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RECENT INFORMATION ON THE STATUS OF ODONTOCETES IN CALIFORNIAN WATERS

Karin A. Forney

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U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southwest Fisheries Science Center

NOAA Technical Memorandum NMFS

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RECENT INFORMATION ON THE STATUS OF ODONTOCETES IN CALIFORNIAN WATERS

Karin A. Forney

SECTION 1 - GENERAL INTRODUCTION

Background

The Marine Mammal Protection Act (MMPA) of 1972 governs the management of marine mammals in the U.S.A. Prior to the 1988 amendment to the MMPA, fisheries could only be granted permits to take marine mammals incidentally if there were scientific evidence to show that all stocks of marine mammals involved in the fisheries were at or above their optimum sustainable population (OSP) level. However, sufficient evidence regarding the status relative to OSP only exists for less than 20% of all stocks. Due to the problems and economic losses associated with this system, the Act was amended in 1988 to allow a 5-year interim exemption period, during which 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 interaction with different fisheries. This period ended on October 1, 1993, but was extended to May 1, 1994. New legislation has now been passed by Congress.

The new legislation governing the management of marine mammals under the MMPA involves setting maximum allowable levels for potential takes of each marine mammal stock. These levels are to be calculated based on a minimum abundance estimate, the estimated maximum net growth rate of the stock, and a recovery factor which takes into account the status of the population. Conservative default values will be used where data on growth rates or status are insufficient. To provide the scientific basis for management under the proposed plan, the National Marine Fisheries Service (NMFS) is responsible for providing Stock Assessment Reports at a minimum of once every three years.

This report is intended as a review document, from which the formal Stock Assessment Reports issued by NMFS can draw information for the majority of toothed whales along the coast of California. Assessments for 20 species have been combined, because the amount and types of information available for each are similarly limited. Harbor porpoise *(Phocoena phocoena)*, for which more detailed information is available, and sperm whales *(Physeter macrocephalus)* are treated in separate stock assessment reports (Barlow and Forney 1994; Barlow 1994). Information on population structure and population status is included for each species. In cases where different stock divisions are possible based on the available information, and population status may be different depending on how the stock is defined, alternatives are discussed. For the assessments in this report, information is only included for the eastern North Pacific and, for some species, the central North Pacific high seas driftnet fisheries. Individual species accounts are presented in taxonomic order, according to the classification in Perrin (1989). A summary table is included as Appendix A.

Species list:

PHOCOENIDAE	PORPOISES
Phocoenoides dalli	Dall's porpoise
DELPHINIDAE	DOLPHINS
Lagenorhynchus obliquidens	Pacific white-sided dolphin
Grampus griseus	Risso's dolphin
Tursiops truncatus	Bottlenose dolphin
2 stocks:	coastal form
	offshore form
Stenella coeruleoalba	Striped dolphin
Delphinus delphis	Short-beaked common dolphin
Delphinus capensis	Long-beaked common dolphin
Lissodelphis borealis	Northern right whale dolphin
Pseudorca crassidens	False killer whale
Orcinus orca	Killer whale
Globicephala macrorhynchus	Short-finned pilot whale
ZIPHIIDAE	BEAKED WHALES
Berardius bairdii	Baird's beaked whale
Mesoplodon densirostris	Blainville's beaked whale
Mesoplodon hectori	Hector's beaked whale
Mesoplodon stejnegeri	Stejneger's beaked whale
Mesoplodon ginkgodens	Ginkgo-toothed beaked whale
Mesoplodon carlhubbsi	Hubbs' beaked whale
Ziphius cavirostris	Cuvier's beaked whale
KOGIIDAE	PYGMY/DWARF SPERM WHALES
Kogia breviceps	Pygmy sperm whale
Kogia simus	Dwarf sperm whale

SECTION 2 - STATUS BY SPECIES

Outline of species accounts

The following information is provided for each of the species listed above (sections in parentheses are only included when applicable):

1. Introduction
   - History of exploitation and management
   - Biology

2. Population and stock structure
   - Biological basis of populations
   - Recommended stocks for management

3. Population size
   - Estimation methods
   - Population estimates

4. Population growth rates and trends
   - Trends in abundance
   - Growth rate at MNPL

5. Stock status relative to OSP and K
   - OSP determination
   - Condition indices
   - (Other information bearing on status)

6. Current removals
   - Incidental take
   - Direct take
   - Illegal killing
   - Research and live capture
   - Other causes

Dall's porpoise, *Phocoenoides dalli*

INTRODUCTION

History of exploitation and management

In the eastern North Pacific, exploitation levels of Dall's porpoise have historically been low. In contrast, incidental mortality of this species has occurred in Japanese fisheries in the central and western North Pacific since at least the mid-1960's and probably since the fisheries began in 1952 (Jones 1984; 1990). Japanese harpoon fisheries for small cetaceans have traditionally also taken many Dall's porpoise. There is evidence for several stocks within the range of this species, but it has not been adequately demonstrated whether animals along the U.S. west coast are part of a distinct stock or are continuous with animals in the central and western Pacific (Perrin and Brownell 1994). Due to the low levels of incidental mortality in the eastern North Pacific, no direct management actions have been taken for this species in this region.

Biology

Dall's porpoise are a common pelagic species endemic to the North Pacific. They are found in temperate waters from Japan north into the Bering Sea, across the Aleutians, and south along the coast of North America to at least 28°N (Morejohn 1979). They are most frequently sighted near the continental slope and in deeper offshore waters, but they also occur over shelf waters. Seasonal movements are thought to occur and appear to be related to water temperatures (Leatherwood et al. 1982). Two common color morphs are known: the *truei*-type and the *dalli*-type, which are found in different frequencies in different regions. Dall's porpoise are known to feed on a variety of fishes, cephalopods and crustaceans (Morejohn 1979). Regional differences in reproductive parameters apparently exist (summarized by Gaskin et al. 1984, and Jefferson 1988; 1990). Dall's porpoise in the northwestern North Pacific and Bering Sea are reported to reach sexual maturity at 3 years (females) and 5-6 years (males), with most females having an annual reproductive cycle, a 10-11 month gestation and a 2-4 month lactation period (Newby 1982). In contrast, Dall's porpoise from coastal Japanese waters were found to have a later onset of sexual maturity (7 years for females, 8 years for males), and a mean calving interval of 2-3 years, with an 11.4 month gestation and a lactation period of 1-2 years (Kasuya 1978). Insufficient data are available to estimate reproductive parameters for coastal animals found in California/Oregon/Washington waters.

POPULATION AND STOCK STRUCTURE

Biological basis of populations

Perrin and Brownell (1994) review stock structure for this species and identify seven stocks, including one *truei*-type stock and six *dalli*-type stocks. The divisions are based primarily on differences in parasite loads (Walker 1990), pollutant levels (Subramanian et al. 1986) and observed patterns of migration and breeding (Yoshioka et al. 1990). Coastal animals are reported to be larger than offshore ones along the coasts of Japan and California, but other osteological evidence has not been conclusive (Walker and Sinclair 1990), and genetic studies of the two morphs have failed to demonstrated clear differences (Shimura and Numachi 1987). The stock structure of animals in the central and eastern Pacific remains unclear, but based on patterns in the western North Pacific, it is likely that additional stocks will emerge in this region when sufficient data are available (Perrin and Brownell 1994). Based on inter-annual changes in local abundance of Dall's porpoise along the California coast (Barlow, in press; NMFS, unpublished data), however, it is likely that these animals are part of a population extending northward into Oregon and Washington.

Recommended stocks for management

Due to the lack of evidence on the relationship of animals occurring along the U.S. west coast to those in other areas of the North Pacific, it is recommended that for management purposes, the stock be defined to include only those animals within the U.S. Exclusive Economic Zone (EEZ) of California, Oregon and Washington.

POPULATION SIZE

Estimation methods

Line transect abundance estimates for Dall's porpoise in California have been made based on aerial survey data collected 1975-78 (Dohl et al. 1980), 1980-83 (Dohl et al. 1983), and in 1991-92 (Forney et al., in press). For Oregon and Washington, Green et al. (1992) obtained line transect abundance estimates based on 1989-90 aerial surveys. Shipboard line transect estimates are available from a 1991 comprehensive ship survey for marine mammals in California (Barlow, in press). Separate line transect estimate of Dall's porpoise abundance have been made for entire North Pacific (Buckland et al. 1993), for the western North Pacific north of 40° latitude (Turnock 1987), and for the eastern North Pacific (Bouchet and Withrow 1984) based on sighting data from various shipboard platforms; however, these estimates are not stratified by area or stock.

Population estimates

For the entire North Pacific, Buckland et al. (1993) estimate a population of 1,186,000 Dall's porpoise (95% confidence interval: 997,000 - 1,410,000) based on ship surveys conducted between 1987 and 1990. No information on the proportion of animals in different geographic regions, including the U.S. west coast, is available from these surveys. For aerial surveys conducted in the Southern California Bight between 1975 and 1978, Dohl et al. (1980) present monthly estimates of abundance for Dall's porpoise ranging from 0 to 400 animals, without confidence limits. Based on 1980-83 aerial surveys in central and northern California, quarterly population estimates for animals north of Point Conception ranged between 3,400 and 8,750, without confidence limits. The Oregon/Washington population of Dall's porpoise was estimated to contain 2,149 animals (CV=0.17, 95% log-normal confidence interval: 1,550 - 2,980) based on aerial surveys conducted in 1989-90, primarily between the coast and the 1000m isobath (Green et al. 1992).

Forney et al. (in press) present an abundance estimate of 8,460 (CV=0.24; 95% log-normal confidence interval: 5,320 - 13,453) Dall's porpoise for the 1991-92 aerial surveys, which covered coastal California waters out to 100-150 nmi during the cold-water months of March and April. Based on a 1991 ship survey extending 300 nmi offshore along the California coast during the warm-water months of July-November, Barlow (in press) estimates that there are 78,422 (CV=0.35, 95% log-normal confidence interval: 40,026 - 153,649) Dall's porpoise. The ship survey covered a larger area of the coast and therefore would be expected to yield a higher estimate than the aerial surveys, but the difference appears greater than can be accounted for on the basis of this alone. A stratified analysis of the ship survey data yields an abundance estimate within the smaller aerial survey study area of 26,313 Dall's porpoise (CV=0.30), which is still considerably higher than the aerial survey estimate.

It is likely that the difference between these two abundance estimates is caused primarily by the larger fraction of animals missed by aerial observers. Correction factors for animals missed during aerial surveys have been estimated for harbor porpoise, which (from the air) have similar sighting characteristics to Dall's porpoise. Barlow et al. (1988) estimate that 31.2% of harbor porpoise on the trackline are seen, but no confidence limits are presented. Calambokidis et al. (1993) estimate that the fraction of animals on the trackline which are seen is 0.324 (CV=.173). Applying the latter correction factor to the aerial survey abundance estimate for Dall's porpoise yields a corrected estimate of 26,111 animals (CV=0.30), which is virtually the same as the shipboard estimate for the same area. Given the assumptions and uncertainties regarding the aerial survey correction factor, the shipboard estimate is a more accurate estimate of Dall's porpoise abundance along the California coast.

It is important to note, however, that California represents the southern end of this species' range, and changes in water temperature may influence its apparent abundance in this region. A recent (1993) ship survey, which was comparable to the 1991 ship survey (NMFS, unpublished data), yielded warmer water temperatures and dramatically fewer sightings of this species along the California coast. This observation is consistent with the hypothesis that Dall's porpoise extend farther south into California and are more abundant during cold-water periods, and shift northward out of this region during warm-water episodes. For this reason, the estimates obtained for California in 1991 and for Oregon/Washington in 1989-90 cannot be added to obtain an overall estimate. In the absence of a complete census for the entire California/Oregon/Washington region, the abundance estimate of 78,422 Dall's porpoise obtained by Barlow (in press) for California coastal waters represents the best overall abundance estimate for the combined waters of these three states.

POPULATION GROWTH RATES AND TRENDS

Trends in abundance

Due to the lack of historical abundance estimates with confidence limits for coastal waters of California/Oregon/Washington, it is not possible to make any conclusions regarding population trends for Dall's porpoise in this region. Population size in this region is likely to vary with oceanographic conditions on both a seasonal and inter-annual basis, making the detection of long-term trends more difficult.

Growth rate at MNPL

Gaskin et al. (1984) summarize reproductive information for phocoenids. However, the majority of their data for Dall's porpoise are for the western North Pacific, and the available information is insufficient to estimate growth rates.

STOCK STATUS RELATIVE TO OSP AND K

OSP determination

In waters off California, Oregon and Washington, fisheries are not likely to have caused a population decline, because incidental mortality of this species has historically been low. If these animals are considered to be part of a larger eastern Pacific stock, then the evaluation of status must include the mortality this species has experienced in high-seas drift gillnet fisheries. Assuming that the total estimated mortality in these fisheries for 1989 and 1990 is representative of the mortality for prior and subsequent years, then the take has not exceeded a rate of 2% per year (Hobbs and Jones 1993), and therefore these fisheries are not likely to have reduced the population below OSP. However, uncertainties in these assumptions and the lack of information on other potential sources of mortality preclude a definitive assessment, and the status of Dall's porpoise in relation to OSP should be considered unknown.

Condition indices

No data are available to evaluate potential biological condition indices for this species.

CURRENT REMOVALS

Incidental take

The observed incidental take of Dall's porpoise in California fisheries has been low during periods when observer programs provided information on mortality. No Dall's porpoise are known to have been incidentally killed in California gillnet fisheries between 1980 and 1985, when observer coverage was less than 1% of the total fishing effort (Diamond et al. 1987). Since July 1990, with approximately 4-15% observer coverage for the driftnet fisheries in California, observed mortality of Dall's porpoise is one animal for July-December 1990, two animals in 1991, one animal in 1992, and nine animals in 1993. Total annual mortality estimates for Dall's porpoise are 23 (s.e. 22) for July-December 1990 (Lennert et al. 1994), 17 (s.e. 12.8) for 1991 (Perkins et al. 1992), eight (s.e. 7) for 1992 (Julian 1993), and 82 (s.e. 36) for 1993 (Julian 1994).

Barlow et al. (1994) report that fishery mortality is also known in Alaska trawl and gillnet fisheries, and in the salmon driftnet fishery in British Columbia. No annual estimates are available for this mortality. Additional estimates of mortality within the U.S. Exclusive Economic Zone (EEZ) for the Japanese high seas salmon mothership fishery, which has been operating in the North Pacific since 1952, have been made for 1981-87 and range between 741 and 4,187 animals (Jones 1984; 1990). Depending on true population structure along the west coast of North America, these additional sources of mortality may or may not be relevant to the assessment of animals along the California/Oregon/Washington coast.

Direct take

No direct take of Dall's porpoise is known to occur in the eastern North Pacific.

Illegal killing

No illegal killing is known or suspected for this species.

Research and live capture

Based on records from one marine park, Walker (1975) reports that 4 Dall's porpoise were captured in Southern California from 1966 to 1972. No additional live-captures are known for this species (Reeves and Leatherwood 1984).

Other causes

Examination of a single Dall's porpoise from California (O'Shea et al. 1980) revealed moderate to high pollutant loads. However, the effects of pollutants on cetaceans are not well understood.

Pacific white-sided dolphin, *Lagenorhynchus obliquidens*

Two forms: northern and southern

INTRODUCTION

History of exploitation and management

The Pacific white-sided dolphin is found only in continental slope, shelf and offshore waters of the North Pacific ocean. In recent years, offshore animals have been subject to a relatively high level of mortality in high-seas driftnet fisheries. Coastal populations have been taken in smaller numbers in gillnet and purse-seine fisheries. Within the U.S. west coast EEZ, mortality has generally been thought to be low in relation to population size, and no direct management actions have been taken for this species.

Biology

Pacific white-sided dolphins are thought to be continuously distributed across the temperate North Pacific. Two morphologically distinct populations have been suggested for the northeastern Pacific (Walker et al. 1986). Pacific white-sided dolphins are present year-round along the California coast, with apparent seasonal changes in abundance (Dohl et al. 1983; Leatherwood et al. 1984). The timing and extent of movement of animals from the two populations are not known, as they cannot practically be distinguished in the field. The larger, southern temperate form is thought to inhabit waters from the Southern California Bight to Baja California, Mexico. The smaller, northern temperate form is thought to range northward from the Southern California Bight to Alaska. Thus, the Southern California Bight appears to represent an area of overlap or clinal variation for the two forms. The diet of Pacific white-sided dolphins includes cephalopods and a variety of fishes. Insufficient data exist to estimate age at sexual maturity, calving interval and reproductive rates (Perrin and Reilly 1984); however, considerable variability has been found in length at sexual maturity (Harrison et al. 1972; Walker et al. 1986).

