APPENDIX D - only pages 116 - 161 - seabird section

Ecosystem Considerations for 2002

Reviewed by
The Plan Teams for the Groundfish Fisheries
of the Bering Sea, Aleutian Islands, and Gulf of Alaska

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Seabirds

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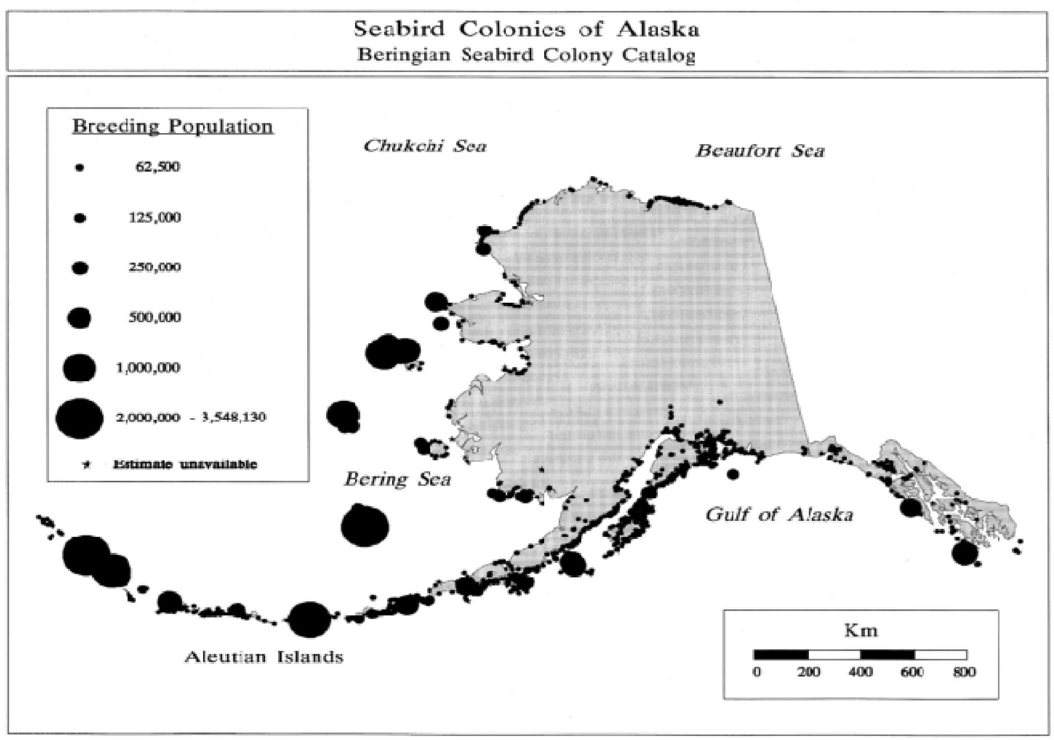
Seabirds spend the majority of their life at sea rather than on land. The group includes the albatrosses, shearwaters, and petrels (*Procellariiformes*), cormorants (*Pelecaniformes*), and two families of the *Charadriiformes*: gulls (*Laridae*), and auks, such as puffins, murres, auklets, and murrelets (*Alcidae*). Several species of sea ducks (*Merganini*) also spend much of their life in marine waters. Other bird groups contain pelagic members such as swimming shorebirds (*Phalaropodidae*), but they seldom interact with groundfish fisheries and, therefore, will not be discussed further. For detailed descriptions of seabird life histories, population biology, and foraging ecology, see section 3.5.1 of the draft Programmatic SEIS on Alaska Groundfish Fisheries (DPSEIS, NMFS 2001a).

This current section is limited to minimal background material plus new information such as: updated seabird population and diet information; maps of seabird colony locations, short-tailed albatross (*Phoebastria albatrus*) observation locations, movement of satellite-tagged northern fulmars (*Fulmarus glacialis*), and at-sea distribution of several seabird species relative to fishing effort; and updated seabird bycatch estimates.

Thirty-eight species of seabirds breed in Alaska. More than 1600 colonies have been documented, ranging in size from a few pairs to 3.5 million birds (Figure 1). The U.S. Fish & Wildlife Service (USFWS) is the lead Federal agency for managing and conserving seabirds and is responsible for monitoring populations, both distribution and abundance. Breeding populations are estimated to contain 36 million individuals in the Bering Sea (BS) and 12 million individuals in the GOA (Table 1); total population size (including subadults and nonbreeders) is estimated to be approximately 30 percent higher. Five additional species occur in Alaskan waters during the summer months and contribute another 30 million birds (Table 2).

The sizes of seabird colonies and their species composition differ among geographic regions of Alaska, due to differences in marine habitats and shoreline features. In the southeastern GOA, there are about 135 colonies, and they tend to be small (<60,000 birds, and often < 5,000). These colonies are concentrated near the outer waters of southeast Alaska, or near large inland straits and fjords, such as Glacier Bay, and Icy and Sumner straits. Exceptions are two colonies with 250,000-500,000 birds at Forrester and St. Lazaria Islands (Figure 2). Along the coast of northcentral GOA, colonies are generally small but number over 850 locations, with larger colonies at the Barren and Semidi island groups. Moving west along the Alaska Peninsula (with 261 colonies) and throughout the Aleutians (144 colonies), colonies increase in size, and include several with over 1 million birds and two with over 3 million birds. Large colonies are also found on the large islands of the BS, where each may have over 3 million birds. Relatively few colonies are located along the mainland of the BS coast, and colonies along the Chukchi and Beaufort seas are small and dispersed.



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Appendix 1. Map of seabird colonies of Alaska.

Figure 1. Seabird Colonies of Alaska. Beringian Seabird Colony Catalog, 2000. USFWS.

Table 1. Estimated populations and principal diets of seabirds that breed in the Bering Sea and Aleutian Islands and Gulf of Alaska regions.

Species	Population [1,2]		Diet [3,4]
	BSAI	GOA	
Northern Fulmar (*Fulmarus glacialis*)	1.500,000	600,000	Q,M,F,Z,I,C
Fork-tailed Storm-Petrel (*Oceanodroma furcata*)	4,500,000	1,200,000	Q,I,Z,C,P,F
Leach's Storm-Petrel (*Oceanodroma leucorrhoa*)	4,500,000	1,500,000	Z,Q,F,I
Double-crested Cormorant (*Phalacrocorax auritis*)5	9,000	8,000	F,I
Pelagic Cormorant (*Phalacrocorax pelagicus*)	80,000	70,000	S,C,P,H,F,I
Red-faced Cormorant (*Phalacrocorax urile*)	90,000	40,000	C,S,H,F,I
Brandt's Cormorant (*Phalacrocorax penicillatus*)	0	Rare	H,F,G,I
Pomarine Jaeger (*Stercorarius pomarinus*)	Uncommon-Rare	Uncommon	C,S,F
Parasitic Jaeger (*Stercorarius parasiticus*)	Uncommon	Uncommon	C,S,F
Long-tailed Jaeger (*Stercorarius longicaudus*)	Uncommon	Rare	C,S,F
Bonaparte's Gull (*Larus philadelphia*)	Rare	Uncommon	Z,I,F
Mew Gull (*Larus canus*) [5]	700	40,000	C,S,I,D,Z
Herring Gull (*Larus argentatus*) [5]	50	300	C,S,H,F,I,D
Glaucous-winged Gull (*Larus glaucescens*)	150,000	300,000	C,S,H,F,I,D
Glaucous Gull (*Larus hyperboreus*)[5]	30,000	2,000	C,S,H,I,D
Black-legged Kittiwake (*Rissa tridactyla*)	800,000	1,000,000	C,S,H,P,F,M,Z
Red-legged Kittiwake (*Rissa brevirostris*)	150,000	0	M,C,S,Z,P,F
Sabine's Gull (*Xema sabini*)	Uncommon	Uncommon	F,Q,Z
Arctic Tern (*Sterna paradisaea*) [5]	7,000	20,000	C,S,Z,F,H
Aleutian Tern (*Sterna aleutica*)	9,000	25,000	C,S,Z,F
Common Murre (*Uria aalge*)	3,000,000	2,000,000	C,S,H,G,F,Z
Thick-billed Murre (*Uria lomvia*)	5,000,000	200,000	C,S,P,Q,Z,M,F,I
Pigeon Guillemot (*Cepphus columba*)	100,000	100,000	S,C,F,H,P,I,G,Q
Black Guillemot (*Cepphus grylle*)	Rare	0	S,F,I
Marbled Murrelet (*Brachyramphus marmoratus*)	Uncommon	Common	C,S,H,P,F,G,Z,I

Kittlitz's Murrelet (*Brachyramphus brevirostris*)	Uncommon	Uncommon	S,C,H,Z,I,P,F
Ancient Murrelet (*Synthliboramphus antiquus*)	200,000	600,000	Z,F,C,S,P,I
Cassin's Auklet (*Ptychoramphus aleuticus*)	250,000	750,000	Z,Q,I,S,F
Least Auklet (*Aethia pusilla*)	9,000,000	50	Z
Parakeet Auklet (*Cyclorrhynchus psittacula*)	800,000	150,000	F,I,S,P,Z,C,H
Whiskered Auklet (*Aethia pygmaea*)	30,000	0	Z
Crested Auklet (*Aethia cristatella*)	3,000,000	50,000	Z,I
Rhinoceros Auklet (*Cerorhinca monocerata*)	50	200,000	C,S,H,A,F
Tufted Puffin (*Fratercula cirrhata*)	2,500,000	1,500,000	C,S,P,H,F,Q,Z,I
Horned Puffin (*Fratercula corniculata*)	500,000	1,500,000	C,S,P,H, F,Q,Z,I
Total	36,000,000	12,000,000	

Notes; 1 = Source of population data for colonial seabirds that breed in coastal colonies: modified from USFWS 1998. Estimates are minima, especially for storm-petrels, auklets, and puffins.
2 = Numerical estimates are not available for species that do not breed in coastal colonies. Approximate numbers: abundant $\geq 10^6$; common = 10^5-10^6; uncommon = 10^3-10^5; rare $\leq 10^3$.
3 = Abbreviations of diet components: M, Myctophid; P, walleye pollock; G, other gadids; C, capelin; S, sandlance; H, herring; A, Pacific saury; F, other fish; Q, squid; Z, zooplankton; I, other invertebrates; D, detritus; ?: no information for Alaska. Diet components are listed in approximate order of importance. However, diets depend on availability and usually are dominated by one or a few items (see NPFMC 2000).
4 = Sources of diet data: see species accounts in seabird section of NPFMC 2000.
5 = Species breeds both coastally and inland; population estimate is only for coastal colonies.

Table 2. Comparative population estimates and diets of nonbreeding seabirds that frequent the Bering Sea and Aleutian Islands and Gulf of Alaska regions.

Species	**Population** [1,2]			**Diet** [3,4]
	BSAI	GOA	World[5]	
Short-tailed Albatross (*Phoebastria albatrus*)	Rare	Rare	1,500	Q,F,I
Black-footed Albatross (*Phoebastria nigripes*)	Uncommon	Common	250,000	Q,M,F,I,D
Laysan Albatross (*Phoebastria immutabilis*)	Common	Common	2.5 million	Q,M,F,I
Sooty Shearwater (*Puffinus griseus*)	Common	Abundant	>30 million	M,C,S,A,Q,S,F,Z,I
Short-tailed Shearwater (*Puffinus tenuirostris*)	Abundant	Common	23 million	Z,I, C,Q, F,S
Ivory Gull (*Pagophila eburnea*)	Uncommon	0	~35,000	M,P,R,I,F,Q

- Source of population data for colonial seabirds that breed in coastal colonies: modified from USFWS 1998. Eastimates are minima, especially for storm-petrels, auklets, and puffins.
- Numerical estimates are not available for species that do not breed in coastal colonies. Approximate numbers: abundant $\geq 10^6$, common = 10^5-10^6, uncommon = 10^3-10^5; rare $\leq 10^3$.
- Abbreviations of diet components: M, Myctophid; P, walleye pollock; G, other gadids; C, capelin; S, sandlance; H, herring; A, Pacific saury; F, other fish; Q, squid; Z, zooplankton; I, other invertebrates; D, detritus; ?, no information for Alaska. Diet components are listed in approximate order of importance. However, diets depend on availability and are usually dominated by one or a few items (see text seabird section of NPFMC 2000).
- Sources of diet data: see species accounts in text.
- World population estimates are provided solely to provide a relative scale. In populations where multiple breeding colonies exist, any analysis of effects on populations must be considered at the colony level, not at the global level. These estimates provided by: Hasegawa, pers. comm.; Whittow, 1993; Whittow, 1993; C. Baduini, pers. comm.; Oka et al 1987; USFWS.
- Species breeds both coastally and inland; population estimate is only for coastal colonies.

Seabird Demographic Trends

Population trends and reproductive success are monitored at 3 to 14 colonies per species (Figure 2). There have been considerable changes in the numbers of seabirds breeding in Alaskan colonies since the original counts made in the mid-1970s. Trends are reasonably well known for species that nest on cliffs or flat ground such as fulmars, cormorants, glaucous-winged gulls, kittiwakes, murres and for storm-petrels, and tufted puffins (Table 3). Trends are known for a few small areas of the state for pigeon guillemots, murrelets, auklets, and terns (Table 4). Trends are unknown at present for other species [jaegers, most auklets, and horned puffins; (Byrd and Dragoo 1997, Byrd *et al.* 1998, 1999)]. Population trends differ among species. Trends in many species vary independently among areas of the state, due to differences in food webs and environmental factors.

<u>Trends in Productivity</u>

Overall, seabird breeding chronology in 2000 was earlier than average or unchanged (Table 5). Most species in the SE Bering Sea began nesting earlier than average. Seabirds also nested earlier on Buldir Island in the Aleutians, and sites in the GOA and Southeast Alaska. The one exception was the black-legged kittiwake colony on Middleton Island. This is in sharp contrast to the 1999 season (Dragoo et al. 2000), when most colonies began nesting later or were unchanged compared to the averages for previous years.

