PRESENTATIONS

### Goals and Objectives of the Workshop

Victoria Cornish, NMFS Office of Protected Resources

The workshop has two goals: (1) to determine whether a rotational schedule can and should be developed for MMPA observer programs; and (2) to begin to develop a long- term plan for monitoring all MMPA Category I and II fisheries. Specific objectives include determining the ultimate goal of an observer program, taking into consideration target precision levels, management needs, logistical concerns, and the goal of bycatch reduction; developing criteria for determining how often and at what level fisheries should be observed; and identifying options for alternative monitoring programs, and when they may be appropriate.

### Management Issues in Developing a Rotational Schedule for MMPA Observer Programs

Victoria Cornish, NMFS Office of Protected Resources

Sections 117 and 118 of the MMPA establish a long term regime for governing interactions between marine mammals and commercial fisheries. The short term goal is to reduce serious injuries and mortalities to below the Potential Biological Removal (PBR) level within six months, while the long term goal is to reduce marine mammal mortality and serious injury to insignificant levels approaching a zero mortality and serious injury rate by April 2001. Under Section 117, NMFS must prepare Stock Assessment Reports for all U.S. marine mammal stocks. These must provide estimates of stock abundance and human-caused mortalities and serious injuries (including fishery takes, ship strikes, etc.). Stock Assessment Reports must also include information on each stock's PBR level and status relative to PBR. The MMPA defines:

$$PBR = N_{min} * \tfrac{1}{2} R_{max} * F_r$$

where $N_{min}$ is a minimum population estimate, $R_{max}$ is the maximum theoretical rate of population growth, and $F_r$ is a recovery factor between zero and one. Section 118 of the MMPA directs NMFS to categorize fisheries by level of takes: Category I fisheries have frequent serious injuries or mortalities of marine mammals; Category II fisheries have occasional serious injuries or mortalities of marine mammals; and Category III fisheries have rare or no known serious injuries or mortalities of marine mammals. Fishers in Category I and II fisheries must register with NMFS and observers must be taken if requested to by NMFS. Fishers in all categories must report to NMFS if they incidentally kill or injure any marine mammals.

The frequency of taking for the purpose of fishery classification has been defined relative to the PBR level for each stock it encounters. Fisheries that take 50% or more of a marine mammal stock's PBR are considered Category I for that stock. Fisheries that take between 1% and 50% of the PBR of a marine mammal stock are considered Category II if total takes of that stock by all fisheries is greater than 10% of PBR. Category III fisheries are those which take less than 1% of the PBR of a marine mammal stock with total fishery takes greater than 10% of PBR, or which take any portion of a stock whose total takes by all fisheries is less than 10% of PBR.

The MMPA requires all fisheries to reduce their mortality and serious injury of marine mammals to insignificant levels approaching a zero rate (Zero Mortality Rate Goal – ZMRG). This concept has been a part of the MMPA since 1972, but for the first time a target date of April 2001 was specified in the 1994 amendments. Preliminary proposals suggested that ZMRG be set at 10% of PBR. Further analyses may result in an alternative approach to ZMRG. The MMPA also directs NMFS to develop Take Reduction Teams (TRT) for Category I and II fisheries. TRTs use observer data to develop plans (Take Reduction Plans – TRP) and to assess progress in reducing takes. These plans are to provide mechanisms for reducing takes to below PBR within six months, and to ZMRG within five years

The objectives of MMPA observer programs are to: (1) obtain statistically reliable estimates of incidental mortality and serious injury; (2) determine the reliability of fishers' reports of marine mammal mortality and injury; and, (3) identify changes in fishing methods or technology that may increase or decrease incidental mortality and serious injury. Priorities for observer programs are fisheries that take: (1) species listed as endangered or threatened under the Endangered Species Act (ESA); (2) strategic marine mammal stocks; and (3) marine mammal stocks for which the level of take is uncertain. Along

Table 1. MMPA Category I and II commercial fisheries, with status of TRTs and observer programs

| Area | Category I | Category II |
|---|---|---|
| Atlantic | <u>Northeast Multispecies Sink Gillnet*</u><br>Gulf of Maine/US Mid-Atlantic Lobster Trap/Pot*<br><br><u>Atlantic Ocean/Caribbean/Gulf of Mexico Large Pelagics Drift Gillnet*</u><br><u>Atlantic Ocean/Caribbean/Gulf of Mexico Large Pelagics Longline*</u> | Gulf of Maine Small Pelagics Surface Gillnet<br>Southeastern US Atlantic Shark Drift Gillnet*<br><u>US Mid-Atlantic Coastal Gillnet</u>*<br><u>Atlantic Squid/Mackerel/Butterfish Trawl</u><br>North Carolina Roe Mullet Stop Net<br>North Carolina Haul Seine |
| Pacific | <u>CA/OR Thresher Shark/Swordfish Drift Gillnet</u>*<br>CA Angel Shark/Halibut and Other Species Large Mesh (>3.5 in) Set Gillnet | WA Puget Sound Salmon Drift Gillnet<br>OR Swordfish Floating Longline<br>OR Blue Shark Floating Longline<br>CA Anchovy/Mackerel/Tuna Purse Seine<br>CA Squid Purse Seine |
| Alaska | | Bristol Bay Salmon Set Gillnet<br>Bristol Bay Salmon Drift Gillnet<br>AK Peninsula/Aleutians Salmon Drift Gillnet<br>AK Peninsula/Aleutians Salmon Set Gillnet<br>Kodiak Salmon Set Gillnet<br>Cook Inlet Salmon Set Gillnet<br>Cook Inlet Salmon Drift Gillnet<br>Prince William Sound Salmon Drift Gillnet<br>Yakutat Salmon Set Gillnet<br>SE Alaska Salmon Drift Gillnet<br>SE Alaska Salmon Purse Seine<br>AK Pair Trawl<br>Metlakatla/Annette Island Salmon Drift Gillnet |
| * = | TRT established that includes this fishery | |
| <u>Underline</u> = | Observer program operating in 1997 | |

the Atlantic coast there are currently four Category I and six Category II fisheries, six of which are observed, and six of which have TRTs (Table 1). There are two Category I and five Category II fisheries along the Pacific coast, and only one of these fisheries is both observed and has a TRT. There are 13 Category II fisheries in Alaska, and none is currently either observed or under a TRT.

The ESA requires that all Federal agencies seek to conserve threatened or endangered species. It prohibits the taking or importing of endangered species, and may prohibit the taking of threatened species. Authorizations for incidental taking of listed species in commercial fisheries are provided under Section 7 of the ESA for fisheries in Federal waters and under section 101(a)(5)(E) of the MMPA. Section 7 requires consultations for all federal actions, including fishery management measures. Consultations may require a monitoring program as a Term and Condition of issuing an Incidental Take Statement. The action agency (in this case NMFS) is required to provide the monitoring. Fisheries that currently require monitoring as a Term and Condition of an Incidental Take Statement that also have marine mammal concerns include: Northeast multispecies sink gillnet; Atlantic Ocean large pelagic drift gillnet; Atlantic Ocean, Caribbean, Gulf of Mexico large pelagic longline; Southeastern U.S. Atlantic shark gillnet; CA/OR drift gillnet; and Hawaii longline/setline.

**Funding Considerations**

Tom Eagle, NMFS Office of Protected Resources

From FY1995 through FY1998, NMFS operated about 10 mortality estimation projects at annually budgeted costs ranging from $3.046 million to $4.128 million. These did not include funds earmarked for the observer program administration and training at the Alaska Science Center. In FY1998, seven projects were funded for a total of $4.102 million. No MMPA Implementation budget changes have been requested for FY1999. Increases from $0.5 million to $2.5 million have been requested for FY2000 to FY2004. These increases are not specific to observer programs, and include funds for enforcement and any other needed research. Specific uses for these funds have not been designated, and the agency's case for obtaining additional funding would be helped by information from this meeting on the anticipated applications.

**The Atlantic Coastal Cooperative Statistics Program**

Laurie Allen, NMFS Northeast Region

The Atlantic Coastal Cooperative Statistics Program (ACCSP) is a cooperative state-federal marine and coastal fisheries data collection program developed to coordinate present and future marine and coastal data collection and management activities. Its mission is to cooperatively collect, manage, and disseminate fishery statistical data and information for the conservation and management of fishery resources for the Atlantic coast and to support the development and operation of a national program. Congressional funding was provided to the Atlantic States Marine Fisheries Commission (ASMFC) for development of the ACCSP, and such support will continue to be sought for program implementation and maintenance in the future. The level of funding to implement any one portion is not known at this time. [Workshop participants were provided with a copy of the Memorandum of Understanding between cooperating parties in the effort, a copy of the report of an OPR workshop addressing the bycatch component of the ACCSP (see below), and a list of all current state and federal data collection programs.]

The primary function of the ACCSP is to provide a nexus for state and federal data collection programs so that information collected in these currently disparate programs are both consistent and readily available to managers and scientists. It will provide detailed criteria for collection of minimum data elements to achieve that goal. Many individual programs will continue to pursue their own goals beyond those minimum data elements, but the ACCSP will provide for a comprehensive set of minimal, compatible fishery data for many uses.

The ACCSP is made up of a coordinating council and a number of technical committees. The Coordinating Council is made up of 15 Atlantic Coast States, the Potomac River Fisheries Commission, the District of Columbia, NMFS, USFWS, the New England Fishery Management Council, the Mid-Atlantic Fishery Management Council, the South Atlantic Fishery Management Council, and the ASMFC. Of particular relevance to the bycatch program are the technical committees. The Operations Committee is comprised of state and federal marine fisheries agencies and oversees daily operations. The Technical Committee, also comprised of marine fisheries agencies, provides recommendations on design and implementation of the program. An Advisory Committee, comprised of state designated commercial and recreational fishery representatives, evaluates technical recommendations. Through this partnership system of managers and fishery participants, various methods of data collection were evaluated and systems were refined.

One of the components of the ACCSP is the Bycatch Monitoring Program. A workshop to develop an Atlantic coast bycatch monitoring program was held in September 1997, setting up the basic program structure and methods. Additional working group meetings were held in November and December 1997 to define specific data elements and criteria. Many methods of collecting bycatch data were explored, including development of an At-Sea Observer Program. The goals of the observer program were defined as follows:

- To quantitatively and qualitatively monitor all east coast commercial and for-hire recreational fisheries bycatch of living marine resources throughout the year in estuaries, inshore and offshore waters from Maine through Florida
- To obtain, with fishermen's cooperation and support, accurate and representative fisheries bycatch data that will be used for state and federal programs including Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA), MMPA, and ESA.
- To provide state and federal fisheries agencies a comprehensive and long-term at-sea observer program with standardized data elements and program design, sampling strategies, priorities, and data management.

The greatest benefit promised by this program is within the last of these objectives.

The objectives of the 1997 workshop were numerous. One objective was to identify data needs for stock assessment and marine resource management by taking a look at existing programs and problems to see where these might be improved. Current bycatch data collection methods were evaluated. The methods evaluated included logbooks, dealer reports/trip tickets, at-sea observers, stranding, entanglement, port sampling, vessel contracts and vessel tracking. Of these, logbooks, dealer reports, trip tickets, and at-sea observers are quantitative methods that will provide the most useful data for the program. Stranding and entanglement reports and port sampling will provide qualitative information useful to focus effort and identify problem areas. Vessel contracts and vessel tracking provide additional information, but these data are sometimes problematic and not necessarily representative.

Fisheries with probable or proven high bycatch of protected species will be the highest priority for the ACCSP At-Sea Observer Program. Fisheries with probable or proven high bycatch of finfish species of importance will be the second priority. The ACCSP prioritization process should be used to delineate more specific priorities. As a general guide to states, the program recommends a minimum 2% coverage level for all fisheries based on days-at-sea or fishing day (trip level for headboats) until such time that data are available to estimate values for the coefficient of variation (CV). Once CV values are available, sampling for 20-30% CV is recommended for both protected species and finfish. These recommendations do not address the difficulty of assessing both fish catch and bycatch with equal levels of precision, given the differences in sampling protocols or spatial and temporal allocation of observer effort that might be needed.

The cooperating parties are expected to agree to the Implementation Plan/Program Design by August 1998. Much of the actual implementation timing is dependent on funding. The ACCSP has not fully identified funding options for all phases of plan implementation, including funding for the at-sea observer program. It is hoped that the data systems can be in place by August, but it is unlikely that bycatch data collection will begin immediately.

**Planning the frequency of mortality observer programs to prevent false strategic designations**

Paul Wade, NMFS Alaska Fisheries Science Center (paper submitted to workshop)

At this point, it is not possible to observe every Category I and II fishery for marine mammal mortality in every year. Therefore, it is necessary to decide how often to observe some fisheries. In this short note, I will describe one possible criterion to consider. As a starting point, every Category II fishery should be observed at least once (most, if not all, Category I fisheries have already been observed at least once). This is an obvious point, as a Category II fishery that has not been observed could possibly have mortality greater than PBR. Unobserved fisheries that were placed in Category II were mostly documented to have takes from logbook and other sources, and were the types of fisheries with the potential for high levels of take. Therefore, an immediate goal is to create a rotation scheme to observe each Category II fishery at least once.

As most, if not all, Category I and II fisheries become observed at least once, it will be worthwhile to consider how often, and with what intensity of effort, they should be observed again. A method has been proposed for using a simulation method to determine adequate intervals for abundance surveys

(Wade and DeMaster submitted). The method is aimed at providing sufficient sampling frequency to reduce the rate of "false positives" under the PBR management scheme to an acceptable level, where false positive is defined as having a mortality estimate greater than the estimated PBR when the true mortality rate will not lead to depletion. A false positive leads to the designation of a stock as strategic when it should not be. Here I briefly point out that this method could also easily be extended to examine the consequences of various intervals for observing fisheries. Please refer to Wade and DeMaster (submitted) for details on the methods, and further explanation.

How can information about the false positive error rate be used? Obviously, the rate of false strategic designations is of concern only when stocks are designated strategic. If an observer program does not lead to mortality estimates that exceed PBR for any stock, then the false positive error rate is irrelevant (who cares what the false positive error rate might be if there are no positives, so none can be in error?). If initial estimates of mortality in a fishery produce very low mortality estimates, the probability of false positives in the future will likely be low. However, if mortality estimates are on the same order of magnitude as the PBR (such as from 0.5PBR to 1.5PBR), the false positive error rate should be considered.