POPULATION AND STOCK STRUCTURE

Biological basis of populations

The distinction between northern and southern temperate forms is based on differences in body length and cranial measurements between adult specimens collected from north of 37°N and south of 32°N (Walker et al. 1986; Chivers et al. 1993). The measurements overlapped in specimens collected between 32° and 37° (33° and 36°, Chivers et al. 1993), which suggests that the two forms co-occur in this region, or that there is a clinal change between the two forms. External morphology is highly variable in this species, and no systematic differences have been identified between the two regions. The relationship between coastal animals and animals found offshore and in the western North Pacific is not known.

Recommended stocks for management

A high level of take in the central North Pacific high-seas driftnet fisheries may have had an impact on the population (Hobbs and Jones 1993); however, these fisheries have now been discontinued, and the offshore portion of the population can now be expected to recover. Future mortality is likely to be restricted primarily to driftnet fisheries, and abundance and mortality estimates are currently available for coastal animals. Recent surveys (Green et al. 1992) suggest that seasonal movement of animals between California and Oregon/Washington occurs, with the majority of animals in California waters during winter/spring. Although there is evidence that there are two morphologically distinct populations in California waters, they cannot at this time practically be differentiated in the field, and estimates of mortality and abundance exist only for both forms combined. It is recommended that for management purposes, the stock be defined to include Pacific white-sided dolphins of both forms within the U.S. EEZ of California, Oregon and Washington. If it is shown that geographical, morphological and/or genetic information can be used to separate the northern and southern forms, two separate management stocks should be defined for this species in the future.

POPULATION SIZE

Estimation methods

Line transect abundance estimates for Pacific white-sided dolphins have been made based on aerial survey data collected in California waters in 1975-78 (Dohl et al. 1980), 1980-83 (Dohl et al. 1983), and in 1991-92 (Forney et al., in press). Shipboard line transect estimates are available from a 1991 comprehensive ship survey for marine mammals in California (Barlow, in press), and from Platform of Opportunity Programs in the entire North Pacific (Buckland et al. 1993). Aerial surveys in Oregon and Washington have provided seasonal line transect abundance estimates for this region in 1989-90. Additional sighting data are available from several National Marine Fisheries Service surveys conducted between 1978 and 1985 along the California coast and south into tropical waters. Separate line transect estimates of abundance for Pacific white-sided dolphins in the entire North Pacific have recently been made based on sighting data collected by observers aboard Japanese and U.S. vessels in 1987-90. The range of coverage is from the west coast of North America across the Pacific to Japan and south to about 20°N (Buckland et al. 1993; Miyashita 1993), but effort was sparse in much of the area, and the resulting abundance estimates have a high degree of uncertainty.

Population estimates

For aerial surveys conducted in the Southern California Bight between 1975 and 1978, Dohl et al. (1980) present monthly estimates of abundance for Pacific white-sided dolphins ranging from 0 to 54,000 animals. However, no confidence limits are available for these estimates, and it is likely that this range of values is driven primarily by sampling variance, rather than actual changes in abundance. Based on 1980-83 surveys, quarterly population estimates for California north of Point Conception ranged between 26,000 and 86,000 animals, again without confidence limits. Forney et al. (in press) present a best abundance estimate of 121,693 (CV=0.48; 95% log-normal confidence interval: 51,041 - 290,144) Pacific white-sided dolphins for the 1991-92 aerial surveys, which covered coastal California waters out to 100-150 nmi during the cold-water months of February-April. Based on a 1991 ship survey extending 300 nmi offshore along the California coast during the warm-water months of July-November, Barlow (in press) estimates that there are 12,310 (CV=0.54; 95% log-normal confidence interval: 4,590 - 33,010) Pacific white-sided dolphins. The large difference between these two estimates is consistent with previous suggestions of a seasonal change in abundance of this species within California waters (Dohl et al. 1980; 1983), as well as a northward movement into Oregon and Washington during spring/summer (Green et al. 1992). Based on the virtual absence of Pacific white-sided dolphins in Oregon/Washington during the cold-water months (Green et al. 1992), the 1991 California winter/spring estimate (Forney et al., in press) may be considered a complete population estimate for California, Oregon and Washington.

A separate population estimate has been made for Pacific white-sided dolphins in the entire North Pacific. Buckland et al. (1993) present an abundance estimate (corrected for size bias in sighting rates) of 931,000 (CV=0.90; 95% confidence interval 206,000 - 4,216,000). This is remarkably similar to an estimate of 988,000 animals (CV and confidence interval can be calculated as 0.70 and 287,000 - 3,401,000, respectively, based on information given in the paper) presented by Miyashita (1993) for the western and eastern North Pacific based on a largely different data set spanning the same time period. The two population estimates rely on slightly different assumptions and have a large uncertainty, so the closeness of these values is surprising. Combining the estimates and assuming additive variances results in an average estimate of 959,500 animals, with a CV=0.57 and a 95% log-normal confidence interval of 342,000 - 2,694,000). In both papers, the authors note that the estimates are likely to be biased upwards due to attraction of Pacific white-sided dolphins to the survey vessel. It is currently not known what relationship, if any, animals found in the central North Pacific have to Pacific white-sided dolphins in coastal regions of the U.S. west coast.

POPULATION GROWTH RATES AND TRENDS

Trends in abundance

The apparent abundance of Pacific white-sided dolphins varies seasonally and inter-annually with fluctuations in water temperatures (Dohl et al. 1980; 1983; Green et al. 1992; Forney et al., in press; Barlow, in press), but no long-term trends in the abundance of this species have been identified.

Growth rate at MNPL

Perrin and Reilly (1984) summarize life history information for delphinids, but insufficient data exist to estimate the growth rate at MNPL for Pacific white-sided dolphins.

STOCK STATUS RELATIVE TO OSP AND K

OSP determination

In waters off California, Oregon and Washington, fisheries are not likely to have caused a population decline, because incidental mortality of this species has historically been low. Higher mortality has been observed for high seas driftnet fisheries in the central North Pacific, but the level of mortality is not likely to have impacted the large overall population (Hobbs and Jones 1993). However, uncertainties in abundance and mortality estimates and the lack of information on other potential sources of mortality preclude a definitive assessment, and the status of Pacific white-sided dolphins in relation to OSP should be considered unknown.

Condition indices

No data are available to evaluate potential biological condition indices.

CURRENT REMOVALS

Incidental take

Incidental mortality of Pacific white-sided dolphins has occurred in high seas driftnet fisheries, tropical tuna seine fisheries, and in California gillnet and seine fisheries (Fox 1977; Perkins et al. 1992; Hobbs and Jones 1993; Julian 1993; 1994; Lennert et al. 1994). Data on fishery mortality in California fisheries are available for gillnet fisheries monitored by CDFG (1979-86) and NMFS (since 1990). Between 1980 and 1985, less than one percent of all gillnet effort was observed, yielding one animal observed taken in a driftnet in 1981 (Diamond et al. 1987), and two animals observed taken in nearshore gillnets in 1985 (Collins et al. 1986; Wild 1986). Three strandings of this species judged to be fishery-related were observed in Southern California between 1975 and 1990 (Heyning et al. 1994).

Since 1990, observations have covered approximately 4-15% of fishing effort for set and drift gillnet fisheries (Perkins et al. 1992; Julian 1993; 1994; Lennert et al. 1994). Observed mortality of Pacific white-sided dolphins was three animals for July-December 1990, five animals in 1991, three animals in 1992, and two animals in 1993. Total annual mortality estimates derived from these figures are 68 animals (s.e. 38) for July-December 1990 (Lennert et al. 1994), 42 (s.e. 30.2) animals for 1991 (Perkins et al. 1992), 23 (s.e. 16) animals for 1992 (Julian 1993), and 18 (s.e. 12) animals for 1993 (Julian 1994).

A much higher level of mortality has been observed in the North Pacific high seas driftnet fisheries since 1989 (Hobbs and Jones 1993); however, the relationship of these Pacific white-sided dolphins to coastal California animals is not clear. No total estimate for all high seas fisheries is available for 1989, but the estimated total mortality for the high seas population in 1990 was 5,759 animals. Confidence limits for mortality estimates are only available for the Japanese squid driftnet fishery, which was responsible for an estimated 4,459 (95% confidence interval: 3,924 - 4,994) deaths in 1990 and 6,119 (95% confidence interval: 3,683 - 8,555) in 1989 (Hobbs and Jones 1993). These mortality levels are low in relation to the estimate population size in this region, but the available abundance estimates may be biased upwards due to vessel attraction (Buckland et al. 1993).

Direct take

None known.

Illegal killing

None known.

Research and live capture

Based on records from one marine park, Walker (1975) reports that 51 Pacific white-sided dolphins were captured in Southern California from 1966 to 1972. From 1973 to 1982, 28 Pacific white-sided dolphins are known to have been captured for public display and scientific research (Reeves and Leatherwood 1984). Since 1982, 12 additional animals have been taken from California waters, the most recent being three animals captured in November, 1993. Brownell et al. (in press) estimate a minimum total live capture removal of 128 Pacific white-sided dolphins between the late 1950's and 1993. No MMPA permits for live captures are currently active.

Other causes

In the few specimens of Pacific white-sided dolphins that have been examined for pollutants, observed loads were variable (Britt and Howard 1983; Taruski et al. 1975). However, the effects of pollutants on cetaceans are not well understood.

Risso's dolphin, *Grampus griseus*

INTRODUCTION

History of exploitation and management

Risso's dolphins along the U.S. west coast have not been subject to substantial incidental mortality, but some takes have occurred in squid purse seine and driftnet fisheries. Additional mortality has been reported in high seas drift gillnet fisheries (Hobbs and Jones 1993). Historically, incidental mortality has not been considered a problem, and no direct management actions have been taken for this species.

Biology

Risso's dolphins have a largely pelagic distribution in tropical and warm temperate waters of both hemispheres. In the eastern North Pacific, they are known to occur from equatorial waters to about 50°N, with two apparent gaps in distribution centering around latitudes 20°N and 42°N (Leatherwood et al. 1980; Green et al. 1992). Their diet consists almost exclusively of cephalopods. Maximum age is reported to be at least 20 years. Insufficient data exist to estimate age at sexual maturity, calving interval or reproductive rates.

POPULATION AND STOCK STRUCTURE

Biological basis of populations

Risso's dolphins are distributed worldwide in pelagic and continental slope waters of warm temperate and tropical regions. They appear to be most abundant in the northern areas during warm water periods. Animals found in California are likely to be part of a population extending north and south to an unknown extent. The apparent gap in distribution centered around 20°N may indicate a distributional boundary separating warm temperate from tropical populations. A second area of apparent low density near 42°N may be due to local avoidance of colder upwelled water (Green et al. 1992), as animals have been found year-round both north and south of this area on recent surveys (Green et al. 1992; Forney et al., in press; Barlow, in press). Historically, however, Risso's dolphins were rare north of California. Based on this fact and a comparison of surveys in Oregon/Washington in 1989-90 with similar surveys in central and northern California in 1980-83, Green et al. (1992) suggest seasonal interchange of animals between California and Oregon/ Washington. However, no data on movement of individuals or on the genetics of animals from different regions are currently available to confirm these patterns.

Recommended stocks for management

Based on the evidence for movement between California and Oregon/ Washington, and the apparent distributional gap for this species between California and the eastern tropical North Pacific, it is recommended that the stock be defined to include those animals within the U.S. EEZ of California, Oregon and Washington.

POPULATION SIZE

Estimation methods

Line transect abundance estimates for Risso's dolphins have been made based on aerial survey data collected 1975-78 (Dohl et al. 1980), 1980-83 (Dohl et al. 1983), and 1991-92 (Forney et al., in press). Shipboard line transect estimates are available from a 1991 comprehensive ship survey for marine mammals in California (Barlow, in press). Additional sighting data are available from several National Marine Fisheries Service surveys conducted between 1978 and 1985 along the California coast and south into tropical waters.

Population estimates

For aerial surveys conducted in the Southern California Bight between 1975 and 1978, Dohl et al. (1980) present monthly estimates of abundance for Risso's dolphins ranging from 0 to 10,200 animals. However, no confidence limits are available for these estimates, and it is likely that this range of values is driven primarily by sampling variance, rather than actual changes in abundance. Based on 1980-83 surveys, quarterly population estimates for California north of Point Conception ranged between 13,000 and 30,000 animals, again without confidence limits. Forney et al. (in press) present a best abundance estimate of 32,376 (CV=0.46, 95% log-normal confidence interval: 13,812 - 75,891) Risso's dolphins for the 1991-2 aerial surveys, which covered coastal California waters out to 100-150 nmi during the cold-water months of February-April. Based on a 1991 ship survey extending 300 nmi offshore along the California coast during the warm-water months of July-November, Barlow (in press) estimates that there are 8,496 (CV=0.42; 95% log-normal confidence interval: 3,890 - 18,555) Risso's dolphins. The difference in estimates is consistent with movement of animals northward into Oregon/Washington waters during the warm-water months, as proposed by Green et al. (1992). Because surveys in Oregon/Washington were conducted in different years than the California surveys and oceanographic conditions vary from year to year, the abundance estimates for Oregon/Washington (Green et al. 1992) and California (Forney et al., in press; Barlow, in press) cannot be considered additive. The winter/spring 1991-2 aerial survey estimate is likely to be a more accurate population estimate for all three states combined, because during these cold-water months the majority of Risso's dolphins in this population were probably in California (Green et al. 1992). Thus the best overall abundance estimate for Risso's dolphins in California, Oregon and Washington combined is the estimate of 32,376 animals obtained by Forney et al. (in press) for California, but this estimate is likely biased downwards due to an unknown number of animals that were farther north at the time.

POPULATION GROWTH RATES AND TRENDS

Trends in abundance

Although anecdotal evidence suggests that Risso's dolphins may have become more abundant in California during the last two decades, the apparent increase in sightings may in fact be due to more intensive sampling of pelagic waters off California, rather than actual changes in abundance. Due to the lack of confidence limits, estimates made by Dohl et al. (1980; 1983) cannot be directly compared to the more recent estimates. A comparison of 1979/80 ship survey sighting data with the 1991 ship survey indicate that no significant trend is detectable (Barlow 1993)

Growth rate at MNPL

Perrin and Reilly (1984) summarize life history information for delphinids, but no estimate of net annual reproductive rate could be made for Risso's dolphins. Thus the growth rate of this species is unknown.

STOCK STATUS RELATIVE TO OSP AND K

OSP determination

Fishery mortality for Risso's dolphins has historically been low relative to population size throughout the eastern North Pacific. However, due to the lack of information on other potential sources of mortality, the status of Risso's dolphins in relation to OSP should be considered unknown.

Condition indices

No data are available to evaluate potential biological condition indices.

CURRENT REMOVALS

Incidental take

Mortality of Risso's dolphins is known to occur in squid purse seine and drift gillnet fisheries. Evidence of fishery interactions has been found on stranded specimens in Southern California (Heyning et al. 1994). Systematic data on fishery mortality exist for gillnet fisheries in California based on monitoring programs conducted by CDFG and NMFS during 1979-86 and from July 1990 to the present. No Risso's dolphins are reported to have been taken incidentally to fishing operations in California prior to 1991 (Miller et al. 1983; Herrick and Hanan 1988; Lennert et al. 1994), but observer coverage of fishing effort was less than 1% except for 1990, when roughly 4% of effort was observed. In 1991-93, observations covered approximately 10-15% of fishing effort for set and drift gillnet fisheries (Perkins et al. 1992; Julian 1993; 1994). Observed mortality of Risso's dolphins was five animals in 1991, five animals in 1992, and four animals in 1993, resulting in total annual mortality estimates of 42 (s.e. 24) Risso's dolphins for 1991 (Perkins et al. 1992), 38 (s.e. 18) animals for 1992 (Julian 1993), and 36 (s.e. 27) animals for 1993 (Julian 1994). Some mortality is also known to have occurred in the high seas drift gillnet fisheries (Hobbs and Jones 1993), but the relationship between these animals and those found in California/Oregon/Washington is not clear.

