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Status review
Harbor Seals (*Phoca vitulina*) in Alaska

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STATUS REVIEW

Harbor Seals (*Phoca vitulina*) in Alaska

by

John L. Sease

National Marine Mammal Laboratory
Alaska Fisheries Science Center
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
7600 Sand Point Way NE, BIN C-15700
Seattle, Washington 98115-0070

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INTRODUCTION

Harbor seals (*Phoca vitulina*) occur throughout most of Alaska from Southeast Alaska, the Gulf of Alaska, and the Aleutian Islands to as far north as Bristol Bay and Kuskokwim Bay in the Bering Sea (approximate latitude of 60°N) (Pitcher 1984). Once considered ubiquitous and abundant throughout their range in Alaska, harbor seals may be experiencing population declines in some areas. Surveys conducted by the Alaska Department of Fish and Game (ADF&G), the National Marine Fisheries Service (NMFS), and others from the 1960s through 1991 suggest that numbers of harbor seals may have declined in some parts of Alaska, especially in the vicinities of the Kodiak Archipelago and Prince William Sound (Everitt and Braham 1980; Pitcher 1986, 1989, 1990; Hoover 1988; Hoover-Miller in press; Loughlin 1992).

Under the provisions of the Marine Mammal Protection Act of 1972 (MMPA), the Secretary of Commerce (or the Secretary of the Interior in the case of walruses, polar bears, sea otters, or manatees), after consultation with the appropriate scientific advisors, can designate a marine mammal species or stock as "depleted" when it falls below its optimum sustainable population (OSP). Similarly, under the provisions of the Endangered Species Act (ESA), the Secretary can designate a species (or "subspecies" or "distinct population segment") as "endangered" or "threatened" when it is in danger of becoming extinct or endangered,

respectively. On May 18, 1988, the NMFS listed northern fur seals (*Callorhinus ursinus*) as depleted under the MMPA (53 FR 17888) in response to a reduction in the number of animals that returned to rookeries on the Pribilof Islands during the breeding season. On November 26, 1990, also in response to observed population declines, the NMFS listed Steller (northern) sea lions (*Eumetopias jubatus*) as threatened under the ESA (55 FR 49204). Some resource managers and others (e.g., Pitcher 1990) speculate that harbor seals in the Bering Sea and Gulf of Alaska may be exhibiting signs of decline parallel to those seen earlier in northern fur seals and Steller sea lions. Depending on the severity of these declines, protective status under the MMPA or ESA may be appropriate now or in the near future for one or more "distinct population segments" or for the species as a whole.

The purposes of this review are to summarize biological information about harbor seals in Alaska, primarily that which is relevant to the possible population decline, and to assess the current status of the species in Alaska. The biological background section of this report draws principally from Bigg (1981), a general review of the harbor seal from a world-wide perspective, and from Hoover (1988) and Hoover-Miller (in press), which focus on harbor seals in Alaska.

BIOLOGICAL BACKGROUND

Known as common or hair seals throughout Eurasia, harbor seals occur predominantly in coastal and estuarine waters of the temperate, subarctic, and to a lesser extent, arctic regions of the North Atlantic and North Pacific oceans. Accordingly, the range of the harbor seal perhaps is more extensive than that of any other pinniped (Shaughnessy and Fay 1977, Bigg 1981).

Harbor seals generally are non-migratory, with local movements associated with such factors as tides and weather, season, food, and reproduction (Scheffer and Slipp 1944; Fisher 1952; Bigg 1969a, 1981), although some long-distance movement of tagged animals has been recorded (Pitcher and McAllister 1981). Considerable fidelity of individuals for haul-out sites also has been recorded (Pitcher and Calkins 1979, Pitcher and McAllister 1981, Harvey 1987, Yochem *et al*. 1987). Despite being a predominantly coastal species, harbor seals may occasionally be seen 75 to 100 km from shore (Fiscus *et al*. 1976, Wahl 1977, Spalding 1964, Pitcher and McAllister 1981, Kajimura and Loughlin 1988). Harbor seals frequently enter estuaries and ascend rivers, especially during spawning runs of anadromous fishes, and may remain for extended periods upriver or even in freshwater lakes (Bigg 1969a, 1981; Hoover 1988). About 100 harbor seals may reside year-round in Lake Iliamna on the Alaska Peninsula (O.

Mathisen, pers. commun. *cited in* Loughlin 1992). Harbor seals commonly haul out on sandbars, reefs, or protected tidal rocks. Glacial ice also is a preferred haul-out platform where it is available (Bigg 1969a, 1981; Hoover 1988; Loughlin 1992).

Taxonomy

The harbor seal is an "earless," or "true" seal of the Order Carnivora, suborder Pinnipedia, and family Phocidae. The precise subspecific taxonomy of harbor seals is uncertain (Scheffer 1958, McLaren 1966, Bigg 1981), but there probably are two Pacific subspecies: *P.v. stejnegeri*, the insular seal of eastern Asia and the Kuril, Commander, and Aleutian islands and *P.v. richardsi*, the eastern Pacific form. The closely-related spotted seal (*P. largha*) has been considered a third Pacific subspecies in the past, but now is generally regarded as a separate species (Shaughnessy and Fay 1977, Bigg 1981, Burns *et al.* 1984). The morphological distinction between *P. largha* and *P.v. stejnegeri* in the western North Pacific is clearer than between *P. largha* and *P.v. richardsi* in the eastern North Pacific (Shaughnessy and Fay 1977).

The distribution of *P.v. richardsi* and *P.v. stejnegeri* in the Aleutian Islands, as well as the degree and geographical location of overlap or separation, is unclear (Shaughnessy and Fay 1977, Burns *et al.* 1984). Shaughnessy and Fay (1977) refer to these subspecies as the *richardsi-stejnegeri* complex, with

clinal variation around the Pacific rim from Baja, California, to Alaska, to the Kuril Islands and Japan.

Harbor seals probably evolved in the North Pacific from a ringed seal-like ancestor at least 2 to 3 million years ago. *Phoca largha* is thought to be the ancestor of *P. vitulina*, which later dispersed into the Arctic and Atlantic oceans (McLaren 1966).

Physical Description

Harbor seals are moderate-sized pinnipeds. Standard lengths range from about 150 to 190 cm for adult males and 140 to 170 cm for adult females. Total body weight is much more variable, especially with seasonal fluctuations in body condition and blubber thickness, ranging from about 75 to 180 kg for adult males and about 60 to 145 kg for adult females. At birth, pups are about 75 to 100 cm long and weigh 10 to 20 kg (Bishop 1967, Pitcher and Calkins 1979, Bigg 1981, Burns and Gol'tsev 1984). The sex ratio of harbor seals in the Gulf of Alaska is close to 1:1 through about 20 years of age (Pitcher and Calkins 1979).

Pelage color of adult harbor seals is notoriously variable. Background color varies from almost white to almost black. Numerous contrasting spots, blotches, or rings mark the dorsal and, to a lesser extent, lateral surfaces (Shaughnessy and Fay 1977, Bigg 1981). Both *P.v. richardsi* and *P.v. stejnegeri* exhibit light and dark color varieties. The geographical

extremes of the *richardsi-stejnegeri* complex in Baja, California, and the Kuril Islands tend to be predominantly dark, with animals becoming progressively lighter approaching the center of distribution in the Gulf of Alaska (Shaughnessy and Fay 1977). The extreme individual variability in subspecies and in spotted seals, however, makes differentiation based on coloration and pelage markings extremely difficult, even for experienced biologists.

With few exceptions, harbor seal pups shed their white lanugo coat *in utero* and exhibit an adult-like hair and marking pattern at birth. Spotted seals, however, typically shed the lanugo at 2 to 4 weeks after birth (Shaughnessy and Fay 1977, Bigg 1981).

Harbor seals undergo a complete molt each year, typically during the 2 or 3 months following pupping. Shedding and replacement of hair may take 1 to 2 months (Scheffer and Slipp 1944, Bigg 1981), but because hair is replaced at different times on different parts of the body, the entire process for an individual animal can take 4 to 6 months (Stutz 1967, Ashwell-Erickson *et al*. 1986). Harbor seals spend the greatest proportion of time hauled out on land during the molting period (Johnson 1976a, Calambokidis *et al*. 1983), presumably to promote the hair replacement process by increasing blood flow to the skin (Feltz and Fay 1966, Ashwell-Erickson *et al*. 1986). Reduced

metabolic rate during the most intense molting period reduces food requirements and allows more extended haul-out time (Ashwell-Erickson *et al.* 1986).

Haul-out Behavior

Harbor seals regularly haul-out of the water to rest, molt, give birth, and nurse their young. Preferred haul-out sites include sandbars, reefs, isolated islands, or protected tidal rocks. Harbor seals also haul out on ice at numerous locations in Alaska. Where ice pans calved from glaciers are available, harbor seals appear to prefer ice to terrestrial haul-out sites, especially when pupping (Bishop 1967; Bigg 1969a, 1981; Hoover 1988; Hoover-Miller in press). Seals also haul out along the edge of shore-fast ice in low-salinity bays and estuaries that freeze over in winter (Pitcher 1975). Important characteristics of haul-outs include ready access to water, isolation from disturbance, protection from wind and wave action, and access to food (Pitcher 1984). Individual seals can show considerable fidelity to a specific haul-out or group of haul-outs, although some movement to distant haul-outs has been recorded (Divinyi 1971, Calambokidis *et al.* 1978, Pitcher and Calkins 1979, Pitcher and McAllister 1981, Harvey 1987, Yochem *et al.* 1987, Godsell 1988).

Harbor seals tend to be solitary animals when in the water, but they are moderately gregarious when hauled out on land or ice, forming loose groups composed of both sexes and all ages.

There is no strong social structure in hauled out groups comparable to that of fur seals or sea lions (Godsell 1988). In some areas, especially those with wide, sandy or cobble beaches such as Tugidak Island or Bristol Bay, harbor seals may haul out in groups as large as several hundred to several thousand animals (Bishop 1967; Pitcher 1986, 1990; Loughlin 1992). In other areas, such as the Aleutian Islands, Southeast Alaska, and British Columbia, where rocky coastlines and narrow boulder beaches are more prevalent, harbor seals more typically haul out in groups of about 30 animals or fewer, rarely to as many as a few hundred (Burns and Gol'tsev 1984, Imler and Sarber 1947, Bigg 1969a, Pitcher 1989).

Harbor seals may spend about 44% of their time hauled out on land or ice (Sullivan 1979). Frequency of attendance at haul-outs for individual radio-tagged seals near Tugidak Island, Alaska, varied from 16 to 80 percent, suggesting that numbers of seals counted at Tugidak Island represented about 35 to 60 percent of the local population (Pitcher and McAllister 1981).