I have modified my computer program to allow consideration of estimating mortality at frequencies of less than every year. For an example here, I repeated calculations for the Alaska stock of harbor porpoise done previously (see Wade and DeMaster submitted, Fig 2). In addition, I considered the same scenario but where mortality is estimated only every 2$^{nd}$, 3$^{rd}$, or 4$^{th}$ year, instead of every year. I repeated the calculations already made where mortality is estimated every year (as was done in all cases in that paper). Furthermore, I calculated one example of the consequences of improving the CV of the mortality estimate, rather than improving the frequency. In all cases (except the base case carried over from the previous calculations), all estimates of mortality within the most recent four-year window were averaged to make a single point estimate of mortality, and this was compared to the calculated PBR. If the mortality point estimate was greater than PBR, this represents a false positive, because the underlying true mortality rate (1%) was low enough that it would not lead to depletion.

The results could be used to plan the frequency and intensity of observer programs. For example, if the goal was to reduce the error rate to 10% or less, this could be achieved in a variety of ways. Consider the cases where CV(M)=0.6 (Figure 1). If mortality was estimated every year, abundance surveys would only need to be done every 5$^{th}$ or 6$^{th}$ year (squares). If mortality was estimated every 2$^{nd}$ year, surveys need to be done every 3$^{rd}$ year (circles). With mortality estimated every 3$^{rd}$ year, surveys need to be done every year (stars). Finally, with mortality estimated every 4$^{th}$ year, even surveys every year cannot achieve a 10% or less error rate (diamonds). Consider the one example of improving CV(M) to 0.4 40 (no symbol, thick line). Now a 10% error rate can be achieved by doing both surveys and mortality estimates every 4$^{th}$ year. Note that improving the CV to 0.4 leads to a lower error rate at a 4 year interval than does a 2 year interval with a CV of 0.6.

These calculations were made as an example of what can be considered. Four variables contribute to the error rate — the CVs of abundance and mortality estimates, and the frequency of surveys and observer programs. Various combinations of these four variables can be compared to help in planning surveys and observer programs. If the only consideration was cost (which is not the case, as human resources, ship and airplane availability, and other issues also need to be considered), then an optimal solution could conceivably be found across all four variables. This would require knowing the cost associated with any given effort level for both a survey and observer program, and knowing the relationship between effort and the CV of both the abundance and mortality estimates (as discussed for surveys in Wade and DeMaster (submitted)).

A caveat needs to be added. Wade and DeMaster (submitted) argue that the false negative error rate is not important, as the PBR management scheme has already been designed to ensure that stocks are designated strategic often enough to prevent their depletion. However, this is true only under the assumption of continued monitoring. If a Category II fishery is only observed once, and results in

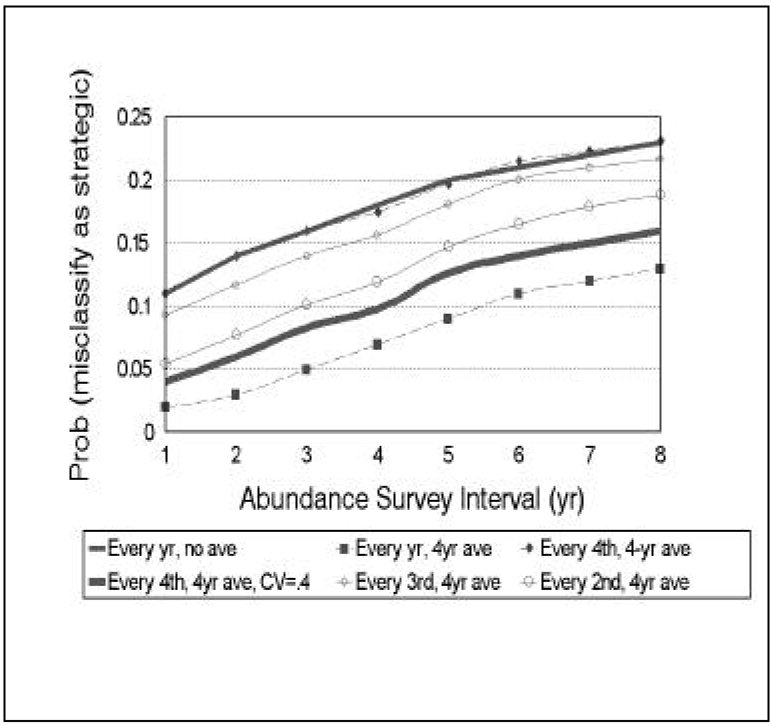


Figure 1. False positive (false strategic designation) error rate vs. abundance survey interval and mortality observer program interval for the southeast stock of Alaska harbor porpoise: CV(A)=0.26, CV(M)=0.60. The simulations assumed a 1% true mortality rate. All abundance estimates within an 8-year window were averaged. Mortality estimates were averaged over a 4 yr window in all cases except one, where no averaging was done (no symbol, thick line).

estimates of mortality which do not exceed the PBR of any stock, there may be a temptation to make no plans to observe such a fishery again in the foreseeable future, given limited resources. In such cases, however, the false negative error rate will be important to consider. The PBR scheme assumes that regular monitoring will take place, and that mortality will be decreased appropriately when the PBR is exceeded. Where a fishery is observed only once, and no plans are made for future observation, the false negative error rate should also be calculated. This can readily be done with the same computer program I have written.

**Strategies for the Statistical Monitoring of Fishery Bycatch**

Jay Barlow, NMFS Southwest Fisheries Science Center
(paper submitted to workshop, presented by: Grant Cameron, NMFS Southwest Fisheries Science Center)

I want to make a few points that I think are important for this meeting: (1) A coefficient of variation in mortality estimates is not, by itself, a very good criteria for establishing target levels of observer coverage for a fishery. (2) Observer programs that monitor the results of a Take Reduction Plan require special consideration and may, for a couple years, demand higher levels of coverage than would otherwise be warranted. (3) There are typically large logistic hurdles and start-up costs associated with new observer programs and a small pilot program should precede a full-blown observer program to work out these problems. (4) Given the infrastructure costs associated with starting a new observer program, the very premise of rotating observer programs may be flawed and a constant low-level of effort might be preferred for most Category II fisheries.

*(1) A coefficient of variation in mortality estimates is not, by itself, a very good criteria for establishing target levels of observer coverage for a fishery.*

The primary job of an observer program is to determine whether marine mammal bycatch in a given fishery is greater than the PBR (Wade MS 1998a) or ZMRG. If mortality levels are close to the PBR level, a very precise estimate of mortality may be needed to correctly make this decision and a higher coverage rate is needed. If, however, mortality is much less than the PBR, less precision and a lower observer coverage is needed (Barlow 1989). Of course, it is difficult to know the answer before you start an observer program. Therefore, it would be most efficient if observer programs start small (see suggestion #3 below re: pilot programs) and build up to required levels of coverage after evaluating preliminary data. Another issue is dealing with rare species. If a fishery takes an endangered or rare species, a single observation of entanglement may be sufficient to push estimated mortality over PBR. This problem is exacerbated if observer coverage is low (if coverage is 5%, a single mortality event would be extrapolated to an annual estimate of 20 such events). Averaging multiple years can help reduce the impact of single rare events, but a higher coverage rate may also be needed for fisheries that take endangered species or other rare species.

*(2) Observer programs that monitor the results of a Take Reduction Plan require special consideration and may, for a couple years, demand higher levels of coverage than would*

*otherwise be warranted.*

A Take Reduction Plan should, within 6 months of implementation, reduce marine mammal mortality in a Category I fishery to below PBR for all species taken by that fishery; if mortality were reduced to less than 50% of PBR, this would effectively make that fishery equivalent to a Category II fishery. This does not, however, mean that we should immediately reduce observer coverage to a level that is typical of Category II fisheries. There is concern that many of the strategies for reducing bycatch (especially pingers) may become less effective as animals acclimate or become habituated to them. Furthermore, it is likely that a high level of observer coverage will help ensure that take reduction measures are adopted by all fishers. High levels of observer coverage will probably be necessary until the Take Reduction Plan is proven to be effective for a couple of years.

(3) *There are typically large logistic hurdles and start-up costs associated with new observer programs and a small pilot program should precede a full-blown observer program to work out these problems.*

Few, if any, observer programs have achieved their targeted level of observer coverage in their first year. The logistic problems that impede rapid implementation include (1) identifying and locating active fishing vessels, (2) establishing a rapport with fishers, (3) establishing local port offices, (4) establishing a reliable method for fishers to notify when they are leaving port, and (5) determining efficient methods of allocating available observers to departing vessels. To efficiently allocate observers, the logistical infrastructure should precede the large-scale implementation of an observer program. The frustration caused by rushing to implement an observer program can act to alienate fishers if observer delays cost them valuable fishing time.

(4) *Given the infrastructure costs associated with starting a new observer program, the very premise of rotating observer programs may be flawed and a constant low-level of effort might be preferred for most Category II fisheries.*

Clearly it is desirable to monitor all Category II fisheries, but funding is insufficient to obtain precise estimates of mortality for all Category II fisheries in any one year. However, a rotating schedule of covering different fisheries is not the only solution to this dilemma. For many fisheries, a constant low level of observer coverage may be preferred. The advantages of the latter approach are many: (1) mortality estimates are averaged over several years and therefore are not as likely to be influenced by yearly vagaries in fishing practices. (2) Start-up and infrastructure costs can be amortized over longer time periods. (3) Fishers become accustomed to occasionally having observers aboard. (4) Fishers are more likely to stay current with bycatch reduction methods (e.g., maintaining and replacing batteries in pingers) if they know that they may be observed at any time. The primary disadvantage of observer programs with low percentage coverage is that the potential for bias is increased (e.g., due to observer-induced changes in fishing practices). This latter problem can be ameliorated by ensuring random placement of observers on all actively fishing vessels and, where possible, placing observers after nets are set. Although with lower coverage rates it may take longer to obtain precise estimates of mortality for any one fishery, it will not take any longer than a rotating observer scheme to obtain precise estimates of mortality in all fisheries collectively. Indeed, it may take less time due to the greater efficiency of continuing programs.

### A Five-Step Stratified Optimum Allocation Scheme

Kathryn Bisack, NMFS Northeast Fisheries Science Center (paper submitted to workshop)

This report describes the evolution since 1990 of a sampling design for the Northeast multispecies sink gillnet fishery. Sampling plans in 1990 to 1992 were proportional to the fishing effort in trips by time-area. Starting in 1993, a five-step stratified optimum allocation scheme was developed in an effort to reduce the overall CV of the harbor porpoise bycatch estimate and, in theory, to save money on sampling effort. The steps were as follows:

(1) A spatial and temporal stratification was developed based on harbor porpoise bycatch patterns and fishing effort. The spatial strata include: Northern Gulf of Maine (NGOM = NEFSC statistical catch reporting areas 511 and 512); Southern Gulf of Maine (SGOM = areas 513, 514,and 515); and, South of Cape Cod (areas 537, 538, and 539). Temporal strata include: Winter (January-May); Summer (June - August); and, Fall (September - December). Temporal strata are large of necessity, due to the high inter-annual variation in the timing of peak harbor porpoise interactions with this fishery (Figure 2).

(2) Strata sampling proportions were then estimated using historic averages of bycatch rates in each strata, and minimizing the total variance of the bycatch estimate (Table 2).

(3) Bycatch CV versus observer sampling trips were estimated under both proportional and optimal sampling (Figure 3). One can sample for a desired CV for the bycatch estimate, or one may choose to sample where the CV curve is flatter. For example, the planned observer schedule may be difficult to attain and therefore the risk of attaining a high CV is minimized on the flat part of the curve. The total number of sampling trips are determined within this step.

(4) Observer trips determined in Step 3 were then allocated by the proportions in Step 2.

(5) The season/area allocation in Step 2 was reallocated in more detail (e.g., by port and month) and proportional to effort within each cell.

Actual CVs were higher than expected (Figure 3 and Table 3). CVs in 1990 and 1991 are higher since sampling was approximately 1 percent from January 1990 to May 1991. Sampling increased starting in June 1991 to approximately 10 percent. An explanation for higher CV s in the other years needs investigation. Here are a few facts. First, the CV of the 1992-1996 point estimates is 25%, which is a measure of inter-annual variability. Second, the CV of the 1992-1996 pooled bootstrap replicates is 31%, which is a measure of within and inter-annual variability. Third, the inter-year CV (between years CV=0.25) is greater than the intra-year CV (within year CV=0.18). Recall, in step 2 above, the bycatch rates were averaged over the years

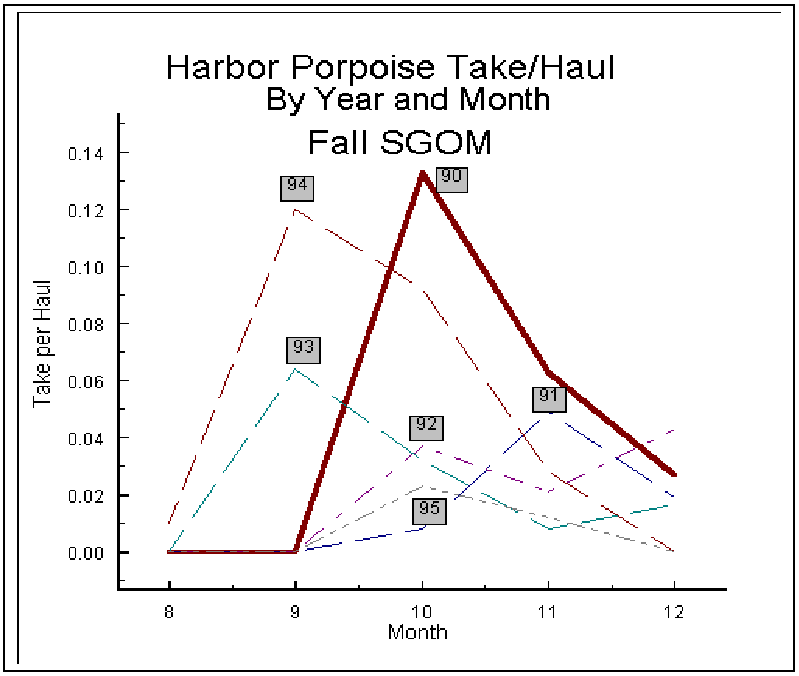


Figure 2. Harbor porpoise take per haul by year and month during the fall in the Southern Gulf of Maine.

which results in a lower variance by the nature of averaging across years.

