POTENTIAL INTERACTIONS BETWEEN COMMERCIAL FISHING VESSELS AND STELLER'S AND SPECTACLED EIDERS IN ALASKA

By

Fritz Funk

Final Report
Federal Aid Project E-5-HP
Alaska Department of Fish and Game
Division of Commercial Fisheries
P.O. Box 25526
Juneau, AK 99802-5526

June 2008

[1]The Regional Information Report Series was established in 1987 to provide an information access system for all unpublished divisional reports. These reports frequently serve diverse ad hoc informational purposes or archive basic uninterpreted data. To accommodate timely reporting of recently collected information, reports in this series undergo only limited internal review and may contain preliminary data; this information may be subsequently finalized and published in the formal literature. Consequently, these reports should not be cited without prior approval of the author or the Division of Commercial Fisheries.

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EXECUTIVE SUMMARY

Spectacled eiders breeding in Alaska were listed as threatened in 1993, followed by the listing of the Alaska-breeding population of Steller's eider in 1997. Primary reasons for concern for both eider species were the near disappearance of the species from the Yukon-Kuskokwim Delta and the low numbers of breeding birds on the North Slope. Causes of the declines in the Alaska-breeding birds are unknown. The larger Russian component of both eider species is more abundant and mixes with the Alaska breeding population during the late-summer molt and on the wintering grounds.

Spectacled eiders molt in both northwestern Alaska and eastern Siberia, and have been only recently discovered wintering in leads in the pack ice south of St. Lawrence Island. Steller's eiders move to locations in southwestern Alaska during the summer molt, and the mixture of Asian and Alaskan breeding populations winters from the eastern Aleutian Islands to Lower Cook Inlet and Kodiak Island, with Izembek Lagoon being the center of molting and wintering abundance. The potential impacts of fisheries on these eider species has been unknown. The current project was undertaken to describe which commercial fisheries occur in space and time near habitat used by the threatened Alaska components of the two eider populations.

Steller's and spectacled eiders could be envisioned to interact with fisheries in four possible ways: 1) entanglement, 2) competition for prey, 3) collisions or other interference with fishing vessels or fishing-related structures, and 4) habitat exclusion or avoidance because of fishing-related activity. Entanglement of Steller's and spectacled eiders has not been reported to be a problem to date, but effort distributions were investigated as one way to get a handle on the potential risk from this source. Prey competition is unlikely because commercial fisheries do not directly take the shallow-water mollusk and crustacean species in the Steller's eider diet. Vessel strikes have been reported by observers and are investigated in this report. Habitat exclusion is difficult to quantify, but knowledge of nearby fishing effort distributions is essential for a first step.

Seventeen records of collisions between fishing vessels and Steller's eiders appeared in fisheries observer reports which also had reliable time-of-day information, along with nineteen king eider strikes. Plotting the date and time of day of these observations revealed that all Steller's eider collisions except one had occurred at night during the winter and spring, along with all nineteen of the King eider observations. The collisions occurred in light levels well below astronomical twilight. As a result, the vessel collision problem is framed by the annual light regime for further analyses. Combining the presence of substantial numbers of eiders along the Alaska peninsula with the annual light regime, the time period September 1 through April 30 likely represents the greatest risk of collisions between eiders and fishing vessels. Between May 1 and August 30 there is little or no deep darkness in these areas and bird strikes are highly unlikely.

Commercial catch records were examined from ADFG fish tickets and NMFS observers to determine the location and time of catch for salmon, herring, shellfish and groundfish fisheries. Very little fishing effort occurs near Spectacled eider critical habitat so detailed analysis of fishing distributions was organized around Steller's eider distributions.

In addition to active fishing operations, there is potential for vessel collisions and habitat exclusion when vessels are offloading, anchored up, or transiting to or from fishing grounds. No direct records are kept of these activities. However, port of landing can serve as proxy for fishing-related activities such as offloading catch, fueling and staging areas. For the September through April period, Kodiak and Dutch Harbor/Unalaska were by far the

busiest fishing ports, with landings dominated by shellfish and groundfish vessels. Along the Alaska Peninsula, King Cove was ranked 5th, and Port Moller 7th for the number of September through April landings. However, Port Moller landings consisted of late-season salmon, almost all in the early part of September. There were no other landings reported from the north Alaska Peninsula during the September through April period.