Harbor seals tend to haul out in the largest numbers during the pupping and molting periods. Accordingly, these time periods are the best for conducting surveys. Haul-out numbers typically are larger during the molting period than during pupping (Calambokidis *et al*. 1987, Pitcher 1990). In Alaska, peak

numbers of molting seals haul-out from about mid-August through mid-September (Bishop 1967, Pitcher and Calkins 1979, Pitcher 1990).

Daily haul-out patterns appear to be highly variable. Where terrestrial haul-outs are flooded during the tidal cycle, seals understandably haul out in greatest numbers during low tide (e.g., Calambokidis *et al.* 1979). Where haul-outs remain exposed throughout the tidal cycle, seals may follow a diurnal pattern that is less dependent on tides. Stewart (1984) observed that numbers of harbor seals tended to peak in mid-afternoon on a California beach where haul-out substrate was almost always available. The absolute number of seals hauled out tended to be greater during afternoon low tides than during afternoon high tides. Some individual seals observed at San Miguel Island, California, apparently preferred hauling out at night, as other individuals prefer hauling out during the day (Yochem *et al.* 1987).

It is generally assumed that in Alaska, greatest numbers of seals tended to haul out around low tide (Bishop 1967; Pitcher 1975, 1990). However, Bishop (1967) concluded that seals on Tugidak Island haul out anytime that sufficient beach is available above the surf line. Thus, where tidal fluctuation is not great or on sandy beaches (e.g., Tugidak Island), the number of seals on a haul-out may build during the day to a maximum in

mid- to late afternoon (Pitcher[1], NMFS[2]). Where tide fluctuation is large (e.g., Southeast Alaska or Prince William Sound) haul-out behavior is likely to be more tide-dependent.

Calambokidis *et al.* (1983, 1987) found highest counts of seals on ice in Glacier Bay, Alaska, at mid-day. Counts on glacial ice also may be maximized when the ice is concentrated close to the face of the glacier by wind or flooding tides (Bishop 1967, Pitcher 1975). Larger numbers of seals may haul out in calm weather than during storms. Haul-out behavior also can be altered dramatically by factors as diverse as rock slides, eagles, and human disturbance (Bishop 1967; Johnson 1976c; Calambokidis *et al.* 1983, 1987).

Feeding Ecology

Harbor seals are coastal feeders and dives tend to be shallow and of short duration. Dive depths typically are less than 80 meters but can reach 500 meters (Kolb 1982, Stewart *et al.* 1989). Most dives are shorter than 11 minutes in duration and average only 1 to 3 minutes (Harvey 1987). Feeding trips away from the haul-out typically are shorter than 12 hours but trips of up to 6 days have been recorded (Thompson and Miller 1990 *cited in* Hoover-Miller in press).

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[1] K. Pitcher, Alaska Department of Fish and Game, 333 Raspberry Road, Anchorage, Alaska 99518. Pers. commun.

[2] NMFS, unpubl. data. Alaska Fisheries Science Center, National Marine Mammal Laboratory, NOAA, 7600 Sand Point Way NE, Seattle, WA 98115.

In general, descriptions of food items result from analyses of stomach contents and feces. These results are biased by several factors, however. Otoliths and bones from fish verify the presence of a particular prey species in the diet, but many bones may not be recoverable, especially from feces, thus under-representing the relative importance of a particular prey species. Variable ease of detection and identification of bones from different prey species can bias results from any food habits study. Harbor seals may not eat the heads of large fish, such as salmon, so otoliths and other easily-identified bones may not be present in stomachs or fecal material (Pitcher 1980a). In addition, reduction in size of otoliths as they dissolve in seals' stomachs results in an underestimate of prey size. This is especially true for cartilaginous fishes or for delicately-boned fishes such as herring and smelts (Pitcher 1980a, Harvey 1989). Conversely, items like octopus and squid beaks may accumulate in the stomach over a period of time before being regurgitated. Analysis of stomach contents can over-emphasize the relative importance of these foods while analyses of fecal materials may miss them entirely (Pitcher 1980a, Harvey 1989).

Harbor seals consume a wide variety of fishes, cephalopods, and crustaceans. Fish prey in Alaska includes at least 27 species from 13 families (Pitcher 1980b), including Gadidae (cods and walleye pollock (*Theragra chalcogramma*)), Clupeidae

(herrings), Cottidae (sculpins), Pleuronectidae (flounders, turbot, sole, Pacific halibut (*Hippoglossus stenolepus*)), Salmonidae, Osmeridae (smelts, eulachon (*Thaleichthys pacificus*), capelin (*Mallotus villosus*)), Hexagrammidae (greenlings), and Trichodontidae (sandfish). Octopus, gonatid squids, and shrimps also are important (Imler and Sarber 1947, Wilke 1957, Spalding 1964, Pitcher and Calkins 1979, Pitcher 1980b, Burns and Gol'tsev 1984).

Harbor seals are opportunistic feeders, so diet varies geographically and seasonally. The relative importance of individual food items in the Gulf of Alaska during the 1970s is given in Table 1. In general, walleye pollock was the most important prey species in the eastern areas: the Northeast Gulf, Prince William Sound, and off the Kenai Peninsula. Octopus was the most important prey in western areas: lower Cook Inlet, Kodiak, and off the Alaska Peninsula (Pitcher and Calkins 1979, Pitcher 1980b). In another study, walleye pollock and cods (*Gadus spp.*) accounted for 63.5% and octopus 28.7% of identifiable food items in seals collected near the Pribilof Island in the early 1980s (Burns and Gol'tsev 1984). Seasonal shifts in diet take place as seals follow spawning species such as eulachon, Pacific herring (*Clupea harengus*), capelin, and salmon (*Oncorhynchus* spp.) (Pitcher and Calkins 1979, Pitcher 1980b).

Table 1.--Relative importance of major prey of 269 harbor seals collected in the Gulf of Alaska during 1973 to 1978. Ranks (R) are by a modified Index of Relative Importance (IRI), the product of percent relative frequency (%F) and percent volume (%V). Only those prey with an IRI of 2 or larger are included (adapted from Pitcher 1980b).

R	Prey species	IRI	%F	%V
1	Walleye pollock (*Theragra chalcogramma*)	445	20.8	21.4
2	Octopus (*Octopus* spp.)	313	17.1	18.3
3	Capelin (*Mallotus villosus*)	92	8.8	10.4
4	Eulachon (*Thaleichthys pacificus*)	57	4.9	11.6
5	Pacific herring (*Clupea harengus*)	41	6.4	6.4
6	Pacific cod (*Gadus macrocephalus*)	20	6.2	3.2
7	Flatfishes (family Pleuronectidae)	13	5.1	2.6
7	Shrimps	13	3.8	3.3
9	Salmon (*Oncorhynchus* spp.)	9	2.0	4.4
10	Squids (family Gonatidae)	7	4.4	1.6
11	Pacific sandfish (*Trichodon trichodon*)	7	2.2	3.0
12	Sculpins (family Cottidae)	4	2.2	1.9
14	Skates (*Raja* spp.)	2	0.7	2.7
14	Pacific sand lance (*Ammodytes hexapterus*)	2	4.2	0.5
14	Pacific tomcod (*Microgradus proximus*)	2	1.6	1.0

Havinga (1933), Fisher (1952), and Bigg (1973 *in* Bigg 1981) reported that weaned pups first feed on shrimps. Pups collected in the Gulf of Alaska in the 1970s, however, fed almost exclusively on small fishes (Pitcher 1980b), while five pups collected in the Aleutians in 1980s had fed on mysids (Burns and Gol'tsev 1984).

Reproductive Biology

Female harbor seals first ovulate between the ages of 3 to 7 years. Females first ovulated at age 3 or 4 years in a heavily-hunted population in the Gulf of Alaska during the 1960s (Bishop 1967), and between 3 and 5 years of age for 21 harbor seals collected in the Aleutian Islands between 1968 and 1973 (Burns and Gol'tsev 1984). The mean age for first ovulation and first pregnancy was 3.3 years for females collected during 1958 to 1968 from a fast-growing population in British Columbia (Bigg 1969a, Olesiuk *et al*. 1990). For seals collected during the mid-1970s, Pitcher (1977) calculated ages of first ovulation and pregnancy at 3.7 and 4.4 years, respectively, for harbor seals in Prince William Sound, Alaska, and 5.0 and 5.5 years, respectively, in the Gulf of Alaska. These estimated ages for the Gulf of Alaska by Pitcher (1977) are significantly higher than Bigg's (1969a) for British Columbia and Pitcher's (1977) for Prince William Sound (Pitcher and Calkins 1979). Male harbor seals mature by about 6 years of age (Bishop 1967, Bigg 1969a, Pitcher 1977, Pitcher and Calkins 1979).

Bigg (1969a) estimated fecundity (pregnancy) rates of 80% for females 2 to 7 years old and 97% for seals older than 7 years. Actual rates could be slightly lower because of additional *in utero* mortality after the sampling period. Burns and Gol'tsev (1984) observed pregnancy rates of 75% for 16 mature females collected from 1968 to 1973 in the Aleutian Islands. During the mid-1970s in the Gulf of Alaska, ovulation rates increased from 7% for 3-year-old females to 100% by age 7. Pregnancy rates increased from 17% at age 4 years to 100% at age 8 years, and dropped to 92% for all females older than 8 years (Pitcher and Calkins 1979). Bishop (1967) found 92% of multiparous females showed signs of two successive pregnancies or two successive annual ovulations.

Time of birth and breeding activity vary geographically. Bigg (1969b) reported clinal variation in pupping dates along the western coast of North America with pupping taking place latest (May through September) in Washington State and progressively earlier moving southward toward Mexico (March through May) and northward toward Alaska. Bigg's (1969b) analysis probably was confounded by the uncertain taxonomic status of the spotted seal and inclusion of its early pupping dates (March through May) from the Pribilof Islands and the Bering Sea (Burns and Gol'tsev 1984). Harbor seals may pup slightly later in northern regions of Alaska than at Tugidak Island or in Southeast Alaska (Shaughnessy and Fay 1977, Burns and Gol'tsev 1984), but there is

no discernible clinal variation among seals from northern British Columbia and Alaska (Temte *et al*. 1991). Pupping dates are summarized in Table 2.