Conclusion, under the current optimal sampling scheme, the predicted CV will be downwardly biased since inter-annual variability in the variance of the bycatch rate is not included in the allocation method. The take home message is inter-annual variability needs to be considered in a rotational sampling schedule. Fisheries need to be studied for several years to understand the complexity of the system.

Table 2. Proportional allocation (based on fishing effort) of observer trips for the New England multispecies sink gillnet fishery by season and large area, and (in parentheses) optimal allocation with the objective of minimizing the total variance of the harbor porpoise bycatch estimate. Each value represents the percentage of observer trips assigned. The analysis is based on 1990 - 1995 observer and effort data.

| Season | Northern GOM | Southern GOM | South of Cape Cod | Season Total |
|---|---|---|---|---|
| Winter (Jan - May) | 1 (1) | 24 (38) | 9 (14) | 34 (53) |
| Summer (Jun - Aug) | 2 (4) | 22 (4) | 11 (0) | 35 (8) |
| Fall (Sep - Dec) | 1 (1) | 22 (36) | 8 (2) | 31 (39) |
| Area Total | 4 (6) | 68 (78) | 28 (16) | 100 (100) |

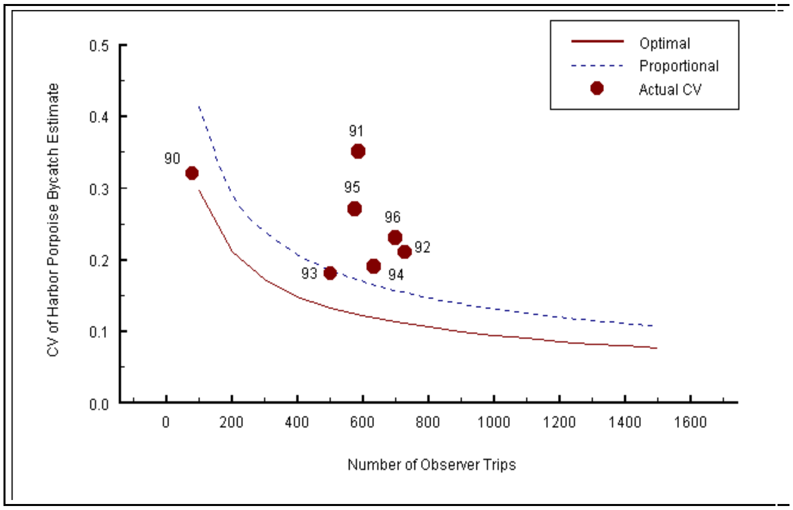


Figure 3. CV of harbor porpoise bycatch given number of observer trips under optimal and proportional sampling.

In addition, if the dynamics of the fishery change from year to year, a design which was optimal for one year may not be optimal in the next. This will be particularly true in 1999. While the fishery did not change much between 1990 and 1997, vessels operating under the TRP in 1999 will ping with acoustic devices in almost all areas. If one presumes that pingers will be 80% effective, the characteristics of the fishery and its bycatch rate will be entirely different. Numbers obtained from 1999 probably cannot be averaged with those from previous years, as the fishery is effectively operating with a new gear type.

Finally, an optimal allocation is confounded when there are more than one bycatch species of interest. Table 4 compares the optimal allocation of effort to minimize the total variance of the harbor porpoise bycatch estimate with that needed to minimize the total variance of the harbor seal bycatch estimate. Figure 4 displays the expected harbor porpoise CV when sampling is optimal for harbor porpoise, and the expected CV of harbor porpoise when sampling is optimal for harbor seals. The CV for harbor porpoise doubles under a scheme which optimizes for the other species (Figure 4). The Northeast Fisheries Science Center (NEFSC) has moved from optimal sampling for harbor porpoise back toward proportional sampling, to observe the multiple species taken in the NE multispecies sink gillnet fishery.

Table 3. Harbor porpoise bycatch estimates, confidence intervals, and coefficient of variance, 1990 - 1996.

| Year | Bycatch Estimate | 95% Confidence Interval | Coefficient of Variance |
|---|---|---|---|
| 1990 | 2,900 | 1,500-5,500 | 32 |
| 1991 | 2,000 | 1,000-3,800 | 35 |
| 1992 | 1,200 | 800-1,700 | 21 |
| 1993 | 1,400 | 1,000-2,000 | 18 |
| 1994 | 2,100 | 1,400-2,900 | 19 |
| 1995 | 1,400 | 900-2,500 | 27 |
| 1996 | 1,200 | 800-1,800 | 23 |

| Season | Northern GOM | Southern GOM | South of Cape Cod | Season Total |
|---|---|---|---|---|
| Winter (Jan - May) | 1 (0) | 34 (62) | 10 (4) | 45 (66) |
| Summer (Jun - Aug) | 7 (2) | 5 (12) | 0 (0) | 12 (14) |
| Fall (Sep - Dec) | 3 (1) | 40 (19) | 0 (0) | 43 (20) |
| Area Total | 11 (3) | 79 (93) | 10 (4) | 100 (100) |

Table 4. Optimal allocation of observer trips for the New England multispecies sink gillnet fishery by season and large area with the objective of minimizing the total variance of the harbor porpoise bycatch estimate, and (in parentheses) the harbor seal bycatch estimate. Each value represents the percentage of observer trips assigned. The analysis is based on 1990 - 1994 observer and effort data.

Proportional sampling based on fishing effort has proven to be a safer sampling strategy, and future sampling designs for this fishery are returning to that approach given the multiple species taken. To date, bycatch includes harbor porpoise, white-sided dolphins, common dolphins, harbor seals, harp seals, gray seals and hooded seals.

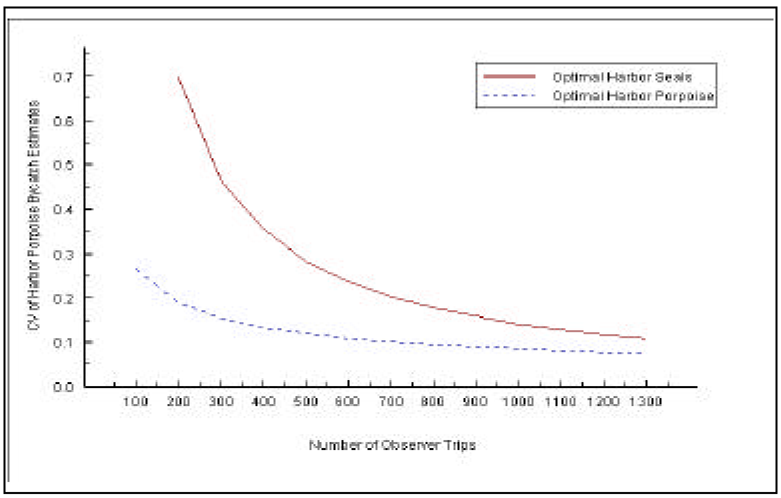


Figure 4. CV of harbor porpoise bycatch estimate given sampling priority optimal for harbor porpoise versus optimal for harbor seals.

**Correction Factors and Fishing Effort**

Kathryn Bisack, NMFS Northeast Fisheries Science Center (paper submitted to workshop)

In designing an observer program with the ultimate goal of estimating a statistically sound estimate of marine mammal bycatch, it is important to recognize how the data are collected. This includes the observer data and the total fishing effort data. In the New England multispecies sink gillnet fishery observers have multiple tasks to perform at sea, and therefore observed marine mammal bycatch rates may need to be adjusted for 'observer biases'. To obtain the best bycatch CV one can either sample all trips for marine mammals (no biological fish sampling) or sample for multiple purposes and correct bycatch rates. In addition, monitoring changes in the effort data collection system becomes important since the fishing effort data are used to expand observed bycatch rates to total fishery bycatch estimates.

History of Bycatch Estimation Methods

Several methods have been developed to obtain comparable and consistent harbor porpoise bycatch estimates within a changing and evolving sampling scheme. For example, estimates for 1990-1992 used a ratio estimator technique (Bisack 1993; Smith et al. 1993), and it was assumed that the observer recorded all bycatches. Subsequent analysis showed that while the observer was performing other duties, they missed some harbor porpoise falling out of the net while the gear was retrieved. Members of the 1994 Harbor Porpoise Workshop Committee convened by the Northeast Fisheries Science Center (NEFSC) in Woods Hole, MA recommended that the bycatch from 1990-1992 be recalculated to compensate for the 'off-watch' observer bias (Palka 1994). Recalculated bycatch estimates for 1990-1993 are documented in Bravington and Bisack (1996).

Observer Data

A correction factor or the effectiveness of off-watch observers relative to on-watch observers was estimated for the 1990-1993 observer data. The correction factor adjusts the off-watch bycatch rate to the on-watch rate. The correction factor point estimates were 0.72 (CV=0.27, CI=0.38 - 1.00, 80% hauls off-watch) from January 1990 to May 1992, 0.43 (CV=0.33, CI= 0.23 - 0.83, 50% hauls off-watch) from June 1992 to May 1993, and 1.00 (CV = 0.11, CI = 0.64 - 1.00, 50% hauls off-watch) from June 1993 to May 1994 (Bravington and Bisack 1996; Bisack 1997). Total bycatch estimates without the correction factors were considered downwardly biased.

Starting in June 1994, observer trips were either designated as marine mammal trips or fish trips. On marine mammal trips, the observer watched the gear and surrounding water on all haul backs. On fish trips the observer did biological fish sampling and was not required to watch the gear during haul backs, although every possible effort was made to collect such information. Approximately 90 percent of the trips are designated marine mammal trips until April 1998.

In March 1998, the Protected Species Branch (PSB) of NEFSC was asked whether the observer program could increase the biological fish sampling to 20% from 10%. This request was based on future analysis anticipated by the Population Dynamics Branch (PDB) at NEFSC. The sink gillnet currently has a trip limit of 1000 pounds of cod and it is expected to be reduced to 600-700 pounds. These data would then be used to determine whether vessels were high-grading. That is, if the trip limit was 700 pounds per trip, and a vessel caught over that amount, how much would they be throwing back into the ocean to remain within their trip limit. If we assume the fish thrown back do not survive, then the cod mortality may be greater than the total effort data estimates.

To determine the impact of correcting the observer trips dedicated to biological fish sampling, the variance of the following relationships was investigated:

$$r = w_{ON} * r_{ON} + w_{OFF} * \left( \frac{r_{OFF}}{B} \right)$$

That is, the overall bycatch rate (r) is equal to the on-watch weight ($w_{ON}$) times the on-watch bycatch rate ($r_{ON}$), plus the off-watch weight ($w_{OFF}$) times the off-watch rate ($r_{OFF}$) divided by the correction factor (B). The weights ($w_{ON}$ and $w_{OFF}$) represent the proportion of hauls off and on watch.

Data for these analyses include the 1996 harbor porpoise bycatch sampling estimate of 1200, and its CV of 23%. There were roughly 700 trips sampled in 1996 of which 71 were fish trips (10%) and 581 were dedicated marine mammal trips, and 45 were pinger trips. An aggregate on-watch rate of harbor porpoise takes per haul from 1994 to 1997 (0.019) was supplied by the observer program. These data and the relationship defined above were used to recalculate the CV of the harbor porpoise bycatch estimate.

The following scenarios were examined. A CV was estimated for: (1) five different marine mammal fish-tradeoffs (90, 10), (80,20), (70,30), (60,40), (50,50) where the first number is the percent of trips dedicated to marine mammals or $w_{ON}$; and, (2) four different CVs associated with the correction factor (CV=0, 0.25, 0.50, 0.85). The CV on the correction factor was historically less than 35%. Results are displayed in Figure 5.

The following observations are noted from this analysis. First, when 90% of the observer trips are dedicated to marine mammals, the range of the bycatch estimates CVs are very small, for the different CVs of the correction factors . Only dedicated marine mammal trips were used in the 1996 harbor porpoise bycatch analysis. This result implies the 1996 harbor porpoise bycatch CV would not change if the dedicated fish trips were corrected and added to the bycatch analysis, even if the CV of the correction factor was as high as 85%. Second, as more trips are dedicated to biological fish sampling, the CV increases, and is highest at the 50% mark.

Based on these results, the PSB at NEFSC recommended biological fish sampling be increased to 20% of the observer trips starting in April 1998. It is predicted that the CV of the total bycatch will remain below 30% with this mix of sampling (Figure 5).

These results may differ as more pingers (active acoustic devices) are used in the Gulf of Maine sink gillnet fishery and if they are 80% effective. More analyses need to be conducted, however, the analysis presented here are appropriate for this time period, prior to the implementation of the harbor porpoise TRP.

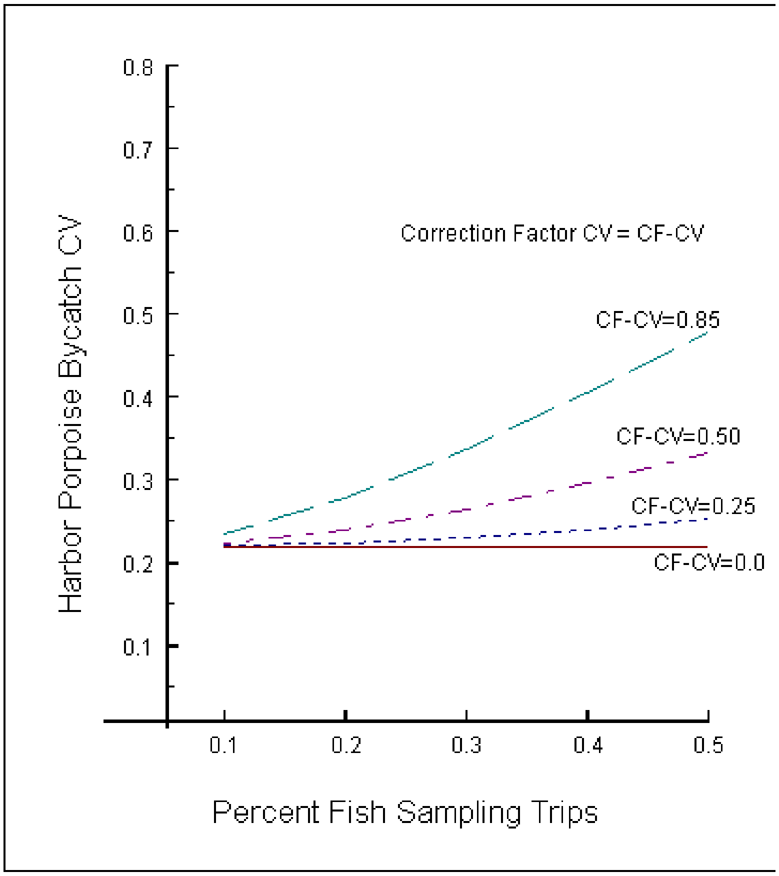


Figure 5. Harbor porpoise CV tradeoff between marine mammal and fish sampling trips.