Direct take

None known.

Illegal killing

None known.

Research and live capture

One Risso's dolphin is reported to have been live-captured in 1978 off the Southern California coast between 1966 and 1982 (Walker 1975; Reeves and Leatherwood 1984).

Other causes

No specimens from the U.S. west coast have been examined for pollutants, but levels are expected to be low for this pelagic species.

Bottlenose dolphin, *Tursiops truncatus*

Two forms: coastal bottlenose dolphin and northern offshore bottlenose dolphin

INTRODUCTION

History of exploitation and management

In the eastern North Pacific, bottlenose dolphins have not historically been subject to high mortality, although some fishery mortality occurs and specimens have been live-caught for public display. Three stocks have been recognized for the eastern North Pacific (Walker 1981). Two of these stocks - the northern offshore and coastal forms - occur in California waters. Most of the biological information about this species has been obtained from populations in other parts of the world, but some biological data have been collected for animals in the eastern North Pacific. No direct management actions have been taken for this species, although efforts to reduce overall dolphin mortality in the eastern tropical Pacific have resulted in a decrease in fishery mortality of bottlenose dolphins in that region.

Biology

Two forms of bottlenose dolphins occur along the coast of California (Walker 1981), with a distributional boundary between the two parapatric forms occurring within a few miles (or less) of the coast (Hansen 1990). The affiliation of bottlenose dolphins found in the vicinity of the Channel Islands in Southern California has not been clearly established, although specimens which have stranded on the islands exhibit the morphological characteristics of the offshore form (Walker 1981), and animals sighted in these areas have been assumed to be part of the offshore population for abundance estimation (Forney et al., in press; Barlow, in press). Recent sighting locations for presumed offshore bottlenose dolphins ranged from within a few miles of the coast, around the Southern California islands, to at least 300 nmi offshore, and north to approximately 40°N latitude (Hill and Barlow 1992; Carretta and Forney 1993). The coastal form has been sighted primarily within a narrow coastal band of approximately 1 km width (Hansen 1983; NMFS, unpublished data; Defran and Weller 1992), and historical records have been primarily south of Los Angeles County (Hansen 1990). However, a northward range expansion into central California has been documented since the 1982-83 El Niño event (Wells et al. 1990). In recent years, coastal bottlenose dolphins have commonly been seen along the entire Southern California coastline south of Point Conception (NMFS, unpublished data), and have also regularly been seen in Monterey Bay (Maldini

1992). Individuals sighted in southern California have been re-sighted off Baja California (Ensenada or San Quintín) and Monterey, California, indicating that long-range movement occurs.

The coastal form of bottlenose dolphin is most commonly seen in groups of less than about 25 animals, but larger groups of up to 139 animals have been reported (Defran et al. 1986; Hansen 1990; NMFS, unpublished data). In California, the northern offshore form is primarily seen in groups of up to 100 animals (Hill and Barlow 1993; Carretta and Forney 1993), often including other cetaceans, such as pilot whales, Risso's dolphins, and sperm whales (Hill and Barlow 1992; Wells and Scott, in press). The diet of bottlenose dolphins has been shown to vary considerably based on local prey availability. Coastal animals tend to feed primarily on year-round resident fishes and invertebrates of the littoral and sub-littoral zones, while offshore animals are known to feed on a variety of epipelagic fishes (e.g. scombrids) and cephalopods (Walker 1981). Biological data on growth and reproduction have been collected for this species in other parts of the world, but a large variation in these parameters has been documented, and it is not possible to generalize from one region to another (Wells and Scott, in press). Some specimens of the northern offshore and coastal forms in the North Pacific have been examined (Walker 1981; Perrin and Reilly 1984), but the available data are insufficient to estimate biological parameters for these populations.

POPULATION AND STOCK STRUCTURE

Biological basis of populations

Evidence for the separation of the two forms of bottlenose dolphins was obtained in a study of parasite faunas and morphological measurements, including tooth size and cranial characteristics (Walker 1981). Differences in body length have also been documented (Walker 1981; Chivers et al. 1993), with the coastal form being somewhat larger than the offshore form. The existence of coastal and offshore populations of bottlenose dolphins in other parts of the world is also well-established (Wells and Scott, in press). Offshore bottlenose dolphins found in California were considered to be distinct from bottlenose dolphins found in the eastern tropical Pacific by Walker (1981), based on differences in cranial characteristics, tooth size, and parasite loads. However, in a recent re-examination of available data, Chivers et al. (1993) conclude that small sample sizes do not allow for conclusive confirmation of a difference between these two groups.

Recommended stocks for management

Two stocks should be distinguished for management purposes: (1) a coastal form, found within approximately 1 km of the coastline of southern and central California; and (2) an offshore form, considered here to include animals more than approximately 1 km offshore, around the Channel Islands and farther offshore along the entire California coast, within the U.S. EEZ. Refinement of these definitions may be required if additional studies (e.g. genetic, tagging, or photo-identification) clarify the ranges and distributional boundaries of the two forms. Furthermore, both forms extend south of California into Mexican waters, and cooperative research on abundance and mortality of these populations throughout their range should be initiated by the U.S. and Mexico, so that biologically meaningful units can be managed in the future.

POPULATION SIZE

Estimation methods

Estimation methods have differed for the two forms and will be described separately. For coastal bottlenose dolphins, population sizes have been estimated based on photo-identification studies of animals with natural marks on their dorsal fins. A catalogue of several hundred animals is maintained by the Cetacean Behavior Laboratory at San Diego State University (Defran, pers. comm.), but the photographs were taken over the period of nearly a decade, and the extent of mortality of identified individuals cannot be assessed. Mark-recapture abundance estimates have been calculated based on photo-identification work, but confidence limits are broad (Hansen 1990). Recently, the National Marine Fisheries Service has conducted a series of eight bimonthly aerial line transect surveys at varying times of the year between 1990 and 1993 (NMFS, unpublished data). Abundance estimates are not yet available from these surveys, but actual counts from a single survey can be used to define a minimum population size.

The abundance of offshore bottlenose dolphins has recently been assessed in two separate surveys along the California coast. Barlow (in press) has calculated line transect abundance estimates for the offshore animals based on a summer/fall ship survey which extended offshore approximately 300 nmi along the entire California coast. Separate winter/spring line transect estimates were obtained based on aerial line transect surveys conducted in March-April 1991 and February-April 1992 (Forney et al., in press). These currently are the only available abundance estimates for the northern offshore form of bottlenose dolphins along the California coast.

Population estimates

Coastal bottlenose dolphins: Mark-recapture population estimates for the coastal form of bottlenose dolphins in San Diego and Orange Counties range from 173 to 240 animals, depending on the estimation method used (Hansen 1990). Based on the assumptions of the four methods used, the estimate of 240 animals has been judged the most reliable (Hansen 1990). This is less than the 404 animals which have been photographically identified between 1981 and 1989 within a larger area extending from Santa Barbara County south to Ensenada, Mexico. Re-sightings indicate that movement of animals between these areas is common. Hansen and Defran (1990) estimate that only 65% of dolphins in this area have distinctively marked fins enabling individual identification, yielding a corrected population estimate of 546 bottlenose dolphins based on the number of identified and unidentifiable individuals photographed for the period 1981-1989 (Defran and Weller 1992). This cannot be considered a minimum count, however, because an unknown number of animals are likely to have died within the study period. The relatively low proportion of newly identified animals in recent years (Defran and Weller 1992) suggests that even if mortality were very low, the population is not likely to be substantially larger than the number of identified individuals. Depending on the true natural mortality level, the current population size may in fact be less than 546, particularly since no confidence limits are available for the 35% unidentifiable dolphins.

The NMFS aerial line transect data (NMFS, unpublished data) yield similar information on population sizes for a study area extending from the U.S./Mexico border to Point Conception. Complete analyses of these data have not yet been performed, so no line transect estimates are currently available. The maximum number of bottlenose dolphins counted within a single survey of this coastline was 215 animals, on October 25, 1991. A replicate survey completed later on the same day resulted in an additional 9 animals, which, based on the location of the sightings and maximum travel speed, could not have been recorded on the first survey. This results in a count of 224 animals along the Southern California coast (south of Point Conception). On this same day, Maldini (1992) reports that 21 animals were photographically identified in Monterey Bay, yielding an overall count of 245 bottlenose dolphins in central and southern California. The actual number of dolphins present is likely to have been higher by an unknown amount, because no surveys were conducted between Point Conception and Monterey Bay, and submerged animals are often missed on aerial surveys, particularly when water turbidity is high.

<u>Offshore bottlenose dolphins</u>: Dohl et al. (1980) reported 32 monthly abundance estimates based on aerial surveys conducted 1975-77, ranging from 0 to 925 animals for the entire Southern California Bight (both forms combined), but no minimum abundance estimates or confidence limits were presented. Most of the animals seen by Dohl et al. (1980) were probably of the offshore type, based on sighting locations. Barlow (in press) estimates a population of 1,503 (CV=0.48; 95% log-normal confidence interval: 615 - 3,674) offshore bottlenose dolphins along the California coast based on a summer/fall 1991 ship survey extending approximately 300 nmi offshore. Winter/spring 1991-92 aerial surveys yielded an estimated 3,260 (CV=0.49; 95% log-normal confidence interval: 1,320 - 8,052) bottlenose dolphins along the California coast (Forney et al., in press). Given the relatively large coefficients of variation, these two estimates are not significantly different. Despite the fact that the aerial survey estimate is likely to be biased downward due to animals that are submerged when the aircraft passes overhead, it is greater than the shipboard estimate. Thus it is appropriate to combine the results of the two surveys to produce

a more accurate and precise estimate of offshore bottlenose dolphin abundance. This yields an average abundance estimate of 2,382 animals, with a calculated CV=0.36 and a 95% log-normal confidence interval of 1,188 - 4,774 animals (assuming additive variances). This is currently the best available estimate of abundance for this stock of bottlenose dolphins.

POPULATION GROWTH RATES AND TRENDS

Trends in abundance

No information regarding trends in abundance exists for either population of bottlenose dolphins in California. Even though a recent comparison between ship surveys in 1979/80 and 1991 reveal very similar sighting rates for offshore bottlenose dolphins, (Barlow 1993), this does not necessarily indicate that the abundance has not changed, because the coefficients of variation are large for both surveys. Similarly, the mark-recapture estimate for coastal bottlenose dolphins based on 1981-83 data is similar to the October 1991 aerial survey counts, but the differences between and uncertainties inherent in the two methods prevent a direct comparison.

Growth rate at MNPL

Although reproductive information has been obtained for bottlenose dolphins in some other parts of the world, the large variation in these parameters known to exist between populations in different areas does not allow generalization from one to another. For both forms of bottlenose dolphins in California, population growth rates are unknown.

STOCK STATUS RELATIVE TO OSP AND K

OSP determination

Although fishery-related mortality has probably been low, coastal bottlenose dolphins may be more vulnerable to other factors, such as pollutants. The low estimates of abundance for coastal animals suggest that the take of more than a few animals per year is likely to be unsustainable. No evidence regarding historical population sizes, natural vs. human-caused mortality rates, or status in relation to OSP is available for coastal bottlenose dolphins. The offshore population has historically not been heavily exploited, but fishery mortality and live-captures have removed animals from this population. Given the low estimates and uncertainty in population size of offshore bottlenose dolphins, even the take of a few tens of animals per year could have an impact. Thus the status of both populations of bottlenose dolphins in California is unknown.

Condition indices

Insufficient data exist to evaluate biological parameters in relation to population condition or status for either of the two bottlenose dolphins stocks in California.

CURRENT REMOVALS

Incidental take

No incidental mortality was observed for either form of this species in California gillnet fisheries between 1980 and 1985, when less than 1% of effort was monitored (Diamond et al. 1987). Between July 1990 and December 1991, approximately 4-10% of fishing effort was monitored without any observed takes of this species (Perkins et al. 1992; Lennert et al. 1994). In 1992, however, with approximately 13% coverage, three (presumed offshore) bottlenose dolphins were observed killed in a driftnet, yielding a total estimated mortality for 1992 of 23 animals (s.e. 21; Julian 1993). No bottlenose dolphins were observed taken in 1993 (Julian 1994), with 14-15% of fishing effort observed. Based on the location of California fisheries, it is likely that mostly offshore animals would be taken. However, depending on the extent of offshore movement of coastal animals, they may also be affected. Additional evidence of fishery interactions exists in the form of bottlenose dolphins stranded with net marks and knife cuts (Heyning et al. 1994). Some mortality of bottlenose dolphins is also known for the high-seas drift gillnet fisheries in the central North Pacific (Hobbs and Jones 1993), eastern tropical Pacific tuna purse seine fisheries (Hall and Boyer 1992), and gillnet fisheries in the Gulf of California (Vidal et al. 1994). However, the relationship of these animals to those found in California is not clear.

Direct take

None known.

Illegal killing

None known.

Research and live capture

Based on records from one marine park, Walker (1975) reports that 18 bottlenose dolphins were captured in Southern California between 1966 and 1972. Some additional bottlenose dolphins were captured from both the coastal and offshore populations prior to 1966 (Norris and Prescott 1961). Capture locations are only given for two animals caught offshore of Santa Catalina Island, but based on the reported frequent association with pilot whales during captures, these animals are likely to have been part of the offshore stock. From 1973 to 1982, nine additional bottlenose dolphins were captured off California for public display and scientific research (Reeves and Leatherwood 1984). Since 1982, no additional bottlenose dolphins have been live-captured in California.

Other causes

Pollutant levels, especially DDT residues, found in Southern California coastal bottlenose dolphins have been found to be extremely high (O'Shea et al. 1980; Schafer et al. 1984; Kelly 1990). The effects of these pollutants on the population are not clear, but they may affect reproduction or make the animals more prone to other mortality factors (Gaskin 1982; Britt and Howard 1983).

Striped dolphin, *Stenella coeruleoalba*

INTRODUCTION

History of exploitation and management

The striped dolphin is primarily found more than 200 nmi from the California coast, and thus has not been the subject of substantial mortality in California gillnet fisheries. Mortality is known for tuna purse seine fisheries in the eastern tropical Pacific (Hall and Boyer 1992) and for high-seas gillnet fisheries in the central North Pacific (Hobbs and Jones 1993). Due to the rarity of sightings and lack of fishery mortality in California, no direct management actions have been necessary for striped dolphins in this region, but efforts to reduce dolphin mortality in the eastern tropical Pacific tuna purse-seine fishery have involved this species as well as other dolphins.

Biology

Striped dolphins are a gregarious species, and are found in tropical and warm temperate pelagic waters of all oceans. Prior to 1992, records of this species in California and farther north along the North American coast were rare, but a recent ship survey extending approximately 300 nmi offshore has shown that striped dolphins are more common in offshore waters than previously suspected (Hill and Barlow 1992; Barlow, in press), and often occur in mixed schools with short-beaked common dolphins. They feed primarily on mesopelagic fishes (especially myctophids), squids and crustaceans (Miyazaki et al. 1973; Perrin et al. 1994). Estimates of reproductive parameters, made by various investigators based on specimens taken in the Japanese drive and harpoon fisheries and in the eastern tropical Pacific tuna fishery, have been reviewed and summarized by Perrin and Reilly (1984). The available data indicate an age at sexual maturity of approximately 9 years, a gestation period of 12 months, and a lactation period of 8-20 months. Calving interval has been estimated as 3.3 years from specimens collected in the eastern tropical Pacific. For the western North Pacific, estimates of calving intervals range between 1.4 and 4.2 years. The ranges of estimates of gross and net annual reproductive rates are 0.103-0.110 and 0.023-0.044, respectively.

