SOUTHWEST FISHERIES SCIENCE CENTER

NATIONAL MARINE FISHERIES SERVICE SOUTHWEST FISHERIES SCIENCE CENTER P.O. BOX 271 LA JOLLA, CA 92038

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STATUS OF CALIFORNIA CETACEAN STOCKS: A SUMMARY OF THE WORKSHOP HELD ON MARCH 31 TO APRIL 2, 1993

By

Jay Barlow, Joyce Sisson and Stephen B. Reilly

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Southwest Fisheries Science Center
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INTRODUCTION

A workshop was convened on March 31 to April 2, 1993 at the Southwest Fisheries Science Center (SWFSC) in La Jolla, California to review scientific information on the status of cetacean stocks that are found in California coastal waters. The agenda for this meeting is given in Appendix 1. Experts on various aspects of marine mammal studies were invited from universities, private research groups, and other government agencies throughout the country (Appendix 2). This panel, together with members of the SWFSC scientific staff, reviewed a series of papers (Appendix 3) that had been prepared by the SWFSC staff. These papers and a series of background papers (Appendix 4) provided the most recent information on the population size and structure, biology, and incidental fishery mortality of cetacean species that are found off the coast of California. A table summarizing the findings from this review are provided in Appendix 5. The reason for this review was to ensure that the highest quality scientific advice would be provided to managers who are responsible for the conservation of these populations.

The chairman of this workshop, Steve Reilly, made opening remarks, explained logistics for the following 3 days and described the format of the workshop. Each paper to be reviewed would be briefly presented by the author (approx. 15 minutes), and then the floor would be opened up for discussion and comments. The rapporteur, Joyce Sisson, took notes on the subsequent discussions. These notes were compiled and incorporated into this workshop report which has been circulated to all workshop participants for their comments.

MANAGEMENT REGIME

The Marine Mammal Protection Act (MMPA) of 1972 governs the management of marine mammals in the U.S.A. Prior to the 1988 amendments to the MMPA, fisheries could only be granted permits to take marine mammals incidentally if there was scientific evidence to prove that all stocks of marine mammals involved in the fisheries were at or above their optimum sustainable population (OSP) level and that the proposed level of take would not disadvantage any marine mammal stock. However, sufficient evidence regarding the status relative to OSP only exists for a few stocks. Due to problems in determining status and evaluating impacts of probable takes, and because of the disruption to many local fisheries, the Act was amended in 1988 to allow a 5-year interim exemption period, during which time the incidental taking of marine mammals was permitted in commercial fishing operations. During this time, it was expected that additional information would be gathered on the species involved and on the nature and extent of their interactions with different fisheries. This period ends on October 1, 1993, at which time the old system will go back into effect unless new legislation is adopted.

The old system of management under the MMPA was to maintain marine mammals as functioning elements of their ecosystem at their OSP level. As the MMPA has been interpreted, OSP is defined as a range of population levels between carrying capacity of the environment and that level which yields the maximum net production. This management regime put a limitation on kills of marine mammals so as not to reduce their populations below their OSP, but for most marine mammals, OSP is not known. In order for a population to be considered depleted it must be proved that it is below OSP. The requirement to determine status of populations relative to OSP is viewed by many to be a weakness in the current management regime.

A new scheme for governing the management of marine mammals under the MMPA has been proposed by NMFS. The proposed regime is currently being reviewed by Congress and may be subject to substantial changes, but it is likely that the basic elements will remain the same. The NMFS proposal is based on the idea of setting an annual limit on the maximum potential biological removal (PBR) of individuals from a population. PBRs would be calculated based on a minimum abundance estimate, the estimated maximum net growth rate of the stock, and a recovery factor which would take into account the status of the population. Conservative default values would be used in cases where data on growth rate or status were unavailable or insufficient.

Based on the best available information, PBRs would be calculated from the following simple equation.

$$PBR = N_{min} * R_{MNPL} * F$$

N_{min} is the minimum abundance estimate and is obtained from either an actual count (as in the case of pinnipeds which haul out on land and are easy to count) or the lower 95% confidence interval for a statistically-based population estimate (as in the case of most cetaceans which are much more difficult to count). The use of minimum abundance estimates to calculate PBRs is considered by many to be a conservative approach, but this approach is useful for pointing out the importance of obtaining accurate population estimates.

R_{MNPL} is the growth rate of the population at its maximum net productivity level (MNPL). This is not known for most species, and therefore, conservative default values have been set ($R = 0.02$ for cetaceans and manatees and $R = 0.06$ for pinnipeds and sea otters).

F is the safety factor based on the status of the population relative to the Endangered Species Act categories of threatened or endangered, or the MMPA category of depleted or at OSP. Again, a default value is provided if status is unknown (which is currently the state for most cetacean species).

F = 0.1 for endangered species
F = 0.5 for species or stocks with threatened, depleted, or unknown status (most stocks fall under this category)
F = 1.0 for stocks at OSP

Under the new proposal, default values are available for R and F; however, estimates of N_{min} are required for all species. Also it will be necessary to determine exactly what population/stock the new regime will be applied to for all species. For this reason, emphasis is placed in the review papers on determining population size and structure.

In determining stocks for management, it is useful to separate the concept of a "population" from the concept of a "management stock". A population is a natural biological subdivision of a species that is reproductively isolated from other populations. A management stock (or management unit) is an artificial subdivision of a species which is treated as a single unit from the perspective of management. To confuse matters, the term "stock" has often been applied to both populations and management units. Ideally management units or stocks would correspond to biological populations, but real-world constraints, such as international borders and other jurisdictional boundaries, often require that we define management units or stocks on the basis of other factors. In this document the word stock refers to a management unit.

The review committee discussed the new management framework and several members queried whether further changes to the NMFS proposal had been made or were expected. Michael Tillman, the Science and Research Director for the Southwest Region, gave a brief overview of the status of the new management regime in Washington, D.C. He stated that the NMFS plan is now in the hands of Congressional committees, and that he was not aware of any proposed changes to date. The opinion was generally expressed that although details of the proposed management regime are likely to change, the basic elements are likely to remain.

OVERVIEW OF SWFSC RESEARCH ON COASTAL CETACEANS

An overview of the coastal cetacean research program at the SWFSC was given by the program's leader, Jay Barlow. The major impetus for this research has been the incidental take of cetaceans in two California fisheries: the set gillnet fishery for halibut and angel sharks and the drift gillnet fishery for swordfish and pelagic sharks. Under the 1988 amendments to the U.S. Marine Mammal Protection Act, incidental mortality of marine mammals in commercial fishing operations was authorized for the five-year period 1988-1993. During this period, additional data were to be collected on the affected marine mammal species in order to provide a basis for future management decisions. Recent estimates of incidental mortality in U.S. west coast gillnet fisheries have been obtained through the NMFS observer program, which was initiated in 1990. In order to assess the impact of gillnet mortality on cetacean populations, current abundance estimates, including confidence limits are necessary.

Coordinated ship and aerial surveys were initiated in 1991 to estimate the abundance of all cetacean species in the region of the California gillnet fisheries. Standard line-transect methods were used for both platforms. To evaluate the effect of seasonality on cetacean abundance, surveys were designed to cover both cold-water months of winter/spring (Feb-Apr) and warm-water months of summer/fall (July-Nov). The survey periods were chosen based on climatic atlases of the California coast which show that, on average, March/April have the coldest, and September/October the warmest sea surface temperatures. The NOAA research vessel McArthur was used to survey during the warm-water period of 1991 (SOCCS1). A twin-engine turbo-prop DeHavilland Twin Otter airplane was used to survey during the cold-water period in 1991 and 1992 (SOCCS2). Other earlier surveys were completed in 1979/80, and Barlow compared these estimates with those obtained during the 1991 ship survey in order to determine whether long-term changes have occurred in California's cetacean fauna (SOCCS3).

Simultaneous to the above efforts to estimate population size, the NMFS Southwest Regional Office initiated a gillnet observer program to determine the level of marine mammal bycatch in California's fisheries. This work was done in cooperation with the California Department of Fish and Game. Two papers were prepared by SWFSC staff which present estimates of cetacean mortality based on data collected from these programs (SOCCS7 and SOCCS8).

Information relevant to management is summarized in three status of stocks review papers for harbor porpoise (SOCCS4), other odontocetes (SOCCS5), and large whales (SOCCS6). The harbor porpoise review also presents a new line-transect estimate of harbor porpoise abundance based on aerial surveys conducted in 1988-91. Finally, information on the underlying population structure is reviewed for several small cetaceans in a separate paper (SOCCS9).

Workshop participants commented that the format used here to review status of stocks in California was useful, and that future workshops in other NMFS Regions should be planned and should follow a similar format.

REVIEW DOCUMENTS

SOCCS1 Barlow, J. 1993. The abundance of cetaceans in California waters estimated from ship surveys in summer/fall 1991.

Barlow gave a brief introduction to his paper which presents the results of a ship survey conducted in the warm-water months of summer/fall 1991 to estimate the abundance of cetaceans in California waters between the coast and approximately 300 nmi (555 km) offshore. Line-transect methods were used with 2 observers searching through 25x power binoculars and a third observer searching by unaided eye and 7x power binoculars. A fourth semi-independent observer was used to estimate the fraction of trackline groups missed by the primary team. Approximately 5,600 nmi (10,360 km) were searched and 556 groups of cetaceans were seen. For estimating abundance, an objective method (Akaike's Information Criterion) was applied to define strata based on sighting conditions. The estimated fraction of trackline groups that were seen varied between 0.73 and 1.0 for different species and group sizes.

METHODS

Field Methods

There was a general discussion of why the 300 nmi boundary was used. Barlow explained that the farthest edge of the California Current extended to this distance, and it defined a distinct biogeographic province. Robert Brownell was concerned that the 300 nmi boundary may be variable and that satellite maps should be consulted. He also said that the striped dolphin sightings may indicate that the California Current was closer to shore than 300 nmi. Barlow replied that the striped dolphin sightings are perplexing, but that water temperatures at the edge of the study area did not exceed 20°C indicating that the influence of the California Current extended to approximately 300 nmi. He also noted that extensive oceanographic data were collected during the survey and have yet to be analyzed. Douglas DeMaster requested that abundance estimates in this paper be presented for the U.S. EEZ, which corresponds approximately to 200 nmi offshore. This information may prove useful to managers who must set quotas inside U.S. waters. Marine mammals in other areas may be managed by an international body.