The locations, timing, and gear used in Pacific herring fisheries are described but nearly all of the fishing effort occurs during the well-lit period of the year when vessel collisions are unlikely. Pacific herring fisheries occur at herring spawning locations throughout the coastal migration route of Steller's eiders.

Very little Dungeness crab are harvested from areas near Steller's eider critical habitat; in addition, what Dungeness fishing effort occurs is mostly during the well-lighted summer months. Shrimp landings have been minimal in recent years. Scallop harvests occur offshore in the Bering Sea, but most effort occurs during the summer months. Bristol Bay and the Red King Crab savings area are closed to scallop dredging.

The Bristol Bay red king crab fishery, with its brightly lit vessels, could well have the most potential for interactions with late-migrating eiders or overwintering eiders while anchored up or transiting nearshore areas. This fishery has occurred from late October through early December in recent years.

Salmon fisheries occur during the summer period with minimal periods of darkness, so that there is very low potential for eider-vessel collisions. No eider collisions with salmon fishing vessels have been reported. Although gillnet entanglements with Steller's eiders have never been reported, other diving seabirds do become entangled in gillnets, so it is conceivable that there is some entanglement risk. Drift gillnet fishing occurs along the north Alaska Peninsula, primarily from Port Moller to Port Heiden. The largest amount of set gillnet effort near the general Steller's eider molting/summering areas occurs at Nelson Lagoon.

During the spring migration, no groundfish effort occurred in Bristol Bay when it was open to trawling from April 1 to June 15. Bristol Bay is closed to groundfish trawling during the fall Steller's eider migration. The only groundfish fishing found near areas used by Steller's eiders was the yellowfin sole fishery along the northern shore of Kuskokwim Bay. However, this fishery occurs in May, past the time when astronomical twilight has disappeared from the fishing grounds so that the risk of vessel collisions is minimal.

Eider-vessel collisions appear to involve bright lights during periods of darkness, so that it may be possible to detect the distribution of fishing vessels at sea using low-light satellite-borne sensors. NOAA archives of DMP/OLS satellites, which have been used to detect squid fleets at sea, were screened for cloud free periods when Bering Sea fishing fleets might be detected. Among other possibilities, the opening of the 1997 Bristol Bay red king crab fishery on November 1 coincided with a satellite pass over the fishing grounds when cloud cover was less than 10%, providing an ideal opportunity to determine whether crab vessel lights can be detected. However, time constraints precluded examining the imagery from that date.

Further advancements in our knowledge of eider migration routes, from telemetry and other sources, could be used to further narrow the scope of analyses of potential conflict between fishing vessels and eiders. Observer records of vessel-eider collisions provided by far the most valuable information in this analysis. However, the seabird collision data is obtained anecdotally in field notes of fishery observers whose primary mission is to estimate groundfish and shellfish catches. A more dedicated, directed, effort to document seabird encounters would greatly enhance our knowledge of how fisheries and seabirds interact.

INTRODUCTION

The portion of the Spectacled eider (*Somateria fischeri*) population breeding in Alaska was listed as threatened in 1993 (Federal Register 1993), followed by the Alaska-breeding population of Steller's eider (*Polysticta stelleri*) in 1997 (Federal Register 1997). Primary reasons for concern for both eider species were the near disappearance of the species from the Yukon-Kuskokwim Delta and low numbers of breeding birds on the North Slope. Causes of the declines in the Alaska-breeding birds are unknown. The larger Russian component of the Pacific population of both eiders mixes with the Alaska breeding population during the late-summer molt and on the wintering grounds. Spectacled eiders molt in both northwestern Alaska and eastern Siberia (USFWS 1996), and have been only recently been discovered wintering in leads in the pack ice south of St. Lawrence Island (Petersen et al. 1999). Steller's eiders move to locations in southwestern Alaska during the summer molt, and the mixture of Asian and Alaskan breeding populations winters from the eastern Aleutian Islands to Lower Cook Inlet and Kodiak Island (USFWS 2002a).