Total Fishing Effort Data

To make a total marine mammal bycatch estimate for a fishery, the observed bycatch rate is multiplied by total fishing effort. For this reason, it is important that data collected in the observer program are comparable to data collected in the total fishing effort data collection system. For example, in June 1994 the NEFSC weighout (WO) data collection system, in which effort data and catch locations were collected by dockside interviews, was replaced by one in which such information was recorded in mandatory logbooks. The new effort data were not available for analysis at the time the 1994 and 1995 harbor porpoise bycatch estimates were made, and landings data were not matched with the statistical area in which a vessel caught its fish, as it was previously. Therefore, bycatch estimates were derived from a port-based stratification rather than a statistical area stratification scheme (Bisack 1997).

The data collected in the observer program have more detailed units of effort and levels of stratification. However, the effort data do not always match the detail of the observer data. Therefore, the fishing effort data can drive the structure of the bycatch analysis.

**Planning observer coverage by calculating the expected number of observed mortalities**

Paul Wade, NMFS Alaska Fisheries Science Center (paper submitted to workshop)

Planning the amount of observer coverage to allocate to observing a fishery should be based on achieving management goals. Simple "rules of thumb" such as targeting 5 or 10% observer coverage are not sufficient for planning. Five percent observer coverage may be sufficient for a very large fishery, but may be grossly inadequate for a smaller fishery. Targeting achieving a specified coefficient of variation of the mortality estimate, such as 0.3, is a better planning method.

However, another way to investigate whether an observer program has an adequate sample size is to examine the expected number of observed mortalities for a given true mortality rate. Particularly for fisheries being observed for the first time, it may be most appropriate to use a planning method that is more specifically aimed at documenting takes, if takes are occurring. In other words, a first-time observer program for a fishery should make the probability of observing zero takes very small if the true number of takes is great enough to be of concern (i.e., on the order of the PBR, or some other similar measure).

The are several reasons for taking this approach. First, with limited resources, it may not be possible to allocate enough observer coverage to a fishery to immediately produce a mortality estimate with a low CV. Second, observing no takes (when real takes are important) in a first-time observer program could be problematic, as it might lead to the false conclusion that takes are not a problem, when they are. A one-time observer program should be considered to have a flawed design if the probability of observing zero takes is too high, under the assumption that takes are truly great enough to be of concern.

One simple way of making such calculations is to use a binomial distribution, where the mortality rate is the binomial parameter (the mean), and the number of observations is the intended sample size, in some unit of fishing effort (such as sea-days, trips, or whatever unit of effort is the basis for planning observer coverage). I do not intend to take credit for inventing this approach (for example, such a method was used by DeMaster and others in planning the Alaska Category II observer program), I simply wanted to describe the approach in simple terms for those who are not familiar with it.

The steps needed to perform this calculation can be described this way:

(1) Select an expected amount of effort (E) for the fishery. This would most logically be based on the amount of effort seen in the fishery in the most recent year for which this information is available. The effort should be in a unit, such as sea-days or trips, that is related to how effort will be allocated.

(2) Select a level of mortality (M) that is considered to be of concern, in numbers of animals. This could logically be based on the PBR of a stock of concern, or on other information, such as a level of takes predicted from strandings data, for example.

(3) Calculated the binomial parameter $p$=M/E, which is the expected mortality per unit of effort, if M animals are being killed per year.

(4) Select a proposed amount of observer coverage ($n$), in the same unit of effort of E in 1. This is the proposed sample size.

(5) Calculate the probability of observing x=1,2,3,4,...10 mortalities using the binomial distribution *b(x; n, p)*.

Making calculations in this way carries an assumption that marine mammal mortalities have a binomial distribution, meaning the expected rate of bycatch is constant for unit of effort such as a sea-day. This may not be strictly true, as bycatches may sometimes be clumped in distribution for a variety of reasons. However, this provides a reasonable starting point for designing an observer program.

I have written a simple computer program (SEADAYS) that can make these calculations. An example of its use is given here:

(1) Most recent number of sea-days of effort from a target fishery was E=5668. It is assumed that the fishery will have a similar number of sea-days of effort in the year it is observed.
(2) Strandings data have led to an estimate of M=39 mortalities from fishery interactions, which cannot be definitively attributed to a specific fishery. An observer program is started for the fishery suspected of causing the mortalities.
(3) If it is assumed that the true mortality is 39, then the expected mortality rate $p = 39/5668 = 0.0069$.
(4) Proposed sample sizes for the number of observer sea-days are $n$=200, 300, 400, or 500 sea-days.
(5) The expected probability of observing a given number of mortalities can be calculated from a b(x; 200, 0.0069), etc. The calculations in Table 5 are output from SEADAYS.

In this example, it can be seen that with only 100 observer sea-days, the most likely observation will be of zero takes, with only a 50% chance of observing takes. A sample size of 200 increases the probability of observing takes to 75%. A sample size of 400 sea-days increases this probability to 94%.

Table 5. Outputs from the computer program SEADAYS, June 1, 1998.

BINOMIAL PROBABILITIES FOR SAMPLE SIZE N=100 AND P=0.006900

| Pr of obs number | Cumulative Pr of obs that number or more |
|---|---|
| Pr(x= 0)=0.5004 | Pr(x>= 0)=1.0000 |
| Pr(x= 1)=0.3477 | Pr(x>= 1)=0.4996 |
| Pr(x= 2)=0.1196 | Pr(x>= 2)=0.1520 |
| Pr(x= 3)=0.0271 | Pr(x>= 3)=0.0324 |
| Pr(x= 4)=0.0046 | Pr(x>= 4)=0.0053 |
| Pr(x= 5)=0.0006 | Pr(x>= 5)=0.0007 |
| Pr(x= 6)=0.0001 | Pr(x>= 6)=0.0001 |

Probability of observing 1 or more takes: 0.500
Most likely # of observed mortalities: 0

BINOMIAL PROBABILITIES FOR SAMPLE SIZE N=200 AND P=0.006900

| Pr of obs number | Cumulative Pr of obs that number or more |
|---|---|
| Pr(x= 0)=0.2504 | Pr(x>= 0)=1.0000 |
| Pr(x= 1)=0.3479 | Pr(x>= 1)=0.7496 |
| Pr(x= 2)=0.2405 | Pr(x>= 2)=0.4017 |
| Pr(x= 3)=0.1103 | Pr(x>= 3)=0.1612 |
| Pr(x= 4)=0.0377 | Pr(x>= 4)=0.0509 |
| Pr(x= 5)=0.0103 | Pr(x>= 5)=0.0131 |
| Pr(x= 6)=0.0023 | Pr(x>= 6)=0.0029 |

Probability of observing 1 or more takes: 0.750
Most likely # of observed mortalities: 1

BINOMIAL PROBABILITIES FOR SAMPLE SIZE N=300 AND P=0.006900

| Pr of obs number | Cumulative Pr of obs that number or more |
|---|---|
| Pr(x= 0)=0.1253 | Pr(x>= 0)=1.0000 |
| Pr(x= 1)=0.2611 | Pr(x>= 1)=0.8747 |
| Pr(x= 2)=0.2712 | Pr(x>= 2)=0.6136 |
| Pr(x= 3)=0.1872 | Pr(x>= 3)=0.3423 |
| Pr(x= 4)=0.0966 | Pr(x>= 4)=0.1551 |
| Pr(x= 5)=0.0397 | Pr(x>= 5)=0.0585 |
| Pr(x= 6)=0.0136 | Pr(x>= 6)=0.0188 |

Probability of observing 1 or more takes: 0.875
Most likely # of observed mortalities: 2

BINOMIAL PROBABILITIES FOR SAMPLE SIZE N=400 AND P=0.006900

| Pr of obs number | Cumulative Pr of obs that number or more |
|---|---|
| Pr(x= 0)=0.0627 | Pr(x>= 0)=1.0000 |
| Pr(x= 1)=0.1742 | Pr(x>= 1)=0.9373 |
| Pr(x= 2)=0.2415 | Pr(x>= 2)=0.7631 |
| Pr(x= 3)=0.2226 | Pr(x>= 3)=0.5216 |
| Pr(x= 4)=0.1535 | Pr(x>= 4)=0.2990 |
| Pr(x= 5)=0.0845 | Pr(x>= 5)=0.1455 |
| Pr(x= 6)=0.0386 | Pr(x>= 6)=0.0610 |

Probability of observing 1 or more takes: 0.937
Most likely # of observed mortalities: 2

**Comments on using the Binomial distribution to model marine mammal encounter rates**

Stephen J. Smith, Department of Fisheries and Oceans, Bedford Institute of Oceanography (paper submitted to workshop)

Introduction

Wade (1998b) proposed using a binomial distribution to model the number of "takes" of marine mammals in commercial fisheries. In the proposal, the number of sea-days are considered to be trials with the event being whether or not a marine mammal was taken in the catch each day. Under the binomial assumption, the event that two or more marine mammals could be taken in a day is not considered. In this paper I point out that the more appropriate model is actually a Poisson process. While the probabilities for observing one or more marine mammals from the Poisson model do not differ very much from the binomial results given by Wade (1998b), differences will be larger for smaller numbers of sea-days or higher rates of fatal encounters or both.

Materials and Methods

The event being modeled here is the number of fatal encounters observed while monitoring fishing activities. This monitoring is to be done by fisheries observers and because of financial constraints, the monitoring can only be done for a small portion of the fishing effort expended in a year by a particular fleet and/or fishery. Therefore it is of interest to know what the probability is of observing a fatal encounter of the fishing gear with a marine mammal when only a small portion of the fishery is observed. The rate of fatal encounters (called expected mortality rate per unit effort by Wade (1998b)) between marine mammals and fishing gear may be estimated based on the BPR or the marine mammal stock or from some other source of data as suggested by Wade (1998b).

The natural model for counts of the occurrence of an event within time period is the Poisson model (Mood et al. 1974) and has been used in a number of applications such as the number of fatal accidents in a week, the number of radioactive particle emissions per unit time, and the number of bacteria per unit volume. For some event *X*, the probability that $X$=$x$ is given as:

$$\Pr(X = x) = \frac{e^{-\lambda}\lambda^{x}}{x!}$$

where $X$=0. 1, 2, .... The expected value of $X$ is $\lambda$ which is also interpreted as the mean rate of occurrence.

Results and Discussion

In the example given by Wade (1998b) the total amount of effort in a target fishery was 5,668 sea-days. Stranding data indicated that 39 marine mammals had died from fishery interactions, possibly in the target fishery. Over the whole fishery we would model the number of fatal encounters as a Poisson distribution with $\lambda$=39. In our case here, we are interested in the number of fatal encounters for different numbers of sea-days and hence will express the rate of fatal encounters as $\lambda$=39/5668.

Estimates for the probabilities calculated in Wade (1998b) are presented as density estimates in Table 6 and cumulative probabilities in Table 7.

The calculation for one sea-day was done using $\lambda$=39/5668=0.0069. Calculations for more than one day were made using the property that the sum of Poisson random variable is also a Poisson random variable with $\lambda$ equal to the sum of the $\lambda$s from the individual variables. The probabilities in the two tables do not differ very much from those given by Wade (1998b) for the same number of sea-days. For example, Pr(x=0) for 100 sea days was 0.5016 for the Poisson model compared to 0.5004 for the binomial model.

The expected number of observed fatalities($E[x]$) in Table 7 match those given by Wade (1998b) as the most likely number of observed mortalities for the same number of sea days.

If the differences are so small, why make an issue of which model is used? Indeed, for the large number of sea-days and the very small value of $p$ (0.0069) used in the binomial model, the Poisson can be reliably used as an approximation for the binomial (pp. 119-120, Mood et al. 1974). However for fewer numbers of sea-days and for larger rates of occurrence the approximation is poorer. Consider the case where only 50 sea-days are observed and the rate is an order of magnitude higher than before. The probability of observing one or more fatal encounters is 0.9683 for the Poisson model and 0.9720 for the binomial model. Still not a huge difference in the grand scheme of things so why pursue this?

Table 6. Poisson probabilities of observing x=(0, 1, 2..., 6) marine mammals in the catch during various periods of sea-days.

| Number of Marine Mammals | Sea-days 1 | 100 | 200 | 300 | 400 |
|---|---|---|---|---|---|
| $x$=0 | 0.9931 | 0.5016 | 0.2516 | 0.1262 | 0.0633 |
| $x$=1 | 0.0069 | 0.3461 | 0.3472 | 0.2612 | 0.1747 |
| $x$=2 | 0.0000 | 0.1194 | 0.2396 | 0.2703 | 0.2411 |
| $x$=3 | 0.0000 | 0.0275 | 0.1102 | 0.1865 | 0.2218 |
| $x$=4 | 0.0000 | 0.0047 | 0.0380 | 0.0965 | 0.1530 |
| $x$=5 | 0.0000 | 0.0007 | 0.0105 | 0.0400 | 0.0845 |
| $x$=6 | 0.0000 | 0.0001 | 0.0024 | 0.0138 | 0.0389 |

Table 7. Poisson cumulative probabilities of observing $x \geq (1, 2, 3..., 6)$ marine mammals in the catch during various periods of sea-days. $E[x]$ refers to the expected number of marine mammals over the whole period.

| Number of Marine Mammals | Sea-days 1 | 100 | 200 | 300 | 400 |
|---|---|---|---|---|---|
| $x \geq 1$ | 0.0069 | 0.4984 | 0.7484 | 0.8738 | 0.9367 |
| $x \geq 2$ | 0.0000 | 0.1523 | 0.4012 | 0.6126 | 0.7620 |
| $x \geq 3$ | 0.0000 | 0.0329 | 0.1617 | 0.3423 | 0.5210 |
| $x \geq 4$ | 0.0000 | 0.0055 | 0.0515 | 0.1557 | 0.2992 |
| $x \geq 5$ | 0.0000 | 0.0007 | 0.0135 | 0.0592 | 0.1461 |
| $x \geq 6$ | 0.0000 | 0.0001 | 0.0030 | 0.0192 | 0.0617 |
| $E[x]$ | 0 | 0 | 1 | 2 | 2 |

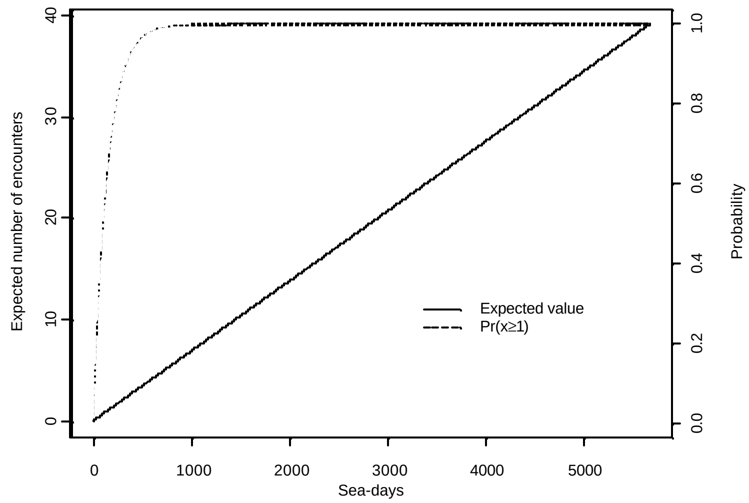


Figure 6. Expected number of marine mammal encounters and probability of at least one encounter over a range of sea-days.