General questions were raised regarding the function of the secondary (independent) observers. Barlow explained that they were present only to obtain a correction factor for the number of animals missed by the primary observers. An independent observer was not always on duty, and therefore, their sightings could not be pooled with the primary observers for the purpose of estimating an overall f(0) for the entire study. They did record angles and perpendicular distances to every sighting, but their estimates are likely to be less accurate than those made using 25x binoculars.

There was general interest in how groups were defined and what happened operationally when sightings were made. Barlow explained that groups were defined as closely associated animals. Practically, however, confusion would sometimes occur as the ship approached a group, and observers discovered that it consisted of 2 or more relatively distinct subgroups. In such cases when it was impossible to determine which of the subgroups was the original sighting, the observers combined all subgroups for estimating group size. John Calambokidis noted that this might explain why the mean group size for blue whales was greater than in his studies. Additionally, when off-effort sightings were made as the vessel closed on a sighting, the observers were told to ignore that group. After making species identifications and group size estimates of the original sighting, observers were instructed to go back to their typical search pattern. If, at that time, they made a re-sighting of the off-effort group, that group would then be treated as a normal on-effort sighting.

DeMaster questioned how distances to dolphins were estimated when closer than 6 nmi to the shore (where binocular reticles could not be used). Barlow responded that this occurred infrequently, but that the observers would often ask for a radar measurement of the distance to shore and would gage the distance to the animals relative to this. DeMaster asked that this information be added to the manuscript.

Larry Hansen questioned why group size estimates were made independently by each observer rather than allowing all observers to arrive at a consensus estimate. Barlow replied that correction factors had been developed for individual observers based on aerial photographs taken during earlier dolphin surveys. Correction factors could not easily be developed for groups of observers because observer groups change on each survey. Hansen expressed his concern that observers never have the opportunity to learn abundance estimation from more experienced observers. Gerrodette responded that, based on his data, experienced observers were not necessarily better at estimating group size. More consistency between observers could result in less accuracy in an absolute sense.

Analytical Methods

The review panel **recommended** clarifying when calibration factors were used to adjust group size estimates. Barlow noted that these were applied to every group. In the paper, Barlow combined species for estimating f(0) into species groups based on similar sighting characteristics. John Heyning suggested a different grouping, with <u>Kogia</u> being combined with porpoises to form a new group of "small, secretive cetaceans". This brought up the question of whether Dall's porpoise, which can show a distinctive "rooster-tail" splash thereby increasing its chances of being sighted, should be included in this group. Barlow explained that this splashing was seldom seen aboard the McArthur during the CAMMS survey. In addition, most Dall's porpoise were surfacing with the less conspicuous "slow roll" behavior, and did not approach the vessel to ride the bow wave. It was suggested that it might be better in estimating f(0) to split the grouping of Dall's porpoise depending on the initial sighting cue. Also, additional work should be done to quantify the fraction of Dall's porpoise that came to the bow.

The grouping of blue whales with other large whales was questioned because this species has a much larger, more conspicuous blow than the others. Barlow explained that he had subsequently looked at the option of estimating blue whales separately (sample size was marginally large enough), but Akaike's Information Criterion (AIC) indicated that it was better to include it with other whales.

Group size calibration factors were developed for 4 observers based on comparison with 2 observers who had been previously shown to estimate group size accurately. Hansen questioned why helicopter photographs were not used to calibrate observers directly and expressed concern that correction factors might change over time. Barlow explained that the available vessel (the McArthur) does not have a helicopter platform and that turbid water conditions in California would probably not permit photographic estimates of group size. Gerrodette added that, based on helicopter calibration photos, the majority of observers do not change the way they estimate group size between years. Anganuzzi questioned whether variance in estimating correction factors was incorporated into estimates of variance for the overall abundance estimate. It was not, but several people expressed the opinion that it should be.

In calculating f(0) values, Rod Hobbs questioned whether AIC was penalized for 1 or 2 parameters for each fit of the Hazard rate model. Barlow said that it was penalized for 2 parameters. Ken Burnham and Jeff Laake said that, given there was no attempt to fix one of the parameters, this approach was appropriate.

Burnham noted that the approach used to deal with group-size bias may not have corrected for all of the bias. He **recommended** regressing group size (within a group size stratum) against estimated g(x). If the resulting correlation coefficient is greater than 0.2, additional group size adjustments may be needed. Laake suggested that using the regression approach might eliminate the need to stratify. Barlow expressed his preference for stratification because 1) it fits well into the AIC framework which was used to determine other stratification factors, and 2) the properties of the regression approach have not been thoroughly explored in the peer-reviewed literature.

Additional questions were brought up regarding the use of independent observers, including whether it would be better to pool the independent observer with the other 3 observers for estimating f(0). Barlow expressed his opinion that the independent observers provide more information than simply adding a 4th observer to the team. An independent observer allows (with some assumptions) a calculation of the number of groups missed by all 4 observers. Burnham agreed, but emphasized that those assumptions may not be correct. The approach used corrects only for "perception bias" and is based on the assumption that all animals within a stratum that surface are equally conspicuous. This is almost certainly not true, and the resulting "heterogeneity bias" may be large.

An alternative approach to measuring perception bias was suggested based on locating animals ahead of the vessel (say, with very powerful binoculars) and tracking them as they approached the vessel. This method could also help deal with "attraction bias" (as may be a problem for Dall's porpoise). This approach has been tried for harbor porpoise along the U.S. northeastern coast. Barlow expressed skepticism as to whether this would work in rough seas for the species that are commonly missed because it would be impossible to actually track them.

There was a general discussion about whether this survey is appropriate for estimating abundance of species with very patchy distributions (beaked whales and Risso's dolphins were cited as examples). Barlow noted that the survey was designed with uniform effort, and Tim Gerrodette emphasized that this should produce a valid estimate of population size regardless of the distribution of the animals. Patchy distribution does contribute to high variance, and this is reflected in the bootstrap estimates of C.V.

The need to smear angles before estimating f(0) was questioned by Hobbs. Barlow replied that although the observers have the ability to measure angles to the nearest degree and have been instructed to do so, the data indicate that they often round to the nearest 5 or 10 degrees. Unless these data are smeared, this rounding could introduce a bias by artificially concentrating sightings at zero perpendicular distance. Independent observers had a protractor in front of them to help estimate angles, but they also tended to round to the nearest 10 degrees, and their angles were also smeared in the analyses.

Methods for estimating the fraction of trackline groups that were seen (g(0)) were presented in the Appendix of SOCCS1 and were discussed by the review panel. Burnham questioned whether the fraction seen the independent observer might be greater than the fraction seen by the primary team (Barlow's method assumed the opposite) because the independent observer is concentrating effort near the trackline. Barlow explained that one of the members of the primary team was also concentrating effort near the trackline and that this, combined with the effort of the other 2 primary observers, would be greater than the searching effort of a single independent observer. Burnham **recommended** that the new analytical methods presented in this paper and in SOCCS2 be submitted to a statistical journal for peer review. Martin Hall questioned whether the estimate of g(0) might be different in different parts of the study area because the reaction of dolphins to the ship might vary geographically (e.g., ETP dolphins which have been chased by tuna vessels for many years, and have learned to avoid ships). Barlow responded that only a few groups of common dolphins, near the southern margin of the study area, avoided the survey vessel, and this sample would not be large enough to form a separate strata. This may be more of a problem next year when surveys will cover California and Baja California waters.

There were several questions about the methods that were used to estimate coefficients of variation (C.V.s) and confidence intervals (C.I.s). Burnham asked why bootstraps were done using contrived legs of 75 nmi rather than using actual legs or days of effort, which might make sampling units more independent. Barlow replied that effort began each day at the same place it ended the day before, and thus using days as the bootstrap unit would not gain anything in independence. Furthermore, some days were very short (due to weather or other logistic factors) and the bootstrap legs of 75 nmi would be more uniform in length. In incorporating variance of g(0) into the bootstrap (p. 17; SOCCS1), Burnham noted that the random sampling from a binomial distribution would produce integer values (not 0.0 to 1.0 values) and that a Beta distribution might be better used there. Barlow clarified that what he used would more correctly be called a binomial ratio. Barbara Taylor questioned whether the bootstrap C.V.s really incorporated all sources of variance. In particular, she was concerned that uncertainty in values of g(0) is underestimated for Dall's porpoise because it is not known whether this species was, on average, attracted or repelled by the vessel. Given this, Taylor questioned whether it might be better not to even present estimates for the abundance of Dall's porpoise. Barlow replied that attraction, if it occurred, was much less than that found for fishery observers further north in the Pacific, and that by presenting an estimate with a correction factor developed for that situation resulted in a valid minimum estimate of population size for Dall's porpoise.

The question of whether to use bootstrap or log-normal confidence intervals was raised in the context of this paper and in the general context of management under the NMFS proposed amendments to the MMPA. The problem that was discussed was that bootstrap lower 95% confidence intervals frequently were zero, which is unrealistic given that some animals were seen. Burnham pointed out that it is possible to constrain a bootstrap estimate so as to prevent it from going below the observed number seen; however, he also said that bootstrap should not necessarily be considered the best approach, and if bootstrap is not proving to be reliable, other approaches could be used. It was suggested that some additional geographic stratification might be required to obtain accurate estimates of statistical error with either bootstrap or analytical variance formulae. The need for stratification is particularly acute for species that are only found in a portion of the study area. It was the general **consensus** of the group that, given some problems with bootstrap confidence intervals, it would be more appropriate to base estimates of minimum population size on log-normal confidence intervals. Burnham and Laake expressed their belief that bootstrap and analytical estimates of variance should be roughly equivalent if the data are stratified appropriately, and that either could be used as a basis for estimating log-normal confidence intervals.

DeMaster questioned whether it is truly appropriate to use the lower 95th percentile as an estimate of minimum population size. He suggested that a 90th or even an 80th percentile may be more appropriate. Burnham confirmed that the tails of confidence intervals are often difficult to estimate. It was generally expressed, however, that the choice will depend on how conservative you want your management to be and that the ultimate decision was outside the purview of this review.