The potential role of fisheries in the decline of these eider species has been unknown. The current project was undertaken to describe which commercial fisheries occur in space and time near habitat used by the threatened Alaska components of the two eider populations. Comprehensive views of the distribution of fisheries in Alaska is hampered by the complex mosaic of federal and state jurisdictions. Generally, fisheries inside of 3 miles from shore are managed by the State of Alaska, while those further offshore are managed by the U.S. National Marine Fisheries Service. Some species, such as Pacific cod, which are distributed in both State and Federal waters, are technically managed separately but with close coordination between State and Federal agencies. For some other species, such as crab and salmon, whose distribution also transcends state and federal boundaries, federal agencies have delegated management authority to the State of Alaska, usually because there had been a precedent for State management before jurisdictional boundaries were extended by the Fishery Management and Conservation Act of 1976. From a research standpoint, it is sometimes difficult to derive a comprehensive view of Alaska fisheries. State and Federal management agencies have different data collection programs to describe the distribution of catch and effort. Confidentiality restrictions on both State and Federal data can make it difficult to share information among agencies, or to release the data required for comprehensive fishery overviews to the public. This project attempted to provide such comprehensive overviews of fisheries that might affect Steller's and spectacled eiders, using confidentiality agreements to share data among agencies, and judicious editing of confidential information to meet both state and federal requirements.

Steller's and spectacled eiders could be envisioned to interact with fisheries in four possible ways:

1. Entanglement
2. Competition for Prey

3. Collisions or other interference, likely related to lighting, with fishing vessels or fishing-related structures
4. Avoidance (habitat exclusion) because of fishing-related activity

Entanglement of Steller's and spectacled eiders has not been reported to be a problem to date. However, self-reporting rates of any such encounters might not be expected to be very high. Observers are one possible source of such information, but to date catch-monitoring observers have mostly only been placed aboard larger crab and groundfish vessels. The National Marine Fisheries Service (NMFS) Marine Mammal Observer Program has gathered information from the small set gillnet operations around Kodiak Island, and the drift gillnet fleet in Cook Inlet. Spectacled eiders do not occur in these areas and Steller's eiders were not found to be entangled in either of those observer programs. While entanglement of Steller's and spectacled eiders is not thought to be a problem, the effort distributions in this report would help to identify where the potential for entanglement interactions might exist.

On the molting and wintering grounds where contact with fisheries is most likely, Steller's eiders forage on marine invertebrates such as mollusks and small crustaceans (Petersen 1980, 1981). Commercial fisheries do not directly take the shallow-water mollusk and crustacean species in the Steller's eider diet.

Vessel strikes are a potential problematic impact of fisheries on eider populations during low light and storm conditions (USFWS 2002b), and will be one focus area of this report.

Avoidance (habitat exclusion) because of fishing-related activity would be very difficult to quantify. A first step, would be to examine the proximity of fishing activities described in this report to Steller's and spectacled eider critical habitat and migration routes.

There have been little or no reports of direct entanglement of Steller's eiders in fishing gear but it is thought there may be more substantial risk from collisions with lighted fishing vessels during darkness and stormy weather.

This project was undertaken to review the potential risks to Steller's and spectacled eiders from fisheries along their migration paths in the Bering Sea and Alaska Peninsula.   The available information on eider migration and distribution is reviewed to narrow the time and space where potential interactions may occur. Darkness emerged as a key feature to be considered in these analyses. The light regime in the eider critical habitat was examined and used to further narrow the window where potential interactions between fisheries and eiders might occur.

CRITICAL HABITAT AND MIGRATION ROUTES

Critical habitat is specified in the ESA as Critical habitat is defined in section 3(5)(A) of the ESA as:

(i) the specific areas within the geographical area occupied by the species...on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection; and

(ii) specific areas outside the geographical area occupied by the species...upon a determination by the Secretary of Commerce (Secretary) that such areas are essential for the conservation of the species.

The U.S. Fish and Wildlife Service (USFWS) designated critical habitat for both eider species in 2001 (Federal Register 2001a,b).