Seabird productivity was generally better than average or equal throughout Alaska in 2000 (Table 6). Exceptions were the murres at Kasatochi Island in the central Aleutians, where both murre species had lower than average productivity. Nearly all piscivorous seabirds had better productivity than past years, whereas the more planktivorous species tended to show no change from previous year's performances. For the piscivorous birds at least, the higher productivity in 2000 was nearly opposite their relative performance in 1999, when most piscivorous birds had lower than average productivity (Dragoo et al. 2000). Again, the planktivorous birds showed little change between 1999 and 2000 trends.

The 'earlier' nesting in 2000 by many seabirds in various locations of Alaska, might be indicative of a large-scale oceanographic condition resulting in changes in the prey base. Presumably because of favorable oceanographic effects on the seabirds' prey, 'early' nesting is often associated with cooler water temperatures and higher breeding success (Ainley and Boekelheide 1990). In 2000, there were reports of capelin in the GOA (D. Roseneau, USFWS, Homer, AK), and capelin appeared to be abundant in Prince William Sound in 2001 (K. Kuletz, pers. comm.). Capelin are a high-lipid fish (Anthony et al. 2000, Roby et al. 2000), and availability of high-lipid prey is often associated with good productivity in seabirds. High lipid and high energetic content is critical to chick growth and fledging mass (Harris and Hislop 1978), and several studies in the GOA have demonstrated the importance of high-lipid fish to seabird growth rates, reproductive success, and population trends (Anthony and Roby 1997, Golet 1998, Piatt, Abookire *et al.* 1998, Roby, Turco *et al.* 1998, Golet, Kuletz *et al.* 2000, Suryan, Irons *et al.* 2000). The generally higher productivity (compared to previous years at the same site) of piscivorous birds in particular, suggest that availability of forage fish was improved in 2000. Reproductive success of seabirds also depends on synchronization of breeding with prey availability (Gaston and Nettleship 1981, Furness and Monaghan 1987, Ainley and Boekelheide 1990), although the mechanisms responsible for synchronization are unclear.

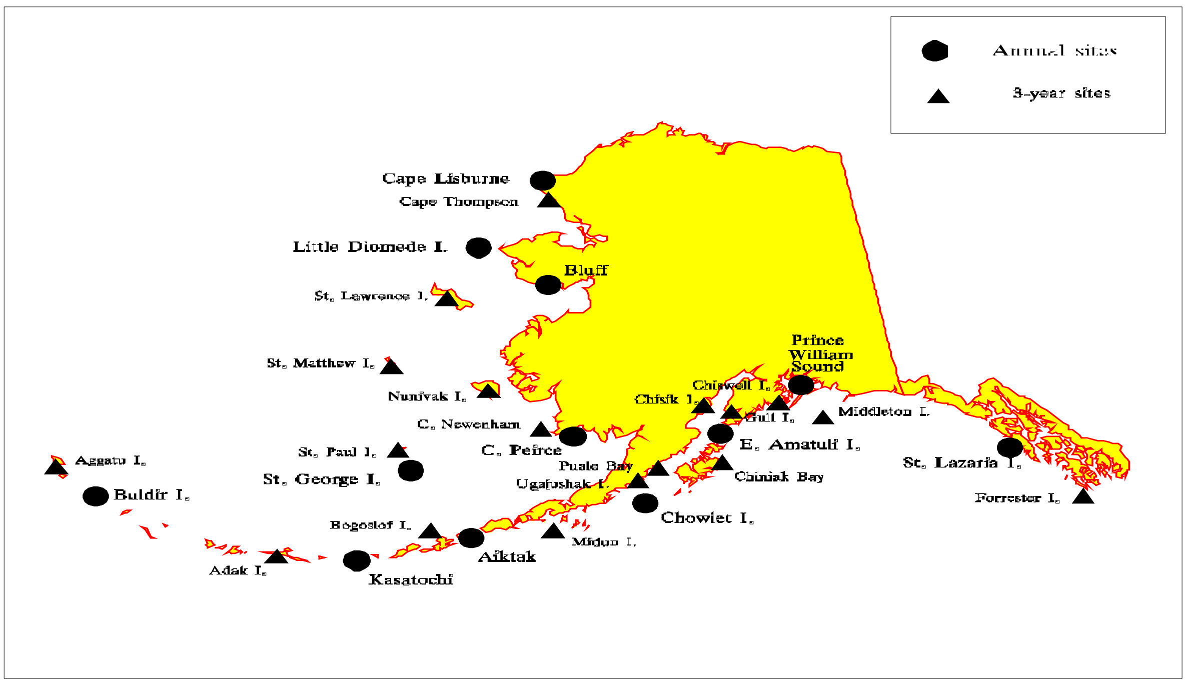


Figure 2. Location of seabird colony sites in Alaska monitored by the U.S. Fish and Wildlife Service and the USGS Biological Research Division. Some sites are monitored annually (circles), while others are monitored on three-year rotation (triangles).

Table 3. Seabird population trends compared within regions[a]. Only sites which were counted in 2000 are included.
This table is printed with permission of the Alaska Maritime National Wildlife Refuge, from their report: Breeding Status and Population Trends of Seabirds in Alaska in 2000.

Region	*Site*	*STPE*	*PECO*	*UNCO*	*GWGU*	*BLKI*	*RLKI*	*COMU*	*UNMU*	*LEAU*	*CRAU*	*RHAU*	*TUPU*
N. Bering/ Chukchi	*Bluff*					+		+					
SE Bering	*C. Peirce*		=			–		–					
	Bogoslof I.												+
	Aiktak I.	+			=				=				+
SW Bering	*Kasatochi I.*			=	=					=	=		
	Koniuji I.						=						
Gulf of Alaska	*Chiniak Bay*					+							
	Gull I.		–			+		+					
	P. William Snd					+							
	Middleton I.		–			–			–				
Southeast	*St. Lazaria I.*	+	+		=				–			=	

[a]Codes:
"– " indicates negative population trend for this site or region,
"=" indicates no discernable trend
"+" indicates positive population trend for this site or region.
Species' codes: FTSP = fork-tailed storm petrel; LHSP = Leach's storm petrel; RFCO = red-faced cormorant; PECO = pelagic cormorant; GWGU = glaucous-winged gull; BLKI = black-legged kittiwake; RLKI = red-legged kittiwake; COMU = common murre; TBMU = thick-billed murre; PAAU = parakeet auklet; LEAU = least auklet; WHAU = whiskered auklet; CRAU = crested auklet; RHAU = rhinoceros auklet; TUPU = tufted puffin.

Table 4. Population trends of seabirds that nest non-colonially or in small, dispersed colonies, for areas where trend data is available. Trends ('-',decreasing; '0' no clear trend; '+', increasing) incorporate surveys in the early 1990s to 2000 or 2001. (Data from Shawn Stephensen, USFWS, Anchorage, and John Piatt, USGS/BRD, Anchorage, unpublished data).

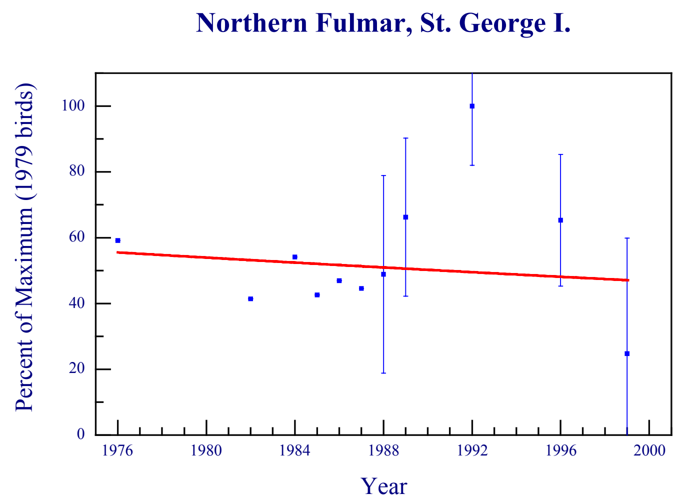
Site	Arctic Tern & Aleutian Tern	Pigeon Guillemot	Marbled Murrelet	Kittlitz's Murrelet
Prince William Sound	-	-	-	-
eastern Kodiak Island	-	0	?	?
Glacier Bay, SEAK	0	-	-	-

Population Trends

Population trends (Table 3) were more mixed among birds and sites than were the productivity trends. Although population trends are affected by changes in seabird productivity (see review NPFMC 2000), seabirds are long-lived, and changes in the sub-adult and adult population would not be expected on an annual basis (Russell 1999). Overall, 12 populations (species-site combinations) showed an increase from previous averages, 7 showed no change and 8 showed decreases. Black-legged kittiwakes increased at most sites in the GOA, although the Middleton Island colony continued to decline. Red-legged kittiwakes continued to decline at Koniuji Island, as they had at the Pribilofs in 1999 (Dragoo et al. 2000). Tufted puffins and storm petrels were more abundant than average in the SE Bering Sea, but kittiwakes and murres declined.

Northern fulmar populations. – Population trends of northern fulmars are of particular interest because fulmars comprise the largest proportion of seabird bycatch in the BSAI and GOA groundfish fisheries, and they are the only procellarid ('tubenose' family) with high bycatch rates that also breeds in Alaska. Over 95% of northern fulmars in Alaska nest at four locations: the Semidi Islands (monitored at Chowiet Island) in the GOA has an estimated 440,000 birds, Chagulak Island in the Aleutians with 500,000 birds, the Pribilofs (monitored at St. George Island) in the central BS with 80,000 birds, and St. Matthew/Hall Islands in the northern BS with 450,000 birds (Hatch and Nettleship 1998).

In the Pribilof Islands (Figure 3), the smaller population on St. Paul Island shows an increase in numbers of fulmars since 1990, although data is only available to 1996. On nearby St. George Island, fulmar numbers have been more erratic, with an unusually high number in 1992, and sharply decreasing numbers between 1992 and 1999. The Pribilofs will be censused by Alaska Maritime National Wildlife Refuge biologists in 2002, which will help determine whether this decline is a significant trend. On Chowiet Island in the Semidi Island group (Figure 4), the study plots monitored by S. Hatch (U.S. Geologic Survey/Biological Resources Division, USGS/BRD, Anchorage, unpublished data) indicate that fulmar numbers remained relatively steady prior to a spike between 1993 - 1995, followed by a steep decline in 1998 and 2001. No trend data exist for the fulmar colonies at St. Matthew/Hall or Chagulak Islands. Data on reproductive success of fulmars is difficult to obtain and productivity parameters of fulmars have not been regularly monitored at any site in Alaska.



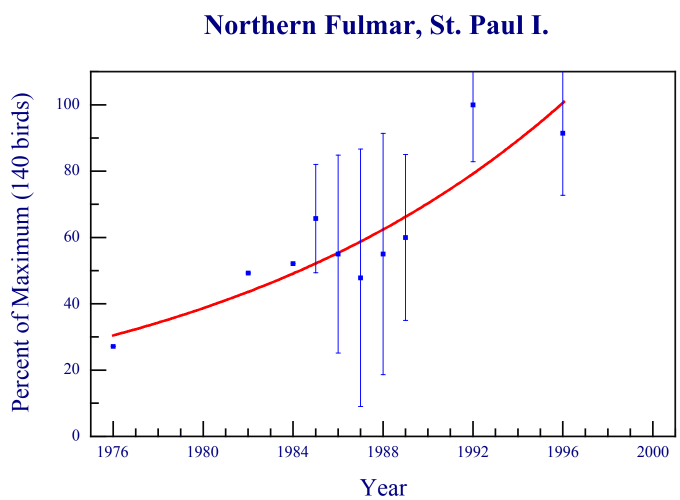


Fig. 3. Population trends of northern fulmars in the Pribilof Islands, based on plot counts on St. George I., 1976 - 1999 (Top) and St. Paul I., 1976 - 1996 (Bottom). Percent of Maximum is based on the number of birds on the study plots only. The majority of the estimated 80,000 fulmars on the Pribilof Islands nest on St. George I. (Data reprinted with permission from Dragoo et al. 2000).

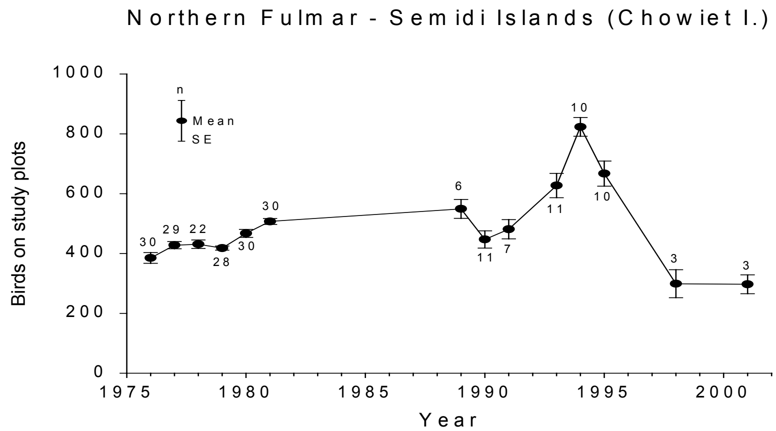


Figure 4. Population trends of northern fulmar on Chowiet Island, based on plot counts taken during summer, 1975 - 2001. (Unpublished data and graphic provided by Scott Hatch, USGS/BRD, Anchorage).

The breeding populations of fulmars in Alaska are fairly well localized and their main colonies are distributed over a large geographic area. For this reason, the fulmar colonies might experience different impacts from environmental as well as fishery-related influences. Fulmars may benefit by obtaining food during fishery operations, but the effects of bycatch mortality might offset such potential gains. To assist in building population models to examine trends and the effects of mortality or food supplementation, affected populations need to be identified and monitored. An effort to identify the colony of origin for fulmars caught in BSAI and GOA groundfish fisheries was begun in 2001, through a USFWS funding initiative to the USGS/BRD, in cooperation with the NMFS North Pacific Groundfish Observer Program. This project will use genetic markers to compare bycaught fulmars with those at specific colonies. Additional information could be obtained by insuring that observers record the color phase of bycaught fulmars, which range from light to dark in plumage. Light-phase fulmars nest at the large colonies in the central and north Bering Sea, whereas dark-phase fulmars predominate along the Aleutians and in the Semidis (Hatch and Nettleship 1998).

Seabirds Interfacing with Fisheries

For detailed descriptions of ecological interactions affecting seabirds and factors that influence the availability of food to seabirds, see the seabird section in the "Ecosystem Considerations in 2001" appendix (NPFMC 2000) and section 3.5.2 in the DPSEIS, respectively (NMFS 2001a).