POPULATION AND STOCK STRUCTURE

Biological basis of populations

This species has a widespread pelagic distribution in tropical and warm-temperate waters of the North Pacific (Perrin et al. 1994). No morphological or genetic information is currently available to identify population boundaries. Although there are regional gaps in the distribution of sighting records for striped dolphins, it is uncertain whether they are an artifact of inadequate coverage or indicative of true range discontinuities (Perrin and Brownell 1994). Additional sighting data have recently closed an apparent gap in the distribution of striped dolphins in the eastern tropical Pacific (Perrin et al. 1985), and the two formerly designated stocks have now been combined. The similarity of length distributions of adults in schools from these two regions (obtained from aerial photographs) also supports designation of a single stock for the eastern tropical Pacific (Perryman and Lynn 1991a). The relationship of animals found in California to animals farther south or offshore is unknown, but sightings made on a recent shipboard line transect survey (NMFS, unpublished data) along the coast of California, Baja California and in the Gulf of California suggest that their range may be continuous between California and the eastern tropical Pacific. However, based on patterns of geographical variation found in other dolphins, Perrin and Brownell (1994) expect that distinct stocks will emerge in the future as additional data are obtained.

Recommended stocks for management

Although it is highly probable that animals found in California are part of a larger population extending south into Mexican waters, and possibly as far south as the eastern tropical Pacific, the current management regime does not allow for species-level management across international borders. For this reason, it is recommended that the stock be defined to include only those animals found along the California coast within the U.S. EEZ. Recent estimates of abundance and fishery mortality, which are essential to successful management, are available for this region. However, cooperative international research on stock structure, abundance and mortality of striped dolphins throughout their range should be initiated, so that biologically meaningful units can be identified and managed in the future.

POPULATION SIZE

Estimation methods

Line transect estimates of abundance for eastern North Pacific populations of striped dolphins have been obtained for California based on a summer/fall 1991 line transect ship along the California coast (Barlow, in press), and for the eastern tropical Pacific based on 1986-90 ship surveys (Wade and Gerrodette 1993). Both estimates will be presented here for completeness, but unless evidence linking populations in the two regions is found, only estimates for California waters should be used for assessment and management purposes.

Population estimates

Barlow (in press) presents an abundance estimate of 19,008 (CV=0.41; 95% log-normal confidence interval: 8,755 - 41,267) striped dolphins based on a summer/fall 1991 ship survey covering the entire California coast out to approximately 300 nmi. No striped dolphins were sighted less than approximately 100 nmi from the coast. Winter/spring aerial surveys in 1991 and 1992, extending only 100-150 nmi offshore in California, yielded no sightings of striped dolphins (Forney et al., in press), probably because of their more offshore, warm-water distribution. Wade and Gerrodette (1993) estimate a population size of 1,918,000 (CV=0.11; 95% bootstrap confidence interval: 1,532,000 - 2,249,000) for the eastern tropical Pacific. Currently there is insufficient evidence to combine populations found in California and in the eastern tropical Pacific; however, if in the future they are shown to comprise a single stock, the total abundance estimate (combining the two estimates above and assuming additive variances) would increase to approximately 1.937 million animals (CV=0.11). This estimate does not include animals along the northern coast of Baja California, a region for which cetacean abundances have not yet been estimated. Similarly, populations of striped dolphins in the central North Pacific may be continuous with the population in California, but currently there is no evidence to support or refute this, and no abundance estimates are available for that region.

POPULATION GROWTH RATES AND TRENDS

Trends in abundance

Although records of striped dolphins in California prior to 1991 are very rare, this can probably be attributed primarily to a lack of sampling in the offshore habitat of this species, rather than an actual population increase. Barlow (1993) has detected an increase in the abundance of tropical/warm temperate small delphinids, (i.e. common dolphins and striped dolphins), between 1979/80 and 1991 in California, but it is unclear whether the apparent increase in abundance is an artifact of sampling methods or indicates a real phenomenon such as population growth or a change in geographic distribution. Thus it is possible that the striped dolphin population has increased in size and/or moved northward into California waters during this period. However, insufficient information exists to make definitive conclusions regarding trends in abundance for this species.

Growth rate at MNPL

Net annual reproductive rates have been estimated for this species based on specimens collected in the Japanese drive and harpoon fisheries, and based on samples obtained from animals in the eastern tropical Pacific. Based on the information reviewed by Perrin and Reilly (1984), estimates of the annual population growth rate for striped dolphins are between 2.3% and 4.4%. The higher estimate is based on specimens which were taken from a heavily exploited population, and is therefore likely to indicate an estimate for a population below its carrying capacity, which would be expected to experience higher growth rates. However, no measures of statistical confidence are available for the above estimates, and the range of possible values is likely to be quite large. Furthermore, regional differences may exist. For these reasons, the growth rate of this species along the U.S. west coast should be considered unknown.

STOCK STATUS RELATIVE TO OSP AND K

OSP determination

Historically, striped dolphins have not been subject to high levels of fishery mortality, and thus they are likely to be at OSP. However, due to the lack of information on other potential sources of mortality, the status of striped dolphins in relation to OSP should be considered unknown.

Condition indices

Based on the assumptions of density-dependent growth, it would be expected that reproductive parameters would change as density changes (Perrin and Reilly 1984). These types of change are very difficult to determine and require large sample sizes over long time periods. For the heavily exploited population of striped dolphins off Japan, such data are available, and Kasuya and Miyazaki (1975) have estimated age at sexual maturity, annual pregnancy rates and length of lactation for three time periods between 1952 and 1973. Although rank differences apparently exist, no statistical tests incorporating variances are presented to establish statistically significant differences, and the rankings do not correspond entirely to what would be expected. Perrin and Reilly (1984) conclude from these data that reproductive parameters for exploited populations may behave in unexpected ways. Thus reliable condition indices, which may be indicative of population status, do not exist for this species.

CURRENT REMOVALS

Incidental take

No incidental mortality of striped dolphins has been observed in California gillnet fisheries, for which less than 1% of effort was monitored in 1980-85, and 4-15% of effort has been monitored since July 1990 (Diamond et al. 1987; Lennert et al. 1994; Perkins et al. 1992; Julian 1993; 1994). Although this does not establish that mortality is zero, it does indicate that fishery mortality is probably no more than a few individuals per year if it occurs. An experimental Canadian squid gillnet fishery, operating in British Columbia between 1980 and 1987, reported the take of one unidentified *Stenella*, probably a striped dolphin (Barlow et al. 1994). In the eastern tropical Pacific, this species is sometimes killed in purse seine operations, but it is not a target species in this fishery, and the mortality is relatively low (Hall and Boyer 1992). Additional mortality of striped dolphins is known to occur in several high seas drift gillnet fisheries in the central and western North Pacific. Total mortality estimates in these gillnet fisheries are available only for 1990, during which an estimated 3071 striped dolphins were killed (upper 95% confidence limit: 3,517; Hobbs and Jones 1993).

Direct take

No direct take is known for the eastern North Pacific.

Illegal killing

No illegal killing of this species is known, and given the rarity of encounters with this pelagic species, it is not likely that illegal killing occurs.

Research and live capture

No records indicating live captures of striped dolphins in the eastern North Pacific are known.

Other causes

No specimens from the U.S. west coast have been examined for pollutants, but levels are expected to be low for this pelagic species.

Short-beaked common dolphin, *Delphinus delphis* and Long-beaked common dolphin, *Delphinus capensis*

INTRODUCTION

History of exploitation and management

Historically, common dolphins in the eastern Pacific have been divided into four stocks: Northern, Central, Southern and Baja-neritic common dolphins, with the northern (short-beaked) and Baja-neritic (long-beaked) stocks extending into waters along the coast of California. In this region they are sympatric, with the range of the more coastal long-beaked common dolphin completely contained within the range of the short-beaked common dolphin. Recent evidence (Rosel 1992; Heyning and Perrin 1994; Rosel et al. 1994) indicates that these two stocks comprise distinct species, but unfortunately, most of the available information on abundance, distribution, and incidental mortality has not distinguished between the two types. For this reason, the two species are combined into a single chapter here, with species-specific information given when available.

Common dolphins have been taken in a number of fisheries in the eastern North Pacific. The most significant takes are likely to be a result of seine and drift gillnet fisheries, which are both more likely to take the short-beaked common dolphin. However, stranded individuals of both species have been found with evidence of interactions with fisheries (Heyning et al. 1994). Common dolphins are very abundant and takes have not been thought to represent a significant proportion of the total population, although this may not be true if a high proportion of the takes are from the less abundant long-beaked species. No direct management actions have been taken to reduce common dolphin mortality along the California coast.

Biology

The common dolphin is a gregarious species, often seen in large conspicuous schools. It is known to feed on anchovies, squid, smelt, myctophids and hake. In the Southern California Bight, the distribution of common dolphins is influenced by seafloor topography (Hui 1979; 1985). Studies in the late 1970's and early 1980's indicated that common dolphin abundance changed seasonally in California waters, being greater during warm water periods (Dohl et al. 1986). However, surveys conducted in 1991-92 (Forney et al., in press; Barlow, in press) designed to cover both the cold-water and warm-water periods did not show seasonal differences in abundance. The distribution and abundance of common dolphins, as well as proportions of the two species, may be affected by El Niño events (Heyning and Perrin 1994).

Reproductive information is available for northern short-beaked common dolphins in the eastern North Pacific, which are likely to be continuous with the population of short-beaked animals found in California (Perrin et al. 1985). For these animals, the peak calving season is spring and early summer (Perryman and Lynn 1991b). Gestation and lactation are 10-11 months and 5-6 months, respectively. Although females can give birth in successive years, longer intervals are more common. Perrin and Reilly (1984) present an estimate of 2.6 years for the calving interval in eastern tropical Pacific stocks of common dolphins.

POPULATION AND STOCK STRUCTURE

Biological basis of populations

Along the California coast, short-beaked and long-beaked common dolphins are sympatric, with the range of the long-beaked form contained within the larger range of the short-beaked form (Perrin et al. 1985; Evans 1982). Both species extend south along the coast of Baja California, Mexico into tropical waters. They can be distinguished based on size, color pattern, and other morphological characteristics (Heyning and Perrin 1994), as well as using genetic techniques (Rosel 1992; Rosel et al. 1994).

Recommended stocks for management

It has been recommended for many years that short-beaked and long-beaked common dolphins be managed as separate stocks (Evans 1975; Perrin et al. 1985). The recent re-classification of long-beaked and short-beaked common dolphins into two species (Heyning and Perrin 1994) confirms this separation. Although both common dolphin species found in California are almost certainly part of larger populations extending farther south into Mexican waters, the current management regime does not allow for species-level management across international borders. Furthermore, current abundance and mortality estimates are only available for animals in California (gillnet fisheries) and in the eastern tropical Pacific (tuna seine fisheries), with a gap in information along the coast of Baja California. For these reasons, it is recommended that two stocks, short-beaked common dolphins and long-beaked common dolphins, be defined at this time to include only those animals found along the California coast within the U.S. EEZ. However, this subdivision is arbitrary and unsatisfactory, because successful management ultimately requires a comprehensive evaluation of impacts from all sources throughout the species range. It is therefore imperative that cooperative international research on stock structure, abundance and mortality of both species of common dolphins throughout their range is initiated, so that biologically meaningful units can be identified and managed in the future.

POPULATION SIZE

Estimation methods

Line transect abundance estimates for common dolphins have been made based on aerial survey data collected 1975-78 (Dohl et al. 1986) and in 1991-92 (Forney et al., in press). However, on these aerial surveys it was not possible to distinguish between the two types, and the abundance estimates represent combined estimates of short-beaked and long-beaked common dolphins, with unknown proportions of each species. Separate line transect abundance estimates for the two species are available only from a summer/fall 1991 comprehensive ship survey for marine mammals in California (Barlow, in press). Additional sighting data are available from several NMFS surveys conducted between 1978 and 1985 along the California coast and south into tropical waters (Lee 1993). However, no abundance estimates for common dolphins were made based on these data. Line transect estimates of abundance have also been made for eastern tropical Pacific populations of common dolphins, based on 1986-90 ship surveys (Wade and Gerrodette 1993).

Population estimates

For both species combined, Dohl et al. (1986) estimated 15,448 (CV=0.36) common dolphins for winter/spring and 57,270 (CV=0.17) for summer/autumn in the Southern California Bight between 1975 and 1978, stating that peak abundances may be closer to 100,000 animals. In contrast, the best abundance estimates for both recent surveys are considerably higher. Forney et al. (in press) present a best estimate of 305,694 (CV=0.34; log-normal 95% confidence interval: 159,864 - 584,552) common dolphins (both species combined) for the 1991-92 aerial surveys, which covered coastal California waters out to 100-150 nmi during the cold-water months. Based on a 1991 ship survey extending 300 nmi offshore along the California coast during the warm-water months of July-November, Barlow (in press) estimates that there are 233,378 (CV=0.28; log-normal 95% confidence interval: 136,562 - 398,834) short-beaked common dolphins, 9,472 (CV=0.68; log-normal 95% confidence interval: 2,817 - 31,842) long-beaked common dolphins, and an additional 2,731 (CV=0.66; log-normal 95% confidence interval: 847 - 8,803) common dolphins of unspecified type, yielding a total of 245,581 common dolphins of both types combined (CV=0.27; log-normal confidence interval 146,958 - 410,391). For the eastern tropical Pacific, Wade and Gerrodette (1993) estimate 476,300 total (short-beaked and long-beaked) northern common dolphins (CV=0.367; 95% bootstrap confidence interval: 200,600 - 807,300). The estimates presented by Barlow (in press) are the only ones for which the two species were distinguished, and therefore they are the best estimates for the management of common dolphins in California.

It is possible that the large differences in seasonal abundance estimates between the earlier and recent surveys in California are due to changes in environmental conditions (i.e. El Niño), which may have caused a shift in the distribution of common dolphins into California waters. This is consistent with the observed decline in common dolphin abundance in waters south of California, reported by Anganuzzi and Buckland (1994). Based on stranding evidence, the proportions of the two types of common dolphins in California waters also appear to be variable, with the relative abundance of the long-beaked common dolphin being higher during periods of warm water (Heyning and Perrin 1994). Because of this inter-annual variability, as well as differences in the study areas, the proportions of short-beaked and long-beaked common dolphins observed by Barlow (in press) should not be used to prorate other estimates into long-beaked and short-beaked animals.

POPULATION GROWTH RATES AND TRENDS

Trends in abundance

The size of the population of common dolphins in California appears to have increased dramatically between the 1975-78 and 1991 aerial censuses. This is confirmed by a recent comparison of NMFS ship survey data for 1979/80 and 1991 (Barlow 1993). The increase is too large to be accounted for by population growth alone, and movement into the study area from other regions to the south is likely. This hypothesis is consistent with the observed significant decline in the population of northern common dolphins in the eastern tropical Pacific (Anganuzzi and Buckland 1994), which cannot be explained by incidental mortality in the tuna purse seine fishery.

Growth rate at MNPL

Perrin and Reilly (1984) summarize life history information for delphinids, but an estimate of net annual reproductive rate was not made for common dolphins. Thus the net growth rate at MNPL is unknown.

STOCK STATUS RELATIVE TO OSP AND K

OSP determination

The status of the two species of common dolphins relative to OSP is not known. Overall, common dolphin mortality in California fisheries has been relatively low compared to the large total population size. However, depending on stock composition of the fishery mortality, it is possible that the less abundant long-beaked common dolphin has been affected. Further study of species-specific mortality is required before a positive assessment can be made for the long-beaked common dolphin. If the populations in California are continuous with populations in the eastern tropical Pacific, the mortality in the tuna purse-seine fisheries may have impacted these species to an unknown extent. Furthermore, any mortality along the coastline of Baja California would also affect California populations, but no information on mortality or abundance in this region is currently available for either species. A significant decline in the abundance of northern (short-beaked) common dolphins has been observed in the eastern tropical Pacific, but the causes of the decline in this region are not clear (Anganuzzi and Buckland 1994). Thus the status of both species of common dolphins should be considered unknown.

Condition indices

Changes in life history parameters have been demonstrated for some eastern tropical Pacific stocks of dolphins, including common dolphins, which have declined significantly in that area since 1974 (Chivers and DeMaster 1991). As would be expected in a declining population, the proportion of females simultaneously lactating and pregnant increased, and, correspondingly, the proportion of mature females lactating decreased. It is possible that data collected in the California gillnet observer program can be used for future evaluation of condition indices in common dolphins, but current sample sizes are too small for such a study. An additional problem, however, is that it is problematic to infer changes for a population spanning several regions based on samples collected in only one region.