Steller's Eider

After breeding along the Arctic coastal plain, mature male eiders depart southward in early July for molting areas along the Kuskokwim delta and Alaska Peninsula (Figure 1). Less is known about the migratory timing or locations of the relict Yukon-Kuskokwim delta breeding population. The mature males remain in these molting areas until October or November, when they disperse broadly along both sides of the Alaska Peninsula, with the major concentrations remaining in Izembek and Nelson Lagoons. Based on limited telemetry data, mature females depart the Arctic coastal plain in late August for the same molting areas used by the mature males (USFWS 2002a).

The critical habitat designation (Federal Register 2001a) for Steller's eider (Figure 2), protects these molting areas, as well as the breeding and overwintering grounds. Telemetry data do not have sufficiently fine scale to determine whether Steller's eiders migrate directly across Bristol Bay, or follow a coastal route, however it is suspected that they fly directly across (P. Martin, USFWS, Anchorage, Alaska, personal communication).

Spectacled Eider

In Alaska, spectacled eiders are known to breed in low-lying arctic and sub-arctic wetlands along the margins of the Yukon-Kuskokwim delta, and the arctic north slope (Figure 3). Limited nesting may also occur on St. Lawrence Island (USFWS 1996). Molting occurs in adjacent nearshore waters, particularly eastern Norton Sound and Ledyard Bay. Males depart the nesting areas for the molting grounds by late June, with females and offspring molting in early September. While moving between nesting and molting areas, spectacled eiders travel along the coast up to 50 km offshore. During the winter months of October through March, they move far offshore to waters up to 65 m deep, where they sometimes gather in dense flocks in openings of nearly continuous sea ice USFWS 1996, Petersen et al. 1999).

The critical habitat designation for spectacled eiders (Federal Register 2001b) protects the Ledyard Bay and eastern Norton Sound molting areas, the Yukon-Kuskokwim delta spawning area, and the St. Lawrence Island offshore wintering grounds (Figure 4).

REPORTED VESSELS STRIKES BY EIDERS

Lighting aboard fishing and cargo vessels has increased greatly in the last three decades. During the 1970s, high intensity sodium deck lights became commonplace on crab fishing vessels, which allowed fishing activity to occur around the clock (Brennan 2002). Subsequently, development of the domestic groundfish fishery increased the number of heavily lit fishing vessels using the nearshore Alaska Peninsula area. Although the primary fishing grounds for the brightly lit fishing vessels occurs offshore, these vessels use the nearshore areas for anchoring during storms, other respites from fishing, deliveries to coastal communities, and transiting nearshore areas such as False Pass.

The attraction of seabirds to lighted vessels at night is well known (Dick and Donaldson 1978), but the extent of mortality from night collisions with vessels and shore facilities is unknown.

There have been documented cases of Steller’s and other eiders striking vessels (USFWS 2002b):

- In December 1980, 150 eiders of unknown species were found on the deck of the M/V Northern Endeavor after the vessel anchored at False Pass to weather a storm with its crab lights on.
- In 1991, three Steller’s eiders fatally struck the Alaska patrol vessel P/V Wolstad, operating with crab lights on.
- In February 1997, two eider strikes were reported in two days, with one fatal strike, aboard a trawler anchored in False Pass.
- Steller’s eiders have been reported striking lighted structures along the shoreline around Cold Bay.

Observers aboard crab and groundfish vessels have begun systematic collection of seabird mortality information. The observations are not comprehensive, but provide the only available at-sea information on seabird strikes. Onboard observer records of seabird strikes from 1993 through 2003 were obtained from the NMFS observer program, which gave the date and time of impact. Only records where the approximate time of impact was recorded were used, so that the relationship between eider strikes and the degree of darkness could be examined. A total of 17 Steller’s eider strikes were reported with reasonable time of day information, along with 19 king eider strikes. Because most of the fishing effort in the winter occurs in the southern part of the Bering Sea, the light regime at nearby Cold Bay was applied to the seabird impact information as a reasonable proxy for the light regime on the fishing grounds. Almost all of the reported eider impacts occurred during hours of complete darkness (Figure 5), in the late winter and early spring.

SOURCES OF FISHING EFFORT AND DISTRIBUTION INFORMATION

Commercial Catch Records

Available records of fishing activity were examined to determine where and when fishing activity might be in close proximity to eiders during their migrations or at times when they use the designated critical habitat. Fishing records examined included State of Alaska fish ticket landing receipts, which note both port of landing and fishing location, and observer records from the NMFS North Pacific Groundfish Observer program. Annual management reports and other management-related publications from the Alaska Department of Fish and Game (ADF&G) were consulted to summarize the locations of herring fisheries, and to determine details for other fisheries.