Seabird Colony Distribution and Groundfish Fisheries

A major constraint on breeding for seabirds is the distance between the breeding grounds on land and the feeding zones at sea (Weimerskirch and Cherel 1998). Seabirds must have access to prey within efficient foraging range of the breeding colony in order to raise their chicks successfully (Piatt and Roseneau 1998, Suryan, Irons *et al.* 1998a, Suryan, Irons *et al.* 2000, Golet, Kuletz *et al.* 2000). If food supplies are reduced below the amount needed to generate and incubate eggs, or the specific species and size of prey needed to feed chicks is unavailable, local reproduction by seabirds will fail (Hunt et al. 1996, Croxall and Rothery 1991).

Table 5. Seabird relative breeding chronology compared to averages for past years within regions[a]. Only sites for which there were data from 2000 are included. This table is printed with permission of the Alaska Maritime National Wildlife Refuge, from their report: Breeding Status and Population Trends of Seabirds in Alaska in 2000.

Region	Site	FTSP	LHSP	PECO	GWGU	BLKI	RLKI	COMU	TBMU	PAAU	LEAU	WHAU	CRAU	RHAU	TUPU
SE Bering	St. Paul I.					–	–	–	=						
	St. George I.					–	–	–	=						
	C. Peirce			=		–		–							
	Aiktak I.	–	=		–										–
SW Bering	Buldir I.					–	=	–	=	–	=	–	=		
	Kasatochi I.										=		=		
	Bogoslof I.						+								
Gulf of Alaska	Gull I.					–		–							
	Chisik/Duck I.					=		–							
	Middleton I.			–	–	+								–	–
Southeast	St. Lazaria I.	–	–		=			=	=						

[a] Codes:
"– " indicates hatching chronology was > 3 days earlier than average for this site or region,
"=" indicates within 3 days of average
"+" indicates hatching chronology was > 3 days later than average for this site or region.

Species' codes: FTSP = fork-tailed storm petrel; LHSP = Leach's storm petrel; RFCO = red-faced cormorant; PECO = pelagic cormorant; GWGU = glaucous-winged gull; BLKI = black-legged kittiwake; RLKI = red-legged kittiwake; COMU = common murre; TBMU = thick-billed murre; PAAU = parakeet auklet; LEAU = least auklet; WHAU = whiskered auklet; CRAU = crested auklet; RHAU = rhinoceros auklet; TUPU = tufted puffin.

Table 6. Seabird relative productivity levels compared to averages for past years within regions[a]. Only sites for which there were data from 2000 are included. This table is printed with permission of the Alaska Maritime National Wildlife Refuge, from their report: Breeding Status and Population Trends of Seabirds in Alaska in 2000.

Region	Site	FTSP	LHSP	RFCO	PECO	GWGU	BLKI	RLKI	COMU	TBMU	PAAU	LEAU	WHAU	CRAU	RHAU	TUPU
N. Bering/ Chukchi	C. Lisburne						=									
	Bluff						+									
SE Bering	St. Paul I.			+			+	+	=	=						
	St. George I.			=			+	+	=	=						
	C. Peirce				=		+		=							
	Bogoslof I.			=	=	=	+	=	+	+						=
	Aiktak/ Ugamak Is.	=	=	=	+	=			+	+						+
SW Bering	Buldir I.						+	=		=	=	=	=	=		
	Ulak I.	=		+	+											
	Kasatochi I.			+	+				–	–		=		=		
	Koniuji I.						=									
Gulf of Alaska	Chiniak Bay						=									
	Gull I.						+		+							
	Duck I.						=		0							
	Pr. Will. Snd.						=									
	Middleton I.				+	+	=								=	=
Southeast	St. Lazaria I.	=	=		+	=			=	=						

[a] Codes: "– " indicates productivity was > 20% below average for this site or region,
"=" indicates within 20% of average
"+" indicates productivity was > 20% above average for this site or region.

Most of the groundfish fisheries have occurred between September and April (Appendix E, NMFS 2001a), and do not overlap temporally with the main seabird breeding period that occurs from May through August (DeGange and Sanger 1987, Hatch and Hatch1990, Dragoo et al. 2000). However, some species, such as larids, pigeon guillemots, and murrelets, may arrive at breeding sites in April, and others, including fulmars, puffins, and murres, are still rearing young in September. Among the 'latest' breeding species are the fulmars, which have a long incubation and chick-rearing periods and generally fledge chicks in September or early October. Both fork-tailed and Leach's storm-petrels do not fledge young until October (DeGange and Sanger 1987, Hatch and Hatch 1990, Dragoo et al. 2000). Seabird attachment to the colony is thus most likely to overlap with fisheries effort during the early (pre and early egg-laying) and during the late (late chick-rearing and fledging) portion of their breeding season. Juvenile birds, generally on their own and not experienced foragers, would also be most abundant during the fall fisheries. Fishery seasons have shifted and could do so in the future. For example, since 2000, the Pacific cod longline fishery in the BSAI has begun in August, and in the GOA, a large portion of the catcher-vessel trawl pollock fishery occurs in June and September (Appendix E, NMFS 2001b).

Indirect effects of groundfish fisheries might affect prey availability around seabird colonies even though they do not overlap with the seabird's breeding season. These potential effects include boat disturbance, alteration of predator-prey relations among fish species, habitat disturbance, or direct take of fish species whose juveniles are consumed by seabirds (see seabird section in Ecosystem Considerations chapter, NPFMC 2000, for review). Additionally, although overall consumption of fish biomass by seabirds is estimated at < 4 % (Livingston 1993), seabirds may impact fish stocks within foraging range of seabird colonies during summer (Springer, Roseneau *et al.* 1986, Birt, Birt *et al.* 1987). Fifteen to eighty percent of the biomass of juvenile forage fish may be removed by birds each year near breeding colonies (Wiens and Scott 1975, Furness 1978, Springer, Roseneau *et al.* 1986, Logerwell and Hargreaves 1997). Seabirds may, therefore, be vulnerable to factors that reduce forage fish stocks in the vicinity of colonies (Monaghan, Walton *et al.* 1994).

To examine the relationship between fisheries effort and seabird colonies, we overlaid seabird colony data from the Alaska Seabird Colony Database (S. Stephensen, USFWS, Anchorage, AK) with coverage of fisheries effort (NPFMC, Anchorage, AK). The maps illustrate areas of overlap between seabirds and fisheries both in terms of potential risk of seabird bycatch, and potential for indirect interactions with the seabird's prey base. These interactions are primarily relevant during the seabird's breeding season, which for most species extends from late April through September, but varies by region and species, and may not always intersect with fishery effort in every region.

For the colony maps, we included only piscivorous seabird species (Table 7), since those species include the groups most susceptible to bycatch, and their prey base may be more subject to influence from the fisheries. Although the fisheries data is current (between 1998-2000), the colony data has been collected since the 1970's, and many of the smaller colonies, in particular, have not recently been surveyed. Colony sizes, therefore, may not be current, although the order of magnitude and distribution of the colonies should be reliable. Larger colonies and regularly monitored sites (Figure 2) include current data.

Table 7. List of Piscivorous Seabird Species or Species Groups included in the Piscivorous Seabird Colony Maps (see Figures 3 and 4).

Species Code	**Piscivorous Species or Species Group**
NOFU	Northern Fulmar (Fulmarus glacialis)
HEGU	Herring Gull (Larus argentatus)
GWGU	Glaucous-winged Gull (Larus glaucescens)
GHGU	Glaucous-winged/Herring Gull hybrid (Larus spp.)
GLGU	Glaucous Gull (Larus hyperboreus)
GGGU	Glaucous-winged/Glaucous gull hybrid (Larus spp.)
MEGU	Mew Gull (Larus canus)
BLKI	Black-legged Kittiwake (Rissa tridactyla)
RLKI	Red-legged Kittiwake (Rissa brevirostris)
UNGU	Unidentified Gull (Larus spp.)
COTE	Common Tern (Sterna hirundo)
ARTE	Arctic Tern (Sterna paradisaea)
ALTE	Aleutian Tern (Sterna aleutica)
UNTE	Unidentified Tern (Sterna spp.)
BLGU	Black Guillemot (Cepphus grylle)
PIGU	Pigeon Guillemot (Cepphus columba)
UNIG	Unidentified Guillemot (Cepphus spp.)
MAMU	Marbled Murrelet (Branchyrampus brevirostris)
ANMU	Ancient Murrelet (Synthilboramphus antiquus)
PAAU	Parakeet Auklet (Aethia psittacula)
RHAU	Rhinoceros Auklet (Cerorhinca monocerata)
TUPU	Tufted Puffin (Fratercula cirrhata)
HOPU	Horned Puffin (Fratercula corniculata)
UNPU	Unidentified Puffin (Fratercula spp.)
TOCO	Total Cormorant (all cormorant species combined)
TOMU	Total Murre (all murre species combined)

Piscivorous Seabird Colonies and Trawl Effort. – In the GOA, seabird colonies are generally small, but are numerous and dispersed along most of the coastline. The main areas of overlap with the trawl fisheries include the east side of the Kodiak Archipelago, and to a lesser extent, the Semidi Islands and Shumagin Islands (Figure 5). Those birds that primarily forage near their colonies, such as cormorants, pigeon guillemots, terns, small larids, and the non-colonial marbled and Kittlitz's murrelets, might be the species most influenced by fisheries in these immediate areas by disturbance or indirect interactions with the prey. Interaction with these 'near shore' foraging species would be most direct during the limited June trawl fishery. Because this fishery extends to the shelf edge, birds from these colonies that may forage >40 km from their colonies, such as fulmars and larger gulls and alcids, have potential for greater interaction and bycatch in these offshore waters. Alcids are, in fact, one of the seabird groups most frequently taken as bycatch in trawl fisheries (see section here, "Bycatch of Seabirds in Fishing Gear"), and trawl fisheries account for most alcid bycatch. Because murres and puffins (the large alcids in this area) are often still raising chicks in September, they would also have the greatest temporal overlap with those fisheries occurring in September. Fulmars nesting on Chowiet Island in the Semidis could likewise interact with trawl fisheries in this region and north along Kodiak and the shelf edge, during both the June and September-October fishery.

In the BSAI, trawl effort is concentrated between Unimak Pass and the Pribilof islands, over a wide area of the shelf waters (Figure 5). The main temporal overlap between trawl fisheries and seabird colonies in BSAI would be late in the bird's breeding season, in August and September. Seabird colonies are sparse along the BS side of the Alaska Peninsula, but the area of Unimak Pass west to Unalaska Island has numerous small colonies (Figure 5). One of the largest colonies, which includes fulmars, is on St. George Island in the Pribilofs, and these birds would have the greatest spatial overlap with the trawl fisheries. Chagulak Island in the Aleutians and St. Matthew/Hall islands in the northern BS support the other two large colonies of piscivorous birds, including fulmars. Trawl effort is absent or at some distance from these colonies. At St. Matthew/Hall islands, birds with greater foraging distances, such as fulmars, could interact with fisheries to the southwest of the islands in late summer or early fall.

Piscivorous Seabird Colonies and Longline Effort.– The longline fisheries have the greatest overlap with seabird colonies in the BSAI, although temporal overlap would be primarily in April and August - September. The hook and line Pacific cod fishery extends farther north along the shelf edge than the trawl fisheries (Figure 6). Again, birds nesting in the Pribilofs, including one of the largest fulmar colonies on St. George Island (~80,000 fulmars), have the greatest potential for interaction with this fishery. Because the St. Geroge Island fulmar breeding population is relative small compared to the other three primary fulmar sites, they might have the greatest potential to experience colony-level effects from bycatch mortality. However, because of the concentration of the fishery north along the shelf edge, birds in the St. Matthew/Hall islands colonies may interact with this fishery as well, and this colony has a much larger fulmar population (~450,000 birds; Hatch and Nettleship 1998) than the Pribilofs. Birds nesting throughout the Aleutian chain overlap in near shore areas, but there is little longline effort beyond the narrow shelf along the islands. As a result, birds foraging near shore or near their colonies, such as cormorants, pigeon guillemots, terns, small larids, and the non-colonial marbled and Kittlitz's murrelets, might be most influenced by these fisheries, either by disturbance or indirect interactions with the prey. Because of the limited temporal overlap with fisheries, the indirect effects of fishing on the seabird prey base could be more important along the Aleutians, although such indirect effects are not well understood.

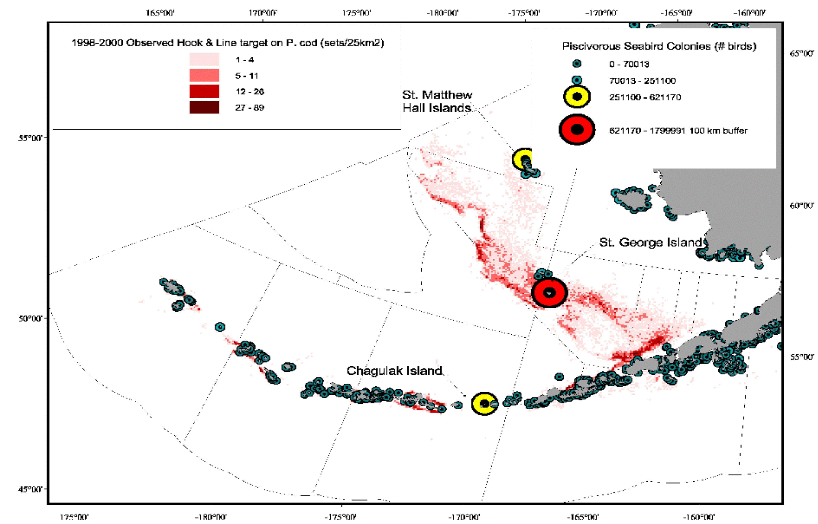


Figure 5. Location and relative size of seabird colonies (counting piscivorous birds only) in Alaska, relative to the 1999 observed trawl effort (hauls / 25 km^2).