Twin pregnancies have been recorded (Scheffer and Slipp 1944), but single pups are the norm (Bigg 1969a, 1981). Females may bear their pups in herds of mixed age and sex composition, but usually on the periphery of large groups or in separate "nursery groups." Bishop (1967) observed females with newborn pups in the center of an unoccupied circle of approximately 15-foot radius. In some cases the parturient female created this buffer area by driving other seals away. More often, however, the buffer formed as nearby seals voluntarily withdrew. Females also commonly bear their pups at isolated sites (Johnson 1976a,b; Calambokidis *et al*. 1978; Hoover 1983). Pups typically are born on land. In the vicinity of tidewater glaciers, however, harbor seals apparently prefer pupping on small ice pans (Bishop 1967; Bigg 1969a, 1981; Streveler 1979; Hoover 1983). Births in the water are unusual (Bishop 1967, Johnson 1976a).

Pups can crawl and swim almost immediately and can enter the water within the first hour (Bishop 1967, Johnson 1976a, Streveler 1979, Hoover 1983, Lawson and Renouf 1985). They can dive for up to 2 minutes at 2 to 3 days of age and up to 8 minutes at 10 days of age (Finch 1966 and Harrison and Tomlinson 1960 *cited in* Bigg 1981).

Table 2.--Pupping seasons for harbor seals in different regions of Alaska, as well as adjacent Soviet and Canadian waters. The pupping season typically lasts about 1½ to 2 months in any particular area and peak numbers of births typically take place about two-thirds of the way through the period (Bigg 1969a,b).

Region	Pupping period[1]	Source(s)
Bering Sea		
Pribilof Islands	M-May to M-July[2]	Scheffer 1977
Pribilof Islands	L-June to E-July	Johnson 1974 *in* Burns and Gol'tsev 1984
Pribilof Islands and Bristol Bay	June to M-July	J.Burns and F.Fay *in* Shaughnessy and Fay 1977
Nanvak Bay	M- to L-June	Vania *et al.* 1969
Aleutian Islands	M-L-June to M-July	Burns and Gol'tsev 1984
Aleutian Islands	M-June	Murie 1959
Gulf of Alaska		
Tugidak Island	E-M-May to L-June	Bishop 1967, Pitcher and Calkins 1979
Aialik Bay	E-May to E-June	Bishop 1967, Murphy and Hoover 1981
Copper River Delta	L-May to L-June	Imler and Sarber 1947
Prince William Sound	M-May to E-July	Pitcher 1977, Pitcher and Calkins 1979
Southeast Alaska		
Glacier Bay	L-May to L-June	Streveler 1979
Stikine River Area	L-May to L-June	Imler and Sarber 1947
Soviet Union		
Kurile Islands	L-March to M-May	Belkin 1964 *in* Bigg 1969b
Commander Islands	L-April to E-May	Barabash-Nikiforov 1938 *in* Bigg 1969b
British Columbia, Canada		
Skeena River Area	L-May to L-June	Fisher 1952
S.E. Vancouver I.	L-June to E-Sept.	Bigg 1969a

[1]E- = early, M- = mid, L- = late

[2]Probably skewed to an earlier date because of confusion with *Phoca largha* (Burns and Gol'tsev 1984, Temte *et al.* 1991)

The first few hours after birth are critical for proper formation of the mother-pup bond (Lawson and Renouf 1987). Disturbance or separation of the pair before a proper bond is established can result in abandonment of pups. Although an abandoned or lost pup might be adopted by another female or may be capable of feeding on its own (Bishop 1967), most subsequently die (Johnson 1976c, Pitcher and Calkins 1979, Streveler 1979).

Harbor seals wean their pups at 3 to 6 weeks after birth (Scheffer and Slipp 1944, Bishop 1967, Bigg 1969a, Johnson 1976a, Hoover 1983), and pups can almost double their weight by that time (Bigg 1969a). Pups may disperse away from the natal area after the mother-pup bond is broken (Johnson 1976a, Hoover 1983).

Ovulation and conception take place a few days after lactation ends (Bishop 1967, Bigg 1969a). Male harbor seals in British Columbia are in breeding condition (active sperm in the epididymal tubules) during about 9 months of the year, or about 6 months before and 2 months after the "normal" breeding season (Bigg 1969a). Males apparently initiate copulation, which rarely has been observed, but presumably takes place in the water (Venables and Venables 1957; Bishop 1967; Johnson 1976a,b; Bigg 1981; Allen 1985; Godsell 1988). Terrestrial copulation does take place, but it apparently is the exception (Allen 1985). Implantation of the blastocyst is delayed about 1.5 to 3 months,

during which time the seal molts (Fisher 1954, Bigg 1969a, Bishop 1967, Pitcher and Calkins 1979).

CENTERS OF ABUNDANCE AND POPULATION COUNTS IN ALASKA

Harbor seals are the most abundant and wide-spread pinniped in coastal Alaska, ranging from Dixon Entrance in Southeast Alaska to the southern Bering Sea (ADF&G 1973 *in* Calkins *et al.* 1975). Known centers of abundance include areas in Southeast Alaska, the northern Gulf of Alaska, including Yakutat and Icy bays, the Copper River Delta, Prince William Sound, numerous bays along the Kenai and Alaska peninsulas, the Kodiak Archipelago, and Bristol Bay, including the north side of the Alaska Peninsula (Calkins *et al.* 1975, Pitcher and Calkins 1979, Hoover 1983, Hoover-Miller in press).

The distribution of harbor seals in the Aleutians Islands is poorly known (Calkins *et al.* 1975). As noted above (see Taxonomy above), the discretness or overlap of the two subspecies (*P.v. richardsi* and *P.v. stejnegeri*) that occur in the Aleutians, or even the validity of retaining these as separate subspecies rather than clinal variation of a single subspecies, is unclear (Shaughnessy and Fay 1977, Burns *et al.* 1984). This uncertainty reflects the general lack of knowledge about the distribution of harbor seals in the Aleutian Islands.

Even in parts of Alaska where harbor seal distribution is better known than it is in the Aleutians, many questions remain. Shaughnessy and Fay (1977: p.413) describe the distribution of harbor seals in Alaska as "a very long (10,000 km), uninterrupted series of hundreds of small breeding populations, over a wide range of latitude and longitude and environmental conditions." Whether these small breeding populations or groups of adjacent populations exist as separate subspecies, separate stocks, or clinal variations of a single stock is unknown.

State-wide Population Estimates

One of the earliest estimates of the harbor seal population in Alaska was "at least 100,000" in the 1960s (Klinkhart 1969 *in* Scheffer 1972). Mathisen and Lopp (1963) counted over 22,000 harbor seals in the northwestern Gulf of Alaska from photographs taken during aerial surveys conducted in 1956 to 1958. The greatest numbers (over 16,000) were in the Trinity Islands (Tugidak and Sitkinak) south of Kodiak. Based on the results from Mathisen and Lopp (1963) and Bishop (1967), as well as estimated harvests from the area, Scheffer (1972) estimated the northwestern Gulf of Alaska population at 15,000 to 25,000 seals.

The Alaska Department of Fish and Game (ADF&G) produced abundance estimates for harbor seals in five regions of Alaska in the 1960s, based on harvest records, aerial surveys in selected areas, and the accumulated knowledge of the ADF&G staff (Table 3). The total estimate of 270,000 harbor seals in Alaska

Table 3.--Estimated harbor seal population in Alaska in the early 1970s, by region (from ADF&G 1973, NMFS/USFWS 1978, Pitcher 1984).

Region	Estimated population
Dixon Entrance to Cape Fairweather (Southeast Alaska)	30,000
Cape Fairweather to the Kenai Peninsula, including Prince William Sound	70,000
Cook Inlet, Kodiak Archipelago, Shelikof Strait, and south side of the Alaska Peninsula	55,000
Aleutian Islands	85,000
North side of the Alaska Peninsula, Bristol Bay, and Pribilof Islands	30,000
Total	270,000

(ADF&G 1973, NMFS/USFWS 1978) was considered more an indication of the general magnitude of the population than a precise estimate of population size (Pitcher 1984). Additional surveys in the mid-1970s, however, suggested that the estimates for the Kodiak Archipelago, the north and south sides of the Alaska Peninsula, and Bristol Bay may have been low (Pitcher 1984).

In 1991, the NMFS began a 3-year survey of harbor seals in Alaska. Surveys conducted during the first year were in Bristol Bay, along the north side of the Alaska Peninsula, in Prince William Sound, and near the Copper River Delta. Surveys will be conducted in the central and western Gulf of Alaska (including the south side of the Alaska Peninsula, the Kodiak Archipelago, and Cook Inlet) during 1992 and in Southeast Alaska (and possibly the Aleutian Islands) in 1993 (Loughlin 1992).

Regional Counts

Estimates and counts of harbor seals are available for several regions of Alaska. While some of these counts focused on harbor seals and other marine mammals, many, especially those in the Aleutian Islands, were opportunistic counts made incidental to seabird surveys. Such counts typically do not take into account tides, time of day, weather, or other factors that can affect harbor seal counts, and therefore probably are conservative.

Southeast Alaska

The most comprehensive counts of harbor seals in Southeast Alaska focused only on a few sites in Glacier Bay during the 1970s and 1980s (Streveler 1979, Calambokidis *et al.* 1987) and near Sitka and Ketchikan during the 1980s (Calkins and Pitcher 1984, Pitcher 1989). Counts included about 7,000 to 10,000 animals for the three areas (see Population Trends below).

Prince William Sound

Counts of harbor seals in Prince William Sound primarily have been trend counts at 25 major haul-outs during the pupping or molting seasons (Calkins and Pitcher 1984, Pitcher 1989). Counts included about 3,000 seals in the mid-1980s (see Population Trends below). Loughlin (1992) estimated a minimum population of about 2,500 seals in Prince William Sound and another 3,500 seals near the Copper River Delta.

Kenai Peninsula

Bailey (1977) counted about 2,500 harbor seals along the south side of the Kenai Peninsula (Point Adams to Resurrection Bay) during June and July 1976. The largest numbers of seals were on the Chugach Islands and in the glacial inlets; the lowest numbers were in the ice-free fjords.

Kodiak Archipelago

The most complete series of harbor seal counts in Alaska are from Tugidak Island, off the southern tip of Kodiak Island. In 1956 and 1957, Mathisen and Lopp (1963) estimated 6,000 to 9,000 harbor seals in the Trinity Islands area (Tugidak and Sitkinak islands) during June and July and 13,000 to 17,000 during September and October. Bishop (1967) estimated 9,500 to 10,000 seals on Tugidak Island in June of 1964. More recent counts have focused only on the southwest beach on Tugidak Island (see Population Trends below).

Alaska Peninsula and Bristol Bay

During seabird surveys of the Sandman Reefs (approximately 100 small islands and numerous rocks, about 50 km south of the Alaska Peninsula) during June and July 1978, Bailey and Faust (1980: p.18) counted over 2,600 harbor seals, noting that the seals "abound throughout the region." Although distribution was not uniform, seals occurred at each of the 30 islands and 17 islets or rocks visited.