The ADF&G fish ticket database is the primary means of collecting data on commercial fisheries landings in Alaska. A fish ticket is basically a bill of sale that indicates the quantity of fish of each species that was delivered and purchased by a processor from a particular fishing permit holder on a given date. Note that landing enumeration by fish tickets differs from the product recovery rate methods of estimation used in many federally-managed groundfish fisheries. The record includes other information, such as gear type, statistical area, management area, and port of landing. A fish ticket is produced for each shoreside delivery. Catches made in a federally-managed groundfish fishery are included only if the vessel happened to deliver the catch to a shoreside plant. Therefore, deliveries made to a floating or catcher-processor vessel outside of state waters are not contained in the database. On the other hand, all landings in state-managed fisheries are included in the fish ticket database. For example, catches made in the high seas crab fishery in the Bering Sea that are delivered to an offshore processor are included in the database because it is a state-managed fishery in which fish tickets are required.

The ADF&G fish ticket system has been compartmentalized into different database systems, defined by species group. For this report, information was compiled from the “Venus” (shellfish), “Zephyr” (salmon), “Neptune” (groundfish), and “Triton” (herring) fish ticket database systems.

Satellite Low-Light Sensors

Eiders appear to collide with vessels at sea because the vessels are displaying bright lights which either confuse the seabirds or attract them. The bright lights themselves could prove a useful tool for describing the distribution of vessels at sea. For example, the distribution of squid fishing vessels, which use particularly intense lights has been captured by DMP/OLS satellite sensors (Maxwell et al. 2004, Waluda et al. 2004). Cloud cover over Alaskan fisheries would likely prove problematic for routine effort detection using these methods, but opportunistic sampling during cloud-free days could be an inexpensive and comprehensive method of describing fleet distributions, particularly for concentrated fishing effort as in the Bristol Bay red king crab fishery. NOAA archives of DMP/OLS satellite images were screened for relatively cloud-free days occurring during the time frame and in the location of the Bristol Bay red king crab fishery. Among other possibilities, opening of the 1997 fishery on November 1 coincided with a satellite pass over the fishing grounds when cloud cover was less than 10%. Time constraints precluded examining the imagery from that date. For future work, the Bristol Bay imagery from the 04:55 GMT satellite pass on November 1, 1997 over Bristol Bay should determine whether high-intensity crab lights are detectable from satellite platforms.

DISTRIBUTION OF FISHING ACTIVITY BY PORT OF LANDING

ADF&G fish ticket records from the general eider wintering location were summarized for the five-year period 1998 through 2002. Viewing fishing records by port of landing serves as a proxy for general vessel activity in nearshore areas around ports of landing. This view could be relevant to quantifying the risk of eiders striking vessels, which can occur at anchor, or tied to docks, particularly if the vessels are brightly lit. Landings are examined both annually, and for the September 1 through April 30 period when darkness is more prevalent on the fishing grounds. Combining the presence of substantial numbers of eiders along the Alaska peninsula with the winter darkness regime, the time period September 1 through April 30 likely represents the greatest risk of collisions between eiders and fishing vessels. Between May 1 and August 30 there is little or no deep darkness in these areas and bird strikes are highly unlikely.

The port of Kodiak has by far the most landings, either on an annual basis or from September 1 through April 30 (Table 1). For the September through April period, Kodiak averaged 3,474 deliveries, followed by Dutch Harbor/Unalaska with 1,757 deliveries. In the September through April period, most of the vessel landing activity occurs on the south side of the Alaska Peninsula, and is dominated by groundfish deliveries (Figure 6).

For the top 15 ports of landing, ranked by number of deliveries, salmon fisheries by far dominate the vessel activity in most ports (Figures 7-9). Groundfish and shellfish vessels dominate deliveries during the winter, when long hours of darkness increase the potential for vessel collisions.

Among the top 5 ports, groundfish, salmon, and herring deliveries followed fairly similar patterns among the years 1998-2002 (Figures 10-14). Shellfish fisheries show the most variability among years.