First of all, the rate of occurrence of 0.0069 is interpreted as a probability in the binomial model. However, given that this rate was calculated as the number of fatal encounters divided by the total number of sea-days, there is no limit on this quantity being bounded by 0 and 1 as required for a probability. In fact this rate is more like an instantaneous mortality rate and as such can exceed 1. While it may be unlikely that the number of fatal encounters would exceed 1 per sea-day, the Poisson model can deal with this while the binomial model would not be applicable at all.

A graphical representation of the pertinent quantities from Table 6 and Table 7 is presented in Figure 6.

Epilogue

Admittedly, the above calculations do not advance the solutions to the problems being tackled at this workshop any further than they already are. However, care must be taken in the definition of the components of this model and its application in any exercise that depends on modeling, statistical or otherwise, to make decisions.

## Qualitative or Reduced Monitoring Methods

Brian Fadely, NMFS Alaska Region

Qualitative or reduced monitoring techniques could be used as a lower cost alternative to observer programs, or to monitor fisheries in off-rotation years. The appropriateness of their use depends on fiscal and logistical constraints, and on the ultimate programmatic goals. Qualitative programs are particularly suited for programs where bycatch or intentional take reduction is the primary goal, but may also provide information on bycatch patterns that could help focus observer program development.

Options suggested by Wynne and Merklein (1996) for Alaska fisheries included: (1) reduced observer coverage, which is focused in time and space or on "hot spots"; (2) selective (voluntary) log reports; (3) aerial net surveys; (4) systematic surveys for beachcast carcasses; and (5) integrated research, monitoring, and education. There are times when each of these can be an effective tool. Surveys for beachcast animals, for example, work particularly well in embayments where it is relatively certain that carcasses would wash ashore, but can be complicated by uncertainty regarding the cause of death. An integrated research program can maintain agency presence during observer program off-years and thereby promote reduced mortality, but it is often difficult to quantify the results of outreach programs.

The utility of qualitative methods in a long-term monitoring program depends on whether on not an estimate of mortality is needed. Compliance monitoring and Vessel Monitoring Systems (VMS) focus on area and season closures and do not require a take-based number. If vessel location and timing were available from the VMS programs, however, it might permit a projection of impacts. Qualitative methods might be most effective in a pilot program, as a means to identify "hot spots". They are less appropriate when a fishery is approaching PBR and the agency faces a statutory requirement to evaluate status.

**The California Drift Gillnet Fishery**

Tim Price, NMFS Southwest Region

When the observer program for the California/Oregon drift gillnet fishery was established in July 1990, NMFS attempted to select vessels at random based on a pre-season drawing of vessels and trip numbers. The 160 available vessels were informed at the beginning of the season of the trips on which they would be expected to take an observer. While vessel operators generally appreciated the advance notice, several problems became apparent. Some vessels do not begin participation in the fishery when the season opens, and may not make as many trips (either in total or observed) as expected. It became obvious that NMFS and some vessel operators defined a trip differently, since some operators considered a return to port for inclement weather as only a brief interruption of a continuing trip. It was also necessary to determine the total number of trips made by each vessel, in order to determine whether the vessel actually took an observer on its designated trip.

The series of changes to the allocation plan since that first year have attempted to address problems and further define trip parameters. Observers began monitoring which vessels were fishing, and then informed some of those vessels that they must take an observer on their next trip. The definition of trip was still problematic, as many of those observed trips were of very short duration. Trips were then defined as consisting of at least five sets resulting in a landing of the target species. Since some operators then made atypically large numbers of sets per day on observed trips in order to decrease trip duration, an additional trip duration requirement of at least six days was added.

Additional observation of the fishery from an alternate platform was attempted in 1993 - 1995, but was abandoned for a number of reasons. The drift gillnet fleet operates 20 to 25 miles offshore, and the skiff carrying observers was operating at the limits of its safety range. The skiff was also required to leave at approximately 0200 hours in order to reach vessels in time for the morning net haul. Upon arrival it was often possible to sample only one vessel, because other vessels in the area would be alerted to the observers' presence and would haul early.

The program is currently conducted by a third-party contractor, who must become familiar with both the vessels operating in the fishery and their fishing patterns. Days away from port are used as a measure of effort, and are monitored on a real-time basis. The contractor presumes that vessels away from port are fishing. Vessels that spend time in remote ports where an observer may not be available to monitor vessel activity must notify the contractor to avoid having all unaccounted days included in their observer requirement. The contractor informs vessel operators whose individual observer coverage is less than the program goal of 20% that they must take an observer on their next trip. Observers are rarely placed aboard vessels that volunteer to take them unsolicited. Vessel operators are supposed to give at least 48 hours notice of departure, but advance notice of less than 24 hours is common. Approximately 100 vessels were active in the fishery during 1997, based on the NMFS registration list cross referenced with the California Department of Fish and Game permit and vessel registration lists. Effort peaked in 1993 at 5,380 sets, and declined to about 2,600 sets by 1997. Observer coverage during 1997 averaged about 26% of both sets and trips; each trip averaged about six sets.

The Pacific Offshore Cetacean Take Reduction Team was formed in 1996 to address takes of marine mammals in this fishery. The team has recommended that the observers sample a representative cross-section of the fleet. There were 28 vessels that did not carry an observer last year, representing about 14% of the fleet effort. The contractor has been asked to reevaluate these vessels based on its own placement criteria. Many of these may be small and lack adequate accommodations, or may be unsafe for observer placement.

The PBR in this fishery is being exceeded for sperm, humpback, and beaked whales. Most of the PBR levels are quite low. The annual observed cetacean catch was reduced by approximately 75% with the use of pingers during a 1996 experiment. The experiment was continued in 1997, and use of pingers became mandatory in October 1998. Pingers must be placed every 300 feet in an alternating pattern on both the float and the lead line. Float lines must be equipped with an extender that suspends the net at least 36 feet below the surface, and skippers must attend workshops on the TRP gear requirements.

Fisher response to the TRP has been cooperative. Approximately 140 of the 160 skippers voluntarily participated in skipper workshops before those became mandatory. Fishers recognize that pingers will be in use for a long time and view pingers as a means to continue their fishery. Most vessel operators have purchased pingers, although a minority have protested by filing suit against the TRP. The availability of pingers was an initial concern, but a facilitator and the gillnetters' federation purchased large quantities before the season and helped to distribute them to individual fishers.

Future plans for observer monitoring of this fishery call for continuation at current levels for at least the next three years (through the 2000 season). With observers onboard, operator use and maintenance of pingers may be higher than it would otherwise. An enforcement regimen is being developed to enforce the regulations that require vessels participating in this fishery to have pingers on board, and on all gear in the water.

**Development of the Turtle Observer Program in the Hawaiian Longline Fishery**

Pierre Kleiber, NMFS Southwest Fisheries Science Center, Honolulu Lab

The Hawaiian longline fishery is based in an historic fishery for tuna, which grew following the addition of swordfish fishers from the U.S. East Coast, and Vietnamese fishers from the Gulf of Mexico who pursue a variety of species. The fishery encounters loggerhead turtles in the northern parts of the fishing area, olive ridleys in the south, and leatherbacks throughout. Green turtles are encountered only sporadically. Marine mammals are encountered infrequently; takes of only 10 animals by this fishery have been documented to date. Observers were placed on fishing vessels on a voluntary basis from 1990 through 1993, and a mandatory logbook program was launched in November 1990. The recognition that sea turtles were taken in this fishery triggered an ESA Section 7 consultation, which resulted in the first of several biological opinions in May 1991. That biological opinion established take limits of 25 turtles per year (any species), and kill limits of one turtle per year for leatherbacks, olive ridleys, and greens. By June 1992, the 1991 logbook data verified that those limits had been exceeded.

A second biological opinion in June 1993 declared the fishery had an adverse impact on turtles, but made no finding of jeopardy. It established the observer program, and revised the take and kill limits. The fishery was limited to no more than 752 takes of any turtle species, 299 kills of any turtle species, and 150 releases of leatherbacks in grave condition. The term "grave condition" was never defined. Another biological opinion was required within one year.

The pilot survey design for the observer program stratified the fishery by trip type and by quarter of the year (DiNardo 1993). Trips focused on tuna were conducted primarily by representatives of the historic Hawaiian longline fleet, while trips focused on swordfish were conducted primarily by the new arrivals from the U.S. East Coast. Trips which harvested a mixture of these two species were initially conducted by Vietnamese fishers, but all groups eventually learned from each other and trips of this type became more common for other groups. The first observer program trip departed in February 1994.

Table 8. Revised take and kill limits imposed on the Hawaiian longline fishery by the third Biological Opinion.

| Species | Takes | Kills |
|---|---|---|
| Loggerhead | 305 | 46 |
| Leatherback | 271 | 41 |
| Olive ridley | 152 | 23 |
| Green | 119 | 18 |
| Hawksbill | 2 | 1 |
| All Species | 849 | 129 |

The third biological opinion released in June 1994 revised take and kill limits again by imposing species-specific guidelines (Table 8). These limits include criteria for hawksbill turtles, although no takes of this species have been documented. The ratios of takes to kills in these limits also do not necessarily reflect the patterns seen in the observer data. A meeting of turtle experts in December 1995 evaluated the significance of the observed takes using a series of population dynamics models. Analysis of the 1995 data in March 1996 revealed that the take and kill limits had again been exceeded, launching a fourth biological opinion.

In August 1996, a new survey design was recommended for the observer program. Instead of trip type, it recommended two vessel size strata --- length greater or less than 70 feet. It proved necessary to update the previous trip type strata every year based on logbook data, since vessels would often change their mode of operation. The new strata roughly correlate with a propensity to target tuna or swordfish. Larger vessels typically fish farther north in latitudes of the subtropical convergence zone, harvest more swordfish, and take more turtles, particularly loggerheads. Observers are allocated based on previous turtle take rates. The new survey design was implemented in April 1997.

Analysis of the 1994-1996 data in March 1997 verified that the take and kill limits had again been exceeded, and the fourth (uncompleted) biological opinion was continued. Starting in January 1998, haul sequence numbers are being keypunched for logbook data, and in July 1998, observers will begin recording these sequence numbers. The sequence numbers will facilitate set by set cross-referencing between logbook data and observer data. Logbook data from observed sets are used whenever possible for developing statistical models because logbook data from all sets are applied to the statistical models to obtain take estimates for the whole fishery.

Analysis of the 1994-1997 data identified sea surface temperature as the most significant explanatory variable for loggerhead takes from a suite of 27 variables including location, time, other environmental factors, catch of a variety of fish species, and gear characteristics, such as light sticks, bait type, and hooks per float. However, because sea surface temperature is often missing from logbook records, it was dropped from the analysis. Latitude then became the most significant variable. There are plans to examine the relationship of takes to proximity to the subtropical convergence zone, since this may actually be more significant than latitude.

Although there have only been two survey designs in the observer program, observer tasks have changed frequently. Observers have been asked to tag turtles, collect biopsy samples, and place ARGOS transmitters on live releases. Documenting measures taken by fishers to mitigate seabird take is another program add-on. The program coverage goal is 5% of trips and sets, and last year the program achieved a 3 to 4% coverage rate. Coverage is stratified according to fishing effort, with most coverage focused on larger vessels (length greater than 70 feet) because they account for most of the turtle take. There is only token coverage on smaller vessels. Since the larger vessels generally fish furthest north, this also results in a focus on loggerhead turtle takes.

### Long-Term Rotation Plan for Alaska Observer Programs/Beachcast Surveys

Brian Fadely, NMFS Alaska Region

There are 13 Category II fisheries in Alaska; 8 of which have been included in an initial rotation monitoring plan for Alaska. Of the five fisheries not included: no participants have been identified in the Alaska pair trawl fishery; the authority of NMFS to monitor the Metlakatla drift gillnet fishery which takes place in tribal waters is questionable; and Prince William Sound and the Peninsula/Aleutians drift gillnet fisheries were observed in 1990-91.

A review of Alaska coastal fisheries (Wynne and Merklein 1996) suggests that intentional take remains a problem. The Alaska panhandle fisheries (Southeast Alaska drift gillnet and purse seine, and Yakutat set gillnet) were scheduled first for observation because of concerns of interactions with endangered humpback whales, and the likelihood of significant interactions with harbor porpoise. Other fisheries in the rotation include: the Cook Inlet set and drift gill net; Kodiak set gill net; and Bristol Bay set and drift gill net. All of these salmon fisheries are closely managed by the State of Alaska. The Alaska Department of Fish and Game response to NMFS monitoring plans to date has been neutral.

The Alaska Scientific Review Group (SRG) examined population trends for marine mammal stocks in Alaska and recommended a different schedule. The SRG noted that the marine mammal populations taken by fisheries in southeastern Alaska were generally stable or increasing, while more stocks of concern may be interacting with fisheries in the northern Gulf of Alaska and Cook Inlet. They recommended that observation of fisheries in that area be given higher priority. Of particular concern was the beluga whale population of Cook Inlet, where the Native subsistence harvest is believed to be greatly in excess of PBR. The SRG recommended that in addition to the observer program, a comprehensive monitoring program be initiated to uniformly assess all sources of take. In the event that beluga whales become listed as threatened under the ESA, data from a combined observer/stranding program would be useful for focusing recovery efforts.