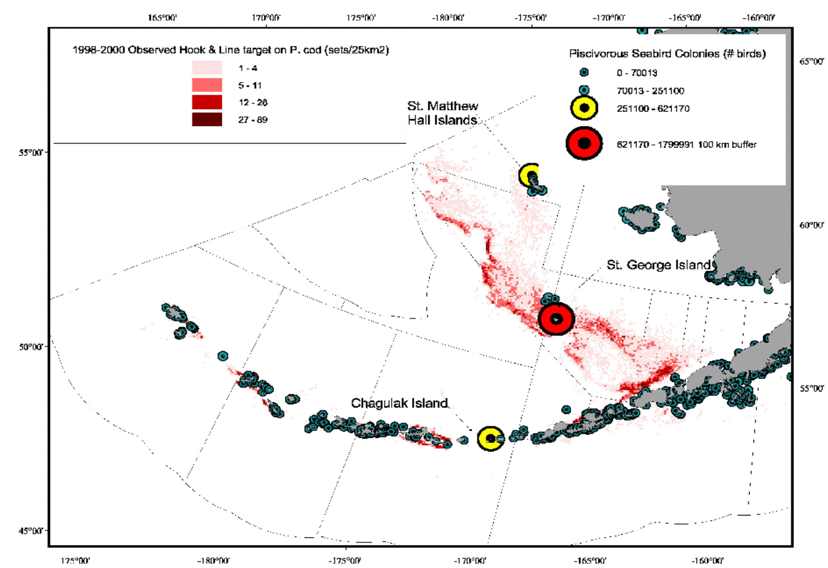


Figure 6. Location and relative size of seabird colonies (counting piscivorous birds only) in the Bering Sea/Aleutian Islands region of Alaska, relative to the 1998-2000 observed hook and line Pacific cod fishery effort (sets / 25 km^2).

Satellite Telemetry Tracking of Fulmars. – A more precise and current example of fulmar foraging from a colony was provided by satellite telemetry tracking of two northern fulmars captured on St. George Island (Scott Hatch, USGS/BRD, Anchorage, AK, unpublished data). These two birds, which laid eggs but did not complete nesting in 2001, were captured and harnessed with the satellite package on 17 June 2001; one bird died of unknown causes between 3-10 October and the other, last recorded in mid-October, continues to transmit signals. Both birds demonstrated a foraging pattern similar to that indicated by the pelagic distribution of fulmars recorded during surveys conducted in the 1970-80s (see below). Both birds ranged along the BS shelf edge, extending from northwest of St. Matthew Island to the Alaska Peninsula. The forage areas overlap extensively with the 1998-2000 longline fishery effort (Figure 7). The surviving bird traveled to the northern GOA in early October. This pilot study demonstrates potential to obtain precise foraging patterns of individual birds throughout the season, and could further be used to determine the extent that individuals depend on the fishery directly for food in different seasons or regions.

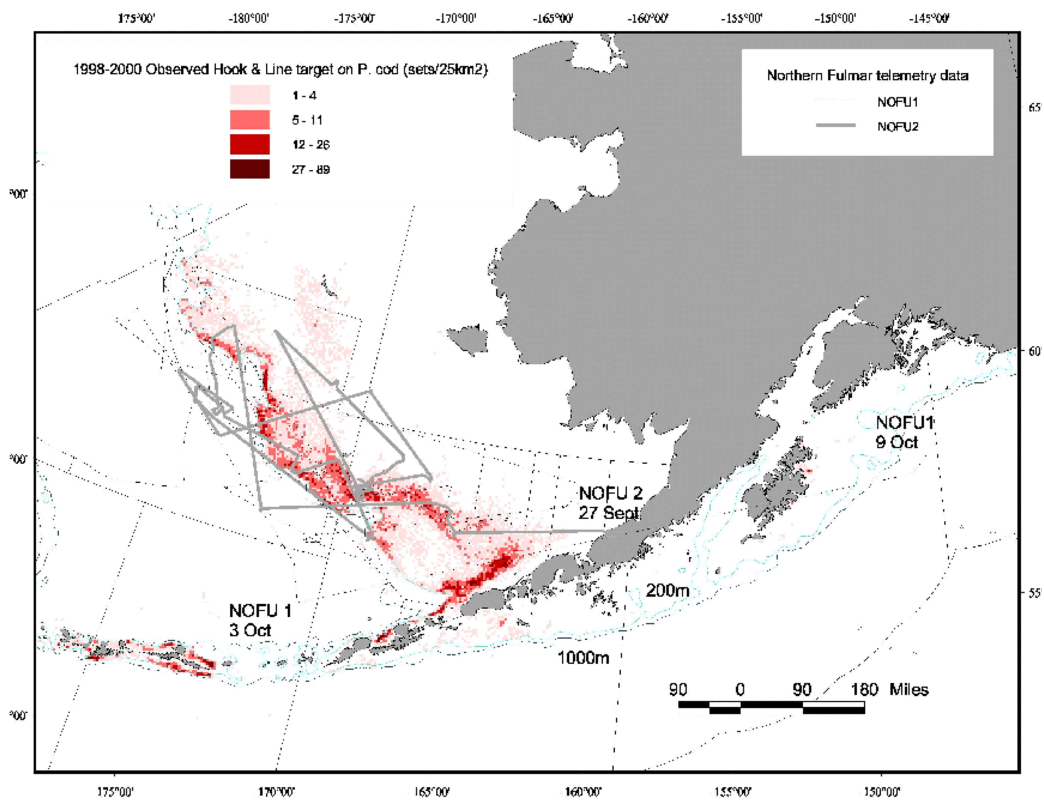


Fig. 7 Locations and track lines of two northern fulmars equipped with satellite telemetry packages. The birds were tagged at St. George Island in the Pribilofs in June 2001, and signals were transmitted every six days. Fulmar No.2 died between 3 - 10 October on the Alaska Peninsula. (Unpublished telemetry data provided by Scott Hatch, USGS/BRD, Anchorage, Alaska)

Seabird Distribution at Sea and Groundfish Fisheries

All species of seabirds depend on one or more oceanographic processes that concentrate their prey at the necessary time and place, such as upwellings, stratification, ice edges, fronts, gyres, or tidal currents (Schneider 1990, Schneider *et al.* 1987, Coyle *et al.* 1992, Elphick and Hunt 1993, Hunt and Harrison 1990, Hunt 1997, review in Hunt *et al.* 1999, Springer *et al.* 1999). Thus, the distribution of birds at sea might be expected to follow patterns similar to those of the commercial fisheries, which also rely on oceanographic processes that concentrate fish. Although some overlap of fisheries effort and seabird distribution is self-evident from bycatch records and observer sightings, there has been little effort to examine this relationship in Alaska.

We examined the at-sea distribution of selected birds relative to the fishing effort in longline and trawl fisheries in Alaska. The selected species include those that are either abundant in Alaska and comprise a significant portion of the seabird bycatch in the groundfish fisheries, or they are species of concern. The seabird data is a preliminary subset of data currently being incorporated into the North Pacific Pelagic Seabird Database (NPPSD) by the USGS/BRD, USFWS, and Mineral Management Service (MMS). The NPPSD will eventually include all available at-sea survey data for the North Pacific, but the data available to date consists of subsets of data collected during cruises of the Outer Continental Shelf Environmental Assessment Program (OCSEAP). Thus, the seabird data, gathered from 1975-1985, may not reflect current population levels, however, it has the advantage of being independent of fishery observer effort, and thus useful to illustrate general distribution at sea. We assumed that general seabird distribution has not altered appreciably at the scale used for this application. (For a detailed explanation of the database, contact John Piatt, USGS/BRD, Anchorage, AK, or David Irons or Shawn Stephensen, USFWS, Anchorage, AK).

At-sea Distribution of Northern Fulmars. – In both the BSAI and GOA, the northern fulmar comprises the majority of seabird bycatch. The fulmars are the only tubenose that is both a significant portion of the seabird bycatch and breeds in Alaska. Over 90% of the fulmars in Alaska nest on four large islands, Chowiet in the GOA, Chagulak in the Aleutians, St. George in the central BS, and St. Matthew/Hall islands in the northern BS (Hatch and Nettleship 1998). The year-round presence of fulmars in Alaska's waters, together with their foraging habits, likely are factors contributing to the large numbers incidentally caught in the BSAI and GOA groundfish fisheries. Additionally, the continued presence and high overlap of fulmars with fisheries effort may partially explain why they are the only species which shows a relationship between fishing effort (number of hooks deployed) and the estimated number of birds taken (NMFS 2001a).

To examine fulmar distribution at-sea during the period of greatest temporal overlap with longline fisheries, we selected only those bird sightings from the months of January through April and September through December, when the vast majority of the hook-and-line Pacific cod harvest occurs. Fulmar distribution shows a strong spatial overlap with the hook-and-line fishery in the BS, primarily in the area between Unimak Pass and the Pribilof Islands, over a wide area of the continental shelf (Figure 8). Fulmars are also scattered northeast toward the mainland side of the shelf edge, and along the central Aleutian chain. In the GOA, longline effort is relatively low, and occurs mainly east of Kodiak. Fulmars appear to be less dense in the GOA, and widely dispersed along the shelf edge. As might be expected, longline bycatch of fulmars in GOA is considerably lower than in the BS (Tables 8 and 9).

At-sea Distribution of Sooty and Short-tailed Shearwaters. – Sooty shearwaters breed in New Zealand and Australia or South America, and short-tailed shearwaters breed in Australia and Tasmania. Both species are trans-equatorial migrants that travel into Alaskan waters where they reside, roughly between May and September (Oka et al. 1987, Harrison et al. 1983). For both species, some non-breeders may remain in Alaska throughout the winter. The increase in shearwater bycatch during late summer/early fall (Figure 16) may reflect a seasonal shift in their distribution just prior to their migration back to their southern breeding grounds.

We examined both species of shearwater together during the months of January through April and September through December (Figure 9), to coincide with the majority of the hook-and-line Pacific cod harvest. In the BS, shearwaters were concentrated at Unimak Pass and to the north, which overlaps with the longline fishery. However, there was a gap in shearwater distribution along the shelf, where the fishery was concentrated, and shearwater abundance is much greater eastward toward the mainland side of the shelf, where fishing effort was low or absent. Few shearwaters were observed along the Aleutian chain. Shearwaters were also distributed along the GOA shelf, particularly near the Semidi Islands, northeastern Kodiak Island, and off the Copper River Delta. There should be little overlap in the GOA between shearwaters and longliners, and shearwaters are not taken in large numbers in that region (Table 9). Trawl fisheries, however, take a large portion of the total shearwater take in bycatch (Table 11), and the distribution of trawl effort (see Figure 5) suggests that shearwaters could overlap in both the BS and the GOA with that fishery.

At-sea Distribution of Black-footed Albatross. – Black-footed albatross breed primarily in the Northwestern Hawaiian Islands and forage in Alaska waters during the summer months, which is reflected in the increased proportion of black-footed albatross of the total seabird bycatch (Figure 16). However, nonbreeders may remain in Alaska, and some breeding birds may travel to Alaska to forage, based on movements of radio-tagged birds.

We pooled observations for all months to examine the distribution of black-footed albatross relative to the hook-and-line Pacific cod fishery. This albatross is found primarily in the GOA, along the shelf edge from the Shumagin Islands area north, particularly the northern portion of the GOA, between Cape Suckling and Yakutat (Figure 10). Low numbers were observed near Nunivak Island in the northern BS, and along the Aleutian Islands. The distribution of black-footed albatrosses is reflected in the much larger numbers of them taken in the GOA longline fishery compared to the BS longline fishery (Tables 9 and 8), despite the lower fishing effort in the GOA. Although the trawl fishery effort is relatively greater in the GOA, black-footed albatross have not been reported by observers as taken in that fishery.

Table 8. Estimated Total Incidental Catch of Seabirds by Species or Species Groups[a] in Bering Sea and Aleutian Islands Longline Fisheries, 1993–1999. Values in Parentheses are 95% Confidence Bounds.

Year	Actual Number Taken [b]	STAL	BFAL	LAAL	NFUL	Gull	SHWR	Unid. Tubenoses	Alcid	Other	Unid. ALB	Unid. Seabird	Total
Bering Sea and Aleutian Islands													
1993	1,942	0	11 (4-21)	617 (458-777)	4,251 (3416-5103)	853 (576-1130)	64 (22-107)	0	15 (4-30)	4 (1-10)	352 (188-517)	1,799 (1399-2200)	7,975 (6981-8968)
1994	2,700	0	37 (7-66)	311 (218-404)	4,826 (4185-5467)	1,734 (1297-2172)	675 (487-864)	350 (226-475)	4 (1-13)	4 (1-11)	76 (43-109)	2,615 (1956-3274)	10,633 (9604-11662)
1995	4,832	0	66 (26-107)	463 (267-660)	9,628 (8613-10643)	3,954 (3274-4634)	330 (225-434)	475 (253-697)	4 (1-11)	45 (16-74)	38 (19-57)	4,211 (3489-4933)	19,214 (17853-20576)
1996	2,002	4 (1-13)	20 (5-48)	234 (156-313)	5,636 (4817-6455)	1,487 (1232-1741)	487 (246-728)	14 (4-26)	46 (9-103)	49 (13-86)	60 (31-90)	442 (326-558)	8,480 (7594-9366)
1997	4,123	0	9 (2-22)	343 (252-433)	13,611 (12109-15122)	2,755 (2276-3234)	300 (154-445)	173 (103-243)	0	7 (2-16)	14 (3-28)	852 (519-1185)	18,063 16491-19634)
1998	5,851	8 (2-15)	9 (2-21)	1,431 (1068-1734)	15,533 (13873-17192)	4,413 (3732-5093)	1,131 (936-1326)	21 (5-38)	53 (24-82)	48 (15-81)	4 (1-11)	1,941 (1584-2297)	24,592 (22769-26415)
1999	3,293	0	18 (4-34)	573 (475-675)	7,843 (6477-9209)	2,208 (1816-2600)	449 (358-540)	409 (144-673)	4 (1-10)	47 (12-85)	0	859 (551-1167)	12,409 (10940-13877)
Average Annual Estimate													
1993-1996		1 (0-4)	33 (18-48)	406 (336-477)	6,087 (5667-6508)	2,007 (1784-2230)	389 (307-471)	210 (146-274)	17 (3-33)	26 (13-38)	132 (89-175)	2,267 (2001-2533)	11,576 (11034-12117)
1997-1999		3 (0-6)	12 (4-20)	782 (653-912)	12,329 (11455-13203)	3,125 (2818-3432)	626 (540-713)	201 (109-293)	19 (9-29)	34 (17-51)	6 (1-12)	1,217 (1025-1410)	18,354 (17414-19294)
1993-1999		2 (0-4)	24 (15-34)	568 (499-636)	8,762 (8317-9207)	2,486 (2303-2670)	491 (431-551)	206 (152-260)	18 (8-28)	29 (19-40)	78 (53-103)	1,817 (1644-1940)	14,481 (13973-14989)

Notes: [a]Species or species group codes.
[b]Actual number taken is the total number of seabirds recorded dead in the observed hauls.
STAL – Short-tailed albatross , LAAL – Laysan's albatross , BFAL – Black-footed albatross, NFUL – Northern fulmar , Gull – Unidentified gulls (herring gulls, glaucous gulls, glaucous-winged gulls), SHWR – Unidentified shearwaters (unidentified dark shearwaters, sooty shearwaters, short-tailed shearwaters)
Unidentified Tubenose – Unidentified procellariiformes (albatrosses, shearwaters, petrels), Alcid – Unidentified alcids (guillemots, murres, puffins, murrelets, auklets)
Other – Miscellaneous birds (could include loons, grebes, storm-petrels, cormorants, waterfowl, eiders, shorebirds, phalaropes, jaeger/skuas, red-legged kittiwakes, black-legged kittiwakes, terns), Unidentified ALB – Unidentified albatrosses (could include short-tailed albatrosses, Layson's albatrosses, black-footed albatrosses)
Source: (NMFS, 2001).
Spectacled eider, Steller's eider, marbled murrelet, red-legged kittiwake, and Kittlitz's murrelet were not reported by observers in any observed sample from 1993 to 1999. Although of these birds only the 2 eider species are listed under ESA in the action area, USFWS identifies the other 3 species as 'species of concern' because of low and/or declining population levels. 'Species of concern' is an informal classification by the USFWS, Office of Migratory Bird Management. Inclusion on the 'species of concern' list has no regulatory implications.