DISTRIBUTION OF FISHING EFFORT NEAR STELLER'S AND SPECTACLED EIDER CRITICAL HABITAT AND MIGRATION ROUTES

Herring Fisheries

Herring fisheries occur at a number of locations that potentially overlap Steller's eider migration routes and critical habitat (Figure 15). For spectacled eiders, the only potential overlap with herring fisheries would occur at Norton Sound and Cape Romanzoff, if the eiders spend time in coastal waters before moving ashore to nest. Most Alaskan herring fisheries are for sac roe and occur in the spring, just before herring begin to spawn. The only non-sac roe herring fishery in the Bering Sea is the Dutch Harbor food and bait fishery, which occurs in the waters around Unalaska Island in mid-July.

During Bering Sea herring fisheries, from 15 to approximately 500 catcher vessels are on the fishing grounds, along with smaller numbers of tenders (typically 18-30m in length), and several large transport vessels (typically 50 to 100+m in length). These vessels, particularly the larger ones, would be brightly lit during hours of darkness and anchored in inshore waters where Steller's eider strikes are a potential hazard. However, reported eider strikes have almost all occurred during very deep darkness, at light levels below astronomical twilight (Figure 5). Almost no herring fishing occurs during the time of year when light levels are extremely low (Figure 16). North Peninsula (Port Moller) sac roe herring fisheries have opened only four times from 1995-2005, with maximum effort levels at only 12 permits fished (Jackson 2006). Port Moller herring fisheries occur when there are about 4 hours or less with light levels below nautical twilight, and no periods below astronomical twilight (Figure 16).

Gillnet gear is used in all Bering Sea herring sac roe fisheries, with purse seine gear also used at Togiak and Port Moller. Beach seines are legal gear in Norton Sound, but harvest only a small percentage of the overall catch.

A food and bait herring fishery using purse seines and gillnets occurs in the vicinity of Dutch Harbor, with a current regulatory opening date of noon on July 15 annually, with most of the harvest completed within one to several days, and the full length of the fishery averaging 12 days from 1994-2004 (Jackson 2006). Since 1997, fishing has occurred during daylight hours using spotter aircraft. Almost all of the harvests have occurred in Unalaska Bay itself, with catcher and support vessels retiring to port when not fishing. An average of 21 catcher vessels participated from 1994-2004 (Jackson 2006).

Alaska's largest herring fishery occurs along the north shore of Bristol Bay near the village of Togiak (Figure 15). From 1995 through 2004, an average of 190 gillnet vessels and 123 purse seine vessels participated in this fishery (Westing et al. 2006). The earliest opening date for this fishery is April 25, with the latest closure date May 26, although the average duration was only 71 hours of fishing for gillnet vessels and 33 hours of fishing for purse seine vessels over the 1995-2004 period. No developed harbors are near the Togiak fishing grounds, so all vessels anchor in what protection they can find. The Togiak herring fishery occurs during periods of very limited darkness, with less than four hours with light levels below nautical twilight, and no periods below astronomical twilight (Figure 16), minimizing the potential for bird strikes.

Several small fisheries occur along the Kuskokwim delta, at Security Cove, Goodnews Bay, Cape Avinof, Nelson Island, Nunivak Island and Cape Romanzof. From 2000 through 2003 the effort at any of these areas ranged from 12 to 86 vessels (Whitmore et al. 2005). The daylight regime in these areas ranges between that at Togiak to the south, and Norton Sound, to the north.

A sizable herring biomass (20,000 to 50,000 tons) spawns in Norton Sound that in past years has attracted over 500 fishermen. Fishing is limited to gillnet vessels and small beach seine operations only, hence average vessel size is small (6 to 11m). In recent years, effort in the Norton Sound fishery has dwindled because of poor markets for herring roe. In addition, Norton Sound herring sometimes spawn before ice-free conditions are present, increasing the risk of preparatory investment for fishermen and processors. As a result, an average of only 52 vessels participated in the Norton Sound herring fishery from 2000 through 2005 (Alaska Department of Fish and Game, Nome Office 2005). During the period 1990 through 1999, when fishing was less limited by processing capacity, dates of herring catches ranged from May 20 through June 22 , with the mode of herring catch occurring on May 25. This fishery occurs during well-lit periods, with darkness never dropping below nautical twilight levels, and with less than 5 hours below civil twilight (Figure 16), resulting in very low risk of bird strikes.