Other information bearing on status

Dohl et al. (1986) demonstrated seasonal movement in and out of the Southern California Bight, with highest abundance in summer/fall, which coincides with the majority of fishing effort. However, the two recent NMFS surveys did not confirm this movement pattern; common dolphin abundance was very similar during the winter/spring and summer/fall survey periods. It is possible that the movement is not strictly seasonal, but rather follows environmental changes which can occur on both seasonal and inter-annual scales.

CURRENT REMOVALS

Incidental take

Incidental take of common dolphins has occurred in several fisheries in the eastern North Pacific, but short-beaked and long-beaked common dolphins have not always been distinguished. The extent of and types of fisheries involving common dolphin mortality have changed throughout the years, but include primarily purse seine and gillnet fisheries. Mortality of common dolphins has been documented for the tuna purse seine fishery in the eastern tropical Pacific (Hall and Boyer 1992), for high seas driftnet fisheries in the central Pacific (Hobbs and Jones 1993), and for gillnet fisheries in the Gulf of California (Vidal et al. 1994). However, the relationship between animals in these regions and California common dolphins is not clear.

In California waters, take on the order of a few to tens of common dolphins has been documented in observer programs with very limited coverage (<1 to a few percent of effort) since at least 1977 (Herrick and Hanan 1988; Diamond et al. 1987). Diamond et al. (1987) present estimates of total annual take (for both species of common dolphins combined) for 1980-83 (no observed takes, so the mortality estimate is zero), 1984 (660 individuals), and 1985 (1060 individuals). Sample sizes in these years are small and these estimates have large errors associated with them. Since July 1990, observations have covered approximately 4-15% of fishing effort for set and drift gillnet fisheries (Perkins et al. 1992; Julian 1993; 1994; Lennert et al. 1994). Observed mortality of both species of common dolphins was nine animals for July-December 1990, 44 animals in 1991, 49 animals in 1992, and 28 animals (5 short-beaked, 23 of unknown type) in 1993. Total annual mortality estimates derived from these figures are 203 animals (s.e. 82) for July-December 1990 (Lennert et al. 1994), 373 (s.e. 88) animals for 1991 (Perkins et al. 1992), 356 (s.e. 66) animals in driftnets and 17 (s.e. 11) in setnets for 1992 (Julian 1993), and 45 (s.e. 25) short-beaked and 208 (s.e. 69) unspecified common dolphins for 1993 (Julian 1994).

Although the available mortality data are based on limited observer coverage, it appears that on the order of hundreds of common dolphins are taken annually in California waters. The proportions of short-beaked and long-beaked common dolphins in this mortality are not known. Heyning et al. (1994) report that specimens of both species have stranded with evidence of fishery interaction, but due to differences in distribution and likelihood of stranding, it is not possible to use the observed stranding ratio to prorate the overall mortality estimates by species. Based on the locations of common dolphin mortality in gillnets, it is likely that a majority of these animals are short-beaked common dolphins. However, an attempt should be made in the future to collect skin samples from all observed common dolphin takes in gillnets, so that species identity can be determined with genetic techniques. Insufficient mortality data are available for common dolphins at this time to evaluate age or sex biases in fishery takes.

Direct take

None known.

Illegal killing

None known.

Research and live capture

Published live-capture records have not differentiated between the two species of common dolphins, but some information is available for common dolphins of unspecified type. Although records prior to 1972 are incomplete, a few captures of common dolphins are reported for 1958-60 (Norris and Prescott 1961), and based on the records for one marine park, Walker (1975) reports that 22 common dolphins were collected between 1966 and 1973 in the Southern California Bight for public display. An additional 16 common dolphins were live-captured between 1973 and 1982 (Reeves and Leatherwood 1984). No further captures have occurred since 1982 (NMFS, unpublished data).

Other causes

Specimens from California have been found to have high levels of pollutants in their tissues (O'Shea et al. 1980; Britt and Howard 1983). However, the effects of pollutants on cetaceans are not well understood.

Northern right whale dolphin, *Lissodelphis borealis*

INTRODUCTION

History of exploitation and management

The northern right whale dolphin is endemic to the North Pacific Ocean, and is found primarily in temperate continental slope and offshore waters. In recent years, offshore animals have been subject to relatively high mortality in high-seas driftnet fisheries. In the eastern North Pacific, northern right whale dolphins have been taken incidentally in coastal gillnet fisheries. In California, mortality appears to be relatively low, and no direct management actions have been taken for this species.

Biology

Little is known about the biology of northern right whale dolphins. They are known to be gregarious and have often been sighted in association with other cetacean species (Norris and Prescott 1961; Leatherwood and Walker 1979; Baird and Stacey 1991). Sightings in central and northern California appear to be most frequent in offshore and slope waters; in southern California, animals are also seen seasonally in shelf waters. In the Southern California Bight, historical evidence suggests that animals are most abundant in the winter, when water temperatures are low (Leatherwood and Walker 1979; Dohl et al. 1980). They may move north or offshore during warm-water periods. Sightings made south of Point Conception during 1991 and 1992 aerial and shipboard surveys (Forney et al., in press; Barlow, in press) are consistent with offshore movement: all summer/fall sightings were beyond the continental slope and all winter/spring sightings were in shelf waters of the Southern California Bight. North of Point Conception, animals were seen primarily in slope and offshore waters during both of these surveys, with no apparent seasonal change. Aerial surveys conducted in Oregon and Washington in 1989-90 (Green et al. 1992) indicate that this species is rare or absent in winter (December-February), and is most common in Fall (September-November), although there were differences between the two years of the study. Combined with patterns of abundance in California, these surveys suggest seasonal movement of animals from California into Oregon and Washington, but the evidence is not conclusive.

The diet of northern right whale dolphins consists primarily of squid and small mesopelagic fish, such as myctophids and deep water smelts (Fitch and Brownell 1968; Leatherwood and Walker 1979). Little information is available on reproductive parameters for northern right whale dolphins. Based on animals incidentally taken in the Japanese squid driftnet fishery, Ferrero et al. (1993) estimate age at sexual maturity for this species to be 9-10 years for males and 6-9 years (revised estimate

9-10 years; Ferrero, pers. comm.) for females. Interbirth interval is reported to be 2-3 years. Natural mortality rates are not known.

POPULATION AND STOCK STRUCTURE

Biological basis of populations

At this time there is no conclusive biological evidence to support separate stocks of northern right whale dolphins. An apparent region of lower density in the eastern North Pacific (between coastal and offshore regions) may be due to lower sampling effort, because sighting effort has not been systematic throughout the range. A gap in the distribution of this species between northern and southern California coastal regions has been suggested by Dohl et al. (1983), but the sighting data they present do not support this conclusion. Leatherwood and Walker (1979) provide a summary of distributional, morphological and life history data available for northern right whale dolphins in the eastern North Pacific. In a comparison with Japanese data for the western North Pacific, they identified no differences in color pattern or body size. Ferrero et al. (1993) have examined specimens collected in the central and western Pacific for morphological and life history characteristics, but these data have not been compared to eastern Pacific coastal animals. Recent genetic work (Dizon et al. 1993) on specimens from both coastal and offshore waters has revealed a high level of genetic variability in mitochondrial DNA sequences (which is theoretically associated with large populations) for both coastal and high seas animals. Furthermore, no geographically concordant differences were found in the mtDNA sequences. Both sets of genetic results are consistent with a single large population of northern right whale dolphins (Dizon et al. 1993), although they do not necessarily prove that this is true.

Recommended stocks for management

A high level of take in high-seas driftnet fisheries has reduced the central Pacific population of northern right whale dolphins to approximately 24-73% of its historical abundance (Hobbs and Jones 1993). These fisheries have now been discontinued, and the offshore portion of the population can now be expected to recover. Future mortality is likely to be restricted primarily to coastal driftnet fisheries, and abundance and mortality estimates are currently available for coastal animals in California. Although it appears likely that coastal animals are part of a continuous North Pacific population, no international agreements are in place for management at this level. Therefore it is recommended that, for management purposes, the stock be defined to include only those animals occurring within the U.S. EEZ of California, Oregon and Washington. However, international cooperative agreements should be encouraged, and additional research on stock structure, abundance and mortality throughout the entire North Pacific should be conducted, to ensure that future management will be at a biologically appropriate level.

POPULATION SIZE

Estimation methods

Line transect abundance estimates for northern right whale dolphins in California have been made based on aerial survey data collected 1968-76 (Leatherwood and Walker 1979), 1975-78 (Dohl et al. 1980), 1980-83 (Dohl et al. 1983), and in 1991-92 (Forney et al., in press). Shipboard line transect estimates are available from a summer/fall 1991 comprehensive ship survey for marine mammals in California (Barlow, in press). Additional sighting data are available from several National Marine Fisheries Service surveys conducted between 1978 and 1985 along the California coast and south into tropical waters. Aerial line transect surveys were also conducted in Oregon and Washington in 1989-90, but no abundance estimates were made for this species (Green et al. 1992). Separate line transect estimates of abundance for northern right whale dolphins in the entire North Pacific have recently been made based on sighting data collected by observers aboard Japanese and U.S. vessels in 1987-90. The range of coverage is from the west coast of the North America across the Pacific to Japan and the southeast coast of China (Buckland et al. 1993; Miyashita 1993), but effort was sparse in much of the area, and the resulting abundance estimates have a high degree of uncertainty. Hiramatsu (1993) estimates population abundance based on by-catch ratios for northern right whale dolphins and Pacific white-sided dolphins combined with line transect abundance estimates for the latter species, but some of the underlying assumptions are not likely to be valid, and the estimates are not included here.

Population estimates

Based on aerial surveys conducted in the Southern California Bight between 1968 and 1976, Leatherwood and Walker (1979) provide a crude estimate of peak abundance of 17,800 animals. No confidence limits are given and the authors caution that this figure is highly tentative because the surveys were not designed to produce abundance estimates, and some of the assumptions used to obtain this estimate may not be met. For aerial surveys conducted in the Southern California Bight between 1975 and 1978, Dohl et al. (1980) present monthly estimates of abundance for northern right whale dolphins ranging from 0 to 20,425 animals. However, no confidence limits are available for these estimates, and it is likely that this range of values is driven primarily by sampling variance, rather than actual changes in abundance. Based on 1980-83 surveys (Dohl et al. 1983), quarterly population estimates for California north of Point Conception ranged between 27,000 and 61,500 animals, again without confidence limits.

Forney et al. (in press) present a best abundance estimate of 21,332 (CV=0.43, 95% log-normal confidence interval: 9,548 - 47,658) northern right whale dolphins for the 1991-92 aerial survey, which sampled California waters out to 100-150 nmi during the cold-water months of February-April. Based on a 1991 ship survey extending 300 nmi offshore along the California coast during the warm-water months of July-November, Barlow (in press) estimates that there are 9,342 (CV=0.57, 95% log-normal confidence interval: 3,322 - 26,272) northern right whale dolphins. Although these estimates may suggest seasonal changes in abundance, the difference is not statistically significant. The recent abundance estimates are also lower than previous values, but a statistical comparison is not possible because no estimates of variance are available for the earlier period.

Based on the California surveys and observed seasonal patterns of distribution for northern right whale dolphins in Oregon and Washington (Green et al. 1992), it is likely that these animals form a continuous population, with seasonal shifts in distribution. If the animals occurring in Oregon/Washington in the fall are assumed to be animals which have moved northward out of California, then the winter/spring abundance estimate for California is a good approximation of the total population size. The observed patterns of occurrence are consistent with this, and therefore the California winter/spring aerial survey abundance estimate of 21,332 northern right whale dolphins may be considered an overall estimate for California, Oregon and Washington combined.

For northern right whale dolphins in the entire North Pacific, Buckland et al. (1993) present an estimate, corrected for size-biased sampling, of 68,000 animals (CV=0.709; 95% confidence interval 20,000-239,000). This is smaller than an estimate of 308,000 animals (CV and 95% confidence intervals can be calculated as 0.55 and 113,000-840,000, respectively, based on information given in paper) presented by Miyashita (1993) for the western and eastern North Pacific based on a largely different data set spanning the same time period. The two population estimates rely on slightly different assumptions, but the difference between them is not statistically significant due to the large uncertainty in both. Combining the estimates and assuming additive variances results in an average estimate of 188,000 animals (CV=0.47, 95% log-normal confidence interval: 79,000 - 449,000). According to the authors, both estimates are likely to be biased downwards due to the difficulty in sighting this species in the field.

POPULATION GROWTH RATES AND TRENDS

Trends in abundance

Only limited information is available on possible population trends along the California coast, and in offshore waters (the area of the high-seas driftnet fisheries). Based on a comparison of ship survey data collected in 1979 and 1980 with similar data collected in 1991, Barlow (1993) suggested a general decrease in the abundance of temperate cetaceans, possibly due to a general warming trend of waters in this region. However, variances in this study were too high to detect a decrease specifically for this species. In the central North Pacific region, backcalculation techniques have indicated that this population has been reduced to an estimated 24-74% (Mangel 1993) or 20-90% (Hobbs and Jones 1993) of its pre-exploitation size due to mortality in high-seas driftnet fisheries. These fisheries have recently been discontinued and populations are now expected to recover. Overall, unresolved questions of stock structure, distribution, and seasonal and inter-annual movements of this species preclude a statement regarding trends in abundance of northern right whale dolphins along the California/Oregon/Washington coast.

Growth rate at MNPL

Specimens collected in the high-seas driftnet fishery in 1990 have provided preliminary information on individual growth rates, age and length at sexual maturity, inter-birth intervals and gestation period (Ferrero et al. 1993). However, the available information does not allow estimation of a population growth rate at this time, and therefore the growth rate at MNPL should be considered unknown.

STOCK STATUS RELATIVE TO OSP AND K

OSP determination

Two scenarios are possible in regard to the OSP determination of animals in California/Oregon/Washington: (1) these animals form a distinct stock, and (2) these animals are part of a population extending into the central North Pacific, possibly as far west as Japan. In the former case, it is expected that the population would be at OSP because historical mortality has been relatively low. In the latter case, the population is estimated to be at 20-74% (Mangel 1993) or 20-90% (Hobbs and Jones 1993) of its historical size, spanning the full range of OSP status categories. Given the likelihood of a continuous population, no definite status determination can be made at this time. Until additional information becomes available to resolve questions of stock structure, the status of northern right whale dolphins in relation to OSP should be considered uncertain.

Condition indices

No data are available to evaluate potential biological condition indices.

CURRENT REMOVALS

Incidental take

Incidental take in California fisheries has been relatively low during periods when observer programs provided information on mortality. Between 1980 and 1985, when observer coverage was less than 1% of the total fishing effort, one northern right whale dolphin was observed incidentally killed (Diamond et al. 1987). No annual estimates of mortality are presented for this period, but a crude extrapolation based on the ratio of observed to total effort yields an estimated overall mortality of 110 animals for the period 1980-85, or roughly 18 per year. This value, however, has a high degree of uncertainty. Since July 1990, with approximately 4-15% observer coverage for the driftnet fisheries in California, observed mortality of northern right whale dolphins was zero animals for July-December 1990 (Lennert et al. 1994), seven animals for 1991 (Perkins et al. 1992), two animals for 1992 (Julian 1993), and seven animals for 1993 (Julian 1994). Corresponding total mortality estimates are zero animals for July-December 1990, 59 animals (s.e. 27.5) in 1991, 15 animals (s.e. 10) in 1992, and 63 animals (s.e. 25) for 1993.

In the central North Pacific, much greater numbers of animals have been taken since the early 1980s in five different Japanese, Korean and Taiwanese driftnet fisheries (Hobbs and Jones 1993). Total annual by-catch estimates for these fisheries are only available for 1990, during which an estimated 11,051 northern right whale dolphins were killed (8,224 of these animals were estimated to have been killed in the Japanese squid fishery alone). For 1989, the Japanese squid fishery was estimated to have killed approximately 11,000 animals. These high-seas driftnet fisheries have now been banned as a result of a United Nations resolution.

Direct take

Whaling records indicate that this species has been taken in directed fisheries during the 19th and early 20th centuries, but the magnitude of these takes is not known (Mitchell 1975; see Baird and Stacey 1991 for an overview).

Illegal killing

None known.

Research and live capture

Based on records from one marine park, Walker (1975) reports that 2 northern right whale dolphins were captured in Southern California from 1966 to 1972. From 1973 to 1982, 3 additional northern right whale dolphins were captured for public display and scientific research (Reeves and Leatherwood 1984). No further animals are known to have been live-captured since 1982.