RESULTS

Results indicated a much higher abundance of blue whales than was previously thought to be in this area. Brownell questioned whether abundance in 1991 might have been anomalously high and whether the photo-ID estimates might better reflect the typical abundance of blue whales. Barlow replied that the most reliable photo-ID estimate was also based on 1991 data and was still considerably lower than the line-transect estimate. Calambokidis explained that mark-recapture methods typically give very low estimates of C.V., but are frequently biased by heterogeneity in recapture probabilities due to geographic segregation, individual behavior, etc. However, most of such biases should have been eliminated by comparing coastal photos taken in 1990 with the more offshore photos taken during the 1991 CAMMS cruise. Barlow and Calambokidis both agreed that the difference is puzzling and that attempts should be made to reconcile the differences between their estimates.

It was pointed out by Greg Green that some of the species that are estimated to be more abundant during the aerial surveys conducted in winter/spring (SOCCS2) are abundant in Oregon and Washington waters in summer/fall and rare or absent in winter/spring. These species include Risso's dolphins, Pacific white-sided dolphins, and northern right whale dolphins. This may indicate a seasonal movement of these species between California, Oregon, and Washington.

DISCUSSION

Anganuzzi pointed out that during 1991, the relative density of common dolphin observed from tuna vessels was very low along the Baja California Peninsula. This may indicate a movement of common dolphins into California waters during El Niño conditions. Barlow agreed that his data were consistent with that interpretation, but cautioned against jumping to conclusions because the increase in California could also have been caused by an influx of animals from farther offshore. Bill Perrin pointed noted that previous work indicated that there was a continuous distribution of this species from California into Mexico.

Linda Jones questioned how transect lines were covered and how that might relate to seasonal movement of animals. Barlow said that two sweeps were made through the study area to avoid confounding seasonal effects. Brownell noted that the continuous distribution of pilot whales into tropical waters (p. 22; SOCCS1) is, in fact, only continuous with Baja California. There is an apparent hiatus in the distributions shown in SOCCS18 south of Baja California. He also pointed out that continuous distributions may not be a good indicator of stock structure given that Dall's porpoise are distributed continuously across the North Pacific and 7-8 distinct stocks are recognized with in this region.

DeMaster questioned why harbor porpoise abundance is so much higher than other estimates for this area. Barlow noted that this was probably due to hitting one or two patches of anomalously high density and that the uncertainty in this estimate is reflected in the high C.V. of the estimated abundance. The panel **recommended** that harbor porpoise might be excluded completely to avoid misuse of this high number. Barlow responded that harbor porpoise estimates are valuable in estimating f(0) for the "porpoise" group. An alternative suggestion was made to footnote the table entry with a reference to a better estimate of harbor porpoise abundance. Perrin **recommended** adding some discussion of how the C.V.s from this study compare to those of other studies that have been done on cetacean abundance.

In discussing the benefits of pooling vs. stratification, Burnham said that the discussion could put it in a more positive light by emphasizing the tradeoff between bias and variance. Hansen requested a clarification of the difference between "biological criteria" and "objective criteria" as a basis for pooling (p. 28; SOCCS1). Barlow explained that the former referred to subjective similarities in sighting characteristics and the latter referred to stratifying factors that were determined by statistical methods (i.e., AIC). Laake suggested that geographic post-stratification based on biological criteria is likely to be important in accurately estimating C.V.s.

The correction factors for missed animals were relatively small, and the review panel thought it was important to emphasize that they did not change the abundance of most species by very much. Calambokidis thought it was also important to mention that g(0) refers only to perception bias and probably underestimates the effect of perception bias by assuming that all groups are equally available to be seen. Barlow questioned the group about the appropriateness of using estimates of g(0) for Dall's porpoise based on the correction factor developed by Turnock and Quinn (1991). Hobbs replied that it would not really be applicable because of differences in search methods (3 observers using 25x and 7x binoculars vs. 1 observer using 7x binoculars). Laake suggested that, in referring to the estimate of Turnock and Quinn, that the term g_0 be used, because formally, g(0) cannot exceed 1.0. Taylor again emphasized that Dall's porpoise are a difficult species to sample and that a dedicated survey may be required to get a reliable estimate of this species. Barlow suggested that a good argument can be made that using the correction factor developed by Turnock and Quinn would result in a negatively biased estimate of Dall's porpoise abundance which would be in the spirit of making an estimate of minimum population size.

SOCCS2 Forney, K.A. and J. Barlow. 1993. Winter abundance estimates for cetaceans along the California coast based on 1991 and 1992 aerial surveys.

Karin Forney presented the paper discussing the results of the two aerial line-transect censuses of cetaceans along the California coast during March-April 1991 and February-April 1992. These two surveys were designed to provide a combined estimate of cetacean abundance within approximately 100-150 nmi (185-278 km) of the coast. A primary team of observers searched through bubble windows which allowed an unobstructed view of the trackline directly underneath the aircraft. A third, semi-independent observer searched through a belly window and made observations of animals missed by the primary team. A total of 253 sightings were made of a minimum of 18 cetacean species (some animals could only be identified to higher taxa). Of those groups that were on the trackline, the fraction seen by at least one team, g(0), was estimated to be at least 0.71 for groups of 10 or less small cetaceans, 0.93 for groups of greater than 10 small cetaceans and 0.97 for medium and large sized cetaceans.

These two years of survey data provided the target level of precision in the abundance estimates for five species (C.V. <= 0.365) and C.V.s are close for four additional species. C.V.s range from 0.23 to 0.51 for small cetaceans, and from 0.34 to 1.08 for the large cetaceans. More reliable abundance estimates for some of the large cetaceans (blue whale, humpback whale, sperm whale, and gray whale) have been obtained in other studies using photo-identification methods, ship line-transect surveys, or land-based census techniques.

Several sources of potential bias were addressed in this analysis. Three sources of downward bias (perception, availability and environmental) and one source of upward bias (probability of detection) were identified. In this analysis, they corrected for one source of downward bias (perception) by utilizing a partially independent observer, enabling estimation of a maximum correction factor for the fraction of animals missed by both teams. The upward bias was minimized using a post-stratification by school size. Overall, the estimates produced by Forney and Barlow may still be biased downward.

METHODS

Survey Methods

It was noted that the size of the study area (in km^2) was not mentioned in the paper. Hansen inquired about how the survey altitude of 700' was chosen. Forney responded that it was a tradeoff between the size of the smallest object that can be seen and the apparent speed of objects. An ideal altitude for harbor porpoise might be less than 700', but this was a good compromise for most other species. Hansen also expressed concern that groups could be missed while observers were measuring declination angles. Barlow said that sightings were so rare and this took so little time that any bias would be trivial. Also, when a sighting is made, observers go off-effort, and any additional animals seen while circling are considered part of the same group.

Jones noted that approximately 75% of the survey effort was at Beaufort 3-4, which are excluded when making estimates of harbor porpoise abundance (SOCCS4). She questioned how this might affect abundance estimates, and Calambokidis questioned whether bad weather was distributed uniformly in all regions. Forney noted that the effect of weather on sightings varied between species, and that harbor porpoise are undoubtedly the hardest to see in rough weather. Within the 4 geographic strata that were used, weather patterns were fairly uniform. Clearly, however, weather was better in the Southern California Bight than in central California. Barlow stated that data from independent observers showed that relatively few groups were missed despite less-than-optimal sighting conditions.

The review group asked Forney to review the procedures during a sighting and to explain why there appeared to be so many off-effort sightings. Forney stated that when a sighting was made, the aircraft circled to make species identifications and group size estimates. Additional sightings made while circling which were obviously not part of the current sighting group were treated as off-effort sightings, but most off-effort sightings were made in transit to and from the defined transect lines. A request was made to differentiate between these two types of off-effort sightings in the manuscript.

Analytical Methods

Laake questioned how the segment lengths used for the bootstrap related to the transect lengths flown on the survey. Forney responded that bootstrap segments of 20 km were slightly smaller than the grid spacing shown in Figure 1 of the manuscript. Laake suggested that a larger scale might be more appropriate for the bootstrap, but Barlow cautioned that bootstrap segments that are too long can incorporate geographic variability in addition to the desired sampling variability. Burnham suggested that bootstraps could be done without correction factors, but that the variance of the correction factor should be included afterwards, and the log-normal confidence intervals should be computed based on the corrected variance. Reilly suggested computing both bootstrap and analytical variances for comparison. The latter should be based on the empirical formulae for the variance in encounter rate from Buckland et al. (1993).

There was much discussion about how to treat sightings that were not identified to species level. Heyning pointed out that right whales are baleen whales and should be included in the general category of unidentified baleen whales in Figure 2 of the document. Heyning also questioned the validity of assigning species to unidentified sightings based on the nearest sighting of a species. Forney explained that the alternative is to prorate unidentified sightings based on sightings made throughout the study area and that the approach used in the paper could be viewed as the lesser of two evils. Reilly pointed out that Forney's approach will generally be superior if there is a positive spatial autocorrelation for species. Hall suggested that the presence of spatial autocorrelation could be tested on identified sightings using a jackknife approach. Barlow suggested that this might be better done on the larger set of MOPS data; however, because of the possible differences in habitats between the ETP and California, this data set may not be relevant. Hansen questioned whether unidentified sightings should be simply excluded from abundance estimates. Forney responded that this would discard an unacceptably large subset of sightings. There was a general **consensus** that the paper should present a comparison between the estimates obtained using the species assignment method with estimates obtained without assigning unidentified species to a particular species.

Regarding the methods used to estimate abundance, Burnham said that the comments he made about SOCCS1 in reference to secondary observers, group size bias, and bootstrap methods apply to this paper also. Hobbs questioned how the group size category of 1-10 was determined, and Forney explained that it was based on her aerial observation experience and was confirmed by nonparametric tests which showed distributions of perpendicular distances to differ for groups above and below a group size of 10.