Everitt and Braham (1980) surveyed 14 sites along the north side of the Alaska Peninsula in June and August of 1975, 1976, and 1977. June counts were the largest, at 18,367, 25,066, and 14,116 seals, respectively. Four of the largest haul-outs on the north side of the Alaska Peninsula (Port Moller, Port Heiden, Cinder River, and Seal Islands) have been counted repeatedly

since the mid-1960s. From 1965 through 1991, total counts at these sites during June have varied from fewer than 5,000 seals to almost 20,000 (Pitcher 1986, Everitt and Braham 1980, Loughlin 1992) (see Population Trends below).

The ADF&G (1973 *cited in* Everitt and Braham 1980) reported that harbor seals occurred all along the north coast of Bristol Bay, but without any areas of high concentration. Everitt and Braham (1980) counted about 300 seals and found no consistent, large haul-outs along the north coast of Bristol Bay (Cape Peirce to Kvichak Bay) in 1975. Nanvak Bay, just west of Cape Peirce and outside of the Everitt and Braham (1980) study area, has been the largest harbor seal haul-out in northern Bristol Bay. Numbers of seals there have been as high as 2,000 to 3,000 from the mid-1970s to mid-1980s (Johnson 1976a, Frost *et al.* 1982, Johnson *et al.* 1989) (see Population Trends below).

Aleutian Islands

Murie (1959: p.307) found harbor seals throughout the Aleutians in 1936 and 1937, but noted that they were not "particularly abundant." Burns and Gol'tsev (1984) found harbor seals less abundant in the vicinity of the Islands of Four Mountains than elsewhere in the Aleutians, although they judged that densities there were still somewhat higher than areas elsewhere within the species' range. The lack of protected embayments potentially affected seal abundance at the Islands of

Four Mountains. According to Sekora (1973: p.177), however, harbor seals were "common" throughout the Aleutian Islands, but "not so numerous" as along the Alaska Peninsula. Fiscus *et al.* (1981: p.74) noted that "harbor seals were present throughout most of the [central Aleutian Islands] survey area, scarce in the Delarofs and most of the Rat Islands, and nowhere abundant."

Eastern Aleutians (Fox Islands): In March of 1960, Kenyon (*cited in* Sekora 1973) counted about 2,500 harbor seals on Amak Island and in the Fox Islands (Umnak to Unimak in the eastern Aleutians). Everitt and Braham (1980) identified several islands in the Fox Island group where small concentrations of harbor seals regularly occurred and obtained their maximal count for these islands of 3,948 seals in August 1976. Nysewander *et al.* (1982) also counted about 2,500 seals in the same area during the summers of 1980 and 1981 during seabird surveys.

Central Aleutians (Western Andreanof Islands - Adak to, but not including, Atka): Seabird surveyors visited many of the islands in the central Aleutian Islands during 1980. Although relative abundance of harbor seals varied throughout these islands, animals occurred at almost all islands visited. The total count for 20 islands and island groups was 1,431 seals (AINWR 1981). Fiscus *et al.* (1981) visited 68 islands or islets in the central Aleutians during Steller sea lion surveys in 1979 and counted 674 harbor seals (including 15 pups).

Western and West-Central Aleutians (Near, Rat, and Delarof island groups): During the summer of 1977, seabird surveyors counted 695 harbor seals in the Delarof Islands and at Semisopochnoi Island (AINWR 1978). During the summer of 1979, 1,956 harbor seals were counted in the Near Islands, at Buldir Island, and at the Segula Island Group of the Rat Islands (AINWR 1980).

Trapp (1980) reported that harbor seals were abundant during the summer of 1975 on the reefs and rocky coastlines of Alaid and Nizki islands of the Semichi Group in the Near Islands. Approximately 75 to 100 seals occurred in the vicinity of Gull Island, a small island off Alaid (Trapp 1980). Total counts of seals for the entire Alaid-Nizki area were about 300 in the summer of 1979 (AINWR 1980) and 88 in 1984 (Zeillemaker and Trapp 1986).

Kenyon and King (1965) counted 145 harbor seals in the Kiska-Little Kiska-Tanadak island group during May 1965. During July and August 1978, 877 seals were counted in the same area (AINWR 1979).

POPULATION TRENDS

Although repeated counts of seals were conducted in a variety of areas in Alaska beginning in the 1970s, many of these

counts and estimates are not comparable due to differences in survey technique, geographical coverage, and time of year. For example, it is difficult to compare counts made during pupping with counts made during the molting period. It was not until systematic, repetitive counts became available that trends could be detected (Pitcher 1990).

A list of repetitive counts for 12 locations in Alaska is given in Table 4. Caution must be exercised when interpreting these trend data, however. Harbor seals are difficult to see and count when in the water; they are virtually impossible to count when underwater. Most counts, therefore, are made at haul-outs. As noted above, harbor seals spend proportionally more time hauled out during the pupping and molting periods (Calambokidis *et al.* 1987, Pitcher 1990); thus, surveys are most successfully conducted during these times. The counts listed in Table 4 are from either the pupping or molting seasons. Counts from each time period for Tugidak Island are listed separately.

Counts also can be affected by the viewing platform. Some of these data (*e.g.*, Tugidak Island and Johns Hopkins and Muir inlets in Glacier Bay) are from land-based counts, where seals were viewed from cliffs or promontories. Others (*e.g.*, Prince William Sound, Bristol Bay, and Alaska Peninsula) are counts from aerial photographs. Counts from Aialik and Glacier bays are predominantly on-ice counts; the others are land counts.

Table 4.--Mean and maximal number of harbor seals counted at several locations in Alaska. These locations may be those with the greatest potential for monitoring harbor seal population trends in Alaska (adapted from Hoover-Miller in press).

Region	Year	Mean	n	Maximum	Month(s)	Source
Southeast Alaska						
Ketchikan Region	1983	1,059	(9)	1,998	August	Calkins and Pitcher 1984
	1984	1,553		2,471	Aug.-Sept.	Pitcher 1989
	1988	1,821	(5-7)	2,597	August	Pitcher 1989
Sitka Region	1983	1,181	(6-9)	1,967	September	Calkins and Pitcher 1984
	1984	1,201	(4-12)	2,217	Aug.Sept.	ADF&G[1]
Glacier Bay						
Johns Hopkins Inlet	1975	1,442	(2)	1,445	June	Streveler 1979
	1976	1,921	(7)	2,109	June	Streveler 1979
	1977	2,330	(4)	2,588	June	Streveler 1979
	1978	3,305	(3)	3,419	June	Streveler 1979
	1983			1,257	June	NPS[2]
	1984			4,250	June	Calambokidis *et al.* 1987
	1987			1,226	June	NPS[2]
	1988			3,627	June	NPS[2]
	1989			1,854	June	NPS[2]
	1990			2,036	June	NPS[2]
	1991			1,751	June	NPS[2]
Muir Inlet	1973	1,131	(5)	1,347	June	Streveler 1979
	1974	1,042	(12)	1,172	June	Streveler 1979
	1975	606	(12)	775	June	Streveler 1979
	1976	463	(5)	538	June	Streveler 1979
	1977	793	(4)	941	June	Streveler 1979
	1978	1,112	(4)	1,230	June	Streveler 1979
	1982			943	June	Calambokidis[3]
	1983			725	June	Calambokidis *et al.* 1987
	1984			1,013	June	Calambokidis[3]
	1989			100	June	NPS[2]
	1990			100	June	NPS[2]
	1991			89	June	NPS[2]

Table 4.--Continued.

Region	Year	Mean	n	Maximum	Month(s)	Source
Prince William Sound	1983	1,585	(6-10)	2,986	Aug.-Sept.	Calkins and Pitcher 1984
	1984	1,796		3,022		Pitcher 1989
	1988	1,058	(5-9)	1,749	Aug.-Sept.	Pitcher 1989
	1989	down more than			Aug.-Sept.	NMFS[4]
	1990	10% from 1988			Aug.-Sept.	NMFS[4]
	1991	893			Aug.-Sept.	Loughlin 1992
Aialik Bay	1979	793	(8)	1,311	June	Murphy and Hoover 1981
	1980	915	(11)	1,633	June	Murphy and Hoover 1981
	1981	830	(8)	1,063	June	Hoover 1983
	1986		(1)	391	June	Hoover-Miller[5]
Tugidak Island (southwest Beach)	1976	2,184	(11)	3,566	June	Pitcher 1990
	1977	1,173	(7)	1,900	June	Pitcher 1990
	1978	1,182	(25)	2,086	June	Pitcher 1990
(pupping period)	1979	1,022	(14)	1,356	June	Pitcher 1990
	1986	616	(4)	676	June	Pitcher 1990
Tugidak Island (southwest Beach)	1976	6,919	(12)	9,300	Aug.-Sept.	Pitcher 1990
	1977	6,617	(2)	6,640	Aug.-Sept.	Pitcher 1990
	1978	4,839	(12)	6,817	Aug.-Sept.	Pitcher 1990
(molting period)	1979	3,836	(21)	4,886	Aug.-Sept.	Pitcher 1990
	1982	1,575	(10)	2,323	Aug.-Sept.	Pitcher 1990
	1984	1,390	(9)	2,187	Aug.-Sept.	Pitcher 1990
	1986	1,270	(10)	1,673	Aug.-Sept.	Pitcher 1990
	1988	1,014	(10)	1,437	Aug.-Sept.	Pitcher 1990
	1990	960	(9)	1,283	Aug.-Sept.	Pitcher 1991

Table 4.--Continued.

Region	Year	Mean	n	Maximum	Month(s)	Source
Alaska Peninsula - North						
Port Moller	1966[6]	2,900	(4)	8,000	June-July	Pitcher 1986
	1968[6]	1,025	(2)	1,250	July	Pitcher 1986
	1969[6]	2,460	(5)	3,300	June-July	Pitcher 1986
	1970[6]	1,567	(3)	2,500	June-July	Pitcher 1986
	1971[6]	2,975	(2)	4,100	June-July	Pitcher 1986
	1973[6]	1,675	(1)	1,675	July	Pitcher 1986
	1975	5,321	(2)	6,078	June	Pitcher 1986
	1976	6,573	(2)	7,968	June	Pitcher 1986
	1977	3,959	(2)	4,335	June	Pitcher 1986
	1985	3,465	(7)	4,010	June	Pitcher 1986
	1990	2,516	(7)	2,989	June	NMFS[4]
	1991	2,958	(5)	3,426	June	Loughlin 1992
Seal Islands	1966[6]	1,112	(5)	3,200	June-July	Pitcher 1986
	1968[6]	325	(2)	350	July	Pitcher 1986
	1969[6]	900	(1)	900	June	Pitcher 1986
	1970[6]	1,000	(2)	1,000	June	Pitcher 1986
	1971[6]	1,275	(2)	1,550	June-July	Pitcher 1986
	1973[6]	374	(1)	374	July	Pitcher 1986
	1975	646	(2)	1,137	June	Pitcher 1986
	1976	516	(2)	786	June	Pitcher 1986
	1977	308	(2)	497	June	Pitcher 1986
	1985	1,081	(8)	1,521	June	Pitcher 1986
	1990	711	(7)	819	June	NMFS[4]
	1991	704	(5)	886	June	Loughlin 1992

Table 4.--Continued.