Other causes

Examination of a single northern right whale dolphin from California (Britt and Howard 1983) revealed low pollutant levels. Overall, levels are expected to be low for this pelagic species.

False killer whale, *Pseudorca crassidens*

INTRODUCTION

History of exploitation and management

False killer whales are known only as sporadic visitors into California waters. Along the California coast, records of sightings and strandings are very rare, and no fishery-related mortality has been documented. In the eastern tropical Pacific, small numbers of takes in the tuna purse seine fishery may occur. No direct management actions have been taken for this species along the California coast.

Biology

False killer whales are found in oceanic tropical and warm temperate waters throughout the world. In the eastern North Pacific, they occur mainly south of 30°N (Leatherwood et al. 1982), but have been reported as far north as Alaska (Stacey and Baird 1991). Movement into more northern water is likely to occur during warm water periods. The diet of false killer whales includes squid and pelagic fishes, such as yellowfin tuna and bonita. They have also been known to attack other marine mammals (Leatherwood et al. 1982). Reproductive information has been obtained from mass strandings and from fisheries data and is summarized in Perrin and Reilly (1984). The gestation period for false killer whales has been reported as 15.5 months and 11-12 months. Length of the lactation period is approximately 18 months. Age at sexual maturity is estimated to be between 8 and 14 years.

POPULATION AND STOCK STRUCTURE

Biological basis of populations

Based on the rarity of records of false killer whales in California, and the generally tropical distribution of this species, animals seen in California must be part of a population extending south into tropical waters. A number of disjunct populations have been identified on a worldwide basis (Kitchener et al. 1990; Perrin and Brownell 1994), but no regional populations have been identified in the eastern North Pacific. Sighting records for shipboard surveys conducted in the eastern tropical Pacific between 1986 and 1990 show a widespread and apparently continuous distribution of false killer whales within this region (Wade and Gerrodette 1993).

Recommended stocks for management

In the absence of international management agreements between the U.S. and other countries in which animals from this population occur, the management stock can include only those animals within the U.S. EEZ of California, Oregon and Washington. However, this subdivision is unsatisfactory, because these regions represent only the northern portion of this species' range. Successful management requires a comprehensive evaluation of population size and of potential impacts from all sources throughout the species' range. It is therefore imperative that cooperative international assessments and management plans be initiated, so that biologically meaningful units can be managed in the future.

POPULATION SIZE

Estimation methods

No false killer whales were encountered in California, Oregon and Washington on recent line transect surveys (Green et al. 1992; Hill and Barlow 1992; Carretta and Forney 1993). Line transect estimates of abundance have been calculated based on ship surveys conducted between 1986 and 1990 (Wade and Gerrodette 1993) in the eastern tropical Pacific.

Population estimates

No population estimate is available for the recommended management region California, Oregon and Washington. Extensive ship surveys in 1991 (Hill and Barlow 1992) and aerial surveys in 1991-92 (Carretta and Forney 1993) yielded no sightings of false killer whales in California waters. 1989-90 aerial surveys in Oregon and Washington also did not result in any false killer whale sightings. One group was sighted in Southern California waters on a Southwest Fisheries Science Center (NMFS) cruise in December 1984 (Lee 1993), but no estimate of abundance was made. Based on the 1986-90 ship surveys in the eastern tropical Pacific, Wade and Gerrodette (1993) present an abundance estimate of 39,800 (CV=0.64; 95% log-normal confidence interval: 11,500 - 109,500) false killer whales in that region.

POPULATION GROWTH RATES AND TRENDS

Trends in abundance

No information on trends in the abundance of this species is available.

Growth rate at MNPL

Perrin and Reilly (1984) summarize life history information for delphinids, but an estimate of net annual reproductive rate was not made for false killer whales. The growth rate at MNPL of this species is unknown.

STOCK STATUS RELATIVE TO OSP AND K

OSP determination

Despite the rarity of fishery interactions with this species, other potential sources of mortality are unknown, and therefore the status of false killer whales in relation to OSP should be considered unknown.

Condition indices

Insufficient data are available for false killer whales to evaluate biological parameters that may indicate population condition or status.

CURRENT REMOVALS

Incidental take

No incidental take of this species has been documented for coastal gillnet fisheries in the eastern North Pacific (Perkins et al. 1992; Julian 1993; 1994; Lennert et al. 1994; Barlow et al. 1994). Although no takes of false killer whales have been documented in the California driftnet fishery, such mortality is possible, particularly during warm-water periods. Nine false killer whales were observed taken in high-seas driftnet fisheries in 1988-90 (Hobbs and Jones 1993), occasional takes have occurred in eastern tropical Pacific tuna seine operations (Hall and Boyer 1992), but no total mortality estimates are available.

Direct take

None known in the eastern North Pacific.

Illegal killing

None known. However, false killer whales have been known to take fish from sport fishing lines and are suspected of taking tuna from longlines (Leatherwood et al. 1982). It is therefore possible that illegal killing of false killer whales occurs.

Research and live capture

Only one false killer whale has been reported taken off Southern California in 1963 (Brown et al. 1966). No permits are currently active for the capture of false killer whales off California (NMFS, unpublished data).

Other causes

No false killer whale specimens from the U.S. west coast have been examined for pollutants, but levels are expected to be low for this pelagic species.

Killer whale, *Orcinus orca*

INTRODUCTION

History of exploitation and management

Killer whales are found worldwide in virtually all parts of the oceans. In the eastern North Pacific, direct exploitation has occurred in coastal whaling and live-capture fisheries along the coasts of California, Washington and British Columbia (Rice 1974; Reeves and Leatherwood 1984). A few animals have also been incidentally caught in fishing gear, and mortality due to interactions with fishermen is known to occur in Alaska (Dahlheim and Waite 1992). Concern over the relatively high levels of live-capture in British Columbia and Washington during the 1960's and 1970's resulted in tighter regulations and a gradual shift towards importing animals captured in other regions of the world (Bigg and Wolman 1975; Reeves and Leatherwood 1984). No direct management actions have been taken to reduce fishery-related mortality for this species.

Biology

Records of killer whales exist for virtually all oceans of the world, and populations in some regions (e.g. off Vancouver Island) are well studied. Distinct populations from five major regions of the world can be distinguished based on acoustic characteristics of their vocalizations. They appear to be most abundant within approximately 800 km of major continents (Mitchell 1975). They are known to prey on many species of fish, birds, and marine mammals, including large baleen whales. Some reproductive information has been collected, and is summarized in Perrin and Reilly (1984). Results indicate a gestation period of 12-16 months ('best' estimate 15 months), and a calving interval of at least 3-8 years. Length at birth is reported to be 208-276 cm. Age at sexual maturity is approximately 10 years for females and 15 years for males.

POPULATION AND STOCK STRUCTURE

Biological basis of populations

Due to their cosmopolitan distribution and the wide ranges of individual pods (Dahlheim et al. 1982; Schulman and Kelly 1990), it is difficult to assess the stock structure of this species. In some regions, such as near Vancouver Island, British Columbia, acoustic techniques have revealed the existence of two distinct populations, one resident and one present seasonally. In California, sightings of killer whales are relatively rare, and no resident populations have been identified. Movement of individually photo-identified animals has been observed between Monterey, California and Mexico (Schulman and Kelly 1990), as well as between central California and Glacier Bay Alaska (transient pod; M. Dahlheim and N. Black, pers. comm). Overall, however the relationship between animals found in California and animals seen in other areas of the eastern North Pacific remains unclear.

Recommended stocks for management

Recent evidence of long-range movement of individuals may indicate a link between California and Alaska. However, genetic studies and differences in vocalization patterns indicate that killer whale pods may be the most appropriate management unit. Pending additional information on population structure of killer whales along the U.S. west coast, it is recommended that for management purposes, the stock be defined to include only those animals within the U.S. EEZ of the California coast (with animals in Oregon/Washington and Alaska managed as two separate units). It is anticipated that additional photo-identification work may help clarify movement patterns and indicate more appropriate population boundaries.

POPULATION SIZE

Estimation methods

No abundance estimates are presented based on aerial surveys conducted between 1975 and 1983 in California (Dohl et al. 1980; 1983). Line transect abundance estimates for killer whales have been made based on aerial survey data collected in 1991-92 (Forney et al., in press). Shipboard line transect estimates are available from a 1991 comprehensive ship survey for marine mammals in California (Barlow, in press). For all of the above surveys, the rarity of sightings presents a problem in estimating abundance, and the resulting variances are very large. Some photo-identification work has been done on killer whale sightings along the U.S. west coast and Mexico (Schulman and Kelly 1990), but no abundance estimates are currently available based on these studies.

Population estimates

The few abundance estimates which have been made for killer whales in California are consistently low, with high variances. Forney et al. (in press) present a population estimate of 65 (CV= 0.69, 95% log-normal confidence interval: 19 - 220) animals based on 1991-92 aerial surveys, which covered all coastal California waters out to 100-150 nmi during the cold-water months of March and April. Based on a 1991 ship survey extending 300 nmi offshore along the California coast during the warm-water months of July-November, Barlow (in press) estimates that there are 307 (CV=1.20, 95% log-normal confidence interval: 48 - 1,947) killer whales. Based on the expected downward bias in aerial survey estimates (due to animals that are submerged when the aircraft passes overhead), Barlow's shipboard estimate is likely to be more accurate.

POPULATION GROWTH RATES AND TRENDS

Trends in abundance

No trends in the abundance of this population are known.

Growth rate at MNPL

Estimates of net annual reproductive rates between 1.7 and 3.1% are reported for killer whales based on observed changes in net pod sizes near Vancouver Island, B.C. and Puget Sound, Washington (Perrin and Reilly 1984; Brault and Caswell 1993). However, due to uncertainties in these estimates and likely regional differences, the growth rate of animals in California should be considered unknown.

STOCK STATUS RELATIVE TO OSP AND K

OSP determination

Based on the apparently wide-ranging habits of killer whales, uncertainty in the overall effects of regional mortality throughout the eastern North Pacific, and the potential long-term impacts of removals in the 1960s and 1970s, the status of killer whales in California should be considered uncertain.

Condition indices

No data are available to evaluate potential biological condition indices.

CURRENT REMOVALS

Incidental take

Barlow et al. (1994) report that killer whales are uncommonly caught or killed in driftnet fisheries of the eastern North Pacific. Two animals were reported taken in the Alaska trawl fishery for pollock between 1986 and 1988, and interactions of killer whales with the Alaskan sablefish fishery have been documented (Dahlheim and Waite 1992). The pod affiliation of these animals is not known, but if they were part of the more wide-ranging transient pods, these mortalities could affect populations of killer whales in California. One stranded animal with net marks was found in

Southern California in 1985 (Heyning et al. 1994), indicating that fishery interaction also occurs in California. However, no mortality was observed through direct monitoring of gillnet fisheries in California between 1980 and 1985 (Diamond et al. 1987; less than 1% of effort observed), and between July 1990 and December 31, 1993 (with 4-15% of fishing effort observed; Perkins et al. 1992; Julian 1993; 1994; Lennert et al. 1994), so no annual mortality estimates are available. Based on the above information, it is likely that fishery mortality for killer whales in California is low.

Direct take

Between 1962 and 1967, a total of 5 animals were taken in California coastal whaling operations (Rice 1974). One additional killer whale has been reported taken off British Columbia (Hoyt 1981), but it is not known whether this animal was from a pod potentially ranging into Californian waters.

Illegal killing

None known.

Research and live capture

One animal has been reported captured off California in 1961 (Hoyt 1981). Additionally, an estimated 72 killer whales were permanently removed from the wild (i.e. captured or killed) during live-capture operations in Washington and British Columbia between 1962 and 1980 (Reeves and Leatherwood 1984). Although Hoyt (1981) reports pod affiliation for some of these animals, it is not known how many, if any, of these killer whales may have belonged to pods potentially ranging into Californian waters. No animals have been live-captured along the U.S. west coast since 1980.

Other causes

Pollutant levels were found to be high in animals examined from British Columbia and Washington (Calambokidis et al. 1984). Based on the high levels of pollution in California waters, animals occurring in California may have similarly elevated pollutant levels. However, the effects of pollutants on cetaceans are not well understood.

Short-finned pilot whale, *Globicephala macrorhynchus*

INTRODUCTION

History of exploitation and management

Pilot whales in California have been killed in purse seine and gillnet fisheries. Annual mortality has generally been considered to be low, on the order of tens of animals (Miller et al. 1983). Very little is known about their current distribution patterns in this region. It is likely that animals seen in California comprise the northern portion of a population extending south into tropical waters or west into subtropical waters of the Central Gyre. No direct management actions have been taken to reduce pilot whale mortality along the California coast.

Biology

Short-finned pilot whales are found in oceanic tropical and warm temperate waters of the Atlantic, Indian and Pacific oceans. In the eastern North Pacific, the range of this species extends from equatorial waters north to Alaska, although sightings north of Point Conception are uncommon. Morphological variation has been documented between short-finned pilot whales found in tropical Pacific waters and those found farther north in temperate waters of the North Pacific (Polisini 1981). In Southern California, a year-round resident population was known prior to the 1982-83 El Niño, with larger congregations of animals seen during the winter squid spawning season. Since this El Niño, pilot whales sightings off California have been infrequent, and it is possible that this population has shifted its distribution to the south or west. However, the movement and range of this species are not well understood, so no definitive statements can be made in this regard. The gestation period for this species is reported as 12 months, but little other reproductive information is available (reviewed by Perrin and Reilly 1984).

POPULATION AND STOCK STRUCTURE

Biological basis of populations

Up to three distinct populations of short-finned pilot whales have been suggested for the entire North Pacific based on apparent gaps in distribution (Dohl et al. 1983). It is unlikely that animals in California are a discrete population, because historically the number of animals off California has been low (hundreds to low thousands), and they have become extremely rare since the 1982-83 El Niño. Pilot whales found in California are probably part of a population extending south along Baja California, Mexico. Although is has been stated that these animals are abundant along the coast south of Point Conception at least to Guatemala (Dohl et al. 1983; Leatherwood et al. 1982), ship surveys conducted by NMFS in 1978-1990 resulted in no pilot whale sightings along the coast between the southern end of Baja California and approximately 20° N. A large population of pilot whales is found in waters of the eastern tropical Pacific south of 20° N (Wade and Gerrodette 1993). This apparent hiatus in sightings, as well as morphological evidence (Polisini 1981) suggest that animals seen in the eastern tropical Pacific are a distinct population, separate from animals found along the coasts of Baja California and California.

Recommended stocks for management

Based on distributional and morphological evidence, animals found along the California coast should be considered a separate stock from those found in the eastern tropical Pacific. It is likely that animals found in California are part of a population extending south into Mexican waters and/or west into offshore waters. However, in the absence of international management agreements between the U.S. and Mexico, the management stock can be defined to include only those animals occurring within the U.S. EEZ of California, Oregon and Washington. However, this subdivision is unsatisfactory, because this area encompasses only the northern portion of the presumed range of this population. Successful management requires a comprehensive evaluation of impacts from all sources throughout the population's entire range. It is therefore imperative that cooperative international assessments and management plans be initiated, so that biologically meaningful units can be managed in the future.

POPULATION SIZE

Estimation methods

Line transect abundance estimates for pilot whales in California have been made based on aerial survey data collected in 1975-78 (Dohl et al. 1986). However, the abundance of pilot whales has changed dramatically since these surveys, presumably due to the effects of the 1982-83 El Niño. No pilot whales were sighted while 'on effort' (actively searching on pre-determined transect lines) during winter/spring aerial surveys in 1991-92, although one group of four animals was sighted 'off effort' (while in transit) during the 1992 surveys (Carretta and Forney 1993). A summer/fall 1991 ship survey along the entire California coast also yielded no sightings of this species, so no abundance estimate could be made (Barlow, in press). Additional historical sighting data are available from several National Marine Fisheries Service surveys conducted between 1978 and 1985 along the California coast and south into tropical waters, but no abundance estimates are available for these surveys (Oliver and Jackson 1987; Lee 1993).