Correction factors for missed animals were discussed at length. Heyning questioned whether a rough estimate of availability bias might be made for some species based on what is known of their dive patterns. Forney noted that although dive times are known for many, surface intervals are often not measured, and even if known, animals may not be visible from the air for the duration of a surfacing series. Barlow noted that Cascadia Research made estimates of the fraction of humpback whales missed on aerial surveys, but Calambokidis noted that their estimates were for a different type of aircraft and were based on a small sample size. Perrin noted that availability bias was estimated for whales in aerial surveys of the North Atlantic. DeMaster and Laake noted that C.V.s should be estimated for correction factors, and these should be used when estimating the C.V.s of abundance estimates. Calambokidis said that he was troubled by the interpretation of g(0) as the minimum proportion seen when, in fact, it does not include availability bias or the effect of heterogeneity in sighting probabilities. He suggested that a different phrase be used to clarify what was meant.

RESULTS

Brownell noted that estimates of Pacific white-sided dolphins and northern right whale dolphins were an order of magnitude greater than estimates from the ship survey and wondered whether seasonal changes in distribution could account for this. Forney noted that a direct comparison is not simple for a number of reasons such as the difference in areas surveyed and because the differences are statistically significant only for Pacific white-sided dolphins. The discussion section does, however, mention that possibility, and it was noted that this interpretation is consistent with distributional data for Oregon and Washington. Hansen noted that the estimates derived from the different platforms should be analyzed for inherent differences and perhaps, the could be calibrated.

DISCUSSION

Laake and Calambokidis **recommended** clarifying what was meant by "minimum proportion of animals seen" (bottom p. 18; SOCCS2). Heyning requested a clarification of why, given the contrasting colors of Dall's porpoise, their sighting characteristics were said to be similar to harbor porpoise (p. 21). DeMaster **recommended** removing gray whales from Table 3 and discussing them only in the text. There, he said, the new count obtained using shore-based survey methods could be mentioned. Reilly asked why abundance of common dolphins was only estimated for pooled short- and long-beaked forms. Forney replied that it was impossible to distinguish these putative species from the air and that it would be potentially misleading to prorate them based on the ship survey (in a different season) or based on strandings (which are biased by distance from shore). Wayne Perryman noted that, in the future, photogrammetric measurements can be used to separate the two forms of common dolphins. Taylor **recommended** that, by looking at the sensitivity of abundance estimates (and lower 95% C.I.s) to the various input parameters, the important parameters (such as g_0) could be identified, and work on future surveys could be concentrated on improving estimates of those parameters.

SOCCS3 Barlow, J. 1993. Changes in cetacean abundance in California coastal waters: a comparison of ship surveys in 1979/80 and in 1991.

Barlow presented the results of his analysis comparing the data from NMFS ship surveys conducted in California waters in September-October 1979 and June-July 1980 with the data collected in July-November 1991. His primary goal was to determine whether changes in abundance and distribution of cetaceans had occurred between these two time periods. Analyses were limited to the region of overlap between these surveys, and comparisons were made between the line-transect estimates of abundance during the pooled years of 1979/80 and the year 1991. To increase statistical power, comparisons were also made between the encounter rates (the number of groups encountered per unit of searching effort and the number of individuals encountered per unit effort) of both groups and individuals for the same time periods.

The survey methods used on all surveys were very similar with a few minor exceptions.

1) In 1979/80 observers did not distinguish between the two stocks of common dolphin (short-beaked and long-beaked form) and all common dolphins are, therefore, pooled in the comparison.
2) In 1979/80 group sizes and the percentage composition of mixed-species groups were estimated by consensus of all observers. In 1991 they were estimated independently by each observer and therefore, the 1979/80 estimates were compared with the average of all the 1991 estimates.
3) Distances to groups of animals were estimated "by eye" in 1979/80 and in 1991, binocular reticles were used to estimate distance.
4) The 1991 survey was designed to separate geographic stratum around the Channel Islands that was not covered in the earlier surveys; therefore, the 1991 Channel Island Stratum was excluded from the comparison.
5) In 1991, animals that were seen more than 3 nmi from the transect line were typically not pursued for species identification and group size estimation (but were recorded as a sighting, typically in one of the unidentified species categories and often with only a minimum group size estimate).
6) In 1991, a semi-independent observer was used to estimate the fraction of animals on the trackline the primary observers

missed. Independent observers were not used in the prior surveys, so these data are not used in the comparisons.

Results of the analyses indicate a general increase in the abundance of tropical delphinids, a decrease in the abundance of temperate delphinids, and an increase in the abundance of baleen whales. These results corroborate the results of aerial surveys which also indicated an increase in the abundance of common dolphins (a tropical species). The reasons for these changes are not certain, but they do not appear to be a statistical artifact.

METHODS

The panel was interested in the distributions of perpendicular distance and how they might have been effected by the 3 nmi truncation in 1991. Barlow said that sightings were made and recorded at distances greater than 3.0 nmi, but many of these remained unidentified. The group **recommended** that plots of perpendicular distance should be included in the paper. Laake and Paul Wade suggested that the differences in perpendicular distances between the two surveys could be related to changes in characteristic group sizes. Hansen suggested that the methods used to estimate sighting distances may have been significantly different between surveys.

Hall inquired whether oceanographic data were collected on both surveys. Barlow replied that they were, and a paper had been published based on the 1979/80 cruise correlating sightings data with chlorophyll, but that data have not been analyzed from the 1991 cruise. There are, however, published reports of a long-term warming trend in the eastern North Pacific since the mid-1970s. Calambokidis questioned whether observers were able to search effectively in Beaufort sea state 5. Encounter rate estimates were limited to effort conducted at Beaufort 5 or less. Barlow said that observers were able to use 25x binoculars up to Beaufort 5. Also, the distribution of rough and calm seas was approximately the same on the two cruises, therefore, sea state is not likely to affect trends in abundance.

RESULTS AND DISCUSSION

A number of comments were noted regarding the apparent shift in distribution for a number of species. DeMaster noted that pilot whales appear to have declined in abundance, unlike other tropical/warm temperate species. He suggested that this should be emphasized. Green added that the sightings of pilot whales have not increased in Oregon and Washington. Additional data on changes in the relative proportions of short- and long-beaked common dolphin specimens obtained from the fisheries have been found by Heyning and Perrin (see SOCCS16), and should be cited. Trends in the abundance of common dolphins along Baja California were also discussed. Hall mentioned that there appears to be a "shift" in the distribution of common dolphins that might account for the apparent decline. Wade suggested that the MOPS/PODS data be reanalyzed to obtain estimates for Baja California, and added, that the upcoming survey should provide some answers. Green noted that the apparent decrease in Risso's dolphins and Pacific white-sided dolphins in California might be explained by an increase in these species during the summer in Oregon and Washington. These patterns and those discussed in SOCCS3 are consistent with a general northward shift of cetacean distributions, similar to a shift that has been seen in fish distributions.

Calambokidis requested a rewording of the section dealing with changes in baleen whale abundance to emphasize that this may be a local increase in abundance and may not reflect population growth, and he **recommended** more discussion of problems and caveats. In addition, there was a **consensus** that additional comparisons need to be made using data from surveys conducted in Oregon and Washington waters and from data collected during eastern tropical Pacific (ETP) surveys.

SOCCS4 Barlow, J. and K.A. Forney. 1993. An assessment of the status of harbor porpoise in California in 1993.

The status of harbor porpoise in California was reviewed by Barlow with emphasis on the effect of set gillnet fisheries on the population. Movement of porpoise on the U.S. west coast appears to be limited, and SOCCS4 proposed that porpoise in central California (where the fishery is located) be managed as a separate stock. Previous population estimates were reviewed in this document and new estimates were made based on aerial surveys conducted in 1988-1991 using correction factors recently developed by Calambokidis et al. (1993, SOCCS 11). The population size was estimated to be 3,810 (CV=0.24) in central California and 13,900 (CV=0.21) in the entire state of California. Minimum population sizes were estimated from lower 95th percentiles to be 2,481 for central California and 9,571 for California as a whole. There was no information on population trends or growth rates in this area. The status of the central California population relative to its carrying capacity or OSP (optimum sustainable population) is unknown, but the population has probably been reduced by fishery mortality. In the early 1980s, estimates of mortality in set gillnet fisheries for halibut was in excess of 200 harbor porpoise per year, but estimates since 1987 indicate less than 100 porpoise per year are taken.

POPULATION AND STOCK STRUCTURE

The review panel discussed (at great length) the proposed management stock(s) for harbor porpoise. The evidence was reviewed for treating harbor porpoise in central California as a separate management stock. Primarily there was no direct evidence presented to indicate that harbor porpoise are moving from northern California to fill in for the animals that are being removed by fisheries in central California. In addition, even though genetic studies have not shown any difference along the U.S. west coast, Heyning cautioned against attributing any importance to negative genetic results. A migration rate of 1% per year of the total population in northern California would be sufficient to replace the number currently being removed from central California, but it would be optimistic to assume such a migration is occurring without any evidence. It was the **consensus** of the review panel that harbor porpoise in central California should be considered a separate management stock.

Andrew Dizon noted that he plans to re-examine DNA sequence data using an analysis of variance method which is expected to provide new information on whether genetic difference exist between California and Washington. DeMaster **recommended** that an attempt should be made to estimate dispersal rates from these data. Dizon and Perrin also noted that the information about the exchange rate of one individual per generation refers only to the establishment of fixed differences by genetic drift without selection. With the advent of new analytical techniques, the possibility of detecting genetic difference between populations is much more hopeful than is indicated in SOCCS4. It was **recommended** that the manuscript be changed to reflect this.

POPULATION SIZE

Calambokidis noted that the new abundance estimates refer only to waters inshore of 50 fathoms and asked if any data exist to quantify the number farther offshore. Green added that an estimated 25% of porpoise in Oregon and Washington were sighted beyond the 50 fathom isobath. Barlow replied that some data exist from 1984/85 ship surveys as well as from more recently ship and aerial surveys, but these data are sparse and many not be representative of the entire California coast. Clearly, however, some sightings have been made in waters that were deeper than 50 fathoms.

Laake questioned how the smearing worked in estimating perpendicular distance and whether the abundance estimate was based on a single stochastic realization of smearing. When Barlow said that it was, Laake **recommended** investigating how much difference this made in the estimate. DeMaster **recommended** presenting abundance estimates separately for northern California.