Background for a combined observer and stranding monitoring program is provided from a study of fishery interactions in the Copper River Delta during 1988-89 (Wynne 1990). This study of strandings demonstrated that the frequency of landings varied by marine mammal species in different parts of the delta, and that the number of carcasses declined over time. Plans for a program to detect similar differences are being developed for Cook Inlet.

**Endangered Species Act Requirements**

Therese Conant, NMFS Office of Protected Resources

Section 7 of the Endangered Species Act (ESA) requires all federal agencies to conserve listed species and to use their authority to further the purposes of the Act. Each Federal agency must, in consultation with and with the assistance of the Secretary (Interior, Commerce) ensure that their actions (authorized, funded, or carried out) are not likely to jeopardize the continued existence of threatened or endangered species, or result in the destruction or adverse modification of critical habitat.

NMFS has been delegated ESA authority from the Secretary of Commerce for most listed marine species. Thus, federal agencies consult through the Section 7 process with NMFS when that federal agency believes that a proposed action may affect a listed marine species under NMFS jurisdiction. In the case of federally managed commercial fisheries, NMFS consults with itself (i.e., the NMFS Office of Sustainable Fisheries seeks consultation with OPR).

Consultations for ESA purposes come as Biological Opinions, which make use of the best available scientific data. A formal Biological Opinion consists of a description of the proposed action, status of the species/critical habitat, the environmental baseline, effects of the action, cumulative effects, and a conclusion of jeopardy or no jeopardy (or destruction or adverse modification of critical habitat). If there is a conclusion of jeopardy, the federal agency, with assistance from the Services (i.e., NMFS or USFWS), must identify a Reasonable and Prudent Alternative (R&PA) to the proposed action before an incidental take statement can be issued. An incidental take statement may only be issued after the Services have determined that the proposed action, or the R&PA, and the resultant incidental take will not jeopardize the listed species or adversely modify critical habitat. The incidental take statement specifies the amount or extent of such incidental take, those reasonable and prudent measures deemed necessary or appropriate to minimize such impact, and the terms and conditions (including reporting) with which the federal agency or applicant must apply.

Incidental take statements are not kill limits; they identify expected levels of take and presume that the agency will take action to minimize impacts before these levels are reached. Monitoring programs resulting from interagency/intra-agency consultations should be designed to: (1) detect adverse effects resulting from a proposed action; (2) assess the actual level of incidental take in comparison with the anticipated take level documented in the Biological Opinion; (3) detect when the level of anticipated incidental take is exceeded; and, (4) determine the effectiveness of reasonable and prudent measures and their implementing terms and conditions. The monitoring requirement specified in the incidental take statement must be designed to assess the species of concern directly; add-ons to monitoring programs for other species are inadequate unless they actually accomplish the monitoring goal. The status of recent Section 7 consultations involving NMFS are presented in Table 9. In some cases, NMFS is not in compliance with the monitoring requirements specified in the Section 7 incidental take statements, and should technically stop the action particularly in those cases where the anticipated incidental take has been exceeded. It was not the intent of Section 7 to simply monitor increasing levels of bycatch; the agency is supposed to be collecting information in order to address problem areas.

Table 9. Recent NMFS fisheries-related Section 7 incidental take requirements to monitor ESA-listed species. Prepared from the Section 7 database, June 1998.

| Fishery | Opinion Signed | Species Affected | R&PAs (Jeopardy Only) | Incidental Take Monitoring Requirement |
|---|---|---|---|---|
| FMP Commercial & Recreational Salmon, CA, OR, WA | 4/29/98 | salmonids | | Monitor catch at levels comparable to those used in recent years |
| Summer Flounder/Turtle 4(d) Regulations | 3/24/98 | turtles | | Sufficient observers must be deployed on vessels without NMFS-approved TEDs |
| Shrimp/Turtle 4(d) Regulations | 3/24/98 | turtles | | Coverage equal to or greater than the 1993 level (ca. 0.02%) |
| Implementation of the Atlantic Large Whale TRP (lobster, sink gill net gear) | 7/15/97 | whales, turtles | | See ITS for lobster, multispecies, shark |

| Table 9 - continued. | | | | |
|---|---|---|---|---|
| Fishery | Opinion Signed | Species Affected | R & P Alternatives (Jeopardy Only) | Incidental Take Monitoring Requirement |
| FMP Weakfish Mid-Atlantic | 6/27/97 | whales, turtles, sturgeon | | NMFS & ASMFC's monitoring program must provide data to effectively monitor |
| FMP Atlantic Pelagic swordfish, tuna, shark | 5/29/97 | whales, turtles | Several R&PAs proposed; different monitoring requirements | Longline- 5%; driftnet - 100%; under evaluation |
| Regulations to implement Pacific Offshore Cetacean TRP for CA/OR thresher shark and swordfish drift gillnet fishery | 3/30/97 | mammals, turtles | | Observer coverage sufficient to produce statistically reliable results (i.e. CV<=0.20) |
| FMP American Lobster | 12/23/96 | whales, turtles | | Logbooks in 1996; no ITS issued 1997 |
| FMP Pacific Groundfish CA, OR, WA | 5/14/96 | salmonids | | Monitoring to include shorebased fishery; monitoring efforts initiated in 1992 must continue at a level sufficient to determine the bycatch rate (language from 9/27/93 ITS) |
| FMP Summer Flounder, Scup, Black Sea Bass | 2/29/96 | whales, turtles, sturgeon | | Observer program must be implemented to assess the levels of incidental take |
| FMP BSAI Groundfish | 1/26/96 | sea lion | | Monitor catch at levels comparable to those used in recent years |
| FMP Western Pacific Pelagic (Hawaii longline) | 7/25/94 | turtles (no mammals due to closure) | | Coverage must remain at a level that will allow sufficient data collection, resulting in statistically reliable analyses. This program must be re-evaluated annually. |
| FMP Northeast Multispecies | 11/30/93 | whales, turtles, sturgeon | | NMFS & Council to establish a scientifically based monitoring plan to submit to the AA within 90 days. The plan may use existing NMFS observer program resources. |
| Experimental pelagic pair trawl tunas | 9/14/93 | mammals, turtles, sturgeon | | Each vessel must carry observer, with a minimum coverage of 20% fishing effort each month |
| ETP Yellowfin tuna purse seine | 7/6/90 | turtles | | Existing dolphin observer program shall expand to turtles |

## DISCUSSION

The workshop participants identified three discrete stages in the monitoring process:
(1) a documentation stage which determines whether there is a bycatch problem;
(2) a bycatch reduction stage during which takes are reduced to PBR, often using area/season closures; and,
(3) a compliance monitoring stage which examines the new fishery that has been created to make sure it remains below PBR.

The management questions at each stage are different, as are the answers to questions of sample size, etc. All of these stages present unique problems and the dynamics of an observer program would change in each phase. The initial program might be a general attempt to gather data about the operation of the fishery, with later attempts to obtain statistically valid information. As mortality approaches or decreases below PBR and takes get rarer and rarer, the estimates of mortality must be made more precise, presumably by increasing coverage. NMFS will be forced to justify this difficult paradox to fishers: as interaction rates decrease it will cost more to monitor the fishery. These high levels of coverage may be necessary in the years immediately following a TRP, but once takes are below PBR it may be possible to take a longer term view of monitoring (i.e., as a means to identify whether a problem recurs). Intense observation should be unnecessary at some point, making monitoring resources available for direction elsewhere.

Target levels of precision for the mortality estimates (often CV=0.3) have been used in many cases as a measure of the effectiveness of a monitoring program. Participants agreed that the CV approach is reasonable and may be correlated with other goals, but that CV itself is not the ultimate goal. There is nothing inherently correct in a fixed CV percentage. Observer programs should be designed to answer specific questions, and those should determine the decision criteria. A focus on CV may not be appropriate depending on where fishery is in the monitoring process. If a fishery is below PBR, for example, there may be little need to devote much effort toward determining precisely how far below it is. In the early stages of a monitoring program, it may be better to determine how much effort is needed to observe any takes which may be occurring.

Observers can provide a realistic picture of the target catch as well as other types of bycatch, and workshop participants discussed whether MMPA observers should be used to collect those data. Data on other types of bycatch may be needed to evaluate whether changes in the fishery required by a TRP may affect target catch or other bycatch. Observers also obtain data on rare takes of rare species. Many participants agreed that use of MMPA observers to collect data directly linked to marine mammal issues is acceptable. However, there was not general agreement regarding the extent that observers should be tasked with collecting other types of data, especially if observations of marine mammal bycatch are compromised. Information on the use and effectiveness of pingers would be an example of a directly linked issue, whereas information on seabird impacts may be of lower priority. Information solely related to fishery management may also be of lower priority, although much of this indirect information could become relevant under a TRP. Fishers may be more likely to support a TRP if they can see that its provisions will not affect catch, while managers may be more supportive if they do not see a concurrent increase in bycatch.

**Classification of Fisheries and Priority for Observation**

The MMPA gives NMFS the authority to place observers in Category I and II fisheries. The basis for this classification is not always precise, and may include stranding data or analogy to similar fisheries. Fishers' self-reports provide only qualitative bycatch information, and they have not been used to any great extent for fishery classification. Workshop participants voiced concerns that some Category III fisheries may be classified incorrectly (and therefore not subject to consideration for an observer program) due to a lack of information. Some maintained that proposals to reclassify fisheries are a regional responsibility; a national review panel does not have sufficient background to address this issue. Others argued that regions need specific information in order to reclassify fisheries, although the agency has reclassified fisheries without specific data in the past solely by analogy to other fisheries of concern.

Workshop participants discussed how the priority for observation of Category I and II fisheries with no information on either stock abundance or levels of human-caused mortality should compare to those where information is available. In the former case, there is insufficient information to accurately prioritize the fishery. They concluded that NMFS should probably focus its resources on fisheries where there are known problems, but may wish to devote some resources to fisheries where information is lacking. The agency has insufficient funds to fill all of its data gaps immediately so there must be a focus on known problem areas.

Participants believed that mortality estimates should be coupled to an adequate assessment program. They maintained that it makes no sense for observers to document the take of marine mammals unless the agency understands the significance of those takes. NMFS knows something about the Hawaii longline fishery, for example, but it knows nothing at all about the status of the marine mammals the fishery affects. The agency could start an observer program in this fishery that would describe how many mammals are taken, but the significance could not be evaluated because the sizes of mammal populations in the fishery's area of operation are unknown. They believed the agency should focus on numbers where they are most important. Observers should not be placed solely for the sake of doing so, but to learn more about the impact of fishery operations on marine mammal populations.

There were some participants who believed that this workshop should commit the agency to observing every Category I and II fishery in the country at least once. Others questioned whether that goal was logistically possible or even desirable. If a region has no infrastructure in place, it is logistically very difficult to bring an observer program on line for a single season. Even if each fishery is observed only long enough to obtain a single reliable mortality estimate, proponents of cycling must recognize that it may take several years to get each of those estimates. At current funding levels, it may take 20 to 30 years to cycle through the entire list of Category I and II fisheries. Once the agency finds that the level of take in any of those fisheries is serious, it is committed to a program in which escalating monitoring costs may limit its ability to cycle into other fisheries. Many of the resulting take reduction plans call for annual monitoring to determine whether the plan is successfully reducing takes and maintaining bycatch at sustainable levels.

Although PBR is a biologically sound goal, it is clear that Congress established a more stringent goal when it identified the long term goal of reducing takes to insignificant levels approaching a zero mortality and serious injury rate (the ZMRG). Given the reduced levels of take and the additional effort necessary to accurately estimate it, programs to monitor fisheries at ZMRG are likely to be prohibitively expensive. Some participants questioned whether the effort and expense needed to reduce takes in any particular fishery to ZMRG could be justified before all fisheries had reduced takes to below PBR. They also questioned whether it would be fair and equitable to force some fisheries to reduce takes to ZMRG while other fisheries may not have even met the short term goal of reducing takes to below PBR. Participants argued that the agency's first priority should be to get all fisheries below PBR, and to address ZMRG once that initial goal had been reached by all fisheries.

**Pilot Programs**

Participants agreed that a Pilot Program is one in which a fishery has never been observed before, and researchers are on a learning curve to determine how the fishery effort is distributed, to collect the basic fishery information that will determine what kind of coverage is needed, and to develop working relationships with participating fishers. A program in which sampling is being maintained at some specified level after researchers understand these basic elements is no longer a Pilot Program; at that stage the program should be collecting statistically valid information. All programs that observe a fishery for the first time will not necessarily be Pilot Programs. The Alaska Region decided to skip the pilot phase in its inshore salmon observer programs due to the operational expense, and will attempt to get quantitative estimates during its first year. In the Alaska case, the 1990-91 Prince William Sound observer program could be considered the pilot for its other fisheries.

Design variables associated with pilot observer programs include: (1) size of the fishery; (2) take rate; (3) size and distribution of the marine mammal stock; and (4) characteristics of the fishery (e.g., some East coast fisheries present a complex variety of gears, seasons, and target species). Monitoring a 10-vessel fishery does not present the same problems as monitoring a 100-vessel fishery. A 1-year pilot program was deemed adequate to sort out logistical problems, but that task must be the focus of the pilot so that a more comprehensive program can be established. Once real data are available from a fishery, more detailed planning can begin.

Fishers' reports of killed and injured animals are useful in the initial phases of a pilot program, providing basic qualitative information on effort and takes when nothing else is available. These reports are not often a major consideration in operational program design since the information they provide have not been found to be representative of the temporal or spatial distribution of takes, nor of take rates. Under some circumstances, however, it may be possible to work with fishers to improve the accuracy and compliance of voluntary reports as an alternative to imposition of an observer program.

Pilot programs often provide basic information on the spatial and temporal distribution of a fishery, but do not result in statistically valid mortality estimates. Despite the poor precision, those data may form the only basis for early management decisions. If an estimate is available, many would feel bound to use it as the "best available data"; some workshop participants were nervous about pilot programs for that reason alone. Based on historical precedent, however, it is unlikely that a fishery would be restricted or closed on those data. The resulting management decision might simply be to monitor the fishery more intensively, and the affected stock might be designated strategic; NMFS would probably delay the formation of a TRT until better data are collected. Even if formed, it would be unlikely that the TRT would recommend changing the existing management regime until it had better data.

**Logistical Barriers to Rotational Observer Programs**

The lack of funding continuity was viewed as a significant logistical barrier to rotational surveys by some participants. Funding is commonly unavailable until the middle of a fiscal year, and must be spent before the end of that year. Those participants believed that such a schedule makes it difficult to implement even previously planned programs. Others felt these were unfair criticisms; while there may be lead time issues, those are not the same as a lack of funding. They asserted that most such programs plans are multi-year, so that funding is assured even in the out-years. Most high priority programs can begin to spend immediately. They conceded, however, that those counter-arguments may more applicable to in-house programs than to contracts.