Region	Year	Mean	n	Maximum	Month(s)	Source
Alaska Peninsula North (cont.)						
Port Heiden	1966[6]	2,000	(4)	2,500	June-July	Pitcher 1986
	1968[6]	1,850	(2)	2,500	July	Pitcher 1986
	1969[6]	1,717	(6)	2,100	June-July	Pitcher 1986
	1970[6]	4,533	(3)	6,500	June-July	Pitcher 1986
	1971[6]	3,750	(2)	5,900	June-July	Pitcher 1986
	1973[6]	4,298	(1)	4,298	July	Pitcher 1986
	1975	5,024	(2)	5,273	June	Pitcher 1986
	1976	7,662	(2)	10,548	June	Pitcher 1986
	1977	6,222	(1)	6,222	June	Pitcher 1986
	1985	5,603	(8)	6,196	June	Pitcher 1986
	1990	4,210	(7)	5,192	June	NMFS[4]
	1991	4,558	(5)	4,825	June	Loughlin 1992
Cinder River	1966[6]	1,150	(3)	1,500	June-July	Pitcher 1986
	1968[6]	700	(2)	800	July	Pitcher 1986
	1969[6]	500	(1)	500	June-July	Pitcher 1986
	1970[6]	3,400	(1)	3,400	July	Pitcher 1986
	1971[6]	350	(1)	350	July	Pitcher 1986
	1973[6]	875	(1)	875	July	Pitcher 1986
	1975	1,896	(2)	2,867	June	Pitcher 1986
	1976	3,783	(2)	4,503	June	Pitcher 1986
	1977	1,530	(2)	1,530	June	Pitcher 1986
	1985	0.1	(7)	1	June	Pitcher 1986
	1990	737	(7)	1,105	June	NMFS[4]
	1991	777	(5)	1,055	June	Loughlin 1992

Table 4.--Continued.

Region	Year	Mean	n	Maximum	Month(s)	Source
Bering Sea						
Nanvak Bay	1975		(21)	2,918	August	Johnson 1976a
	1979		(1)	2,000	Sept.	Frost *et al.* 1982
	1981		(1)	3,100	August	Frost *et al.* 1982
	1983		(1)	2,500	Sept.	K. Taylor *in* Johnson *et al.* 1989
	-- 1990		(127)	470	Apr.-Oct.	Jemison 1991 *in* Hoover-Miller in press
	1991	301	(6)	400	Aug.-Sept.	NMFS[4]

[1]ADF&G, unpubl. data. Alaska Department of Fish and Game, 333 Raspberry Road, Anchorage, AK 99518.

[2]NPS, unpubl. data. National Park Service, Glacier Bay National Park and Preserve, Gustavus, AK 99826.

[3]J. Calambokidis, Cascadia Research Collective, 218½ West Fourth Ave, Suite 201, Olympia, WA 98501. Pers. commun.

[4]NMFS, unpubl. data. National Marine Fisheries Service, Alaska Fisheries Science Center, National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115.

[5]A. Hoover-Miller, unpubl. data. Pacific Rim Research, Box 509, Haines AK 99827.

[6]Alaska Peninsula "counts" for 1966 through 1973 estimated to nearest 100 animals.

A wide variety of other factors (*e.g.*, time of day, tides, wind, surf, ice conditions) can influence haul-out behavior, and may influence haul-out behavior differently at different locations. As presented, the data in Table 4 do not identify tides, weather, or disturbances that could alter results. Consequently, care must be taken when comparing counts. At best, these counts serve as indices of population trends rather than estimates of population size.

Southeast Alaska

Numbers of harbor seals in Southeast Alaska appear to be stable (Pitcher 1990). Of the sites listed in Table 4, only Muir Inlet in Glacier Bay appears to experiencing a decline in abundance. The glacier in Muir Inlet is receding and no longer extends into the tidewater zone, however, and ice conditions are less favorable for seals. Currently "about 100" seals remain in the Muir Inlet during the summer (Schroeder[1]). Numbers of seals on the ice in Johns Hopkins Inlet remain high.

Prince William Sound

The number of harbor seals in Prince William Sound appears to be decreasing. This possible decline was first identified from the numbers of seals counted at 25 trend sites in 1983, 1984, and 1988 (Pitcher 1989). Assessment of population trends in Prince William Sound became substantially more complex with the *EXXON VALDEZ* oil spill in March 1989. Some mortality of

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[1]M. Schroeder, Glacier Bay National Park and Preserve, Gustavus, AK 99826. Pers. commun.

harbor seals undoubtedly did occur within the spill zone, but it may be years before the full effect of the oil spill on harbor seals can be ascertained. Preliminary assessment suggests that harbor seals in the Sound decreased about 15 percent from 1988 to 1991, but the relative influence of an on-going decline and oil-related mortality is unknown.

Counts of harbor seals at Pitcher's (1989) 25 original trend sites have continued as part of the assessment effort in the wake of the oil spill. Counts at 26 additional haul-out sites in the Sound began in 1991 as part of a state-wide effort to establish minimum population estimates (Loughlin 1992). Through continued examination of numbers at the original 25 sites and with comparison of numbers at "oiled" and "non-oiled" sites, these surveys may be able to assess both the effect of the spill as well as the overall status of harbor seals in the region.

Kodiak Archipelago

Pitcher (1989, 1990) described the harbor seal population decline at Tugidak Island, where numbers dropped about 85 percent from 1976 to 1988. For those areas of Alaska for which data are available, Tugidak Island certainly presents the strongest case for a decline in abundance. That decline is apparent for both mean and maximum counts and during both pupping and molting seasons (Figure 1). Anecdotal reports from fishermen and others in the Kodiak Island area that harbor seals have been noticeably

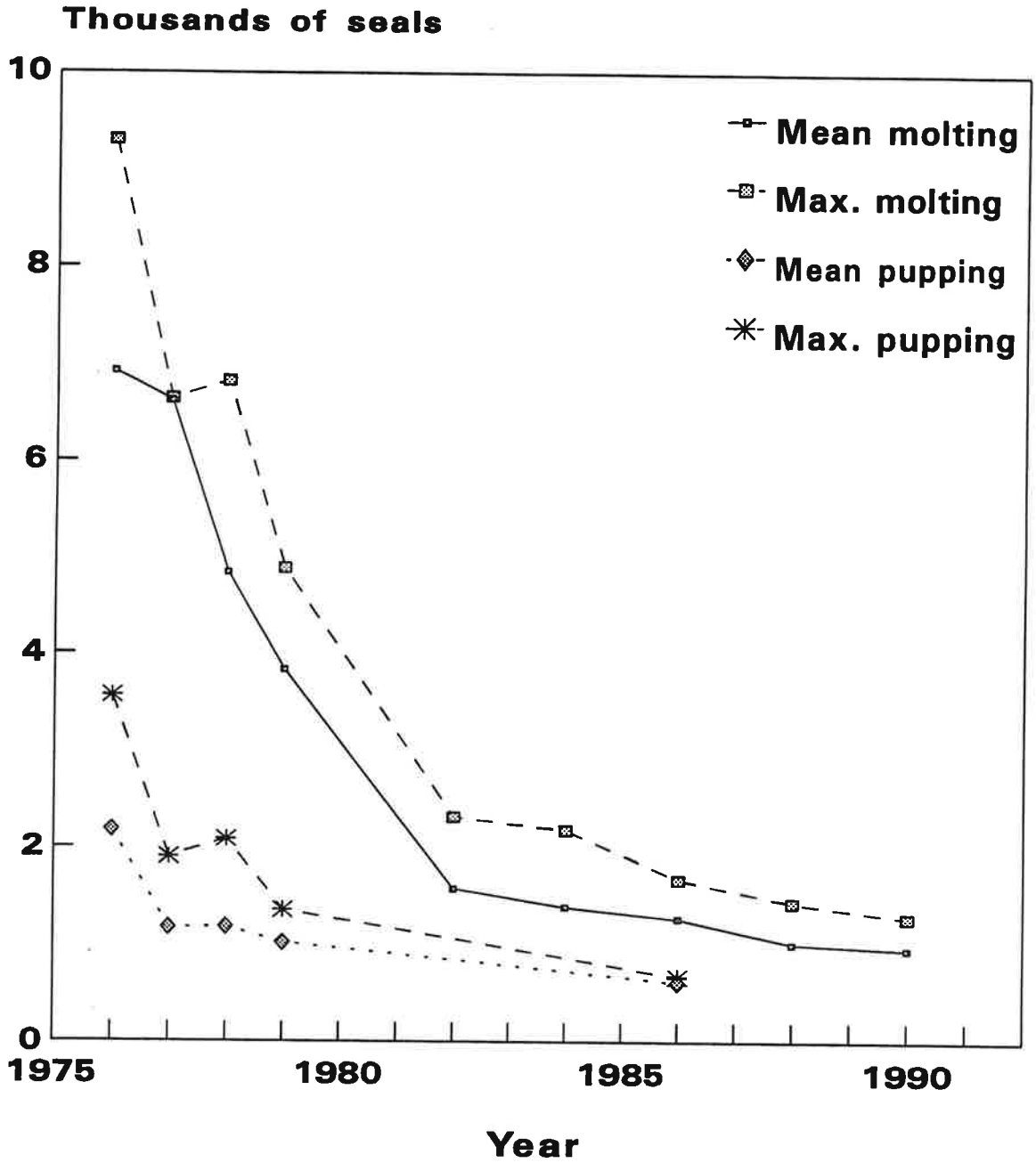

Figure 1.--Counts of harbor seals at the southwest beach on Tugidak Island, Alaska, during the pupping and molting seasons. Mean and maximal numbers are for all counts during a particular season and year (see Table 4).

less numerous during recent years (NMFS[1]) suggest that the Tugidak Island trends may be representative of an area-wide decline in the population.