Shellfish Fisheries

Dungeness Crabs

Dungeness crabs (*Cancer magister*) are widely distributed in bays, estuaries, and along the nearshore coast of Alaska from Dixon Entrance out into the Aleutian Islands. Dungeness crab abundance is lower in the islands of the Aleutian Chain, which are separated by deep passes with swift currents and are closely bordered by steep depth contours. Dungeness crabs primarily inhabit bays, estuaries, and other shallow water habitats that are more common east of the Aleutian Islands.

Dungeness crabs are usually captured in circular pots baited with herring, squid, or clams, individually tethered to floating marker buoys. The pots are about 40 inches in diameter and 14 inches high, constructed of 3/4-inch round, steel frames wrapped in rubber tubing then covered with stainless steel wire mesh woven in 2-inch squares. Two 4⅜" diameter escape rings are required to be built in each pot to allow undersize crabs to leave the pot. The number of pots that can be set by a vessel and the fishing season varies by management area

Dungeness crab fisheries in Alaska use a “3-S” management strategy, setting seasons, size limits (based on carapace width, CW), and sex of harvest in lieu of harvest quotas:

	Season	Sex	Size Limit
Kodiak District, South End	June 15 - December 31	Males Only	6.5 in CW
Kodiak District, All Other	May 1 - December 31	Males Only	6.5 in CW
N. Alaska Peninsula District	May 1 - October 18	Males Only	6.5 in CW
S. Alaska Peninsula District	May 1 - December 31	Males Only	6.5 in CW
Aleutian District	May 1 - December 31	Males Only	6.5 in CW

This harvest policy is predicated on the assumption that the fishing gear is does not cause significant injury so that crabs may be identified, measured, and sexed, with non-legal crabs returned unharmed to the ocean. The minimum legal size is set one molt increment above the size at maturity.

Harvest of Dungeness crabs has fluctuated widely since 1970, a combination of fluctuating abundance and changing market interest (Figure 17). Most of the harvest has occurred in the area around Kodiak Island, with small amounts out on the Alaska Peninsula. Around Kodiak Island, Dungeness crabs were first harvested commercially in 1962, with harvests escalating rapidly to the maximum recorded catch of 3,098 mt in 1968. The number of vessels participating in this fishery varied from as low as four to as high as 125, but less than 25 vessels have been operating since 1995. Harvest declined through the 1970s as both stock levels and market value for Dungeness crabs decreased (Jackson 1997).

Dungeness crab harvests along the south Alaska Peninsula have been recorded since 1968, but landings have been sporadic. The highest landing was 571 mt achieved in 1968. In the 1980s, catch and effort increased as a result of the decline in king crab harvest and stronger market for Dungeness crab and the harvest rose to 545 mt. This harvest attracted 132 vessels to the fishery and local fishermen became concerned about an excessive influx of effort. In subsequent years the BOF designated the south Alaska Peninsula Dungeness crab fishery as “superexclusive”, meaning that vessels that fished Dungeness crab in other management areas could not also fish the Alaska Peninsula. The numbers of vessels operated during 1990s were low, varying from less than 3 to 24.

Fishing effort for the North Peninsula Dungeness crab fishery has been sporadic, with few vessels participating. Most effort has occurred north of Unimak Island. In 1995 six vessels made 19 deliveries for a harvest of 61 mt. Catch information from 1996 to 1998 is confidential, as less than three vessels participated in those years. The average annual harvest in the three-year period from 1996–1998 was approximately 22 mt. No vessels registered to fish for Dungeness crabs in the North Peninsula District in 1999. One vessel, for which landings are confidential, participated in the 2000 fishery.

In the Aleutian District, the Dungeness crab fishery has occurred primarily as a small-vessel, summer fishery in the vicinity of Unalaska Island. Some larger-vessel effort has occurred in other locales within the district, but fishing in these areas has been sporadic throughout the history of the fishery. Interest and activity in this fishery has been erratic from year to year, with the first reliable reports of harvest made in 1970. Since 1974, deliveries have ranged from 0 in several years, to a peak of over 40 mt in 1984–85.