Population estimates

Prior to 1983, Dohl et al. (1980) estimated a resident population of about 400 animals with seasonal increase to up to 2000 animals. After 1983, no abundance estimates are available, although some pilot whales appeared to be present intermittently around Catalina Island during the winter (Shane 1984; 1987). Based on the lack of sightings on the recent 1991 and 1992 aerial and ship surveys, the abundance of pilot whales in California waters would be zero. However, four animals were observed off effort in the Southern California Bight during aerial surveys conducted by the National Marine Fisheries Service in 1992 (Carretta and Forney 1993), and a group of 25 animals was observed and photographed in central California in the Fall of 1992 (Jones and Szczepaniak 1992). These occasional opportunistic sightings and drift gillnet mortality indicate that animals are indeed present, although rare. A more appropriate abundance estimate for this population will be available after the analysis of data from a joint U.S./Mexico ship survey along the coasts of California and Baja California conducted in the summer/fall of 1993. Currently, however, the abundance of this population must be considered unknown.

POPULATION GROWTH RATES AND TRENDS

Trends in abundance

No quantitative data are available to establish trends in abundance of short-finned pilot whales in California/Oregon/Washington. However, pilot whales were common in Southern California before the 1982-83 El Niño, and have been rare since (although a 1993 ship survey covering the same region as the survey conducted in 1991 yielded 5 sightings, and fishery mortality was higher in 1993 than in previous years; NMFS, unpublished data). Thus the apparent abundance of pilot whales can change dramatically with inter-annual variation in oceanographic conditions. Until the range of this population and the movements of animals in relation to environmental conditions can be better documented, no inferences can be drawn regarding trends in abundance of short-finned pilot whales in California/Oregon/Washington.

Growth rate at MNPL

Perrin and Reilly (1984) summarize life history information for delphinids, but an estimate of net annual reproductive rate could not be made for short-finned pilot whales. Kasuya and Marsh (1984) present information on potential growth rates of pilot whales in the western Pacific, but regional differences may exist and therefore these values may not be appropriate for pilot whales in California. The growth rate of this species in California/Oregon/Washington is unknown.

STOCK STATUS RELATIVE TO OSP AND K

OSP determination

If the animals in California prior to 1984 were a discrete population, then a significant impact of fishery mortality would probably have occurred during this time. However, changes in distribution and/or abundance since 1984 make this assessment less useful. Due to the uncertainties in mortality rates and population size, the status of short-finned pilot whales in relation to OSP for California, Oregon and Washington should be considered unknown.

Condition indices

No data are available to evaluate potential biological condition indices.

CURRENT REMOVALS

Incidental take

Incidental mortality of pilot whales has been known to occur in California squid purse seine and driftnet fisheries, in eastern tropical Pacific tuna purse seine operations, and in an experimental driftnet fishery for neon flying squid in Western Canada between 1983 and 1987 (Barlow et al. 1994). Miller et al. (1983) report that pilot whales occasionally have been shot at in the course of squid purse seine operations (this was still legal at the time). Prior to 1983, 30 animals per year were estimated to have been killed incidentally in the squid fishery near Catalina Island, and an additional 30 were estimated taken in the shark driftnet fishery, for a total of 60 animals taken annually off California (Miller et al. 1983). Between 1975 and 1990, additional evidence for fishery mortality comes from stranded animals with net marks or severed flukes (Heyning et al. 1994).

Between 1980 and 1985, when observer coverage was less than 1% of the total fishing effort, two pilot whales were observed incidentally killed (Diamond et al. 1987). No annual estimates of mortality are presented for this period, but a crude extrapolation based on the ratio of observed to total effort yields an estimated overall mortality of 220 animals for the period 1980-85, or roughly 37 per year. This value, however, has a high degree of uncertainty. Since July 1990, with approximately 4-15% observer coverage for the driftnet fisheries in California, observed mortality of short-finned pilot whales was one animal for July-December 1990 (Lennert et al. 1994), zero animals for 1991 (Perkins et al. 1992), one animal for 1992 (Julian 1993), and 11 animals for 1993 (Julian 1994). Corresponding total annual mortality estimates are 23 animals (s.e. 22) for July-December 1990, none for 1991, eight animals (s.e. 7) for 1992, and 100 animals (s.e. 43) for 1993.

Direct take

None known.

Illegal killing

None known.

Research and live capture

Based on records from one marine park, Walker (1975) reports that 33 pilot whales were captured in Southern California from 1966 to 1973. Additional 10's of pilot whales were also captured off Southern California for another marine park prior to 1974, but exact numbers are not available (Brownell, pers. comm.). Since 1974, a total of 18 additional pilot whales have been captured for public display and scientific research (NMFS, unpublished data). No permits are currently active for the capture of short-finned pilot whales.

Other causes

Examination of two short-finned pilot whales from California (O'Shea et al. 1980) revealed moderately high pollutant loads. However, the effects of pollutants on cetaceans are not well understood.

Baird's beaked whale, *Berardius bairdii*

INTRODUCTION

History of exploitation and management

In the eastern North Pacific, Baird's beaked whale is infrequently encountered, but it has been harvested off California, Washington and British Columbia (Balcomb 1989). Due to the general scarcity of sightings along the U.S. west coast, and very infrequent fishery mortality, no specific management actions have been taken to date for this species.

Biology

Most of what is known has been obtained from animals taken in the western North Pacific by Japanese whalers. Ohsumi (1983) reviews available life history information and provides a population assessment for the western Pacific animals. Lengths of mature animals caught were found to be 9.9 to 11.3 m for females (N=11), and 8.9 to 11.1 m for males (N=76). Age at sexual maturity has been estimated as roughly 9 years (Kasuya 1977; Ohsumi 1983). The calving interval is probably 3 years, and maximum age is estimated to be between 35 and 70 years (Leatherwood et al. 1982). Currently, there are insufficient data to estimate pregnancy rates or natural mortality rates.

POPULATION AND STOCK STRUCTURE

Biological basis of populations

Baird's beaked whale is thought to be distributed in offshore waters deeper than approximately 1000m throughout much of the North Pacific and adjacent seas. They may be distributed continuously across the North Pacific. In the eastern North Pacific, animals are thought to move from offshore waters to continental slope waters in summer/fall (Balcomb 1989). Aerial surveys conducted in the early 1980's indicated that this species is most abundant off California in June through October (Dohl et al. 1983). Recent aerial and surveys conducted in February-April 1991-2 and ship surveys conducted in July-November 1991 resulted in sightings of this species in California only during the warm-water months covered by the ship survey. Similarly, year-round surveys in Oregon/Washington yielded sightings of Baird's beaked whales in April-July, when water temperatures in this region are expected to be increasing. Due to uncertainties in determining distribution and migration patterns, no population boundaries presently can be defined.

Recommended stocks for management

For management purposes, it is recommended that the stock be defined to include those animals within the U.S. EEZ along the coast of California, Oregon and Washington. It is likely that animals seasonally move into these coastal waters from other areas of at least the eastern North Pacific.

POPULATION SIZE

Population estimates and estimation methods

Estimates of abundance are currently available only for California, where aerial and shipboard line transect surveys were conducted in the late 1970's, early 1980's and early 1990's (Dohl et al. 1980; 1983; Forney et al., in press; Barlow, in press). Surveys conducted in Oregon and Washington in 1989-90 (Green et al. 1992) resulted in 5 sightings of a total of 21 Baird's beaked whales, but no abundance estimates were made based on these data. Dohl et al. (1980; 1983) also did not make estimates for California due to the rarity of sightings of this species during their surveys. No Baird's beaked whales were sighted during aerial line transect surveys conducted during the cold-water months of February-April 1991-92 (Carretta and Forney 1993). Hill and Barlow (1993) report three sightings of 11 animals during a summer/fall 1991 shipboard line transect survey along the California coast. Only one sighting was made while on effort, yielding a population estimate of 38 animals, with a high degree of uncertainty (CV=1.03, 95% log-normal confidence interval: 7 - 203; Barlow, in press). Due to the large proportion of time that beaked whales spend submerged, this estimate is likely to be biased downward. Additional research on diving behavior of this species will be necessary before more accurate abundance estimates for Baird's beaked whales can be obtained.

POPULATION GROWTH RATES AND TRENDS

Trends in abundance

Both historically and during recent surveys, sightings in the eastern North Pacific appear to be relatively infrequent, with no apparent inter-annual trends in abundance or distribution. Despite small sample sizes, however, there is a pronounced seasonality in sightings, which is likely to confound the detection of long-term trends. Thus any future examination of trends in abundance for Baird's beaked whales should take oceanographic conditions (i.e. water temperature) into account.

Growth rate at MNPL

The growth rate of this species is not known.

STOCK STATUS RELATIVE TO OSP AND K

OSP determination

The status of the population relative to OSP is unknown. Based on the offshore distribution of this species and the infrequency of fishing interactions in the eastern North Pacific, it is likely that the eastern Pacific population is within OSP. However, the effect of historical whaling takes in the eastern North Pacific is unknown. Furthermore, if the animals along the U.S. west coast belong to a single North Pacific population, they may have been affected by Japanese whaling. Analysis of Japanese catch-per-unit-effort data suggests that the population near Japan has been stable for the last 40 years (Kasuya and Ohsumi 1984), but the effect of whaling on the entire North Pacific population is unknown. Thus the status of Baird's beaked whale in the eastern North Pacific should be considered unknown.

Condition indices

None known.

CURRENT REMOVALS

Incidental take

From July 1990 to December 10, 1993, no mortality of Baird's beaked whales was documented in roughly 4-15% observer coverage of California drift gillnet fisheries (Lennert et al. 1994; Perkins et al. 1992; Julian 1993; 1994); however, there have been a total of three unidentified beaked whales and three unidentified cetaceans reported killed, and it is likely that Baird's beaked whales are occasionally taken in driftnets.

Direct take

Between 1956 and 1970, takes of Baird's beaked whales along the coasts of California and British Columbia were 15 and 29 animals, respectively (Rice 1974).

Illegal killing

None known.

Research and live capture

None known.

Other causes

No specimens from the U.S. west coast have been examined for pollutants, but levels are expected to be low for this pelagic species.

Beaked whales of the genus *Mesoplodon*

INTRODUCTION

History of exploitation and management

Beaked whales of the genus *Mesoplodon* are known mainly from fossil records and strandings throughout the world. In the North Pacific, this genus is thought to comprise at least five species, but taxonomists are not in complete agreement. Assignment to the species level is generally based on cranial characters, and field identification of live animals as well as stranded specimens is difficult or impossible. The five species which may be found off the U.S. west coast are:

M. densirostris	Blainville's beaked whale
M. hectori	Hector's beaked whale
M. stejnegeri	Stejneger's beaked whale
M. ginkgodens	Ginkgo-toothed beaked whale
M. carlhubbsi	Hubbs' beaked whale

Their small size has prevented them from becoming a main whaling target, but they may have been taken irregularly in small-scale harpoon fisheries for small cetaceans, particularly in Japanese waters. In California, they are susceptible to mortality in drift gillnets, but due to their offshore distribution, the relatively low rate of fishery interactions, and the general paucity of information regarding these species, no direct management actions have been taken to date.

Biology

Very little is known about the biology of whales of this genus. Most information has come from stranded specimens, which are not likely to be a representative sample of the overall populations. Sightings at sea are infrequent. This may indicate that these animals are rare or may be an artifact of their offshore distribution and of their behavior patterns (they tend to be wary of vessels and appear to spend a large proportion of their time diving). They are thought to feed on mesopelagic fish and squid in deep pelagic waters (Mead 1989). Mead (1989) summarizes limited information available on reproductive biology, such as age at sexual maturity, mean length at birth, and gonad weight for both sexes.

POPULATION AND STOCK STRUCTURE

Biological basis of populations

Although very limited information is available on these five species, they are taxonomically distinct, and therefore comprise five separate biological populations along the U.S. west coast.

Recommended stocks for management

For the management of *Mesoplodon* beaked whales, it is recommended that each species be treated as a separate stock within the combined U.S. EEZ of California, Oregon, and Washington. However, it is imperative that additional data on the biology, distribution, and abundance of these species be collected. The current state of knowledge is insufficient for species-level management.

POPULATION SIZE

Population estimates and estimation methods

Due to rarity of sightings and the difficulty in identifying sighted animals in the field, population estimates are not available for individual species of *Mesoplodon*. Combined estimates for the genus *Mesoplodon* or for beaked whales as a group have been made based on recent aerial and shipboard surveys conducted by NMFS. in California. Two sightings containing a total of three mesoplodont beaked whales were made during March/April 1991 and February-April 1992 aerial line transect surveys conducted along the California coast (Forney et al., in press; Carretta and Forney 1993). Because of the small number of sightings of beaked whales and the number of unidentified beaked whale sightings on these surveys, Forney et al. (in press) present only a combined estimate for Cuvier's, mesoplodont, and unidentified beaked whales of 392 animals (CV=0.41; 95% log-normal confidence interval: 182 - 845). Hill and Barlow (1992) report six sightings containing nine animals during a summer/fall 1991 ship line transect survey along the California coast. The resulting population estimate is 250 mesoplodont beaked whales (CV=0.83; 95% log-normal confidence interval: 60 - 1,040; Barlow, in press), with an estimated additional 1,322 (CV=0.89; 95% log-normal confidence interval: 295 - 5,921) unidentified beaked whales. Prorating unidentified animals based on the proportion of identified sightings of each type of beaked whale is not appropriate, however, because *Mesoplodon* spp. have fewer diagnostic characteristics for field identification than other beaked whales (and therefore may be more likely to be characterized as unidentified beaked whales). For the eastern tropical Pacific, Wade and Gerrodette (1993) present an estimate of 25,300 (CV=0.20; 95% bootstrap confidence interval: 17,400 - 34,400) mesoplodont beaked whales based line transect surveys conducted in 1986-90. However, the relationship of animals found along the U.S. west coast to this population is unknown.

At this time the abundance estimate of 250 for the entire genus *Mesoplodon* (based on the 1991 ship survey) is the best available abundance estimate for California waters. However, this value is likely to be biased downwards due to the relatively large proportion of time these animals spend submerged, and therefore are not available to be seen during surveys. Additional research will be necessary to obtain correction factors for the proportion of animals missed, as has been done, for example, for harbor porpoise (Calambokidis et al. 1993). Additionally, for effective management, it will be necessary to obtain species-specific, rather than genus-level, abundance estimates for this region.

POPULATION GROWTH RATES AND TRENDS

Trends in abundance

No data exist to evaluate trends in abundance of mesoplodont beaked whales.

Growth rate at MNPL

The growth rate of mesoplodont beaked whales is not known.

STOCK STATUS RELATIVE TO OSP AND K

OSP determination

The status of these populations relative to OSP is unknown. Based on the offshore distribution of these species and relatively low levels of fishery interactions in the eastern North Pacific, it is likely that these populations are within OSP. However, California coastal drift gillnet fisheries are known to take animals of this genus, and mesoplodont beaked whales potentially belonging to the same populations as California animals have been taken in high seas driftnet fisheries. Given the low overall population estimate and the lack of species-specific information, the status of these five *Mesoplodon* species should be considered unknown.

Condition indices

No data are available to evaluate potential biological condition indices.

CURRENT REMOVALS

Incidental take

Mesoplodont beaked whales have been observed taken in U.S. drift gillnet fisheries off California. Based on less than 1% observer coverage of fishing effort between 1980 and 1985, Diamond et al. (1987) report a single case of a cow/calf pair entangled in a drift gillnet. A rough extrapolation based on the total number of nets observed and the total number set yields a total of 220 animals between 1980 and 1985, or an annual mortality of roughly 37 animals for this 6-year period. However, this value has a high degree of uncertainty. No mortality information is available for 1986-1989, but in July of 1990 a new observer program was initiated. Between July and December, 1990, a single animal was observed taken, yielding an estimate of 23 animals for this period (Lennert et al. 1994). No whales of this genus were observed taken in 1991 or 1993, so the estimated annual take for these years is zero (Perkins et al. 1992; Julian, 1994). In 1992, three mesoplodont beaked whales were observed taken in California drift gillnet fisheries, resulting in a total kill estimate of 23 animals (s.e. 12; Julian 1993). Additionally, three unidentified beaked whales and three unidentified cetaceans have been reported killed in California driftnet fisheries, and it is possible that some of these animals were of the genus *Mesoplodon*. Thus, the overall average annual mortality in coastal drift gillnets for this genus is likely to be in the low tens of animals. There is also some mortality in the high-seas drift gillnet fisheries (Hobbs and Jones 1993). If large-scale movement occurs in these species, these fisheries may affect animals belonging to the same populations as those found along the coast of California. For species-level management, it is imperative that observer programs include the collection of photographs, skulls, and skin biopsies from whales of this genus, so that species-level identification will be possible in the future.