Table 9. Estimated Total Incidental Catch of Seabirds by Species or Species Groups[a] in Gulf of Alaska Longline Fisheries, 1993–1999. Values in Parentheses are 95% Confidence Bounds.

Year	Actual Number Taken [b]	STAL	BFAL	LAAL	NFUL	Gull	SHWR	Unid. Tubenoses	Alcid	Other	Unid. ALB	Unid. Seabird	Total
Gulf of Alaska													
1993	318	0	29 (9-50)	125 (62-187)	833 (615-1052)	45 (12-77)	59 (18-99)	0	0	3 (1-7)	3 (1-9)	213 (107-318)	1,309 (1056-1563)
1994	126	0	7 (2-16)	169 (89-250)	258 (165-351)	30 (2-81)	26 (5-54)	0	0	0	8 (2-18)	33 (8-66)	532 (397-668)
1995	374	0	236 (169-304)	67 (35-99)	520 (348-692)	99 (53-145)	39 (9-69)	6 (1-16)	0	3 (2-6)	376 (275-476)	173 (105-240)	1,519 (1302-1736)
1996	250	0	658 (455-860)	154 (90-128)	665 (349-982)	121 6-317)	14 (2-35)	0	0	0	0	19 (3-42)	1,631 (1203-2059)
1997	74	0	99 (32-167)	40 (5-109)	307 (164-451)	46 (14-79)	9 (2-21)	0	0	0	0	12 (2-30)	514 (338-689)
1998	184	0	289 (25-596)	217 (56-378)	919 (308-1530)	53 (14-92)	13 (3-30)	0	0	0	4 (1-12)	0	1,495 (792-2198)
1999	159	0	183 (70-297)	202 (123-280)	277 (156-399)	358 (136-581)	50 (8-93)	0	0	7 (1-21)	0	16 (4-37)	1,093 (812-1375)
Average Annual Estimate													
1993-1996		0	233 (179-287)	129 (97-160)	569 461-677)	74 (21-127)	35 (19-50)	1 (0-4)	0	1 (0-3)	97 (71-122)	109 (76-142)	1,248 (1108-1388)
1997-1999		0	191 (79-302)	153 (89-217)	501 (288-715)	153 (76-229)	24 (8-40)	0	0	2 (0-7)	1 (0-4)	9 (1-19)	1,034 (775-1293)
1993-1999		0	215 (158-272)	139 (106-172)	540 (429-651)	107 (63-152)	30 (19-41)	1 (0-3)	0	2 (0-4)	56 (41-71)	66 (47-86)	1,156 (1019-1293)

Notes: [a]Species or species group codes.
[b]Actual number taken is the total number of seabirds recorded dead in the observed hauls.
STAL – Short-tailed albatross, LAAL – Laysan's albatross, BFAL – Black-footed albatross
NFUL – Northern fulmar, Gull – Unidentified gulls (herring gulls, glaucous gulls, glaucous-winged gulls)
SHWR – Unidentified shearwaters (unidentified dark shearwaters, sooty shearwaters, short-tailed shearwaters)
Unidentified Tubenose – Unidentified procellariiformes (albatrosses, shearwaters, petrels), Alcid – Unidentified alcids (guillemots, murres, puffins, murrelets, auklets)
Other – Miscellaneous birds (could include loons, grebes, storm-petrels, cormorants, waterfowl, eiders, shorebirds, phalaropes, jaeger/skuas, red-legged kittiwakes, black-legged kittiwakes, terns), Unidentified ALB – Unidentified albatrosses (could include short-tailed albatrosses, Layson's albatrosses, black-footed albatrosses)

Source: (NMFS, 2001).

Spectacled eider, Steller's eider, marbled murrelet, red-legged kittiwake, and Kittlitz's murrelet were not reported by observers in any observed sample from 1993 to 1999. Although of these birds only the 2 eider species are listed under ESA in the action area, USFWS identifies the other 3 species as 'species of concern' because of low and/or declining population levels. 'Species of concern' is an informal classification by the USFWS, Office of Migratory Bird Management. Inclusion on the 'species of concern' list has no regulatory implications.

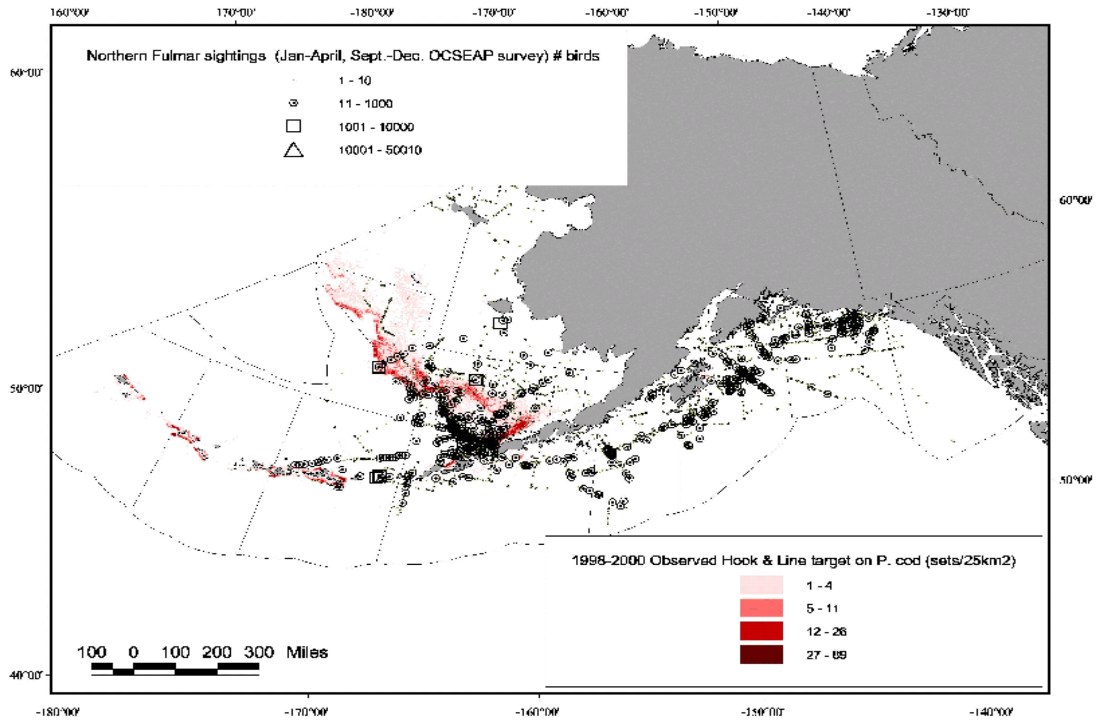


Fig. 8 Distribution of northern fulmars at sea in Alaska, as determined from boat-based surveys conducted between 1975-1985. Data are a subset of the North Pacific Pelagic Seabird Database, under development by the USGS/BRD and USFWS in Anchorage, AK.

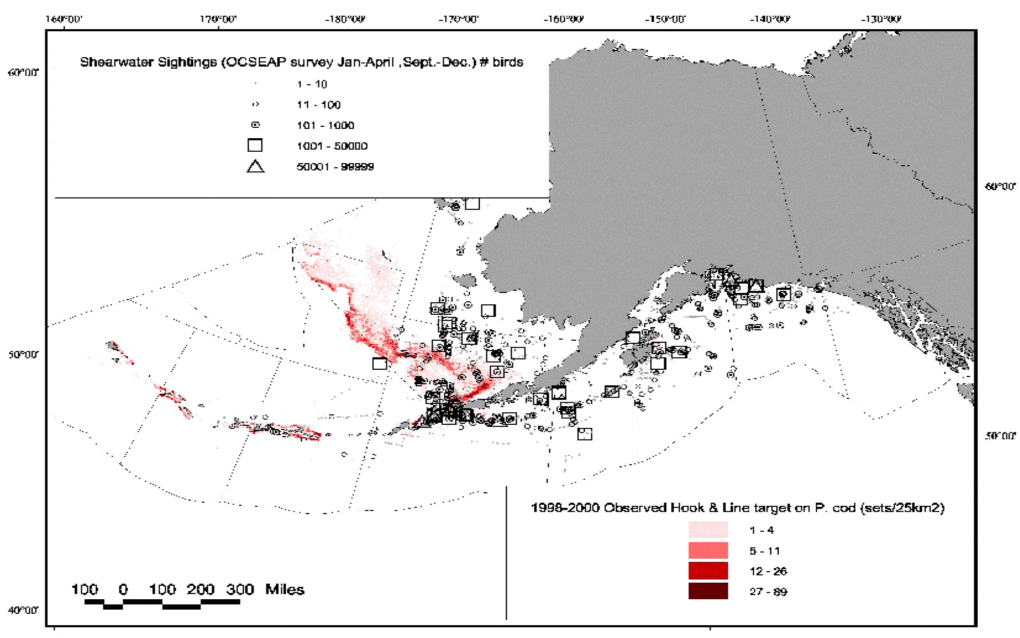


Fig. 9 Distribution of shearwaters (primarily sooty and short-tailed ssp) at sea in Alaska, as determined from boat-based surveys conducted between 1975-1985. Data are a subset of the North Pacific Pelagic Seabird Database, under development by the USGS/BRD and USFWS in Anchorage, AK.

At-sea Distribution of Laysan Albatross. – Laysan albatross, which also breed primarily in the Northwestern Hawaiian Islands, are the most abundant of the three albatross species that visit Alaska in the summer. This species is found in both the BS and the GOA (Figure 11), which is evident in the similar bycatch rates for those regions in the longline fishery (Tables 8 and 9). In the BS, low numbers of Laysan albatross are found south and west of the shelf break, with little overlap with the hook-and-line Pacific cod fishery, which is concentrated along the shelf edge (Figure 11). Larger numbers of Laysan albatross occurred along the central and western Aleutian chain, where the nearshore longline fishery is also concentrated in that region. In the GOA, Laysan albatross are found along the shelf edge, primarily between the Shumagin Islands and eastern Kodiak Island.

Most of the bycatch of Laysan albatross occurs in the longline fishery, and this interaction may be important despite low fishing effort in the GOA. The trawl fishery, which has an effort more equally distributed between the GOA and BS, has occasionally shown relatively high bycatch levels of Laysan albatross (i.e., 1998; Table 11). The distribution of Laysan albatross and fishing effort suggest that the trawl bycatch could more likely occur on the shelf edge of the GOA or closer to shore in the western Aleutians.

At-sea Distribution of Short-tailed Albatross. – The short-tailed albatross is listed as endangered under the ESA, and thus its interactions with the groundfish fisheries are of great interest. Ideally, the at-sea distribution of this (primarily) summer visitor would be independent from the fishery itself. A pilot study was implemented in 2001 to equip short-tailed albatross with satelite telemetry packs at their breeding grounds in Japan, with the goal of tracking their movements throughout the year (G. Balogh, USFWS, Anchorage). However, the most extensive data coverage available for short-tailed albatross is derived from the NMFS Observer database and sightings from commercial fishing vessels, and this was used to illustrate their distribution in Alaskan waters (Figures 12 and 13).

In the BS, the hook-and-line Pacific cod fishery overlaps with short-tailed albatross sightings primarily along the Aleutian chain, although some sightings also overlapped with the fishing effort along the shelf edge (Figure 12). A large portion of the sightings were recorded during the short-tailed breeding season (November to May), and thus may represent primarily immature and non-breeding birds. Most of the recorded take of short-tailed albatross occurred in the northern portion of the shelf edge in the BS, despite relatively fewer sightings there, compared to the Aleutians and with one exception, the takes were of juvenile or sub-adult (i.e. non-breeding) individuals (NMFS, 2001c).

In the GOA (Figure 13), the short-tailed albatross was sighted almost exclusively along the shelf edge, although to what extent this represents the bias of the observer's platforms is unknown. A large part of the trawl effort in the GOA extends from the Shumagin Islands to eastern Kodiak and to the north, but there were few sightings of short-tailed albatross inside of the shelf edge. Two recorded takes of the short-tailed albatross occurred in the GOA near Unimak Pass and Middleton Island in the northern GOA.