Alaska Peninsula and Bristol Bay

Identification of potential trends on the Alaska Peninsula and in Bristol Bay is more difficult. The overall trend for the four Bristol Bay sites (Port Heiden, Cinder River, Port Moller, and Seal Islands) combined shows a slight increase from 1966 to 1991 (Figure 2). During 1975 to 1991, the period when Tugidak Island numbers decreased so dramatically, the combined numbers at the four Bristol Bay sites also declined. High counts in 1976 at Port Heiden, Port Moller, and Cinder River exaggerate this trend. However, it is unlikely that the addition of new pups could explain an increase of about 5,600 seals from 1975 to 1976. Such a sharp, single-year increase might be explained more easily by immigration of seals from other areas to take advantage of locally abundant prey. If the 1976 counts are excluded as anomalous, the decline from 1975 to 1991 becomes equivocal.

Everitt and Braham's (1980) survey data may offer some evidence for movement of seals from the eastern Aleutian Islands and the western Alaska Peninsula eastward into Bristol Bay. For all sites surveyed, approximately 80% of the seals were at sites east of Izembeck Lagoon in June 1975. That proportion jumped to 94% in June 1976 when numbers east of Izembeck Lagoon increased

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[1]NMFS, unpubl. data.

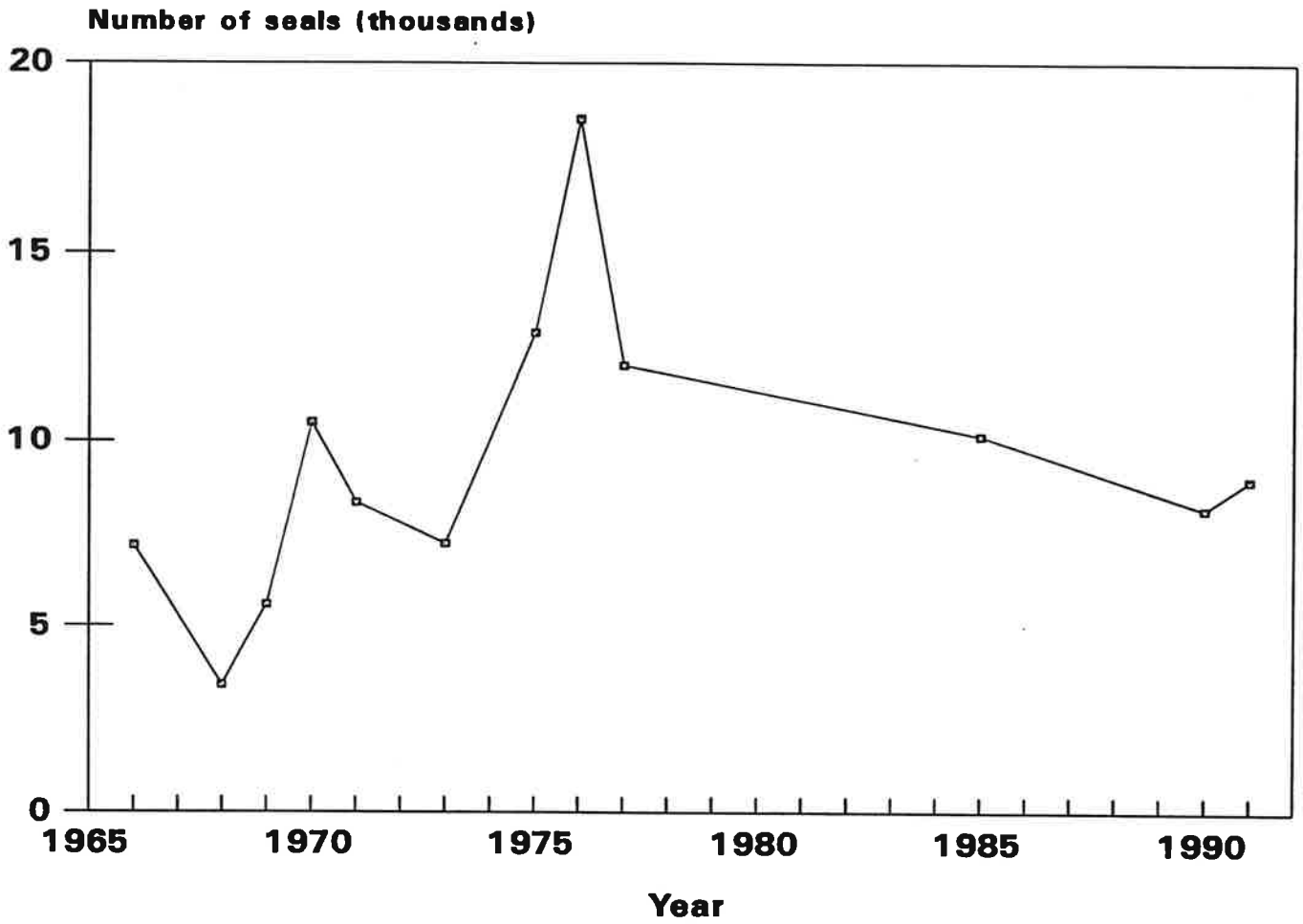

Figure 2.--Combined mean counts of harbor seals at four locations in Bristol Bay, Alaska: Port Moller, Seal Islands, Port Heiden, and Cinder River (see Table 4).

by 8,621, while those from Izembeck Lagoon westward (to Pancake Rocks, just west of Umnak Island) decreased by 2,132. In June 1977 the proportion of seals at sites east of Izembeck Lagoon was again about 80% of the total. This redistribution already was apparent by August of 1976. Although the total count dropped from 25,966 in June to 13,848 in August, the sites east of Izembeck Lagoon decreased by 16,186 while those from Izembeck Lagoon westward increased by 4,068.

Although the numbers of seals at Nanvak Bay apparently can fluctuate during the course of a year from a few hundred to over 3,000 (Johnson *et al.* 1989), the maximal numbers of seals dropped from 3,000 to 2,000 during the mid-1970s and mid-1980s to about 400 to 500 in 1990 and 1991 (Johnson 1976a, Frost *et al.* 1982, Johnson *et al.* 1989, Jemison 1991). The number of walruses (*Odobenus rosmarus*) in the area apparently has increased recently, however, and the disappearance of harbor seals could be explained more by their avoidance of walruses rather than by population decline (Hoover-Miller in press).

Future Surveys

During the next few years, additional data will become available to extend the time series for some of the sites listed in Table 4 and to begin assessment of seal abundance in other areas of Alaska. Examples of these new data include the following:

1. Minimum population estimates of marine mammal species are a

critical element of the proposed regime for management of the incidental take of marine mammals by commercial fisheries, as required under the 1988 Amendments to the Marine Mammal Protection Act (NMFS 1991). Harbor seals in Alaska are among the species for which survey activity already has begun. Bristol Bay, the north side of the Alaska Peninsula, and Prince William Sound were counted in 1991, and results are included in Table 4. Harbor seals in the northern Gulf of Alaska, Cook Inlet, the Kodiak Archipelago, and the south side of the Alaska Peninsula will be counted in 1992, and Southeast Alaska will be counted in 1993 (Loughlin 1992).

2. New studies began in 1991 to examine the abundance and haul-out behavior of seals in Glacier Bay (Matthews[1], Schroeder[2]).

3. Analysis of data collected to examine the effects of the *EXXON VALDEZ* oil spill in Prince William Sound will help assess the overall status and population trends of harbor seals in the Sound.

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[1]E. Matthews, Department of Education, Arts, and Science, University of Alaska Southeast, 11120 Glacier Highway, Juneau, AK 99801. Pers. commun.

[2]M. Schroeder, pers. commun.

CURRENT NUMBERS IN RELATION TO OPTIMUM SUSTAINABLE POPULATION

Optimum sustainable population (OSP) is the management goal for all marine mammal species under the MMPA. OSP is the range between carrying capacity of the environment (*K*) at the upper limit and maximum net productivity level (*MNPL*) at the lower limit. OSP has proven to be an elusive and controversial guideline for marine mammal management, however. Rarely is it possible to identify what *K* is, was, or should be relative to historic or current population levels, presence or absence of harvests or incidental takes by commercial fisheries, etc.

"Dynamic response analysis" is another method for assessing whether or not a species is within OSP. Dynamic response examines trends in abundance over time in conjunction with changes in the rate of population change that are attributable to density-dependent mechanisms of population control (Boveng *et al.* 1988, Goodman 1988, DeMaster *et al.* 1982). Dynamic response analysis has been applied with mixed results for California sea lions (*Zalophus californianus*), harbor seals in California, and northern elephant seals (*Mirounga angustirostris*) (Boveng 1988a,b,c).

The NMFS currently is developing a new regime for managing the incidental take of marine mammals by commercial fisheries (NMFS 1991). While retaining OSP as a management goal, the NMFS

proposes managing incidental takes based more on qualitative judgments of population status than on quantitative estimates.

A status review of the northern fur seal concluded that the Pribilof Island population in 1983 was less than 50% the size of the population in the 1940s and early 1950s (50 FR 9232). The NMFS listed northern fur seals as "depleted" under the MMPA in May 1988 (53 FR 17888). Numbers of Steller sea lions observed at certain rookeries in Alaska decreased by 63% from 1985 to 1989 and by 82% from 1960 to 1989. In response, the NMFS listed Steller sea lions as "threatened" under the ESA in November 1990 (55 FR 49204).

For both northern fur seals and Steller sea lions, population estimates or index counts that apply to a substantial proportion of the population are available for historic and current population levels. Such data allow assessment of a population relative to OSP. In the case of harbor seals in Alaska, however, sufficient data do not exist to calculate current population size as a proportion of K or to perform a dynamic response analysis. The few data sets that identify trends each apply to very limited geographical areas (e.g., the southwest beach of Tugidak Island, Prince William Sound, and four major haul-outs on the north side of the Alaska Peninsula). Although the NMFS is conducting a 3-year, state-wide survey of harbor seals in Alaska (Loughlin 1992), there are no good

baseline data to make large-scale, regional assessments of trends in relation to OSP.

FACTORS POTENTIALLY AFFECTING STATUS

Changes in Vital Parameters

Reproduction

Observed pregnancy rates and age of first breeding for harbor seals in Alaska have been similar as those in other parts of the species' range. Unfortunately, no recent data are available to suggest whether these or other reproductive parameters are changing. Without such information it is difficult to assess the role of reproduction in population declines. However, it is unlikely that reduced reproduction could explain the significant decline observed at Tugidak Island (Pitcher 1990).

Survival Rates

Although reduced survival rates certainly could contribute to population reduction, there currently are no data available to identify a trend in Alaska.