If a rotational schedule for observer programs is implemented, some participants recommended that the agency focus on the use of in-house programs and personnel. They believed that startup and lead time would be reduced if observer programs could be staffed with agency full time equivalent (FTE) and temporary positions rather than contracted personnel. Contracting lead time was described as excessive, compared to the 90 days required to process hiring documents for in-house personnel. NOAA contracting rules require that the funds be in hand before the contract's Request for Proposals can be issued. It commonly takes 180 days or more to issue a large contract, even after the Statement of Work (SOW) package has been prepared and delivered. Award of competitive bid contracts may also be protracted due to challenges. By the time funds are available and contracts are issued, the fiscal year may be nearly over. If the contract is contested, the funds could be encumbered indefinitely. Regardless, a base level of permanent staff is needed to focus on preparation of the SOW, a field manual, and data forms, and to make sure that the data will be collected appropriately. Regional staff may have expertise on the fisheries, but may not have time to conduct the training or perform other activities necessary to field an observer program. Workshop participants discussed the possibility of a core staff that could be assigned within a region, or moved from region to region, to focus on the development and implementation of observer programs.

While in-house programs are often cheaper, others noted that the involvement of states in the monitoring program may lead to greater acceptance by a state and its fishing fleet, and fewer objections raised at the end of the process. Much depends on the specific characteristics of the fishery. There are instances where alternate ways of conducting observer programs can give equivalent results.

Startup and lead time in general were mentioned by several participants as logistical barriers to a rotational observer schedule. In fisheries that are not federally regulated, more lead time may be required because the agency has no background information upon which to base program development. Similar problems exist for federal fisheries where participation is poorly defined (e.g., inshore and coastal gillnet fisheries) or effort is widely distributed. The logistics of starting and stopping an observer program will vary in each region. In Alaska, for example, 10 of the 13 Category II fisheries were grouped into three main areas to facilitate the placement of observers, and observer programs will cycle through each area sequentially. Some regions can easily switch a core staff from one fishery to another, while others have no other fishery to switch those personnel into.

Data processing concerns were also cited among potential problems with rotational scheduling. If evaluations occur every 2 to 3 years, managers must be careful not to average zero values inappropriately when evaluating takes. In years when there are no observer data, a lack of fisher self-reports may not necessarily equate to zero takes. If there is no fishery during a year, however, a zero would be an appropriate value since it would reflect the actual take in that year.

**Sampling Concerns at Low Coverage Levels**

Biasing effort (i.e., changing fishing behavior) or having vessels unavailable for observer placement may be greater problems under low levels of coverage. If fishers know which areas have the potential of high and low bycatch, low coverage levels may provide greater opportunity to choose an area of low bycatch when they carry an observer. If coverage rates are higher (especially in a pulse fishery), fishers will probably behave more normally and go where they must to make money, regardless of whether they carry an observer. Fixed costs for gear and supplies will also be a factor; participants in a longline fishery may be less likely to waste expensive bait and light sticks on a dry run. Low levels of coverage may result in cost-sharing pools, where member vessels required to take an observer are compensated for fishing in areas that have lower catch and bycatch. Although intentional bias is a concern, there are also examples of fishers who engage in blatantly illegal activities (e.g., fishing in closed areas), even when they have an observer onboard. Such disregard may reflect more on the lack of current enforcement and prosecution efforts.

When there are low levels of observer coverage, some participants believed it would be difficult to distinguish rare events from those that occur regularly at a lower level. Similarly, there were concerns that observations for a single year could give an inaccurate picture of a fishery's bycatch due to annual variation in fishery or the environment. The CV of the mortality estimate in any single year will be high and it may take several years to obtain a good estimate. There was concern that at the lower levels of TRP monitoring, results could be skewed by infrequent takes of certain species. Participants believed that there needed to be a distinction between rare takes of a common species (i.e., when the CV of the abundance estimate is low but the CV of the mortality estimate is high), and rare takes of a rare species (i.e., when the CV of both the abundance and mortality estimates are high). The former can be addressed in sample design, but the latter are difficult to address without high levels of observer coverage. NMFS would probably be reluctant to design a management or sampling program to address the taking of a particular rare species if it were the only one involved. It becomes difficult to justify intense coverage for one fishery and not for others that take the same rare species. Right whales on the Atlantic coast were cited as an example, since they are taken in many fisheries at some level. If the agency imposes stringent observer requirements on the drift gillnet fishery due to right whale takes, it may be difficult to justify not taking similar action in the lobster fishery.

Some participants believed that infrastructure costs will be proportionally higher under programs that have low levels of coverage. Coverage reductions by half may only cut overall costs by one third, because the program still needs its basic infrastructure for observer deployment/support and data analysis. Conversely, starting a new monitoring program costs more than continuing an existing program at the same coverage level because that basic infrastructure must be put in place.

**Funding Alternatives**

Workshop participants briefly discussed alternative funding sources for observer programs. A tax on fishery products was raised as a possible mechanism. Since observers are required to address the public's desire for information, it seemed reasonable that the public could help to fund them. Such an option is not something that NMFS could implement by itself and has not been actively considered. At issue would be whether to spread the cost for observer programs among products from all fisheries, or just among those from fisheries that are suspected or known to take marine mammals.

Some participants questioned whether it would be more efficient to combine mammal and turtle funding in an observer program for fisheries that have a bycatch of both. The issue was identified as a problem of funding source. MMPA programs get funding exclusively for observers, but any ESA funding spent on observer programs takes away from other recovery activities. NMFS generally puts an annual limit on the spending of ESA funds for monitoring programs that are required under Section 7 consultations. Those programs simply monitor a fishery to ensure that it does not exceed its level of authorized incidental take. They are not considered scientific research nor do they result in the mitigation of bycatch.

## RECOMMENDATIONS

Workshop participants first described the stages in a process by which long term monitoring of Category I and II fisheries would be accomplished. Separate working groups then discussed sampling design criteria (sample size and duration) and the decision criteria for prioritizing which fisheries would enter into the process. The following section summarizes those discussions, and several general recommendations of the workshop participants.

### Fishery Monitoring Process

Figure 7 is a schematic diagram of the stages in a long-term fishery monitoring process developed during the workshop. All unobserved Category I and II fisheries form the selection pool for future observer programs. Once a fishery has been selected for observation from this pool, NMFS must determine whether a Pilot Program is required in order to observe the fishery. A Pilot Program may be unnecessary if the effort needed to field it is as significant as for an Operational Program. Participants believed that, under these conditions, it is more cost effective to proceed directly into the operational phase, making logistical adjustments during that phase, as necessary. In some cases, the pilot program for one fishery may also serve as the pilot to identify logistical concerns for other closely related fisheries (e.g., Alaska salmon gillnet fisheries).

A Pilot Program may be necessary when the agency knows little about the fishery. In these cases, Pilot Programs are useful in understanding the temporal and spatial patterns of fishing effort and the logistical problems to be faced in a future Operational Program. Although a field program is desirable, coverage levels achieved will probably be low. In some fisheries, the objectives of a Pilot Program may be accomplished without actually placing observers, by studying the fishery to determine where vessels are and how long they stay out. It may be possible for the Pilot Program to develop a rough estimate of mortality and serious injury (M), but an estimate of take rate will likely be a more attainable goal. This estimate of take rate will be important in designing sampling plans during an Operational Program. Any estimate of M is likely to be unreliable at this stage, and CV will probably not be an important factor in sampling design. A more important factor may be getting an accurate snapshot of the fishery. After the Pilot Program is completed, the agency should know whether an Operational Program is feasible, or whether some other way to evaluate impacts of the fishery on marine mammals must be found. The agency may also have evidence to suggest whether M is greater than PBR. If an observer program is feasible and there is evidence of mortality, the program would proceed into the Operational Program phase (assuming funds are available).

The principal purpose of the Operational Program is to develop a reliable estimate of M. The Operational Program also gathers information on fishing practices and other environmental or economic impacts, and verifies the reliability of fishers' reports of incidental encounters or takes. These data may be useful in the development of take reduction strategies should those prove necessary. If the estimated M is less than PBR, there is no immediate need to develop a Take Reduction Plan (TRP). However, the fishery will be monitored on a long-term basis with other fisheries that have achieved PBR take reduction levels. If M is less than ZMRG, the fishery can

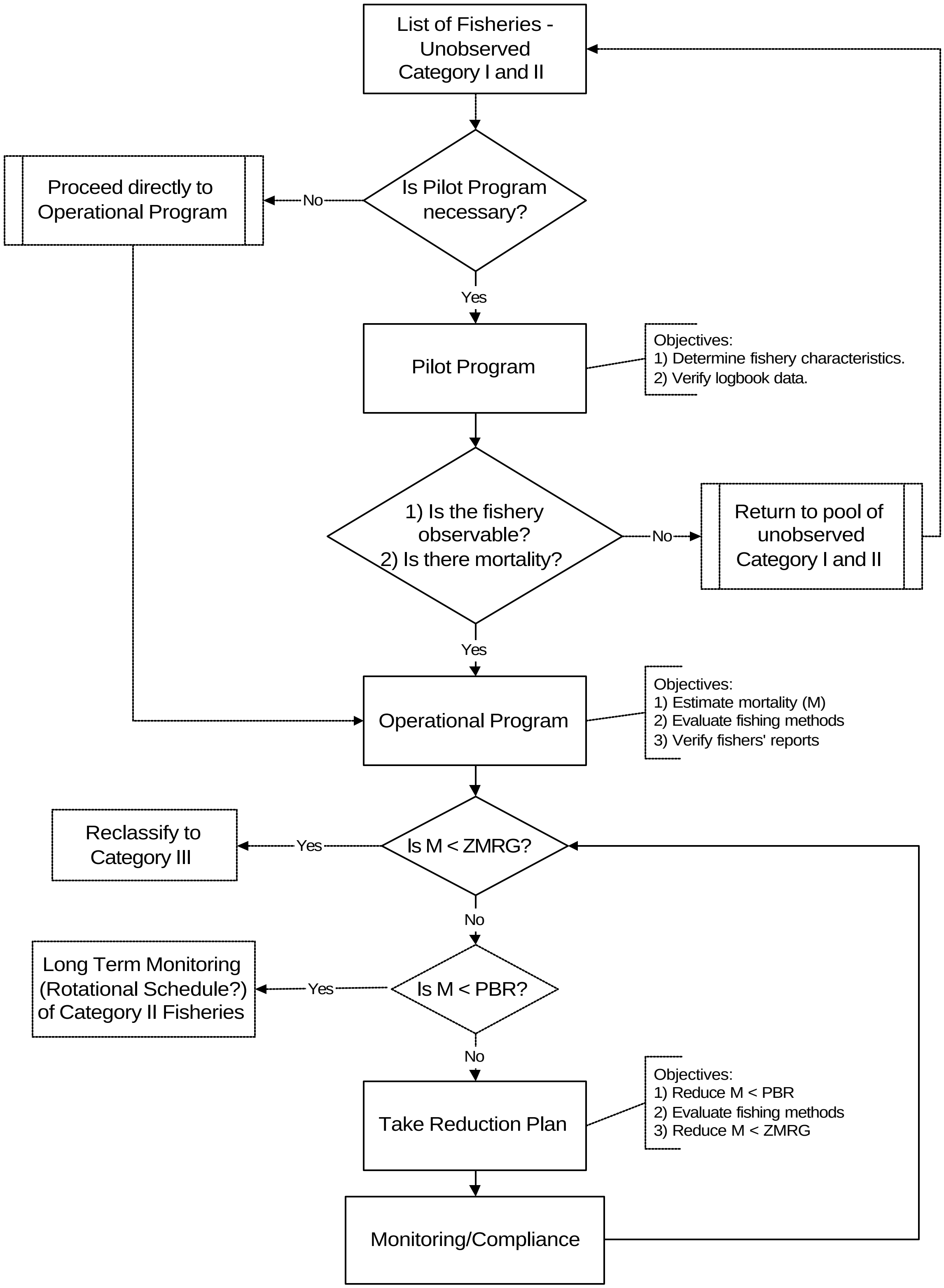


Figure 7. Schematic for a long term monitoring plan for Category I and II fisheries.

be reclassified as Category III. Fisheries that have levels of M in excess of PBR proceed to development of a TRP.

At the TRP phase, a monitoring program must determine whether the plan is successful at reducing M to below PBR. During this phase observers also monitor compliance with regulations to determine whether a failure to achieve plan goals is the result of non-compliance or inadequate (and/or ineffective) take reduction measures. Additional information on fishing practices should be collected, since the characteristics of the fishery will change as a result of the TRP. Some of these changes may not be anticipated, and additional information may prove invaluable should it become necessary to refine the TRP. Once the take reduction goal of the TRP has been achieved, the fishery proceeds directly into a period of Monitoring/Compliance.

The Monitoring/Compliance phase which follows the TRP is a period of intensive monitoring designed to verify that take reduction measures remain effective. The pivotal question is again whether M is less than PBR (and eventually whether M is less than ZMRG); compliance and fishery monitoring responsibilities from the TRP phase are continued. Fisheries that reduce take to sustained levels below ZMRG following implementation of a TRP are reclassified to Category III; those that reduce to levels below PBR proceed to Long-Term Monitoring.

Goals at the Long-Term Monitoring stage are similar to those of Monitoring/Compliance, but the monitoring regime is less intensive. Reliable estimates of M are still required. Fisheries at this stage have successfully reduced take to sustained levels less than PBR, but have yet to achieve ZMRG. Additional measures (and more intensive monitoring) may be necessary to make further reductions. Until such time when those measures are implemented, Long-Term Monitoring is designed to ensure that take levels remain below PBR.

**Sampling Criteria**

Sampling criteria for these stages are described in Table 10. At the Pilot Program stage, the principal objectives are to conduct a preliminary survey of fishery characteristics, and to develop the logistics of placing observers in the field. Observers should be placed proportional to fishing effort (approximately). In many pilot studies, sample size is limited by available funding and observer effort. A power test to determine the probability of encountering a single take should form the basis for setting the minimum sample size for any particular species. If several species of interest are taken in the fishery, the overall sample size should be based on the species with the greatest minimum sample size. Criteria for evaluating observed mortality if PBR is unknown are still needed. Pilot Programs need to be done only once, as close as possible temporally to the actual Operational Program. Their duration should be as short as necessary (ideally within one season or one year). Sampling should be proportional to fishing effort.