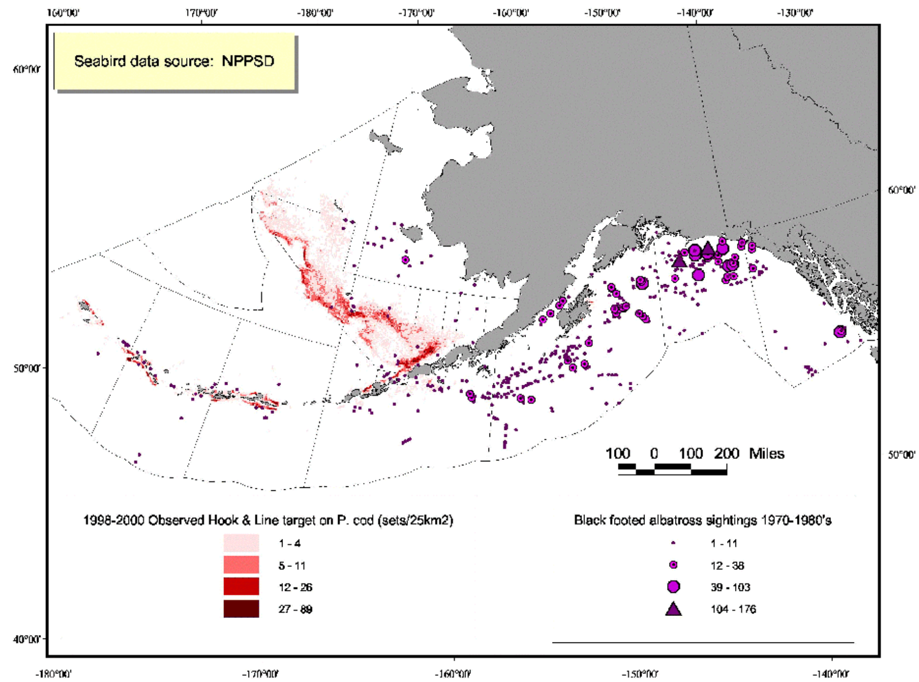


Fig. 10 Distribution of black-footed albatross in Alaska, as determined from boat-based surveys conducted between 1975-1985. Data are a subset of the North Pacific Pelagic Seabird Database, under development by the USGS/BRD and USFWS in Anchorage, AK.

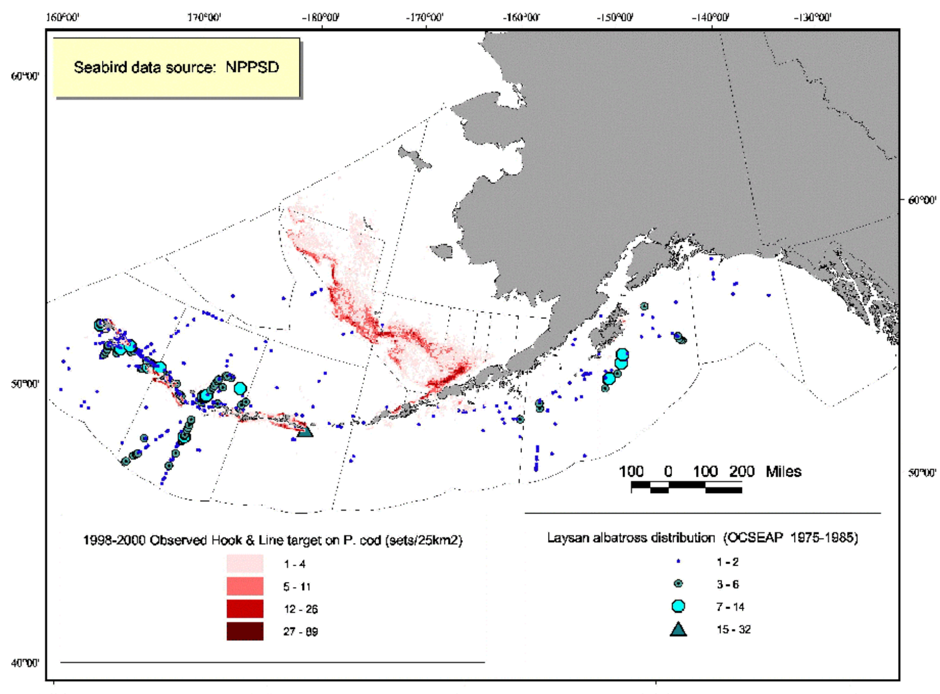


Fig. 11 Distribution of Laysan albatross in Alaska, as determined from boat-based surveys conducted between 1975-1985. Data are a subset of the North Pacific Pelagic Seabird Database, under development by the USGS/BRD and USFWS in Anchorage, AK.

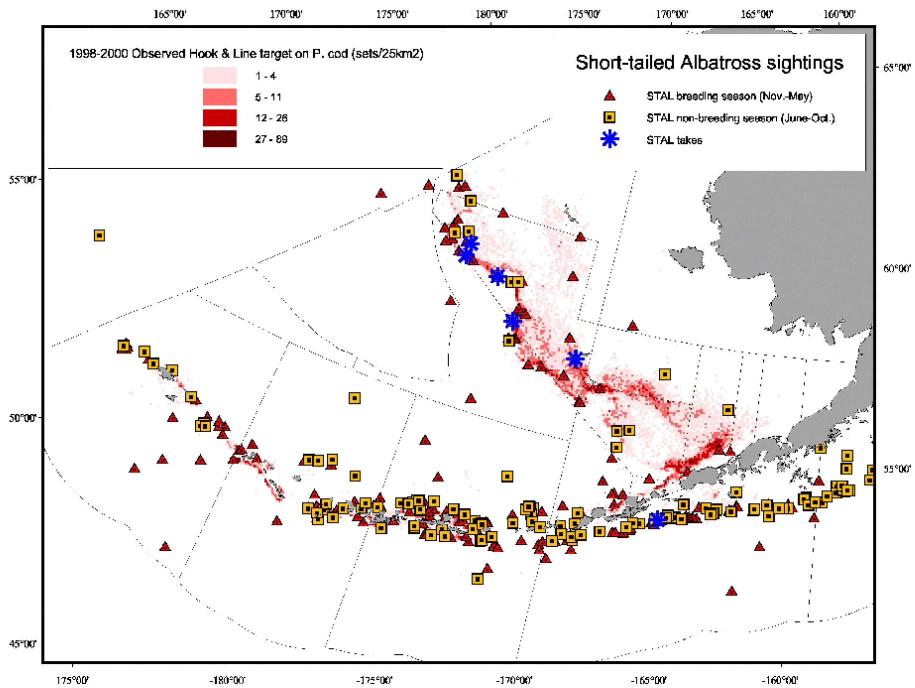


Fig. 12 Short-tailed albatross (STAL) sightings (by breeding season and take locations) in the BSAI in relationship to the 1998-2000 observed hook and line Pacific cod fishery effort (sets / 25 km^2).

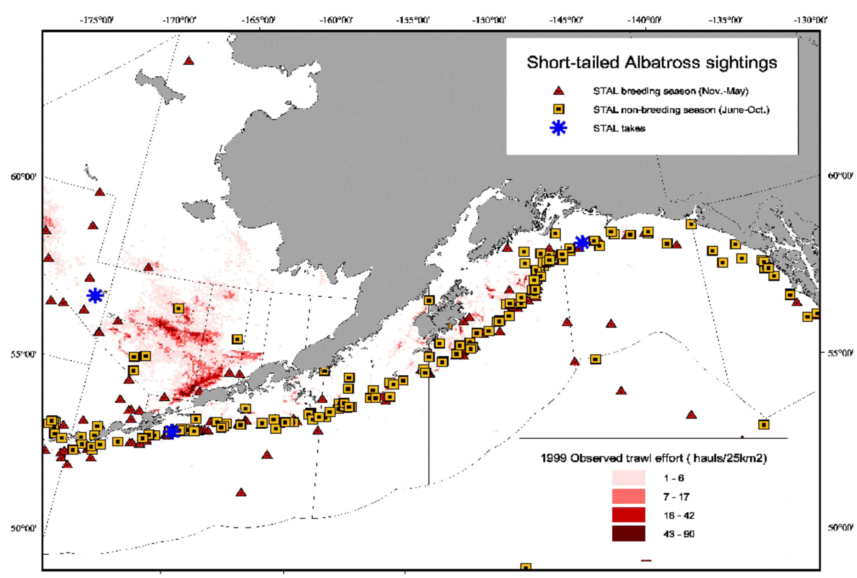


Fig. 13 Short-tailed albatross (STAL) sightings (by breeding season and take locations) in the GOA, relative to the 1999 observed trawl effort (hauls/25km2).

Bycatch of Seabirds in Fishing Gear

Seabirds are caught incidentally in all types of fishing operations (Jones and DeGange 1988) (Figure 14). In a coastal drift gillnet fishery in Washington state, sea state and time of day were significant predictors of seabird bycatch rates, indicating that visibility or maneuverability, as well as feeding behaviors, may affect susceptibility of birds (Melvin, Parrish *et al.* 1999). In groundfish fisheries, longlines account for most seabird bycatch (Table 10, Figures 15-16). Trawls also take some seabirds, primarily those that feed beneath the surface on prey in the water column (Table 11). Pots occasionally take diving seabirds (Table 12). Some birds also are injured or killed by striking the vessel superstructure or gear while flying in the vicinity.

Monitoring Seabird Bycatch and Seabird/Fishery Interactions and Bycatch Estimation Procedures

Data collection regarding seabird/fishery interactions by NMFS in the groundfish fisheries began in 1990 and was expanded during the 1993, 1997, 1999 and 2000 seasons.

A report using 1993-1997 data from the longline fishery describes seabird incidental catch estimation methods and procedures developed by USFWS, in consultation with NMFS (Stehn et al. 2001). Similar methods and procedures were developed by NMFS and used to calculate preliminary estimates using 1993-1999 data for all groundfish fisheries (NMFS 2001a). Standard statistical procedures ("separate ratio estimators" of stratified random sampling; Cochran 1977) for estimating a population total from a sample were used. NMFS calculated rates and estimates for all seabird species or species groups in each stratum of all gears, statistical fishing areas, regions (BSAI or GOA), vessel types (processors, motherships, and catcher-only vessels), time periods (annual or each of 13 four-week periods in a year) for each year from 1993 to 1999. As requested by USFWS, the following eleven groups of seabirds were chosen for analysis: short-tailed albatross, black-footed albatross, Laysan albatross, unidentified albatross, fulmars, gulls, shearwaters, unidentified tubenoses (procellarids), alcids, other bird species, and unidentified seabirds (those not identified to one of the other ten groups).

Incidental catch estimates were based on the number of seabirds by species in samples from observed hauls and the total commercial fish catch as estimated by the NMFS blend program. The NMFS method utilized two measures of fishing effort: total tons of groundfish catch per haul or set for the trawl fishery (NMFS blend program), and the number of hooks or pots per set for both the longline and pot fisheries (estimated for the unobserved fishery in the NMFS blend program using the average number of hooks or pots, respectively, in the observed fishery). The NMFS Observer Program NORPAC database records the weight of the catch by species in the species composition samples and the estimated weight of the entire catch (all species combined) in the whole haul or set. NORPAC also records the number of hooks or pots in the sample and the estimated number of total hooks or pots in the whole set. The number of observed birds in a species composition sample per effort (tons or hooks or pots) of that sample was used to extrapolate the number of seabirds to the whole haul or set, and similarly upwards to the whole fishery, including the unobserved effort.

Table 10. Annual Estimates, by Area, of Total Fishery Effort, Total Numbers and Bycatch Rates of Seabirds Taken in Longline Fisheries. Values in Parentheses are 95% Confidence Bounds.

Year	Effort (No. of Hooks in 1,000s)	No. of Birds	Bycatch Rate No. of Birds per 1,000 Hooks	Percent of Hooks Observed
Bering Sea and Aleutian Islands				
1993	123,232	7,975 (6981-8968)	0.06	24.5
1994	134,954	10,633 (9604-11662)	0.08	24.5
1995	141,779	19,214 (17853-20576)	0.14	24.2
1996	141,810	8,480 (7594-9366)	0.06	23.8
1997	176,534	18,063 (16491-19634)	0.10	22.6
1998	175,530	24,592 (22769-26415)	0.14	23.5
1999	157,319	12,409 (10940-13877)	0.08	25.0
Average Annual Estimates				
1993–1996	135,444	11,576 (11034-12117)	0.09	24.5
1997–1999	169,814	18,354 (17414-19294)	0.11	23.7
1993–1999	150,174	14,481 (13973-14989)	0.10	24.2
Gulf of Alaska				
1993	56,300	1,309 (1056-1563)	0.02	10.2
1994	49,452	532 (397-668)	0.01	4.9
1995	42,357	1,519 (1302-1736)	0.04	12.7
1996	33,195	1,631 (1203-2059)	0.05	10.8
1997	28,047	514 (338-689)	0.02	10.0
1998	29,399	1,495 (792-2198)	0.05	8.1
1999	31,895	1,093 (812-1375)	0.03	8.6
Average Annual Estimates				
1993–1996	45,326	1,248 (1108-1388)	0.03	9.5
1997–1999	29,780	1,034 (775-1293)	0.03	9.3
1993–1999	38,663	1,156 (1019-1293)	0.03	8.9

Table 11. Range of Estimates of Total Incidental Catch of Seabirds by Species or Species Groups[a] in the Combined Bering Sea and Aleutian Islands and Gulf of Alaska Trawl Fisheries, 1997–1999

Year	Actual Number Taken [b]	Estimate Range[c]	STAL	BFAL	LAAL	NFUL	Gull	SHWR	Unid. Tubenoses	Alcid	Other	Unid. ALB	Unid. Seabird	Total
1997	55	low	0	0	80	75	0	77	0	115	0	0	181	528
		high	0	0	149	343	0	662	0	115	0	0	1074	2343
1998	45	low	0	0	134	93	1590	856	1	110	3	0	8	2794
		high	0	0	341	2617	708	1238	163	543	2494	0	1035	9138
1999	154	low	0	0	8	446	0	82	0	664	0	0	17	1218
		high	0	0	27	7810	0	812	0	730	85	0	663	10,187
Average Annual Estimate														
1997–1999		low	0	0	74	205	530	338	0	296	2	0	69	1514
		high	0	0	172	3590	236	904	54	482	860	0	924	7223

Notes: [a]See the species and species groups footnoted in Table 3.5-6.
[b]Actual number taken is the total number of seabirds recorded dead in the observed hauls.
[c]The high and low estimates result from different methodologies used by observers to sample the haul.