Direct take

No direct takes of mesoplodont beaked whales are known in the eastern North Pacific.

Illegal killing

None known.

Research and live capture

None known.

Other causes

No specimens from the U.S. west coast have been examined for pollutants, but levels are expected to be low for this pelagic species.

Cuvier's beaked whale, *Ziphius cavirostris*

INTRODUCTION

History of exploitation and management

Cuvier's beaked whales are more commonly encountered than most other beaked whales. They have been taken in high-seas drift gillnets (Hobbs and Jones 1993) in the North Pacific, and in U.S. drift gillnet fisheries. Due to their offshore distribution and the rarity of fishery interactions, no direct management actions have been taken to date.

Biology

Cuvier's beaked whales are reported to be the most common of the beaked whales (Mead 1984). However, due to their pelagic distribution, data on seasonal movements and life history have been difficult to obtain. No seasonal changes in distribution are apparent from sighting and stranding data (Dohl et al. 1983; Heyning 1989). Information on age at sexual maturity or longevity of this species is not available, although some length-specific information is reviewed by Heyning (1989) and by Mead (1984). Calving appears not to have any seasonal peak.

POPULATION AND STOCK STRUCTURE

Biological basis of populations

Based on an examination of skulls obtained from stranded specimens in the northeastern Pacific, Mitchell (1968) suggested that animals from Alaska and Baja California probably belong to a single panmictic population (Heyning 1989). In the eastern tropical Pacific, sightings of this species follow no apparent pattern (Wade and Gerrodette 1993), suggesting that there may be a single wide-spread population in this region, and perhaps over the entire North Pacific. No separate populations have been identified.

Recommended stocks for management

For management purposes, it is recommended that the stock be defined to include those animals which are within the U.S. EEZ of California, Oregon, and Washington. However, it is likely that these animals belong to a more wide-spread pelagic population.

POPULATION SIZE

Population estimates and estimation methods

The only available estimates for this species are derived from aerial and shipboard line transect surveys conducted recently by NMFS. Dohl et al. (1980; 1983) conducted aerial line transect surveys along the California coast in the late 1970's and early 1980's, but did not make abundance estimates for beaked whales due to the rarity of beaked whale sightings during these surveys. In 1979 and 1980, NMFS also conducted ship surveys for marine mammals along the California coast, and 9 sightings of this species were recorded, but no abundance estimate was obtained. More recently, three sightings containing a total of eight Cuvier's beaked whales were made during winter/spring 1991 and 1992 aerial line transect surveys conducted by NMFS (Forney et al., in press). Hill and Barlow (1992) report 14 sightings containing a total of 34 animals during a summer/fall 1991 ship line transect survey along the California coast. On both surveys, additional sightings were made of animals which could be identified only as ziphiid beaked whales, and a portion of these are likely to have represented additional sightings of *Ziphius cavirostris*.

Because of the small number of sightings of beaked whales and the number of unidentified beaked whale sightings, Forney et al. (in press) present only a combined estimate for Cuvier's, mesoplodont, and unidentified small beaked whales of 392 animals (CV=0.41; 95% log-normal confidence interval: 182 - 845). The best population estimate based on the summer/fall ship survey is 1,621 Cuvier's beaked whales (CV=0.82; 95% log-normal confidence interval: 396 - 6,637; Barlow, in press). Sightings of animals which could not be positively identified yielded an estimated additional 1,322 (CV=0.89; 95% log-normal confidence interval: 295 - 5,921) unidentified beaked whales. However, it is not appropriate to prorate these unidentified animals based on the observed ratio of each species, because *Mesoplodon* spp. have fewer diagnostic characteristics for field identification than *Ziphius cavirostris* (and therefore are more likely to be characterized as unidentified beaked whales). The uncertainty in both the aerial and shipboard estimates is very large. Additionally, the aerial survey estimate is likely to be biased downwards because of the large fraction of time beaked whales spend submerged and are therefore not available to be seen from a fast-moving aircraft. The shipboard estimate of 1,621 Cuvier's beaked whales is expected to be the most accurate, because this slower-moving platform has a higher probability of encountering animals at the surface.

For the eastern tropical Pacific, Wade and Gerrodette (1993) estimate a total of 20,000 (CV=0.27; 95% bootstrap confidence interval: 13,800 - 34,500) Cuvier's beaked whales; however, the relationship of animals found in along the U.S. west coast to this population is unknown.

POPULATION GROWTH RATES AND TRENDS

Trends in abundance

No information on trends in abundance of Cuvier's beaked whale is available.

Growth rate at MNPL

The growth rate of this species is not known.

STOCK STATUS RELATIVE TO OSP AND K

OSP determination

The status of the population relative to OSP is unknown. Based on the offshore distribution of this species and the infrequency of fishery interactions in the eastern North Pacific, it is likely that this population is within OSP. However, the population to which the animals in California/Oregon/Washington belong may have been affected by high seas and coastal drift gillnet fisheries. For this reason, the status of these animals should be considered uncertain.

Condition indices

No data are available to evaluate potential biological condition indices.

CURRENT REMOVALS

Incidental take

The overall average annual mortality from gillnet fisheries in the eastern North Pacific is thought to be in the low tens of animals (IWC 1991). In Southern California, Cuvier's beaked whales have been found stranded with knife marks, indicating that fishery interactions occur (Heyning et al. 1994). With roughly 4-15% observer coverage of fishing effort in the coastal California drift and setnet fisheries, no mortality of Cuvier's beaked whales was documented in 1990 and 1991 (Perkins et al. 1992; Lennert et al. 1994), but six animals were observed taken in 1992 (Julian 1993), and three were observed taken in 1993 (Julian 1994). An additional three unidentified beaked whales and three unidentified cetaceans, which may have been this species, were also reported (Perkins et al. 1992; Julian 1993; 1994; Lennert et al. 1994). Total estimated annual mortality for Cuvier's beaked whales in 1992 is 45 animals (s.e. 17), with an estimated additional 23 (s.e. 12) unidentified beaked whales (Julian 1993). For 1993, total estimated mortality was 27 (s.e. 15) Cuvier's beaked whales. There has also been some mortality documented in high-seas drift gillnet fisheries (Hobbs and Jones 1993), and in an experimental driftnet fishery in Canada in the mid-1980's (Barlow et al. 1994), and but no overall estimates of mortality have been made for Cuvier's beaked whales in these regions. If large-scale movement occurs, the high seas take may affect animals belonging the same population as those along the coast of California.

Direct take

No direct take of this genus is known in the eastern North Pacific.

Illegal killing

None known.

Research and live capture

None known.

Other causes

No specimens from the U.S. west coast have been examined for pollutants, but levels are expected to be low for this pelagic species.

Pygmy sperm whale, *Kogia breviceps*
and
Dwarf sperm whale, *Kogia simus*

INTRODUCTION

History of exploitation and management

In the North Pacific, there are two species within the genus *Kogia* that have been distinguished only relatively recently (Handley 1966). *K. breviceps*, the dwarf sperm whale, and *K. simus*, the pygmy sperm whale, are difficult to separate in the field, and much information is confounded for the two species. For this reason, the two species of the genus *Kogia* will be combined into a single chapter, with species-specific information given when available. Additional study will be required before each of the two species can be evaluated separately. The small size of these two species and the rarity of encounters has prevented them from becoming a whaling target. They have been taken incidentally in the Japanese large-mesh driftnet fisheries in the North Pacific. They have also been taken occasionally in fisheries for small cetaceans (Caldwell and Caldwell 1989). Off California, they are susceptible to mortality in driftnets, but due to their offshore distribution and the rarity of fishery interactions, no direct management actions have been taken to date.

Biology

Little is known about the biology of whales of this genus. Most of what is known comes from stranded specimens. Live stranded animals brought into captivity have not survived for more than a few weeks. Sightings at sea are infrequent, which may indicate that these animals are rare, or may be an artifact of their inconspicuous behavior and pelagic distribution. They are thought to live in deep water at or beyond the edge of continental shelves, and feed on squid, fishes and pelagic crustaceans (Leatherwood et al. 1982). *K. simus* is thought to occur more often in slightly warmer water (Caldwell and Caldwell 1989). Data from surveys conducted in the eastern tropical Pacific and along the California coast (Wade and Gerrodette 1993; Barlow, in press) are consistent with a more tropical distribution for *K. simus* and a more temperate distribution for *K. breviceps*. There may be some differences in distribution for immature and mature animals (Caldwell and Caldwell 1989). Caldwell and Caldwell (1989) and Chantrapornsyl et al. (1991) reviewed information on reproductive biology. Some of the details are as follows:

Kogia breviceps females are thought to give birth in spring after an approximately 11 month gestation period and nurse their calves for approximately one year. Calves are about 1-1.2 m in length at birth. Females may give birth in successive years, as individuals which were both pregnant and lactating have been found. Males and females are believed to reach sexual maturity at about 2.85 m and 2.75 m length, respectively. Maximum reported length is 4.28 m for a specimen of unknown sex from the Indian Ocean. Males grow larger than females.

Kogia simus, the smaller of the two species, is approximately 1 m in length at birth and grows to a maximum length of about 2.7 m. Gestation is believed to last more than 9 months. Length at sexual maturity is between 2.1 and 2.2 m. No information on birth interval is available for this species.

POPULATION AND STOCK STRUCTURE

Biological basis of populations

Due to the sporadic nature of stranding records and uncertainties in the distribution and movement patterns of these species, no population boundaries presently can be defined. The difficulty in sighting and identifying these animals at sea has also prevented the collection of information on possible discontinuities in the distribution of these animals.

Recommended stocks for management

For the management of *Kogia* spp., it is recommended that each species be treated as a separate stock within the combined U.S. EEZ of California, Oregon and Washington. However, it is imperative that additional data on the biology, distribution, and abundance of these two species be collected. The current state of knowledge is insufficient for the recommended species-level management.

POPULATION SIZE

Estimation methods

Sightings of these two species have been recorded infrequently on aerial and shipboard line transect surveys for marine mammals. Four sightings were made during a 1979 ship survey conducted by NMFS, and one additional sighting is reported for an aerial strip transect survey in 1982 (Oliver and Jackson 1987), but no abundance estimates were made based on these sightings. No *Kogia* spp. were sighted during two spring aerial surveys of the California coast during March/April 1991 and February-April 1992 (Carretta and Forney 1993; Forney et al., in press). Barlow (in press) reports three sightings of *Kogia breviceps* during a summer/fall 1991 ship survey along the California coast, and presents an estimate of 870 (CV=0.80; 95% log-normal confidence interval: 220 - 3,433) pygmy sperm whales. No *Kogia* *simus* were seen during either of these two recent surveys, and therefore the abundance of dwarf sperm whales in unknown. For the eastern tropical Pacific, Wade and Gerrodette (1993) estimate 11,215 (CV = 0.294) *Kogia simus*, but the relationship between animals long the U.S. west coast and these eastern tropical Pacific animals is not known.

POPULATION GROWTH RATES AND TRENDS

Trends in abundance

No information is available on trends in abundance of these two species.

Growth rate at MNPL

The growth rates of these two species are not known.

STOCK STATUS RELATIVE TO OSP AND K

OSP determination

The status of the population relative to OSP is unknown. Based on the offshore distribution of this species and the infrequency of fishery interactions in the eastern North Pacific, it is likely that this population is within OSP. However, the population to which animals in California/Oregon/Washington belong may have been affected by mortality in high-seas drift gillnet fisheries. For this reason, the status of these animals should be considered uncertain.

Condition indices

No data are available to evaluate potential biological condition indices.

CURRENT REMOVALS

Incidental take

Pygmy and dwarf sperm whales were not observed taken between July 1990 and December 1991 in the U.S. drift gillnet fisheries off California, with approximately 4-10% coverage of fishing effort (Perkins et al. 1992; Lennert et al. 1994). In 1992 and 1993, one pygmy sperm whale was observed taken in these fisheries each year, resulting in total mortality estimates of 23 (s.e. 21; Julian 1993) for 1992 and nine (s.e. 8.6; Julian 1994) for 1993. Hobbs and Jones (1993) report a total of 37 *Kogia* spp. observed taken in high-seas drift gillnet fisheries in the North Pacific between

1988 and 1990, but no total estimate of annual mortality is presented.

Direct take

Kogia spp. are taken in several small cetacean fisheries (Caldwell and Caldwell 1989) throughout the world, but none of the takes are in the eastern North Pacific.

Illegal killing

None known.

Research and live capture

Live-stranded animals have been taken into captivity in Florida, New England, New Zealand and Australia (Caldwell and Caldwell 1989). They generally did not survive for more than a few days, although one juvenile survived for three months.

Other causes

Because of their inconspicuousness and their habit of lying at the surface, seemingly unaware of approaching vessels, a small number of pygmy and dwarf sperm whales may be hit and killed or injured by ships (Caldwell and Caldwell 1989). They are not likely to be susceptible to potential effects of pollutants due to their pelagic distribution. One immature specimen which stranded in California had no detectable pollutants in its blubber (Britt and Howard 1983).

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Summary of the status of California odontocetes covered by this report, including stock structure, abundance estimates (N), and minimum population estimates (N-min) reviewed at the 1993 Status of California Cetacean Stocks Workshop, held in La Jolla, California, March 31 - April 2, 1993. CV(N) is the coefficient of variation in N; R-MNPL is the population growth rate at the maximum net productivity level; N.A. indicates 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. Sources for abundance estimates are listed below by number.

Species Assumed Stock Structure	N	CV(N)	N-min	Status	R-MNPL	Source
Dall's porpoise						
CA + OR + WA	78,422	0.35	40,026	UNK	UNK	1
Pacific white-sided dolphin						
CA + OR + WA	121,693	0.48	51,041	UNK	UNK	2
Risso's dolphin						
CA + OR + WA	32,376	0.46	13,812	UNK	UNK	2
bottlenose dolphin						
California offshore	2,382	0.36	1,188	UNK	UNK	3
California coastal	245	N.A.	245	UNK	UNK	4
striped dolphin						
California	19,008	0.41	8,755	UNK	UNK	1
short-beaked common dolphin						
California	233,378	0.28	136,562	UNK	UNK	1
long-beaked common dolphin						
California	9,472	0.68	2,817	UNK	UNK	1
total common dolphins						
California	275,638	0.22	179,048	UNK	UNK	3
northern right whale dolphin						
CA + OR + WA	21,332	0.43	9,548	UNK	UNK	2
false killer whale						
CA + OR + WA	N.A.	N.A.	N.A.	UNK	UNK	--
killer whale						
California	307	1.20	48	UNK	UNK	1
short-finned pilot whale						
CA + OR + WA	N.A.	N.A.	N.A.	UNK	UNK	--
Baird's beaked whale						
CA + OR + WA	38	1.03	7	UNK	UNK	1
Blainville's beaked whale						
CA + OR + WA	N.A.	N.A.	N.A.	UNK	UNK	--
Hector's beaked whale						
CA + OR + WA	N.A.	N.A.	N.A.	UNK	UNK	--
Stejneger's beaked whale						
CA + OR + WA	N.A.	N.A.	N.A.	UNK	UNK	--
Gingko-toothed beaked whale						
CA + OR + WA	N.A.	N.A.	N.A.	UNK	UNK	--
Hubbs' beaked whale						
CA + OR + WA	N.A.	N.A.	N.A.	UNK	UNK	--
total mesoplodont beaked whales						
CA + OR + WA	250	0.83	60	UNK	UNK	1
Cuvier's beaked whale						
CA + OR + WA	1,621	0.82	396	UNK	UNK	1
total beaked whales						
CA + OR + WA	3,231	0.56	1,170	UNK	UNK	1
pygmy sperm whale						
CA + OR + WA	870	0.80	220	UNK	UNK	1
dwarf sperm whale						
CA + OR + WA	N.A.	N.A.	N.A.	UNK	UNK	--

SOURCES FOR ABUNDANCE ESTIMATES:

1=Barlow, in press.
2=Forney et al., in press.
3=Estimates calculated as average of values in 1 and 2, with CVs based on additive variances.
4=NMFS, SWFSC (unpublished aerial survey data) and Maldini 1992.

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