Disease

Disease-caused mass mortality of harbor seals has occurred several times during recent years. Pneumonia caused by an influenza virus killed about 450 harbor seals along the coast of New England in 1979 to 1980 (Geraci *et al.* 1982). In 1988, an outbreak of an infectious phocid distemper spread rapidly through

harbor seals in the North and Baltic seas, killing about 18,000 animals (Osterhaus *et al.* 1989a, Osterhaus *et al.* 1989b, Osterhaus *et al.* 1989c). In the Netherlands, a herpes virus caused the deaths of 11 orphaned harbor seal pups in a nursery (Borst *et al.* 1986 *cited in* Bigg 1981). Antibodies to this herpes virus have been found in harbor seals and other pinnipeds in Alaska (Vedder *et al.* 1987, Pitcher 1990). Steller sea lions show signs of exposure to *Leptospira* spp., *Chlamydia psittaci*, San Miguel sea lion virus, and Tillamook (bovine) calicivirus (Barlough *et al.* 1987a, Barlough *et al.* 1987b; Skilling *et al.* 1987; Calkins and Goodwin 1988; Pitcher 1990). Harbor seals in Alaska apparently have been exposed to San Miguel sea lion virus, but at a very low rate (Fay *et al.* 1978). Tillamook (bovine) calicivirus has not been isolated in any Pacific coast phocid seals, including harbor seals (Barlough *et al.* 1987b). Seal pox also has been reported in harbor seals in Alaska, but the implications are not known. Despite these potential disease problems, there have been no reports of unusual numbers of sick or dead harbor seals at Tugidak Island, where seal numbers have decreased most dramatically, or elsewhere in Alaska (Pitcher 1990).

Subsistence and Hunting

Harbor seals have been hunted in Alaska for several primary reasons: subsistence, commercial use of hides, bounties, and predator control. Subsistence hunting of harbor seals and other marine mammals has taken place in Alaska for as long as humans have inhabited the region. Subsistence uses include food, hides,

and materials used in handicrafts. Bounties and predator control, exercised to protect commercial salmon fisheries, began in the late 1800s. The commercial harvest of harbor seals for pelts reached significant levels in the 1960s. In 1972 the MMPA prohibited bounties, predator control, and commercial harvesting of marine mammals while protecting the rights of Alaskan natives to harvest marine mammals for subsistence.

Subsistence Harvests

Subsistence hunting of harbor seals takes place in virtually all portions of the species' range in Alaska. The only major exception is uninhabited or sparsely populated regions of the Aleutian Islands. Unfortunately, few good data exist describing the rates of subsistence harvests of harbor seals. The areas with the largest annual take probably are Southeast Alaska, Prince William Sound, and the Kodiak Archipelago (Table 5). Pitcher (1984) estimated annual subsistence harvests of 1,000 to 2,500 seals. More recent data suggest the annual harvest may be 2,000 to 3,000 seals (ADF&G[1]). Because these estimates are not based on comprehensive surveys, they should be viewed with caution. Hopefully, more accurate estimates of subsistence take will be available in the near future. In 1992, the NMFS Alaska Region is initiating new, state-wide research into subsistence uses of marine mammals in Alaska.

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[1]ADF&G, unpubl. data. Alaska Department of Fish and Game, 333 Raspberry Road, Anchorage, AK 99518.

Subsistence harvests of harbor seals and other marine mammals can vary substantially from year to year. Weather conditions can facilitate hunting or keep hunters on the beach. Minor or temporary changes in seal distribution can affect the availability of seals to hunters. The availability of employment opportunities also can affect subsistence harvests, as hunters may forsake hunting for wage-paying jobs. In addition, when cash is available, the need for subsistence foods is lessened and harvests may decrease.

Bounties and Commercial Harvests

For many years, commercial fishermen considered seals and sea lions to be significant predators that threatened valuable fish resources, especially salmon. Management focused on this real or perceived damage to fish stocks and lost income, responding by levying bounties, hiring seal hunters, and encouraging commercial hunting of seals to control their numbers (Imler and Sarber 1947). Annual harvests increased from 6,000 to 10,000 in the 1930s and 1940s to 12,000 to 24,000 by the late 1940s and early 1950s (Hoover 1988). From 1951 through 1958, the Territory of Alaska Department of Fisheries killed more than 30,000 harbor seals in the Copper River District (Lensink 1958, Matkin and Fay 1980). From 1927 through 1967, the Department paid as much as $1 million in seal bounties (Scheffer 1972).

Harbor seals also were subjected to commercial hunting for pelts in Alaska. Because some of the pelts from bounty animals

Table 5.--Estimated annual subsistence harvest of harbor seals in Alaska by region (from Hoover-Miller in press, Alaska Department of Fish and Game[1]).

Region	Estimated harvest
Southeast Alaska	1,500
Prince William Sound	100-500
Cook Inlet	50
Kodiak Archipelago	200-500
Alaska Peninsula	50
Bristol Bay	200
Total	2,100-2,800

[1]ADF&G, unpubl. data. Alaska Department of Fish and Game, 333 Raspberry Road, Anchorage, AK 99518.

undoubtedly entered the commercial fur market, separation of these harvests can be difficult. Prior to the mid-1960s, harvests probably ranged from 6,000 to 10,000 animals used primarily for subsistence. Alaska harbor seal skins entered the European market in the mid-1960s, which resulted in annual harvests of about 50,000 in 1965 and 25,000 to 30,000 in 1966. Annual harvests decreased to about 8,000 to 12,000 by 1972 (Pitcher 1984). Total combined annual harvests at Tugidak Island, Port Moller, and Port Heiden dropped from about 8,000 seals in 1964 to about 3,000 by 1972 (Table 6). More than 90 percent of harvested seals were newborn pups (Pitcher 1986, 1990). In 1972 the MMPA established a moratorium on commercial hunting of marine mammals. All harvests since 1972 are for subsistence by Alaskan natives.

Fisheries Interaction

Because harbor seals predominantly occupy coastal and estuarine habitats, they commonly come in contact with commercial fishing operations. In some cases, harbor seals and commercial fishermen may be competing for the same target species. This interaction occasionally results in incidental (accidental) entanglement of harbor seals in gillnets, purse seines, and other fishing gear, as well as directed (intentional) take by fishermen who are protecting their catch and gear from damage by foraging seals (Imler and Sarber 1947, Matkin and Fay 1980, Hoover 1988, NMFS 1991, Hoover-Miller in press).

Very little quantitative information is available about the magnitude of interaction between harbor seals and commercial fisheries in Alaska (e.g., the frequency with which seals become entangled in gear, the number of seals that are injured or killed as a direct result of interactions, the value of gear or catch destroyed or damaged by seals, or the damage caused to fish stocks). As noted above, government agencies engaged in predator control for decades, killing thousands of animals annually. Although attitudes have changed, especially since the enactment of the MMPA in 1972, the MMPA authorizes commercial fishermen, under certain conditions, to use lethal means to protect catch and gear from depredation by harbor seals and other marine mammals.

Incidental and Directed Take

Early estimates of harbor seal mortality incidental to domestic and foreign commercial fisheries in Alaska during the mid-1970s varied from about 1,700 (NMFS/USFWS 1978) to about 2,800 (Brooks 1979). Neither estimate is documented. Beginning in 1973, foreign fishing vessels and foreign joint venture processors in the Alaska groundfish fisheries carried observers who recorded marine mammal incidental take as well as fisheries data (see below). Only four harbor seals were observed killed from 1973 to 1983 (Perez and Loughlin 1992). Matkin and Fay (1980) estimated the take of marine mammals associated with the gillnet fishery for salmon in the Copper River Delta and Prince

Table 6.--Commercial harvests of harbor seals at Tugidak Island, Port Moller, and Port Heiden in southcentral Alaska, 1964 to 1972. Most harvested seals were pups (from Pitcher 1986, 1990).

	Total commercial harvest		
Year	Tugidak Island	Port Moller	Port Heiden
1964	5,500	--	--
1965	4,300	1,800	2,200
1966	2,275	2,300	3,100
1967	750	1,935	2,278
1968	800	1,091	2,180
1969	900	1,230	2,940
1970	1,160	858	804
1971	1,100	945	1,746
1972	1,100	0	1,900
Total	17,885	10,159	17,148
Mean	1,987	1,270	2,143

William Sound area in one of the only other efforts to quantify incidental take in Alaska (see below).

The 1988 Amendments to the Marine Mammal Protection Act required that participants in many fisheries, including virtually all gillnet fisheries in Alaska, maintain records of all interactions with marine mammals. The 1988 Amendments also mandated observer programs for four fisheries in Alaska: 1) the drift gillnet and 2) set gillnet fisheries for salmon in Prince William Sound/Copper River Delta, 3) the drift gillnet fishery for salmon in Unimak and False passes (South Unimak), and 4) the groundfish trawl fishery in the Gulf of Alaska and Bering Sea. For those fisheries thought to have a remote likelihood of interactions with marine mammals the 1988 Amendments required neither observers nor logbooks. Consequently, recent data from logbooks or observers are nonexistent for such Alaskan fisheries as salmon purse seine, herring purse seine, and herring gillnet. Observer programs run by the Alaska Department of Fish and Game and the North Pacific Fisheries Management Council have collected limited data from shellfish and groundfish pot fisheries.

<u>Gillnet Fisheries</u>: Matkin and Fay (1980) estimated that about 500 harbor seals were killed or seriously injured as a result of interaction with the Copper River Delta and Prince William Sound drift gillnet fishery for salmon in 1978. Although Wynne (1990) did not attempt to estimate total annual mortality of marine mammals in this fishery in 1988 and 1989, she concluded

that mortality was greatly reduced from the 1978 level. Both studies based their conclusions on direct observation of the fishery and on dockside interviews with fishermen. Possible factors contributing to lower observed mortality in 1988 to 1989 include annual variability in interaction rates (caused by variability in the distribution of mammals and the fishing fleet), changes in the status of involved marine mammal species (perceived local declines in Steller sea lions and harbor seals), and changing attitudes among members of the fishing fleet (e.g., greater reliance on deterrence and less use of lethal force as a defence against depredation by pinnipeds) (Wynne 1990, Wynne[1]).

The first complete year for which fishermen's marine mammal logbooks are available is 1990. According to these logs, 37 harbor seals were killed and 34 injured as a result of incidental take in salmon gillnet fisheries in Alaska during the year. An additional 27 were killed and 24 injured by directed take. The logbook data also include 2 spotted seals killed and 8 injured in Alaska gillnet fisheries. In addition, 5 unidentified seals were killed and 11 injured in Alaskan gillnet fisheries (NMFS[2]). Any or all of these seals may have been harbor seals. Consequently, the total reported take of harbor seals by salmon gillnet fisheries in Alaska in 1990 was 64 to 71 killed and 58 to 77 injured (Table 7).