Table 12. Estimated Total Incidental Catch of Seabirds by Species or Species Groups[a] in the Combined Bering Sea and Aleutian Islands and Gulf of Alaska Pot Fisheries, 1993–1999. Values in parentheses are 95% confidence bounds.

Year	Actual Number Taken [b]	STAL	BFAL	LAAL	NFUL	Gull	SHWR	Unid. Tubenoses	Alcid	Other	Unid. ALB	Unid. Seabird	Total
1993	0	0	0	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0	0	0	0
1995	6	0	0	0	9 (2-23)	3 (1-10)	7 (1-20)	0	19 (2-55)	0	0	0	39 (6-79)
1996	9	0	0	0	80 (7-174)	0	0	2 (1-6)	0	0	0	7 (1-19)	89 (9-183)
1997	4	0	0	0	14 (3-29)	0	0	0	9 (1-26)	0	0	0	23 (4-46)
1998	2	0	0	0	19 (1-54)	15 (1-44)	0	0	0	0	0	0	33 (2-79)
1999	47	0	0	0	166 (71-261)	0	9 (1-26)	14 (5-28)	0	0	0	0	189 (91-286)
Average Annual Estimate													
1993–1996		0	0	0	22 (2-46)	1 (0-3)	2 (0-5)	1 (0-2)	5 (0-14)	0	0	2 (0-5)	32 (6-58)
1997–1999		0	0	0	66 (32-101)	5 (0-15)	3 (0-9)	5 (1-10)	3 (0-9)	0	0	0	82 (45-119)
1993–1999		0	0	0	41 (21-61)	3 (0-7)	2 (0-6)	2 (0-5)	4 (0-10)	0	0	1 (0-3)	53 (31-75)

Notes: [a]See the species and species groups footnoted in Table 3.5-6.
[b]Actual number taken is the total number of seabirds recorded dead in the observed hauls.

On trawl vessels only, observers may use any one of three different sample sizes of groundfish catch to monitor bycatch of birds in a haul. Observers are currently advised to use the largest of the three sample sizes whenever possible. However, observers do not record the sample size choice for monitored hauls that have no observable seabird bycatch. Thus, it has been necessary to calculate two alternative sets of estimates of seabird bycatch for trawlers based on the smallest (ALT1) and largest (ALT2) sizes of sampling effort recorded for fish species (see "low" and "high" estimates in Table 11). In each of these two alternative calculation methods, a "separate ratio estimator" was used to bind the results of the catch ratios and variances of data from the three different sample sizes into arbitrary equal samples which were then inflated upwards to the total catch effort of the NMFS blend program. Although, it is not known with certainty which of the 2 sets of estimates is more accurate, the probable level of seabird bycatch on trawl vessels during the 1990s lies somewhere between the 2 sets of estimates.

The unobserved weight of fish was calculated by subtracting the known weight of sampled fish on observed hauls from the estimated total weight of fish (all hauls). The estimated total number of birds caught was the sum of observed birds in the catch and the estimated unobserved birds. For each species or species group in a stratum, the number of unobserved birds was estimated by multiplying the ratio of the number of observed birds of that species or species group caught per unit of effort of sampled groundfish from observed hauls times the total estimated effort of groundfish caught in unobserved hauls. Bycatch estimates from each stratum were summed to yield total estimates for statistical fishing areas and regions. No estimates were made for those few strata in the NMFS blend program which consisted only of data from unobserved vessels; in this regard the estimates are conservative.

Both the catch rate of birds (number of birds per weight of fish, or birds per 1,000 hooks) and the catch rate of fish (total weight of all fish species per hook/pot/net) were assumed to be equal for observed and unobserved hauls of the same gear, area, and time period. These assumptions may not hold, not necessarily because the presence of the observer may change the fishing practices of the skipper or crew, but rather because, for some other operational reason, the smaller (unobserved) vessels may have different catch rates than the large or mid-sized vessels. The constant catch rates for birds and/or fish among vessel size categories are untested and critical assumptions. If different catch rates do exist for different vessel size categories, then the average area catch rates and the estimates of the total seabird incidental catch number may be overestimated or underestimated.

In the NMFS analysis of 1993 to 1999 observer data, only three of the albatross taken were identified as a short-tailed albatross (and all from the BSAI region). Of the albatross taken, not all were identified. This analysis of 1993 to 1999 data resulted in an average estimate of two short-tailed albatross being taken annually in the BSAI groundfish hook-and-line fishery and zero short-tailed albatross being estimated taken annually in the GOA groundfish hook-and-line fishery. The incidental take limit established in the USFWS biological opinions on the effects of the hook-and-line fisheries on the short-tailed albatross is based on the actual reported takes and not on extrapolated estimated takes.

Based on estimates of seabirds observed taken in groundfish fisheries from 1989 to 1993, 85 percent of the total seabird bycatch was caught in the BSAI, and 15 percent in the GOA.

Longline gear accounted for 90 percent of the total seabird bycatch, trawls for 9 percent, and pots 1 percent. (Wohl *et al.* 1995). NMFS analysis of 1997 to 1999 observer data indicates similar patterns as those seen in the 1989 to 1993 data (Figure 14). Depending on which trawl estimate is used, longline gear accounted for 92 (or 73) percent of the total average annual seabird bycatch, trawl gear for 7 (or 26) percent and pot gear for less than 1 percent. The higher percentage of trawl bycatch coincides with the higher trawl estimate displayed in Table 11. Based on the average annual estimates of seabirds observed taken in groundfish longline fisheries from 1993 to 1999, 93 percent of the longline seabird bycatch was caught in the BSAI, and 7 percent in the GOA (Table 10). Also of note, the bycatch rates in the BSAI are approximately 3 times higher than in the GOA (Table 10).

Bycatch on Longlines

Longlines catch surface-feeding seabirds that consume invertebrate prey which resemble bait. During setting of the line seabirds are hooked as they attempt to capture the bait. Birds that habitually scavenge floating material from the sea surface are also susceptible to being hooked on longlines (Brothers 1991, Alexander *et al.* 1997, Brothers, Cooper *et al.* 1999). Recent studies have implicated longline fishing in these population declines of albatross species. Longline fishing is considered the most recent and potentially most serious global threat faced by albatrosses and other procellariiforme taxa (Brothers *et al.* 1999a). Seabird mortality in Alaska longline fisheries represents only a portion of the fishing mortality that occurs, particularly with the albatrosses. Mortality of black-footed and Laysan albatrosses occurs in both Alaskan and Hawaiian longline fisheries and may be assumed to occur in other North Pacific longline fisheries conducted by Japan, Taiwan, Korea, Russia, and China (Brothers *et al.* 1999b). See section 4.7.1 for a discussion of the potential cumulative impacts of North Pacific longline fisheries on the black-footed albatross (NMFS 2001b).

Estimates of the annual seabird bycatch for the Alaska groundfish fisheries, based on 1993 to 1999 data, indicate that approximately 16,000 seabirds are taken annually in the combined BSAI and GOA groundfish fisheries (14,500 in the BSAI; 1,200 in the GOA) at the average annual rates of 0.10 and 0.03 birds per 1,000 hooks in the BSAI and in the GOA, respectively (Table 10).

Of the estimated 14,500 seabirds that are incidentally caught in the BSAI, the species composition is: 61 percent fulmars, 17 percent gull species, 12 percent unidentified seabirds, 5 percent albatross species, 3 percent shearwater species, and 2 percent ‘all other’ species (Figure 15).

Of the estimated 1,200 seabirds that are incidentally caught in the GOA, the species composition is: 47 percent fulmars, 35 percent albatrosses, 9 percent gull species, 6 percent unidentified seabirds, 3 percent shearwater species, and less than 1 percent ‘all other’ species (Figure 15). Five endangered short-tailed albatrosses were reported caught in the longline fishery since reliable observer reports began in 1990: two in 1995, one in 1996, and two in 1998, and all in the BSAI. Both of the birds caught in 1995 were in the vicinity of Unimak Pass and were taken outside the observers' statistical samples; the bird caught in 1996 was near the Pribilof Islands in an observer's sample; the two short-tails taken in 1998 were in observers’ samples.

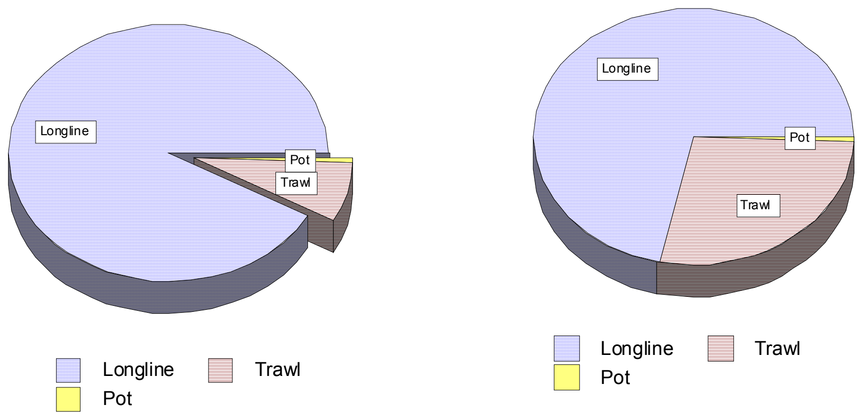


Fig. 14. Average Annual Estimate of Number of Seabirds Taken by Gear Type, 1997-1999. Estimates Differ Based on Trawl Sampling Methodology Used.

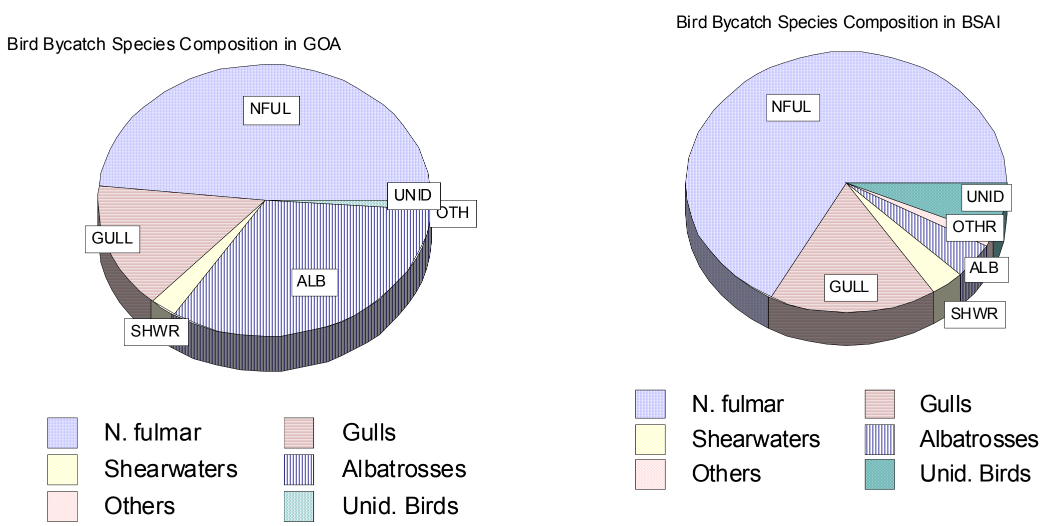


Fig 15. Relative Species Composition of Bird Bycatch in the Longline Fisheries, BSAI (right) and GOA (left). Average annual estimates, 1997-1999.

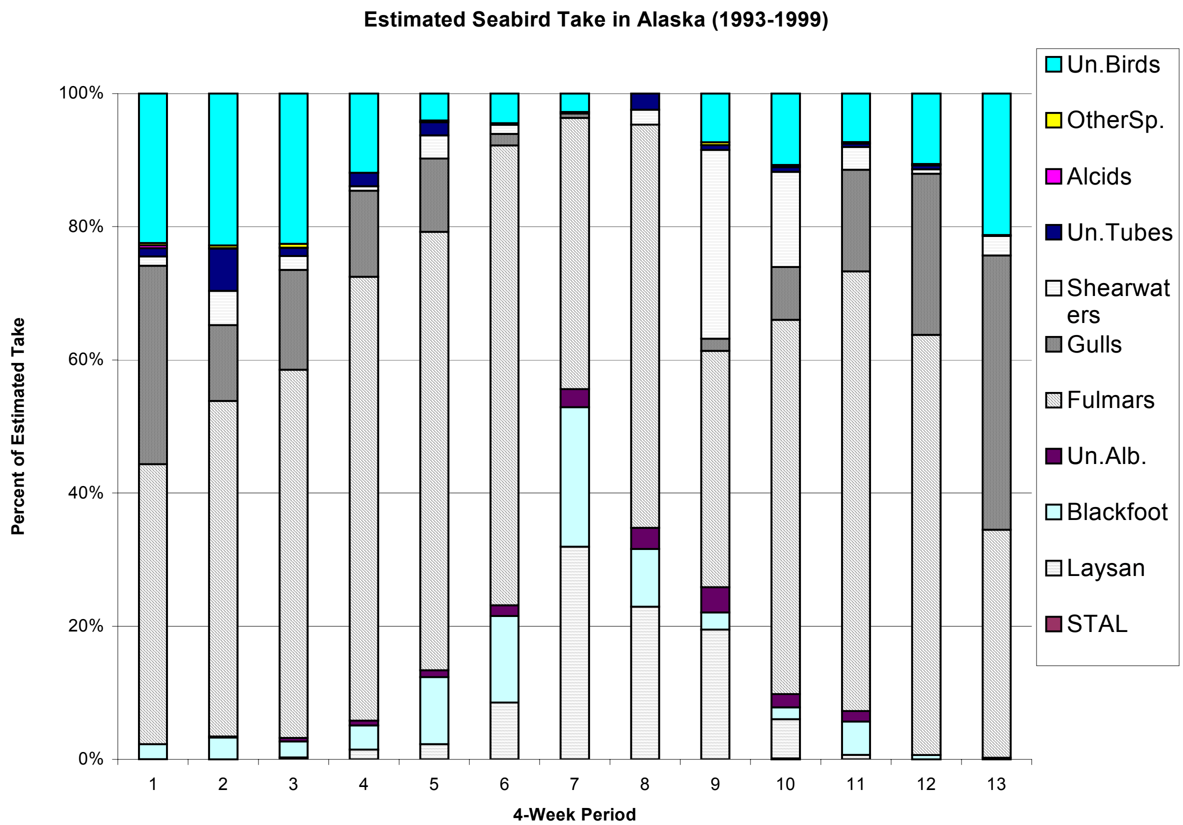


Fig 16 Cumulative Estimated Seabird Bycatch in Longline Fisheries in Alaska, by Species Group, by 4-Week Periods, 1993-1999.