Regarding minimum population size, DeMaster again recommended use of 90th percentiles instead of 95% C.I.s. Again it was decided that this topic relates to the NMFS proposed management regime and it was **recommended** that the question be addressed in a workshop which should be convened to deal specifically with questions relating to the NMFS management proposal. For this manuscript, however, it was **recommended** that log-normal confidence intervals be presented to be consistent with other status of stocks papers.

POPULATION GROWTH RATES AND TRENDS

There was a general discussion of whether population growth rates for harbor porpoises can be assumed to be greater than 2% at their maximum net productivity level. DeMaster argued that, based on the similarities of their life history traits to pinnipeds, their growth rates must be greater than the rate estimated for other cetaceans. He cited Barlow's estimate of a maximum growth rate of 9.4% for harbor porpoise. Barlow explained that 9.4% is a theoretical maximum, and that positive growth has not been observed in any harbor porpoise population. Analogies to pinnipeds are based only on reproductive rates, and nothing is known about mortality rates. Barlow argued that, under the proposed amendments to the MMPA, 2% is the default value for all cetaceans and that the decision to use something other than the default rate should be based on specific data for the population being considered. If a good case could be made, it would be appropriate to change the default value for harbor porpoise; however, this would require changes in the NMFS proposal and would be outside the purview of this meeting. Brownell said that similarly, a lower default value may be appropriate for beaked whales, perhaps 1%.

The published paper by Forney et al. (1991) is the only source of information on trends in abundance for the central California stock. That paper concludes that insufficient data exist to estimate growth rates and that an 8-10 year time series will be required. There was a **consensus** that continued aerial surveys should be conducted in central California to measure the growth rate of harbor porpoise in conjunction with the reduction of the fishery.

STOCK STATUS

Thomas Eagle **recommended** that this section should also address the stock in northern California, which is assumed to be near carrying capacity and may be part of a larger stock including Oregon and Washington.

CURRENT BIOLOGICAL REMOVALS

The mortality rate of harbor porpoise in central California was based on an observer program with a coverage rate of only 10%. DeMaster and Reilly asked why the coverage was so low when the overall coverage in the state is greater than 30%. James Lecky explained that most vessels from Morro Bay were unobservable because they were taking multi-day trips and that this is probably a deliberate strategy to avoid taking observers. DeMaster was concerned that this selection may introduce a biased estimate of mortality, and Hall expressed concern that a coverage rate of less than 10% can result in an upward bias in estimates of mortality. Lecky responded that NMFS proposes to work cooperatively with the USF&WS while they monitor the catch of sea otters from separate vessels in these areas.

SOCCS5 **Forney, K. 1993. Status of populations of odontocetes along the coast of California in 1992.**

Forney presented this document which assesses 15 species of toothed whales found along the coast of California. These species have been combined into one report, rather than as separate reports for each species, because the amount and types of information available for each were similarly limited. Information on population structure and status was included for each species. In cases where different stock divisions are possible, alternatives were discussed.

Before discussing this paper, Brownell raised the point that fisheries that kill marine mammals extend south of California into Mexico. He questioned what was being done to estimate marine mammal mortality in Mexico. Perrin responded that Omar Vidal was doing some work on that subject, but that he was now working in Colombia. Brownell recommended that the author use primary citations rather than citing summary papers. Eagle noted that he liked the species-by-species format of this paper and that he hoped other Fisheries Centers would follow a similar format.

Before the detailed review of the individual species, there was a general discussion of how management stocks would be defined. Cetacean populations extend continuously to the north, south, or west of the California study area. It was pointed out, however, that cooperative management agreements offering population abundance and mortality estimates have not been made with Mexico, nor are there any agreements in place to monitor the incidental catch of marine mammals in international waters (the yellowfin tuna purse seine fishery is an exception, but only a few species are considered to have continuous stock boundaries into the U.S.). Our management authority only extends to the waters within the U.S. EEZ. It was the general **consensus** that, for the purpose of management, stocks would be define to include those animals within the U.S. EEZ, and that cooperative research between California/Oregon and Washington, and between the U.S. and Mexico be continued, or as necessary, initiated.

The odontocete species included in this report are:

ZIPHIIDAE	BEAKED WHALES
Berardius bairdii	Baird's beaked whale
Mesoplodon spp.	Beaked whales
Ziphius cavirostris	Cuvier's beaked whale
PHYSETERIDAE	SPERM WHALES
Kogia breviceps	Pygmy sperm whale
Kogia simus	Dwarf sperm whale
DELPHINIDAE	DOLPHINS
Delphinus delphis	Common dolphin
	short-beaked form
	long-beaked form
Globicephala macrorhynchus	Short-finned pilot whale
Grampus griseus	Risso's dolphin
Lagenorhynchus obliquidens	Pacific white-sided dolphin
	northern form
	southern form
Lissodelphis borealis	Northern right whale dolphin
Orcinus orca	Killer whale
Pseudorca crassidens	False killer whale
Stenella coeruleoalba	Striped dolphin
Tursiops truncatus	Bottlenose dolphin
	coastal form
	offshore form
PHOCOENIDAE	PORPOISES
Phocenoides dalli	Dall's porpoise

Common Dolphins

It was **recommended** that the two putative species of common dolphins (long-beaked and short-beaked forms) should be managed separately. It was pointed out that this would require that mortality estimates be stratified by morphological form and to date, most gillnet observers have not been able to classify the common dolphins with respect to morphotype. Dizon said simple genetic tests can determine common dolphin type and that attempts should be made to get skin samples from all gillnet-caught animals.

Data indicate that the distributions of both forms of common dolphin extend into Mexico. It was **recommended** that management stocks for both forms should be provisionally defined to include those animals found in California coastal waters; however, this is not a satisfactory solution and attempts should be made to work toward cooperative management of these species with Mexico.

The review panel noted that the abundance of common dolphins off northern Baja California had never been estimated and recommended that such an estimate be made. Because the aerial survey was not able to separate the short- and long-beaked forms, it was **recommended** that abundance and minimum population sizes be based on the ship survey. There was considerable concern, however, that the 1991 estimate may not be representative of all years and that large-scale shifts in distributions may occur between years. Again it was **recommended** that log-normal confidence intervals be used for all species.

Regarding incidental take, the observed takes in driftnets have been short-beaked, but Heyning noted that some long-beaked common dolphins have stranded with obvious signs of gillnet mortality. DeMaster suggested that information on the structure (e.g., sex, size class, etc) of the kill be provided in the manuscript. Susan Chivers noted that this information is provided in the annual mortality report to the International Whaling Commission. Hall noted that the mortality of common dolphins in California gillnets in 1991 was greater than the take of this stock by the ETP tuna fleet. Perrin commented that dolphins are intentionally taken in Mexican waters for shark bait and that these data should be obtained from Omar Vidal and included in the document. Brownell noted that the live capture takes reported by Walker only included one marine park (Marineland). Also, there was some discussion regarding the use of pollutant loads as a potential human-induced mortality. It was **recommended** that, for consistency, information on pollutants should be provided for all species if it is given for common and bottlenose dolphins.

Pilot Whales

Oceanographic distributions and morphology (see thesis by Polisini (1980)) indicate that the population of pilot whales in

California extends into Mexico along the Baja Peninsula, but is distinct from pilot whales found farther south in the eastern tropical Pacific. However, our management mandate extends only to the west coast of the U.S., and it was **recommended** that, like common dolphins, the management stock should only include animals within the U.S. EEZ. This approach should be considered provisional until cooperative management is arranged with Mexico.

Wade suggested that improved estimates of pilot whales along Baja California could be obtained from previous MOPS surveys, but that new estimates will be available from planned 1993 surveys. It was recommended that, in the absence of sightings from 1991/92 surveys, minimum abundance estimates for pilot whales should be listed as unknown in the Summary Table, (Appendix 5) but the photo-documented sighting of a group of 25 pilot whales in 1991 should be mentioned in the text. The section on trends in abundance should emphasize that, although quantitative estimates are not available, pilot whales were once common and now they are not. DeMaster mentioned that additional information on potential growth rates is available in a paper by Marsh and Kasuya (1991), and suggested incorporating this information into the status document. Forney replied that it may not be appropriate to use information obtained in another region for this stock.

It was noted that pilot whale mortality in the squid fishery may have been underestimated and could have had an impact on this stock. Lecky noted that shooting of pilot whales to protect catch was not illegal in the early 1980s, and that this source of mortality should also be included with incidental take.

Risso's Dolphin

The distribution of Risso's dolphins was discussed at great length. A hiatus in their distribution has been noted at 42°N and another at 20°N. However, patterns of seasonal abundance in California and Oregon/Washington are consistent with the movement of Risso's dolphins north in summer/fall across the hiatus at 42°N. It was **recommended** that more information on this apparent change in distribution be provided in SOCCS5, but for management purposes a stock should be defined to include all Risso's dolphins along the west coast of the U.S. There was a general consensus that seasonality and distribution differences between California and Oregon/Washington should be looked into before deciding on the structure of a stock. Therefore, it was **recommended** that the abundance estimate and minimum population size be based on the aerial surveys in winter/spring, because most of the animals from Oregon and Washington are thought to be in California at that time. The panel also discussed the criteria used to define whether a population is likely to be within its OSP range. It was concluded that a stock is likely to be within its OSP range if there has been a negligible history of exploitation. Using this reasoning, it was the general **consensus** that the west-coast stock of Risso's dolphins are probably at OSP, but uncertainty about indirect effects of the squid fishery on food supplies resulted in some uncertainty.

Mesoplodont Beaked Whales

Forney noted that the field identification of beaked whales of the genus *Mesoplodon* is difficult at best, and that current estimates of abundance and incidental mortality are all based on a lumped category identified only to genus. This suggests the possibility of defining a management stock that includes more than one species. Although acknowledging the logistic difficulties, there was a **consensus** that a multi-species stock would be a dangerous precedence, and it was **recommended** that each species should be managed as a separate stock.

Because sightings were not identified to species, it was **recommended** that the Summary Table (Appendix 5) should state that population sizes are unknown. Although it may be possible to obtain a rough estimate of the species proportions from strandings, these data are likely to be biased in favor of more nearshore species. Hansen questioned whether it is ever justified to make an abundance estimate based on less than 5 sightings; however, the majority expressed that if a survey is properly designed and if uncertainty is appropriately estimated in the C.V., an estimate is valid even if based on one sighting. Any attempt to set a minimum number of sightings is likely to result in a biased abundance estimate. Jones noted that the observed take of mesoplodont beaked whales appears high relative to the pooled abundance estimates for this genus. It was strongly **recommended** that photographs, skin biopsies, and skulls be collected from all gillnet-caught specimens in order to determine the species and to develop genetic tests for species identification.