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[1]K. Wynne, Alaska Sea Grant Marine Advisory Program, Cordova, Ak 99574. Pers. commun.

[2]NMFS, unpubl. data.

Caution must be exercised in interpretation of these data for several reasons. Logs were kept by individual fishermen, not by impartial observers. A fisherman's primary responsibilities are safe operation of the vessel and catching fish; marine mammal observations do not occupy his full attention as they do for fisheries observers. Interpretation and recording of marine mammal interactions probably is not done uniformly by different individuals. In some cases fishermen might under-report interactions for fear of bringing restrictions and regulations to their fisheries. In addition, results given above are preliminary and may change slightly as reporting and data entry errors are removed from the data bases. Despite these problems, logbook results should give at least a rough estimate of take levels.

Observer data are available for three Alaskan salmon gillnet fisheries in 1990: Prince William Sound drift gillnet, Prince William Sound set gillnet, and Unimak Pass and False Pass (South Unimak) drift gillnet. In the Prince William Sound drift gillnet fishery two harbor seals entangled in nets and died in 1990. Two other harbor seals became entangled and escaped: one freed itself and one was released by a fisherman. Based on the level of observer coverage in the fishery, Wynne *et al.* (1991) estimated a total of 36 harbor seals (95% confidence interval 0-74) killed in the fishery. This is similar to the 1988 take for this fishery reported by Wynne (1990). No harbor seals were taken by the

Table 7.--Estimated annual take of harbor seals, spotted seals, and unidentified seals by commercial fisheries in Alaska during 1990, based on marine mammal logbooks (L) and observer reports (O), when available. Gear type identifies drift (D) or set (S) gillnet fisheries. Recorded number of seals (Rec.) killed or injured includes both incidental take (accidental entanglement) and directed take (intentional deterrence to protect catch and gear). Estimated total take (Est.) is extrapolated from recorded total, based on percent observer coverage and/or proportion of logbooks analyzed (from Wynne *et al.* 1991, NMFS[1]). Fisheries with no logbook or observer data are not included.

Fishery	Gear type	Data type	Killed		Injured	
			Rec.	Est.	Rec.	Est.
Harbor seals						
Salmon gillnet fisheries						
Prince William Sound	D	L,O	9	36	9	36
Prince William Sound	S	L,O	0	0	0	0
South Unimak	D	L,O	8	12	5	8
Southeast Alaska	D	L	8	11	6	9
Yakutat	S	L	0	0	0	0
Cook Inlet	D,S	L	0	0	3	6
Kodiak	S	L	2	4	0	0
Alaska Peninsula	S	L	0	0	0	0
Bristol Bay	D,S	L	37	67	35	64
Salmon troll fishery		L	1	3	0	0
Groundfish trawl fishery		L,O	2	4	0	0
Total - harbor seals			67	137	58	123
Spotted seals						
Total - all fisheries		L,O	2	3	8	15
Unidentified seals						
Total - all fisheries		L,O	5	14	11	22

[1]NMFS, unpubl. data. National Marine Fisheries Service, Alaska Region, P.O. Box 21668, Juneau, AK 99802.

Prince William Sound set gillnet or South Unimak drift gillnet fisheries in 1990 (Wynne *et al.* 1991).

Groundfish Trawl Fisheries: From 1973 through 1988, fisheries observers aboard foreign and joint venture groundfish trawl vessels reported 31 harbor seals killed in trawl nets in the U.S. Exclusive Economic Zone (EEZ) off Alaska: 28 in the Bering Sea and Aleutian Islands Management Area and 3 in the Gulf of Alaska (Perez and Loughlin 1992). While none was killed from 1973 through 1976, over 80% of these harbor seals were killed during a 5-year period from 1983 to 1988. Three spotted seals, which could have been misidentified harbor seals, also were killed from 1983 to 1988 in the trawl fishery in Alaska. Observer coverage during this period varied from about 25 to 75 percent (typically greater than 50 percent) of the total tonnage of fish caught (Perez and Loughlin 1992). According to logbook and observer programs, two harbor seals were killed in groundfish trawl fisheries in Alaska in 1990. Preliminary data suggest that the number of harbor seals taken in the Alaska groundfish trawl fisheries in 1991 was similar to the 1990 take (NMFS[1]).

Salmon Troll Fishery: For the salmon troll fishery in Alaska, interactions with marine mammals typically result in fishermen harassing sea lions and seals away from their gear. This fishery was subject to mandatory logbooks but not to an observer program in 1990. Logbook reports include only one

[1]NMFS, unpubl. data.

harbor seal killed during the year. Steller sea lions typically have caused most of the marine mammal interaction problems for this fishery (NMFS 1991).

Loss of Catch and Gear

Gillnets probably are the gear type most susceptible to losses caused by harbor seals, which take bites from entangled fish or totally remove fish from the nets. Imler and Sarber (1947) estimated that losses caused by harbor seals in the Copper River Delta salmon fishery in 1945 equaled about 2 percent of the catch, representing damage in excess of $15,000. More recent estimates of the losses in the Copper River and Bering River districts are 2.5 to 3.9 percent in 1978 (Matkin and Fay 1980), 1.8 to 3.2 percent in 1988 (Wynne 1990), and 0.3 percent in 1990 (Wynne *et al.* 1991).

Entanglement in Marine Debris

Entanglement in marine debris and derelict fishing web may be a major contributing factor to the observed decline in numbers of northern fur seals in the North Pacific (Fowler 1987). Entanglement is not a likely factor in the decline of Steller sea lions, however (Merrick *et al.* 1987), and probably is not an important factor for harbor seals. The incidence of entanglement by harbor seals in southern California is extremely low (Stewart and Yochem 1985, 1987, 1990). Pitcher (1990) never observed a harbor seal entangled in debris at Tugidak Island and Loughlin *et al.* (1986) observed no entangled seals among 1,197 animals in the

Aleutian Islands. Although the number of seals entangled and drowned at sea is unknown, harbor seals do not exhibit a propensity for entanglement (Loughlin *et al*. 1986; Stewart and Yochem 1987, 1990; Hoover-Miller in press).

Estimated Total Subsistence and Fisheries Take in Alaska During 1990

Extrapolating from existing observer and logbook data (as discussed above), the NMFS Alaska Region derived a preliminary total estimate of fewer than 137 harbor seals killed (through incidental and directed takes) as a result of interaction with commercial fisheries in Alaska in 1990: 130 in salmon gillnet fisheries, 3 in the Alaska salmon troll fishery, and 4 in groundfish trawl fisheries (Table 7). Some of the harbor seals injured through interaction with commercial fisheries die of their wounds. At the worst, if all wounded seals ultimately die, the number of seals reported as injured in logbooks could represent another 123 harbor seals killed each year in Alaska. This would increase the total number killed annually to 260. Similarly, if some of the injured spotted seals or unidentified seals were actually harbor seals, the annual total could be increased by as much as another 30 to 40 seals.

These estimates are based on percent coverage by observers and logbooks in reported fisheries and extrapolation to unreported fisheries. In some cases, notably salmon gillnet fisheries, observer coverage is low, and logbook data must be interpreted with caution (see above). Accordingly, these

extrapolations must be interpreted with equal caution. Added to 2,000 to 3,000 animals taken for subsistence, the total annual removal of harbor seals in 1990 may have been 2,130 to 3,300.

SUMMARY

Harbor seals are the most abundant and wide-spread pinniped in coastal Alaska, ranging from Dixon Entrance in Southeast Alaska to the southern Bering Sea. Harbor seal numbers apparently have declined during recent years in several portions of their range in Alaska, however. This trend is most apparent at Tugidak Island, where numbers declined about 85% from 1976 to 1990. Anecdotal information suggests that this trend may apply in some degree to the entire Kodiak Archipelago.

Numbers of harbor seals in Prince William Sound may have been in decline since the mid-1980s, including declines in excess of 10% since 1988. Some of the Prince William Sound data are not available for public disclosure, however, due to potential litigation surrounding the EXXON VALDEZ oil spill in 1988. The nature of population declines in the Sound and the effects of the oil spill cannot be assessed at this time.

Elsewhere in Alaska, harbor seal population declines are equivocal at most. Unusually high counts in 1976 create an impression of decline in Bristol Bay. In the few other areas for

which data are available, there is no evidence of a declining trend.

Sufficient data do not exist to assess the Alaska harbor seal population with respect to OSP. Large-scale numerical data are not available to evaluate the current population as a percent of *K*, as has been done for Steller sea lions and northern fur seals. Current data are not available to assess OSP through analysis of reproduction or mortality rates using dynamic response analysis, as has been proposed for California sea lions or harbor seals in California.

Examination of other data sources reveal no apparent indications or potential causes of population declines, although all data sets are limited in size and scope. There is no evidence of changes in reproduction or survival rates, no signs of large-scale mortality from disease or any other causes, and no suggestion that entanglement in marine debris is a significant problem. The rates of subsistence harvest and incidental take in commercial fisheries probably are not large enough to cause declines.

RECOMMENDATIONS

The apparent declines in harbor seals in the Kodiak and Prince William Sound areas certainly are a matter of concern. This especially is true since the magnitude and extent of the

declines, as well as potential causes, remain unknown. While the status of harbor seals in Alaska relative to OSP, and consequently relative to "depleted" status under the MMPA or "threatened" or "endangered" status under the ESA, cannot be determined at this time, new data should be evaluated carefully. These data will become available from the following:

1. The NMFS 3-year, state-wide population assessment survey, which will conclude in 1993;

2. The ADF&G satellite telemetry study of harbor seals in Prince William Sound;

3. The University of Alaska Southeast and the National Park Service studies of harbor seals in Glacier Bay;

4. The NMFS state-wide estimates of subsistence take; and

5. Continuing programs for reporting incidental take of marine mammals in commercial fisheries through logbooks and observer programs.

Counts of seals should continue at major trend sites at regular intervals. This includes sites in Southeast Alaska, Prince William Sound, Tugidak Island, and Bristol Bay used by Calkins and Pitcher (1984), Pitcher (1986, 1989, 1990), Everitt and Braham (1980), and others. Surveys at new sites established

during the NMFS population assessment (Loughlin 1992) also should continue as an aid to evaluating population trends.

As funds become available, comparative studies of harbor seal feeding ecology in the decline areas, especially Kodiak Island or Prince William Sound, and non-decline areas, like Southeast Alaska, may offer some clues as to causes of the declines.

As available, tissue samples should be collected for genetic analysis. Results from such analysis could help identify whether or not any distinct stocks exist in Alaska.

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