In the Operational Program phase, the principal objective is a reliable estimate of M. The minimum duration for this phase is two to three years. Extending the program for more than a single year permits an assessment of annual variability, and debugging of sampling strategies and data collection methods. It

Table 10. Sampling criteria for stages in the fishery monitoring process.

| Stage | Frequency | Duration | Strategy |
|---|---|---|---|
| Pilot | Once | 1 season - 1 year | • Proportional |
| Operational | Annual | 2 or 3 years | • Proportional<br>• CV important when M close to PBR<br>• Y1&2 allocate proportionally to total fishing effort<br>Y3 allocate optimally by principal species or trade-off between multiple species |
| TRP | Once | < 1 year | • Proportional<br>• M rate at the 6 month decision point<br>• Increasing sample size to balance decreasing observed mortality |
| Compliance / Monitoring | Annual | 2 or 3 years | • Proportional<br>• Sample size may increase or decrease |
| Long-Term Monitoring | Rotational? | Uncertain | • Proportional<br>• Sample size may increase or decrease |

also allows researchers to determine whether bycatch has changed simply because observers are now present. Continuation for a third year provides an opportunity to reduce CV through an optimal sampling strategy. Sampling should use an allocation strategy proportional to total fishing effort in the first two years, and optimal, if warranted, in the third year. In the optimal sampling year, allocations should be based on: (1) the principal species of interest; (2) a policy decision which determines the principal species if there are multiple species; or, (3) the proportional take rates of multiple species. CV forms the basis for determining sample size at this stage. The precise value of CV chosen is a policy decision which depends on how much risk managers are willing to accept (especially if the estimate of M is close to PBR) that PBR will not be exceeded. The previously accepted CV goal has been 0.30, but workshop participants did not agree that this was universally appropriate. Sample size will be based on the value of CV selected.

At the TRP phase, the principal objective is to determine whether M is less than PBR. Sampling at this stage should be proportional to fishing effort. If the determination whether takes are less than PBR must be made six months after implementation of the TRP, that determination may have to be based on a mortality rate rather than an estimate of annual M. In practice, much will depend on the timing of TRP implementation relative to the fishing season, the length of the fishing season, the seasonal variability of takes, and the magnitude of M (or the mortality rate) in the absence of the TRP. Although in theory the determination that M has been reduced to levels below PBR need only be made once, and the duration of this phase would be less than one year, in practice additional sampling may be needed to increase confidence that M is actually less than PBR. At this stage, the value of CV chosen again depends on how much risk managers are willing to accept that PBR is not exceeded. Sample size may need to be increased relative to prior stages to ensure that the reduced numbers of takes expected after TRP implementation can still be detected.

The Monitoring/Compliance program which follows the TRP phase is designed to verify that M is less than (or much less than) PBR. Reliable estimates of M are again required, and CV is important when M is close to PBR. The duration of the initial phase is expected to be two to three years, during which sampling would be conducted each year to assess annual variability and detect any potential habituation to take reduction measures. Sampling should again be proportional to fishing effort, but workshop participants could not predict whether sample size would be increased or decreased relative to previous programs. Additional statistical evaluation will be needed at this stage.

Following the Monitoring/Compliance phase, a rotating schedule could be considered during the Long-Term Monitoring phase that would verify the continued compliance of fisheries with take reduction measures, and the effectiveness of these measures. The frequency of this rotation was not determined, but would likely be more frequent than once per decade. Under a rotational schedule, it might be difficult to determine whether these Category II fisheries had reduced takes to ZMRG within five years as specified in the MMPA, as there may be a greater need to first insure that other fisheries have reduced takes to below PBR.

As a guide for planning purposes, a previously unobserved fishery could progress through the initial monitoring stages to reach long term monitoring in six to eight years. This presumes that the Pilot Program will last one year, the Operational Program to estimate M will last two or three years, the Take Reduction Plan goals will be achieved in a single year, and Monitoring/ Compliance will continue for two to three years. In practice, this scenario may be too optimistic. It is unlikely that a TRT would be formed before the second year of the Operational Program (year #3 overall), and TRT processes can rarely be completed in less than one year (six months to prepare a TRP and six months to implement the necessary regulations). The current List of Fisheries contains fisheries at different stages of this process. Appendix B lists those fisheries by their stage in this progression.

**Decision Criteria**

The priorities for observing fisheries that Congress identified in Section 118 of the MMPA are not extremely helpful in deciding which of the fisheries at the same level of priority (i.e., fisheries that take a strategic stock, or fisheries for which little is known about bycatch levels) should enter a rotational monitoring cycle first. However, since there are currently a number of programs that are advanced beyond the beginning stage of this process, this working group focused on establishing an initial priority relationship between the process stages. The participants agreed that the agency's highest priority should be programs in the TRP phase. By the time that stage is reached, the TRP has been completed, regulations are in place, and fishery modifications are underway. The considerable obligations that NMFS has assumed to implement and monitor these programs must take precedence over other priorities. The agency must validate that the fishery has achieved the short term goal of reducing take to levels below PBR, and this phase must continue until that goal is achieved.

The working group had difficulty deciding on a single second priority stage. The participants encouraged regions and centers to consider unobserved Category II fisheries on equal par with Compliance/Monitoring of TRP fisheries. Both of these categories were ranked higher than monitored Category II fisheries with takes known to be below PBR (e.g., fisheries eligible for the Long-Term Monitoring phase). The group recognized that political and legal considerations will over-ride other priorities for some fisheries, and may require monitoring at a level adequate to obtain a significant estimate of M for more years than minimally required. There was a strong sense, however, that the agency should begin to examine some fisheries with unknown take levels before revisiting fisheries that have a plan in place and are known to be at levels of take below PBR. Some participants maintained that effort devoted to such long-term monitoring should be minimized whenever possible, either through low level monitoring every year or through more intensive monitoring in non-contiguous years, in order to make funding available to examine additional fisheries.

Once funding becomes available to initiate a Pilot Program, the agency must decide how to prioritize among the available candidates from the List of Fisheries. Working group participants agreed that the agency should first determine that observer data from a candidate fishery will be useful for decision making. Observer documentation of takes would be less useful if the data cannot be placed into context because there is no corresponding estimate of abundance for the subject species, or no reliable source of total fishing effort. The agency must then determine that the mortality is observable, and that the presence of observers would help to answer key questions. Mortality might be considered less observable if take rates are expected to be very low, or if observers are likely to see indirect evidence (e.g., missing buoys) rather than direct evidence of takes.

Fisheries that meet both of these tests should then be evaluated based on the likely impacts or significance of its takes. Foremost among these would be evidence that Strategic Stocks were being taken by the fishery. Other suggested criteria or questions included:

- Does a reliable estimate of mortality exist?
- What is the abundance of the primary species taken?
- What is the magnitude of take, and what is the impact of that mortality?
- Can analogy be made to a fishery with similar characteristics (gear/time/area)?
- What is the probability that the data are valid? (i.e., what is the quality of the mortality data and the mortality estimate?)
- Are there other sources of mortality? (i.e., should an observer program be implemented if something else is known to be the principal cause of mortality?)
- What are the logistics and lead time required to start a program?
- Is there an existing infrastructure for analysis of these observer data?
- What are the costs/benefits of the program (economic considerations)?
- Is the program required under some mandate?
- Are there available alternatives to observers for collection of these data?
- Are there political considerations that will override all others?

There was insufficient time at this workshop for participants to consider the applicability and priority of these remaining decision criteria. Workshop participants recommended that a small group be tasked to complete the prioritization and decision criteria at this and other stages of the fishery monitoring process.

**General Recommendations**

An initial objective of this workshop was to assess whether a rotational schedule would enable NMFS at current funding levels to evaluate more of the unobserved Category II fisheries. Workshop participants concluded that a rotational schedule may only be applicable to the Long Term Monitoring phase of the fishery monitoring process they described. Since no fisheries are expected to reach that stage within the next two or three years, they saw little need to develop a rotational schedule at this time. Current levels of funding will not allow the agency to expand programs beyond their current scope. At some increased level of funding, coverage could be increased to fully implement and monitor some of the existing TRPs, maintain others at current levels, and begin to add programs for some previously unobserved fisheries. Immediate observation of all unobserved fisheries will require substantial increases in funding.

Workshop participants discussed developing a draft schedule for observing fisheries based on funding projections and likely budget scenarios. It should be possible for regions to examine their current programs and their status in this process, and to project the future costs of processing current TRPs through to the Long Term Monitoring phase. Those projections should clarify what funds are available to address other Category II fisheries, and may suggest when new pilot projects could be considered.

Under current funding levels, it may take three to five years before new fisheries can be phased into a monitoring schedule. The agency must recognize that these fisheries can change in the interim. Participants in these fisheries may recognize the liability of marine mammal takes, and adopt technologies or take reduction techniques developed elsewhere as a proactive strategy to avoid imposition of a NMFS observer program. The agency should identify options for alternative monitoring programs, and determine when their use may be appropriate. These may provide ways to reduce bycatch in fisheries that may not either immediately or in the longer term lend themselves to full-blown observer programs.

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# APPENDICES

Appendix A. Participants in a workshop to develop a process for the long-term monitoring of MMPA Category I and II commercial fisheries, held in Silver Spring, MD on June 15-16, 1998.

Participants on June 15 and 16:

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|---|---|
| Laurie Allen | NMFS Northeast Region, Gloucester, MA |
| Kathryn Bisack | NMFS Northeast Fisheries Science Center, Woods Hole, MA |
| Grant Cameron | NMFS Southwest Fisheries Science Center, La Jolla, CA |
| Darryl Christensen | NMFS Northeast Fisheries Science Center, Woods Hole, MA |
| Vicki Cornish | NMFS Office of Protected Resources, Silver Spring, MD |
| Tom Eagle | NMFS Office of Protected Resources, Silver Spring, MD |
| Brian Fadely | NMFS Alaska Region, Juneau, AK |
| Charles Karnella | NMFS Southwest Region, Honolulu, HI |
| Pierre Kleiber | NMFS Southwest Fisheries Science Center, Honolulu, HI |
| Dennis Lee | NMFS Southeast Fisheries Science Center, Miami, FL |
| Chris Legault | NMFS Southeast Fisheries Science Center, Miami, FL |
| Richard Merrick | NMFS Northeast Fisheries Science Center, Woods Hole, MA |
| Brent Norberg | NMFS Northwest Region, Seattle, WA |
| Tim Price | NMFS Southwest Fisheries Science Center, Long Beach, CA |
| Stephen Smith | Department of Fisheries and Oceans, Bedford Institute of Oceanography, Dartmouth, NS, Canada |
| Kathy Wang | NMFS Southeast Region, St. Petersburg, FL |

Participants for portions of June 15 or 16:

| | |
|---|---|
| Therese Conant | NMFS Office of Protected Resources, Silver Spring, MD |
| Cathy Eisele | NMFS Office of Protected Resources, Silver Spring, MD |
| Patricia Montanio | NMFS Office of Protected Resources, Silver Spring, MD |
| Mike Payne | NMFS Office of Protected Resources, Silver Spring, MD |
| Donna Wieting | NMFS Office of Protected Resources, Silver Spring, MD |

Participants via teleconference on June 15 only:

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|---|---|
| Doug DeMaster | NMFS National Marine Mammal Laboratory, Seattle, WA |
| Chuck Fowler | NMFS Alaska Fisheries Science Center, Seattle, WA |
| Jeff Laake | NMFS National Marine Mammal Laboratory, Seattle, WA |
| Mike Perez | NMFS Alaska Fisheries Science Center, Seattle, WA |
| Paul Wade | NMFS Alaska Fisheries Science Center, Seattle, WA |

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| Rapporteur: | Al Didier, Pacific States Marine Fisheries Commission, Gladstone, OR |
| Summer Intern: | Kelly Arbogast, NMFS Office of Protected Resources, Silver Spring, MD |

Appendix B. Status of fisheries relative to the monitoring process described in the June 15-16 workshop, as of June 1998.

| Area | Unobserved Category I & II | Pilot Program | Operational Program | Take Reduction Plan & Monitoring/Compliance | Long Term Monitoring |
|---|---|---|---|---|---|
| Atlantic | Gulf of Maine/US Mid-Atlantic Lobster Trap/ Pot (I) | | Atlantic Ocean/Caribbean/ Gulf of Mexico Large Pelagics Drift Gillnet (I) | Southeastern US Atlantic Shark Drift Gillnet (II) | |
| | Gulf of Maine Small Pelagics Surface Gillnet (II) | | Northeast Multispecies Sink Gillnet (I) | | |
| | North Carolina Haul Seine (II) | | Atlantic Ocean/Caribbean/ Gulf of Mexico Large Pelagics Longline (I) | | |
| | North Carolina Roe Mullet Stop Net (II) | | US Mid-Atlantic Coastal Gillnet (II) | | |
| | | | Atlantic Squid/Mackerel/ Butterfish Trawl (II) | | |
| Pacific | OR Swordfish Floating Longline (II) | | | CA/OR Thresher Shark/ Swordfish Drift Gillnet (I) | WA Puget Sound Salmon Drift Gillnet (II) |
| | OR Blue Shark Floating Longline (II) | | | | CA Angel Shark/Halibut and Other Species Large Mesh (>3.5 in) Set Gillnet (I) |
| | CA Anchovy/Mackerel/ Tuna Purse Seine (II) | | | | |
| | CA Squid Purse Seine (II) | | | | |
| Alaska | Yakutat Salmon Set Gillnet (II) | | | | Prince William Sound Salmon Drift Gillnet (II) |
| | Bristol Bay Salmon Set Gillnet (II) | | | | AK Peninsula/Aleutians Salmon Drift Gillnet (II) |
| | Bristol Bay Salmon Drift Gillnet (II) | | | | |
| | AK Peninsula/Aleutians Salmon Set Gillnet (II) | | | | |
| | SE Alaska Salmon Drift Gillnet (II) | | | | |
| | SE Alaska Salmon Purse Seine (II) | | | | |
| | AK Pair Trawl (II) | | | | |
| | Metlakatla/Annette Island Salmon Drift Gillnet (II) | | | | |
| | Cook Inlet Salmon Set Gillnet (II) | | | | |
| | Cook Inlet Salmon Drift Gillnet (II) | | | | |
| | Kodiak Salmon Set Gillnet (II) | | | | |