Pacific White-Sided Dolphins

The possibility was raised that two distinct morphological forms of Pacific white-sided dolphins exist in southern California. Perrin noted that the evidence for this is extremely weak. It was **recommended** that the management stock be defined to include all members of the species along the U.S. west coast. Green noted that Pacific white-sided dolphins are virtually absent from Oregon and Washington in winter/spring; at which time they appear to be more abundant in California waters. It was **recommended** that the winter/spring aerial survey estimate from California could be used to represent the abundance on the entire west coast. The possibility was discussed that this stock is part of a larger population that has been impacted by high-seas driftnet fisheries. The **consensus** was that this possibility is very remote, but there was no agreement on whether the west-coast stock should be considered at OSP. If the offshore stock is determined to be below OSP, the west-coast stock should probably be listed as having "unknown" status.

Northern Right Whale Dolphins

Green reviewed data from Oregon and Washington which show that, like Pacific white-sided and Risso's dolphins, the northern right whale dolphin is nearly absent in winter/spring. Using the same reasoning as for these other two species, it was **recommended** that the aerial survey estimate should be used to represent the abundance of this species on the entire U.S. west coast. As was the case for Pacific white-sided dolphins, it was **recommended** that if the offshore stock is determined to be below OSP, the west-coast stock should probably be listed as having "unknown" status.

Killer Whales

Recent evidence of long-range movements may indicate a link between California and Alaska. On the other extreme, genetic and phonation differences between pods may indicate that management should be on a pod-by-pod basis. Pending additional information, it was **recommended** that killer whales in California, Oregon/Washington, and Alaska should be managed as 3 separate stocks.

False Killer Whales

It was generally recognized that occasional visitors to California waters such as false killer whales may not fit easily into the proposed management regime. It was **recommended**, however, that the management stock should be defined as the animals in California coastal waters in order to be consistent with stocks defined for other species.

Striped Dolphins

It was **recommended** that the management stock for striped dolphins be defined as the animals in California waters and this stock can be assumed to be at OSP.

Bottlenose Dolphins

It was **recommended** that bottlenose dolphins should be managed as separate inshore and offshore stocks. No consensus was reached regarding animals around the Channel Islands. There is clearly a need to obtain a better estimate of the coastal stock, especially since the recent range expansion into central California. In addition, future work should focus on reconciling the California-Mexico distribution and stock structure.

Dall's Porpoise

It was **recommended** that uncorrected estimates from the 1991 ship survey be used for Dall's porpoise abundance in California.

Pygmy and Dwarf Sperm Whales

As with the genus *Mesoplodon*, members of the genus *Kogia* are not easily distinguished in the field and it is tempting to treat them both as a single management stock. The review panel **recommended** that they be treated as two separate stocks.

Other species

There was insufficient time during this review to cover each species in detail. The latter several species above were discussed only briefly. Other species were not considered at all. It is anticipated, however, that discussions of the species that were covered in greater detail would provide guidelines and a template for revising status of stocks reports for those species covered in less detail.

SOCCS9 Chivers, S.J., K.M. Peltier, W.T. Norman, P.A. Akin, and J. Heyning. 1993. Population structure of cetaceans in California coastal waters.

This paper was not formally presented, rather it was used by Forney and the panel as a background document during review. This paper reviews the available literature bearing on the population structure of six cetacean species found off the coast of California (*Globicephala macrohynchus*, *Grampus griseus*, *Lagenorhynchus obliquidens*, *Tursiops truncatus*, *Lissodelphis borealis*, and *Phocoenoides dalli*). The information is organized by distributional, demographic, phenotypic, and genotypic data as Dizon et al (1991) suggested, but it is not classified into the four hierarchial ESU (Ecologically Significant Units) categories. In general, there is very little information available regarding the biology of these cetacean species, although, most are taken in driftnet and setnet fisheries. These fisheries are monitored to estimate mortality rates for each species and to collect biological data from the incidental kill.

There were frequent **recommendations** by the review panel for additional work on the population structure of cetaceans in California coastal waters.

SOCCS6 Barlow, J. 1993. Recent information on the status of large whales in California coastal waters.

Barlow presented a summary of information on the structure, abundance, growth, and status of large whale populations that are found in California coastal waters. Large whales include all baleen whales plus the sperm whale. Species include:

Balaenoptera musculus	Blue whale
Balaenoptera physalus	Fin whale
Balaenoptera borealis	Sei whale
Balaenoptera edeni	Bryde's whale
Balaenoptera acutorostrata	Minke whale
Megaptera novaeangliae	Humpback whale
Physeter macrocephalus	Sperm whale
Eubalaena glacialis	Right whale

Barlow noted that the question of stock structure for these species had been previously address by the International Whaling Commission (IWC), but for most species, the IWC has not reviewed stock structure since the 1960s or 1970s. Much new information has accumulated since then, and there is no compelling reason to continue to use the IWC stock structures. Barlow also noted that estimates of pre-exploitation abundance from the IWC are based on whaling statistics (encounter rates and catch-per-unit-effort from whaling vessels) and other methods which have been questioned and which now would not be accepted by the IWC. Brownell and Tillman agreed, but **recommended** that a strong statement to that effect should appear in the text. They also **recommended** that the depletion levels (N/K) presented in Table 1 of SOCCS6 should be removed. During discussions of this paper, there was a general **consensus** that because questions of population structure were common, a program to get the necessary biopsy samples which can be used for genetic studies should be initiated. Eagle **recommended** reorganizing this manuscript in the species-by-species format used in SOCCS5.

The review paper was organized based on subject (e.g., population sizes, stock structure, etc.), but the review panel preferred to consider this paper on a species-by-species basis.

Humpback Whales

The evidence for multiple populations of humpback whales in the North Pacific is clear. The panel **recommended** that the feeding population in California, Oregon, and Washington be treated as a separate management stock. Several options were discussed for combining line-transect and mark-recapture estimates of population size. Green noted that the humpback whale estimate cited for Oregon and Washington was withdrawn in their final report. He said that he could provide it as a personal communication. Calambokidis noted that his photo-identification efforts would be ending this year due to lack of funding. Tillman agreed that general statements about the status of the population were accurate, but again cautioned against putting too much emphasis on the prior IWC abundance estimates. Brownell **recommended** that primary sources should be cited for information about historical abundance even though it is an unpublished report, and suggested citing a recent paper by Darling and Mori (1991) on the abundance of humpback whales in Japanese waters.

Blue Whales

The **recommendation** was accepted to consider blue whales in California (and Baja California) as a separate management stock. Because of the apparent conflict between abundance estimates from nearshore photo-identification studies and ship surveys, it was **recommended** that additional effort should be made to resolve the differences. The review panel **recommended** that the line-transect estimates should be used provisionally as the current estimate of blue whale abundance. Heyning noted that information was not included about one source of human-related mortality: ship strikes.

Fin Whales

Evidence was reviewed for local populations of fin whales in California, Oregon, and the Gulf of California. Given this evidence and by analogy to the recommendations for small cetaceans, the panel **recommended** that the management stock be defined as those animals within the limits of the drift gillnet fishery, that are within the coastal waters of California, Oregon, and Washington.

Sei Whales

The panel **recommended** that the stock structure of sei whales should include only those animals in the U.S. west-coast EEZ. The only available abundance estimates are, however, for the entire Pacific basin. Tillman noted that these IWC abundance estimates were based on encounter rate and CPUE data and should not be accepted without caveats.

Bryde's Whales

The panel **recommended** that the stock structure of Bryde's whales should include only those animals in the U.S. west-coast

EEZ. The best available abundance estimates are, however, for the eastern tropical Pacific (ETP). Reilly **recommended** adding additional information about Peruvian whaling in the ETP. Because of the unknown effect of the take on these whales, the status of Bryde's whales should be considered unknown.

Minke Whales

Previous work on the distribution of minke whales has suggested an apparent hiatus in central California. The recent work of Stern et al, (1990) and recent sightings on SWFSC aerial surveys indicate that this may be a sampling artifact. Calambokidis noted that, by analogy to management stocks for small cetaceans, the management stock for minke whales should only include those animals in California. There was general agreement with this; however, the driftnet fishery which takes minke whales extends into Oregon and Washington in some years, and stock boundaries for some species of small cetacean also include Oregon and Washington. Because the estimated population size is small, incidental fishery mortality may have had some impact, and the panel **recommended** that the status of this species be listed as "unknown".

Right Whales

The definition of a separate management stock of right whales that migrate in winter along the western U.S. coast was deemed consistent with the biology of this species elsewhere in the world and was **accepted** by the review panel. Hansen **recommended** that the author should emphasis that the aerial abundance estimate was based on only one sighting and is thus unreliable.

Sperm Whales

The panel **recommended** adding information about migratory behavior and suggested that dive information may be available which could be used to develop a correction factor for aerial surveys. The current aerial survey estimates without correction factors should not be used. A paper by Kasuya (1991) should be referenced for additional information on population structure.

SOCCS8 Julian, F. 1993. Pinniped and cetacean mortality in California gillnet fisheries: preliminary estimates for April 1 to June 30, 1992.

Fred Julian presented an overview of his paper. The impetus for this paper was the growing need for real-time estimates of marine mammal mortality occurring in gillnet fisheries. Previously estimates were only made for the entire year and were not available until April of the subsequent year. Proposed changes to the Marine Mammal Protection Act would require estimates of marine mammal mortality at specific times throughout the year to evaluate whether the number of marine mammals killed exceeds the allocation for any species. It is the intention of the SWFSC to produce mortality estimates each quarter. This paper presents the first quarterly estimate and presents the method that will be used for future quarterly estimates.