It is difficult at this time to make valid comparisons of bird bycatch rates between regions. We cannot discern if the differences between the BSAI and GOA estimated bycatch rates are due to the vastly different levels of fishing effort in each region, the different types of vessels used in each region ('small' catcher vessel in GOA, 'large' catcher-processor in BSAI), different distribution and abundance of birds, etc. An analysis of covariance would allow for a valid statistical comparison of the regional bycatch rates.

Efforts to Reduce Seabird Bycatch in Longline Fisheries

The NMFS Alaska Region has been involved with ongoing efforts to reduce seabird bycatch in the longline fisheries off Alaska since the early 1990s. Efforts have included: collection of bycatch data via onboard observers; outreach and education to the fishing fleet and other stakeholders; coordination with the USFWS and full compliance with requirements of biological opinions issued under the ESA; requiring the use of seabird avoidance measures by vessel operators in longline fisheries off Alaska; research on the effectiveness of such measures; implementation of the United States' *National Plan of Action for Reducing Incidental Catch of Seabirds in Longline Fisheries* (NPOA); and international coordination with scientists, fishery managers, and organizations involved with these issues in other parts of the world. Additional details of these Alaska Region efforts are available in several documents cited here (NMFS 1998, 1999, 2001a, 2001c, 2001d).

The NPOA contains several action elements, one that pertains to reporting. The NPOA states that "NMFS, in collaboration with the appropriate [Regional Fishery Management] Councils and in consultation with USFWS, will prepare an annual report on the status of seabird mortality for each longline fishery, including assessment information, mitigation measures, and research efforts. USFWS will also provide regionally-based seabird population status information that will be included in the annual reports. The reports will be submitted annually as part of the Stock Assessment and Fishery Evaluation (SAFE) Report that is already provided on an annual basis by NMFS and made widely available. Such annual reports will be compiled and incorporated into NMFS' biennial status report to FAO on its implementation of the *Code of Conduct for Responsible Fisheries*." The information contained within this seabird section of the "Ecosystem Considerations for 2002" hereby serves to fulfill the Alaska Region's requirements for annual NPOA reporting.

Mitigation Measures

NMFS required hook-and-line vessels fishing for groundfish in the BSAI and GOA and federally permitted hook-and-line vessels fishing for groundfish in Alaskan waters adjacent to the BSAI and GOA, to employ specified seabird avoidance measures to reduce seabird incidental catch and incidental seabird mortality in 1997 (62 FR 23176, April 29, 1997). Measures were necessary to mitigate hook-and-line fishery interactions with the short-tailed albatross and other seabird species. Prior to 1997, measures were not required, but anecdotal information suggests that some vessel operators may have used mitigation measures voluntarily. NMFS required seabird avoidance measures to be used by vessels fishing for Pacific halibut in U.S. Exclusive Economic Zone (EEZ) waters off Alaska the following year (63 FR 11161, March 6, 1998).

By regulation, all vessel operators using hook-and-line gear to fish for groundfish and Pacific halibut must conduct fishing operations as follows:

1. Use baited hooks that sink as soon as they are put in the water.
2. Discharge offal in a manner that distracts seabirds from baited hooks (if discharged at all during the setting or hauling of gear).
3. Make every reasonable effort to ensure that birds brought on board alive are released alive. In addition, all applicable hook-and-line vessels at or more than 26-ft length overall, must employ *one or more* of the next four measures.
4. Set gear at night (during hours specified in regulation).
5. Tow a streamer line or lines during deployment of gear to prevent birds from taking hooks.
6. Tow a buoy, board, stick, or other device during deployment of gear at a distance appropriate to prevent birds from taking hooks.
7. Deploy hooks underwater through a lining tube at a depth sufficient to prevent birds from settling on hooks during the deployment of gear.

Fishermen currently are provided some flexibility in choice of options in that they can select the most appropriate and practicable methods for their vessel size, fishery, and fishing operations and conditions. At the October 2001 meeting of the North Pacific Fishery Management Council (Council), Washington Sea Grant Program (WSGP) researchers presented results from a 2-year scientific study evaluating the effectiveness of the seabird avoidance measures currently in use. The WSGP final report made four basic types of recommendations to the Council and NMFS: 1) proposed changes to existing regulations, 2) optional actions that could be included in a comprehensive seabird bycatch reduction program and that are non-regulatory in nature (education and outreach and gear suggestions), 3) suggestions for future research, and 4) gear, methods, and operations which should not be allowed as seabird avoidance measures. The regulatory recommendations call for the use of paired streamer lines with standards for performance and construction of the streamer lines and include some suggested guidelines to assist fishers in achieving some of the standards that would be required in regulation. See the 'research' section below, plus all components are more fully described in the WSGP final report (Melvin et al 2001). The Council is also considering an alternative that proposes some variations of requirements for small vessels and is scheduled to take final action on revisions to seabird avoidance regulations at its December 2001 meeting.

Bycatch in Trawls

Trawls primarily catch seabirds that dive for their prey. This probably occurs as the trawl is being retrieved rather than while it is actively fishing. A few birds may also be caught as they are attempting to scavenge fish or detritus at the surface during retrieval. The species composition of seabird bycatch in observed trawl hauls is currently available for 1993 through 1999. The principal bird species reported in trawl hauls were alcids, northern fulmars, and gulls. Small numbers of other species also were caught. NMFS analysis of 1993 to 1999 observer data indicates that trawl gear accounted for 7 to 26 percent of the total average annual seabird bycatch in the BSAI and GOA groundfish fisheries combined, depending on the trawl sampling methodology used (Figure 14).

Onboard observations of birds (including Laysan albatrosses) colliding with the trawl transducer wires (sometimes called third wire) have been made. These wires are typically deployed from the stern of midwater trawl vessels fishing for pollock and carry the transducer net sounder cable down to the head of the trawl net. Any birds killed by such collisions would most likely not be recorded in the observers' sampling of the trawl haul in that it is unlikely that such dead birds would make their way into the trawl net. NMFS is investigating the extent of use of trawl third wires in the trawl fleet and additional details of the bird/vessel interactions. Solutions may be as simple as hanging streamers from the third wire or trawl gantry (Balogh, USFWS; N. Smith, New Zealand Ministry of Fisheries pers. comm.).

Vessel Strikes

Striking of vessels by birds in flight is reported by observers, but bird-strike data have not been analyzed statistically. Some birds that strike vessels fly away without injury, but some are injured or killed. Bird strikes are probably most numerous during the night; birds are especially prone to strike vessels during storms or foggy conditions when bright deck lights are on, which can disorient them. The proximity of the vessels to seabird colonies during the breeding season is also a factor (USFWS, V. Byrd pers. com). Collisons of large numbers of birds occasionally occurs as in the case of where approximately 6,000 crested auklets which were attracted to lights and collided with a fishing vessel near Kodiak Island during the winter of 1977 or in the central Aleutians in 1964 when approximate1y 1,100 crested aukets attracted to deck lights on a processor and collided with structures on the vessel (Dick and Donaldson 1978). Species that most commonly strike vessels include storm-petrels, auklets, and shearwaters.

Research Initiatives and Additional Research Needs

In 1999 and 2000, the WSGP compared seabird bycatch mitigation strategies in 2 major Alaska demersal longline fisheries: the GOA and AI IFQ fishery for sablefish and halibut and the BS catcher-processor longline fishery for Pacific cod. Researchers conducted experimentally rigorous tests of seabird bycatch deterrents on the local abundance, attack rate, and hooking rate of seabirds in both fisheries. The goal was to identify mitigation devices that significantly reduced seabird bycatch with no loss of target catch or increase in the bycatch of other organisms. Control sets with no deterrent established a baseline and allowed exploration of seabird interaction with longline gear as a function of temporal and spatial variation, physical factors such as wind and sea state, and fishery practices (Melvin et al 2001). A key feature of this program was an industry-agency-academic collaboration to identify possible deterrents and test them on active fishing vessels under typical fishing conditions. The Council will take final action at its December 2001 meeting to make changes to the existing regulations based on the WSGP recommendations. See the previous section on "mitigation measures" for additional details as well as the WSGP final report (Melvin et al 2001).

Section 4.3.4 of the Alaska Groundfish Fisheries DPSEIS included several research and/or analysis needs identified by scientists currently researching seabirds in the BSAI and GOA ecosystem (NMFS, 2001a). As the information gaps are filled, the view of how seabirds are affected by fisheries may change. Some additional research and analysis needs identified in SSC comments on the DPSEIS and by other seabird scientists are:

1. Quantitative models to help evaluate the potential population-level impact of fisheries-related seabird mortality, particularly for those seabirds species that are killed in high numbers (e.g. northern fulmar), for abundant species (e.g. sooty shearwater and short-tailed shearwater, Laysan's albatross), and for less abundant species of concern (black-footed albatross).

2. For many species, the potential impact of bycatch mortality needs to be assessed at the colony level. That is, are particular colonies more susceptible to bycatch impacts because of the temporal and spatial distribution of fisheries?

3. Quantitative models to help evaluate the potential population-level impacts from the availability of fishery discards and offal, particularly on juvenile birds.

4. Research and analysis to ascertain how much benefit seabirds of the North Pacific derive from discards and offal and to then balance that with the adverse impacts associated with the incidental take of seabirds in fishing gear as a result of vessels attracting birds via the processing wastes and offal that are discharged.

5. In varying the timing of fishing effort, there may be some effects on the value to seabirds of the discards and offal that result from the fishing activity. Discards in times when the

seabirds have high energy demands or when naturally available food is hard to obtain may be more valuable to the seabirds than would be true in times of plentiful prey. A question that should be explored is whether pulsed fishing saturates the ability of the seabirds to take advantage of the waste produced.

6. Compilation of pelagic (at-sea) data on distribution of seabirds in Alaska and elsewhere in the North Pacific. Such data on the pelagic distribution and abundance of seabirds is critical for addressing questions such as raised in this analysis on seabirds and could be used to assess the potential interactions between commercial fisheries and seabirds (e.g. longlines and albatrosses).

7. Satellite telemetry studies on the short-tailed albatross, a rare and endangered species, to accurately identify spatial and temporal distribution patterns in the BSAI and GOA, particularly as they intersect with commercial fishing activity and the potential for interactions.

8. Investigate the extent of use of trawl third wires in the trawl fleet and if necessary, pursue the development and/or identification of practical and effective methods and devices to reduce seabird interactions with trawl vessels equipped with trawl third wires.

In 2001, steps were taken to address many of these research gaps by way of a congressional funding initiative. Congress allocated $575,000 to the USFWS–Office of Migratory Bird Management to reduce the impact of seabird bycatch in Alaska fisheries. Studies and contracts, implemented in FY01 and in progress in FY02, addressed the following:

1. *Demographics and Productivity of Albatrosses at Their Breeding Sites*
Recent declines in black-footed albatross, and the high bycatch rate of Laysan albatross, require more sophisticated analyses and modeling of potential population-level effects from incidental catch in groundfish fisheries. Analysis of long-term data from the Northern Hawaiian Islands breeding sites was supported. Additionally, a banding database will be completed this year, with the goal of assisting demographics and modeling efforts.

2. Demographics of Albatrosses and Fulmars Caught in Alaska Longline Fisheries
The NMFS North Pacific Groundfish Observer Program will obtain albatross and fulmar carcasses from the BSAI, to be shipped to the University of Alaska, Fairbanks. The UAF Museum will process the carcasses to obtain demographic information such as age and sex, as well as body size, condition and other mensural characteristics. Salvaged tissue samples will be sent to USGS/BRD and University of Washington researchers to conduct genetic analyses. Genetic studies may identify colony or region of origin, and together with the demographic information, assist modeling to determine whether population-level effects occur. If successful, the project will extend another year and include the GOA region.

Funds also supported a pilot satellite telemetry project on fulmars (presented in this report). This will eventually determine where fulmars forage throughout the year, to alert fishers of high density fulmar regions and better understand population dynamics.

3. Short-tailed Albatross Satellite Telemetry Tracking and Data Analysis
A joint U.S.-Japan initiative was implemented to determine the occurrence and marine habitat use of the endangered Short-tailed albatross in the Bering Sea and North Pacific. Birds were tagged at Torishima Island, Japan, and a contract was established to fund analysis of albatross distribution and marine habitat use of tagged birds. Information will alert fishers of albatross high-use areas, and will benefit efforts to enhance albatross population recovery and delisting.

4. Pelagic Seabird Database
All agencies identify the need for a comprehensive database on offshore distribution and abundance of waterbirds in Alaska. Over three decades of various types of surveys need to be standardized and synthesized, but could answer basic questions such as where the birds are, when are they present and how many are there. The database will eventually be available to agency and industry groups via a website, to provide fishers with locations of high density seabird areas to promote bycatch avoidance and efficiency in fishing.

Work began on the development of the North Pacific Pelagic Seabird Database, via a contract with the USGS/BRD, in cooperation with USFWS, NMFS, and MMS. Preliminary results from this effort include the at-sea distribution maps of selected seabirds subject to incidental catch in the fisheries, which have been incorporated into this chapter section.

5. *Outreach Plan and Video for Fishers*
A contract was established with the Washington Sea Grant Program, University of Washington, to develop a comprehensive outreach program and video for fishers, to alert them to the problem of seabird bycatch, methods to reduce bycatch, and instruction on the deployment of bycatch avoidance devices.

6. *Fishery Observer Bird Observation Report*
The NMFS North Pacific Groundfish Observer Program contributes incidental information on seabird sightings and seabird-related incidents to the USFWS. The information, while valuable, needs to be entered into an accessible database. This project will create the database and enter observer notes to make them accessible and quantifiable to all user groups. The main entries of interest include albatross sightings, vessel strikes, rare seabird observations, and notes on effectiveness of mitigation devices. Results will guide improvement of the Seabird Daily Log data sheet used by observers.

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