The methods used in this paper are essentially the same as those used by Perkins et al, (1992) to obtain the annual mortality estimate for 1991. Observations of marine mammal mortality were made by NMFS observers placed aboard commercial fishing vessels. Estimates of the number of fishing days from the California Department of Fish and Game (CDFG) were used as a measure of fishing effort to extrapolate from the observed kill to the total estimated kill. Ratio estimators and mean-per-unit estimators were used for setnet and driftnet fisheries (respectively). Variances were based on the delta method, which had previously been shown to produce estimates that were comparable to bootstrap estimates. Data were stratified by fishery (setnet versus driftnet) and region (for setnet fishery only). Previous annual estimates were also stratified by quarter of the year. Julian noted that approximately 30% of fishing effort was observed overall in both fisheries during this quarter, but that observed effort was less than 2% in the Channel Island stratum and was low in the central California stratum. Most vessels in those areas take multi-day trips and are, thus, not required to carry observers.

There was a general discussion of the types of biases expected from this type of observer program. Calambokidis questioned whether fishers could change their behavior when they know they must take an observer. Julian noted that a preliminary analysis indicates that setnet observations based on post-set notification (fishers are notified that they must take an observer after their nets are already set) have a higher kill rate, but data are not sufficient to indicate that this is a general pattern. Barlow noted that even after nets are set, fishers could influence estimates by only retrieving a subset of the nets that they had deployed the previous day. In the case of pre-set notification, fishers could further influence estimates by setting their nets in areas or at depths that are less likely to result in marine mammal entanglement. Julian noted that effort estimates are likely biased because some trips are not recorded in any way, and like most other sources of potential bias, this would result in an under estimate of marine mammal mortality. Hall noted that when the observation rate is low (such as 2% for the Channel Island stratum), ratio estimates are positively biased. Calambokidis **recommended** a brief list of the potential biases and their direction. Perrin suggested that other published sources have looked that this sort of problem and could be cited.

Several suggestions were made for other potential factors that could be examined. Gordon Waring warned that some vessel may have lower kill rates and that they may be the vessels that most readily allow observers. Hall questioned whether different sampling rates in different areas could have introduced a bias. Heyning noted that whale mortality will typically not be observed in this program because they swim away with the net. Based on stranding data, he estimates 10 gray whales are killed per year in gillnets in California. Lowry pointed out that pinnipeds also may break free of the net but later die because of netting that remains entangled around their necks. The type of fishery causing this hidden source of mortality could be identified by looking at the net type found on stranded animals. As a minimum, the panel **recommended** that gillnet-caused strandings should be added to the mortality estimates.

Lecky noted that the set gillnet fishery will be eliminated (for the most part) in 1994, but inshore setnet fishing will still be allowed along a short section of coastline between Point Conception and the southern end of the sea otter range in California. Perrin pointed out that this type of fishing will continue in many parts of the world and emphasized the value of continuing to gather information on gillnet mortality. Brownell noted that similar fisheries are continuing along Baja California and that more information is needed about marine mammal mortality in those fisheries.

Barlow solicited a general discussion about the problem of estimating kill rates for rare species that are seldom observed. He noted that for some species the observation of even one animal in a net would result in an annual mortality estimate that is greater than the PBR allocation. He suggested that for such species it might be better to base mortality estimates on the kill rate that has been observed over the last several years and on the effort observed in the given year. There was a **consensus** that this approach was unacceptable because it assumes that fishers have no control over their kill rates and would remove the incentive for fishers to reduce those rates. DeMaster noted that a 100% observer program would remove uncertainty from the kill estimates, but such a program might cost more than the total fish landings were worth. DeMaster preferred a suggestion that was made to establish multi-year PBRs for the rare species whose mortality cannot be estimated accurately from a single year's data.

SOCCS7 Perkins, P., J. Barlow, and M. Beeson. 1993. Report on pinniped and cetacean mortality in California gillnet fisheries: 1988-1990.

Barlow explained that the motivation of this paper was to estimate the marine mammal mortality during the period between the end of the CDFG observer program and the beginning of the NMFS observer program and to provide a continuous history of estimated kills. Kill rates (kill-per-set) were compared between the pre-

1988 CDFG data and the 1990/91 NMFS data for sea lions, harbor seals, and harbor porpoise. These rates did not differ significantly for 8 out of 9 comparison (including 2 fisheries, 3 geographic strata, and 3 species). Because rates appear to be similar, the sample sizes in 1990-91 were much greater than in previous years, and pre-1988 data are not direct measures of kill-per-day, the 1990-91 kill rates were used to estimate the marine mammal mortality for 1988-90. Fishing effort was based on CDFG estimates for the 1988-90 period.

The approach used in this paper is basically to extrapolate from kill rates in one year and effort estimates in a previous year to estimate mortality for that previous year. DeMaster **recommended** that the validity of this approach be tested by using 1992 data to estimate mortality in 1991 and then comparing it to actual mortality estimates made for 1991. Forney suggested further, that because of differences in species taken during 1990/91 and subsequent years, it might be desirable to estimate prior-year mortality from the pooled 1990-92 NMFS observer data. The review panel **recommended** that Forney's suggestion should be implemented. This approach may improve precision and may give a more realistic representation of the rarer species.

Hall questioned the approach used in this paper and its dependence on the assumption that kill rates do not change. He said that it is unlikely that kill rates would be constant. Heyning noted that 1987 mortality estimates given by Konno were in fact pooled estimates for several previous years. Heyning also said that rorqual takes were observed by CDFG in the 1980s, but mortality rates were never reported for these species.

CONCLUDING COMMENTS

After the formal review of papers, the review panel again discussed aspects of the NMFS proposed management scheme. Burnham noted that the probability of a population being less than the lower 95th percentile of a 2-tailed distribution is only 2.5%. He reminded the group of the difficulties in estimating the extremes of a distribution and questioned whether the 95th percentile might refer to a 1-tailed distribution, and recommended that if a 2-tailed test were used, then the lower 90th percentile might be more appropriate. DeMaster stated the 95th percentile was an arbitrary "starting point" and suggested that the 90th percentile of a 2-tailed distribution or the 95th percentile of a 1-tailed distribution would be more reasonable. Calambokidis noted that although our opinions on this subject might be valid, the decision to use a specific value is not a scientific decision, rather it is a political judgement based on how conservative we should be in the face of uncertainty. DeMaster pointed out that Taylor's investigation of the proposed management regime might provide an objective way to evaluate the choice of what to use for minimum population size. Wade noted that the issue of which percentile to use could not be divorced from the issue of which safety factors to use. Eagle **recommended** that when Taylor has some results, another workshop should be held to address this issue, as well as issues pertaining to definition of management stocks, default values for R_{MNPL}, and other parameters that are important for estimating PBRs. Taylor **recommended** also giving consideration to providing formal guidelines for when default values should be used for R_{MNPL} and when measured values should be used. The panel concluded that further discussion on the range of these values will be necessary.

The workshop generally **recommended** that the level of activity and the priority of work on population and stock structure should be raised. This work should not be limited by Regions or by the EEZ; efforts should be made to expand the geographic range of sample collection. It was also **recommended** that the level of cooperation and coordination between NMFS Regions be increased, in particular, in the areas of abundance and mortality estimation. Calambokidis and Taylor noted that some problems are common to several regions (e.g., dive time correction factors for Dall's porpoise and beaked whales) and that more might be accomplished by pooling efforts. Green suggested that a workshop should be held to help standardize survey methods. Barlow and DeMaster expressed concern that "standardizing" would impede the progress being made to improve survey methods, but welcomed the idea of a workshop that would help establish what methods are currently considered "state-of-the-art" in line transect. Burnham noted that the "state-of-the-art" has changed much in the last 15 years and will continue to improve. He stressed that this quest for improvements should be encouraged and that standardization should be considered as a floor to be met, not a ceiling.

Because there was obvious interest in population growth rates of harbor porpoise, DeMaster **recommended** that aerial surveys in central California should be continued in order to estimate the growth rate of a harbor porpoise population over a 10-year time period (data are already available for 5 years). Because that population has recently been released from fishery mortality due to fishery closures, it is expected to grow towards carrying capacity. Calambokidis also noted that the large discrepancies in estimates of blue whales were another obvious subject of interest, and additional work should be done to help resolve this controversy.

The panel concluded with the following statements which concern all population assessments where marine mammals are being exploited directly or indirectly:

1) Identification of the structure of the population, estimation of the population's size, estimation of mortality on the population, and an assessment of the rate of exploitation on that population are necessary for stock assessments.

2) Populations can be differentiated using data on morphological,

molecular genetic, distributional, life history, and pollutant differences, as well as with movement data from photo-identification or tagging. The work conducted at the Southwest Fisheries Science Center is notable in that they have been using all of these approaches in their stock assessments.

3) It should be required as a condition under a fishery's incidental take permit, not requested, that data and specimens necessary to make stock assessments be collected by observers placed onboard fishing vessels.

Appendix 1

AGENDA
Workshop to Review the Status of California Cetacean Stocks
March 31 to April 2, 1993
SWFSC, La Jolla, CA 92038

WEDNESDAY

0900	Welcome/introductions	Tillman/Reilly
	Distribution of papers/approval of proposed agenda	
0920	Management framework	Barlow
0940	Ship line-transect abundance	SOCCS1
1030	Coffee break	
1050	Ship line-transect (cont.)	SOCCS1
	Aerial line-transect abundance	SOCCS2
1230	Lunch (@SIO snackbar, weather permitting)	
1400	Trends in abundance	SOCCS3
1530	Break	
1550	Harbor porpoise abundance/assessment	SOCCS4
1700	Adjourn	

THURSDAY

0900	Status of small cetaceans	SOCCS5 SOCCS9
1030	Break	
1050	Status of small cetaceans (cont.)	SOCCS5 SOCCS9
1230	Lunch (delivered from L.J. Cheese Shop)	
1330	Status of whales	SOCCS6
1530	Break	
1550	Status of whales (cont.)	SOCCS6
1700	Adjourn	

FRIDAY

0900	Mortality estimates: 1988-90	SOCCS7
1030	Break	
1050	Quarterly mortality estimates	SOCCS8
1130	Summary/provisions for review of final report	
1300	Adjourn	

Participants:	Affiliations
Jeff Laake	National Marine Mammal Lab
Ken Burnham	U.S. Fish and Wildlife Service
John Calambokidis	Cascadia Research Collective
John Heyning	Los Angeles County Museum
Bob Brownell	Marine Mammal Commission
Jim Lecky	Southwest Region
Gordon Reetz	Minerals Management Service
Doyle Hanan	California Department of Fish and Game
Martin Hall	Inter-American Tropical Tuna Commission
Alejandro Anganuzzi	Inter-American Tropical Tuna Commission
Greg Green	EBASCO
Gordon Waring	Northeast Fisheries Science Center
Larry Hansen	Southeast Fisheries Science Center
Rod Hobbs	AFSC, National Marine Mammal Lab
Doug DeMaster	AFSC, National Marine Mammal Lab
R.H. Defran	San Diego State Univ.
Tom Eagle	NMFS, Office of Protected Resources
Linda Jones	Northwest Fisheries Science Center
Sue Moore	SAIC

SWFSC Participants:

Mike Tillman	Science and Research Director, SWR
Steve Reilly	Chairman, Acting Chief Marine Mammal Div.
Joyce Sisson	Rapporteur, Dolphin-Safe Program
Jay Barlow	Leader, Coastal Marine Mammal Program
Karin Forney	Coastal Marine Mammal Program
Fred Julian	Coastal Marine Mammal Program
Mark Lowry	Coastal Marine Mammal Program
Jim Carretta	Coastal Marine Mammal Program
Bill Perrin	Senior Scientist
Andy Dizon	Leader, Population Identity Program
Susan Chivers	Population Identity Program
Wayne Perryman	Population Identity Program
Jim Gilpatrick	Population Identity Program
Tim Gerrodette	Leader, Dolphin Stock Assessment Program
Paul Wade	Dolphin Stock Assessment Program
Barb Taylor	NRC Post Doc.

Review Documents:

SOCCS1 Barlow, J. 1993. The abundance of cetaceans in California waters estimated from ship surveys in summer/fall 1991.

SOCCS2 Forney, K. A. and J. Barlow. 1993. Winter abundance estimates for cetaceans along the California coast based on 1991 and 1992 aerial surveys.

SOCCS3 Barlow, J. 1993. Changes in cetacean abundance in California coastal waters: a comparison of ship surveys in 1979/80 and in 1991.

SOCCS4 Barlow, J. and K. A. Forney. 1993. An assessment of the status of harbor porpoise in California in 1993.

SOCCS5 Forney, K. A. 1993. Status of populations of odontocetes along the coast of California in 1992.

SOCCS6 Barlow, J. 1993. Recent information on the status of whales in California coastal waters.

SOCCS7 Perkins, P., J. Barlow, and M. Beeson. 1993. Report on pinniped and cetacean mortality in California gillnet fisheries: 1988-90.

SOCCS8 Julian, F. 1993. Pinniped and cetacean mortality in California gillnet fisheries: Preliminary results for April 1 to June 30, 1992.

SOCCS9 Chivers, S. J., K. M. Peltier, W. T. Norman, P. A. Akin, and J. Heyning. 1993. Population structure of cetaceans in California coastal waters.

Background Documents:

SOCCS10 Calambokidis, J. and J. Barlow. 1991. Chlorinated hydrocarbon concentrations and their use for describing population discreetness in harbor porpoises from Washington, Oregon, and California. pp. 101-110 In: J. E. Reynolds III and D. K. Odell (eds.) Marine mammal strandings in the United States. NOAA Technical Report NMFS 98.

SOCCS11 Calambokidis, J. C., J. R. Evenson, J. C. Cubbage, S. D. Osmek, D. Rugh, and J. L. Laake. 1993. Calibration of sighting rates of harbor porpoise from aerial surveys. Final Contract Report to the National Marine Mammal Laboratory. 41pp.

SOCCS12 Calambokidis, J., G. H. Steiger, and J. R. Evenson. 1992. Photographic identification and abundance estimates of humpback and blue whales off California in 1991. Contract Report 50ABNF100137, year 1 submitted to SWFSC. 40pp.

SOCCS13 Dizon, A., C. LeDuc, and R. LeDuc. 1993. Intraspecific structure of the northern right whale dolphin (Lissodelphis borealis): The power of an analysis of molecular variation for differentiating genetic stocks.

SOCCS14 Braham, H. 1991. Endangered whales: status update. NMFS Unpublished Manuscript.

SOCCS15 Perkins, P., J. Barlow, and M. Beeson. 1993. Pinniped and cetacean mortality in California gillnet fisheries: 1991. IWC Working Paper SC/44/SM14.

SOCCS16 Heyning, J. E. and W. F. Perrin. 1993. Two forms of common dolphins (genus Delphinus) from the eastern North Pacific; evidence for two species. Submitted: Contr. Sci. Nat. Hist. Mus., L.A. County.

SOCCS17 Rosel, P. E. and M. G. Haygood. 1992. Genetic variation within and among harbor porpoise populations in the Northeast Pacific, North Atlantic and Black Sea, with an emphasis on identifying stocks in the Northeast Pacific. Chapter 5 in: P. Rosel. Genetic population structure and systematic relationships of some small cetaceans inferred from mitochondrial DNA sequence variation. Ph.D. Dissertation, Univ. Calif. San Diego. 191pp.

Background Documents:

SOCCS18 Wade, P. R. and T. Gerrodette. 1992. Estimates of cetacean abundance in the eastern tropical Pacific. Int. Whal. Commn. working paper SC/44/O18.

SOCCS19 Hobbs, R. C., and L. L. Jones. 1993. Impacts of high seas driftnet fisheries on marine mammal populations in the North Pacific. In: IUPFC Symposium: Biology, distribution and stock assessment of species caught in the high seas driftnet fisheries in the North Pacific Ocean.

SOCCS20 Barlow, J. and D. Hanan. 1993. An assessment of the status of harbor porpoise in central California. Rept. Int. Whal., Special Issue (in press).

SOCCS21 Defran, R. H., and D. W. Weller. 1993. Long-term photographic identification of bottlenose dolphins (Tursiops truncatus) in San Diego (in prep).

Appendix 5

Summary of the status of California cetacean stocks based on the stock structure, abundance estimates (N), and minimum population estimates (N-min) recommended at the 1993 Status of California Cetacean Stocks (SOCCS) review. CV(N) is the coefficient of variation in N; N.A. indicates that information is not available; UNK indicates unknown status; OSP denotes populations that are believed to be at optimum sustainable levels as defined by the MMPA. R-MNPL is the population growth rate at the maximum net productivity level.

Species Assumed Stock Structure	N	CV(N)	N-min	Status	R-MNPL	Source
harbor porpoise						
central California	3,806	0.24	2,393	UNK	UNK	1
northern California	10,062	0.28	5,927	OSP	UNK	1
Dall's porpoise						
California	78,422	0.35	40,026	OSP	UNK	2
Pacific white-sided dolphin						
CA + OR + WA	103,724	0.48	42,561	OSP	UNK	3
Risso's dolphin						
CA + OR + WA	27,146	0.45	11,720	OSP	UNK	3
bottlenose dolphin						
California offshore	2,098	0.36	1,060	UNK	UNK	4
California inshore	240	N.A.	224	UNK	UNK	5
striped dolphin						
California	19,008	0.41	8,755	OSP	UNK	2
short-beaked common dolphin						
California	233,378	0.28	136,562	UNK	UNK	2
long-beaked common dolphin						
California	9,472	0.68	2,817	UNK	UNK	2
total common dolphins						
California	245,581	0.27	146,958	UNK	UNK	2
northern right whale dolphin						
CA + OR + WA	17,118	0.46	7,241	UNK	UNK	3
false killer whale						
CA + OR + WA	N.A.	N.A.	N.A.	OSP	UNK	--
killer whale						
California	307	1.20	48	UNK	UNK	2
short-finned pilot whale						
CA + OR + WA	N.A.	N.A.	N.A.	UNK	UNK	--
Baird's beaked whale						
California	38	1.03	7	UNK	UNK	2
Blainville's beaked whale						
California	N.A.	N.A.	N.A.	UNK	UNK	--
Hector's beaked whale						
California	N.A.	N.A.	N.A.	UNK	UNK	--
Stejneger's beaked whale						
California	N.A.	N.A.	N.A.	UNK	UNK	--
Ginko-toothed beaked whale						
California	N.A.	N.A.	N.A.	UNK	UNK	--
Hubbs' beaked whale						
California	N.A.	N.A.	N.A.	UNK	UNK	--

Summary of the status of California cetacean stocks based on the stock structure, abundance estimates (N), and minimum population estimates (N-min) recommended at the 1993 Status of California Cetacean Stocks (SOCCS) review. CV(N) is the coefficient of variation in N; N.A. indicates that information is not available; UNK indicates unknown status; OSP denotes populations that are believed to be at optimum sustainable levels as defined by the MMPA. R-MNPL is the population growth rate at the maximum net productivity level.

Species Assumed Stock Structure	N	CV(N)	N-min	Status	R-MNPL	Source
total mesoplodont beaked whales						
California	250	0.83	60	UNK	UNK	2
Cuvier's beaked whale						
California	1,621	0.82	396	UNK	UNK	2
total beaked whales						
California	3,231	0.56	1,170	UNK	UNK	2
sperm whale						
California	756	0.49	303	endangered	UNK	2
pygmy sperm whale						
California	870	0.80	220	UNK	UNK	2
dwarf sperm whale						
California	N.A.	N.A.	N.A.	UNK	UNK	--
right whale						
California	16	1.04	3	endangered	UNK	3
minke whale						
California	526	0.97	106	UNK	UNK	2
sei whale						
California	N.A.	N.A.	N.A.	endangered	UNK	--
Bryde's whale						
California	61	1.08	11	OSP	UNK	2
blue whale						
California (summer)	2,250	0.38	1,093	endangered	UNK	2
fin whale						
California	935	0.63	299	endangered	UNK	2
humpback whale						
CA + OR + WA (summer)	626	0.41	482	endangered	UNK	6

SOURCES:
1=Barlow and Forney (SOCCS4)
2=Barlow 1993 (SOCCS1 revision, submitted to Fishery Bulletin)
3=Forney and Barlow 1993 (SOCCS2 revision, submitted to Fishery Bulletin)
4=Estimates calculated as average of 2 and 3, with CVs based on additive variances;
5=Hansen 1990 (N); NMFS unpublished data (N-min)
6=Calambokidis, Steiger and Evenson 1993