Most of the Dungeness crab harvest occurs, in July, August, and September (Figure 18). The prevailing light conditions when most effort occurs makes vessel strikes highly unlikely during this fishery. In addition, only relatively small and trace amounts are harvested along the Alaska Peninsula (Figure 19), in areas where Steller's eiders would be found in the summertime. There is no overlap of Dungeness crab fishing effort and spectacled eider distribution.

Shrimp Fisheries

Five species occur in Alaska shrimp fisheries: northern (formerly, pink) shrimp, *Pandalus borealis*; sidestriped shrimp, *Pandalopsis dispar*; coonstriped shrimp, *Pandalus hypsinotus*; spot shrimp, *Pandalus platyceros*; and humpy shrimp, *Pandalus goniurus*. Northern and sidestriped shrimp now comprise almost all the landings from the areas west of long. 144° W.

The shrimp fishery in western Alaska has been prosecuted primarily with trawls, along with a very small amount of pot effort. In recent years the Bering Sea has contributed most of the harvest because of the decline of shrimp stocks in almost all other areas. Shrimp resources in Alaskan waters have been exploited since 1915, but catch records are available only for the last five decades. In almost all areas, the early exploratory fishing led to rapid escalation of effort, overharvest, and closure. High effort levels coinciding with the oceanic regime shift of 1976–77 combined to reduce shrimp stocks to very low levels, and catches have been extremely low since the early 1980s (Figure 20), with little or no catch along the outer Alaska Peninsula (Figure 21).

The fishery in the South Peninsula area has been closed since 1980. Although only offshore areas in Chignik District have been open for fishing since 1982, no commercial harvests have been reported since 1982–83.

Current shrimp populations remain well below long-term historic averages in most of the Kodiak Area. Localized areas showed increases in shrimp densities during a survey conducted in 2001; however, most commercial trawl shrimp fisheries remain closed. Most of the nearshore areas where shrimp abundance has increased and where the historic trawl fishery once occurred are now within the areas closed to non-pelagic trawl gear by the BOF.

No vessels have registered for the North Peninsula District pot or trawl shrimp fishery since 1994. Currently, shrimp fishing is not permitted in this district due to a lack of data concerning the shrimp stocks.

In the Bering Sea-Aleutians Area, limited shrimp harvests resumed in 1999, but the fishery was then closed because of very limited management and assessment information. Subsequent effort will only be allowed when consistent with the Alaska Board of Fisheries "Management Plan for High Impact Emerging Fisheries".

Because shrimp fishing effort is extremely low, and most of the areas traditionally trawled for shrimp are within areas closed to non-pelagic trawl gear by the BOF or fall within the extensive closure areas for Steller sea lions, the potential for interactions with Steller's eiders is extremely low. Shrimp fishing effort does not overlap the distribution of spectacled eiders.

Weathervane Scallops

The primary commercially fished scallop species in Alaska, the weathervane scallop *Patinopecten caurinus*, occurs offshore aggregated in elongated beds that lie parallel to Alaska's coastline from Southeast Alaska to the Aleutian Islands. Weathervane scallop beds occur on mud, silt, sand, gravel, and to a lesser extent, rocky bottoms at depths of 60–220m.

The scallop fishery is prosecuted using a standard "New Bedford style" scallop dredge. On average, a 15-foot dredge weighs approximately 1.2 mt and a 6-foot dredge weighs about 0.4 mt. The frame design provides a rigid, fixed dredge opening. Attached to and directly behind the rigid frame, is a steel ring bag consisting of 4-inch (inside diameter) rings connected with steel links. A sweep chain footrope is attached to the bottom of the mesh bag. The top of the bag consists of 6-inch stretched mesh polypropylene netting. The mesh netting helps hold the bag open while it is towed along the ocean floor. A club stick attached at the end of the bag helps maintain the shape of the bag and provides for an attachment point to dump the dredge contents on the deck. Steel dredge "shoes" are welded onto both lower corners of the rigid frame. The dredge shoes bear most of the weight and act as "sled runners" permitting the dredge to move easily along the substrate. Each dredge is attached to the boat by a single steel wire cable operated from a deck winch. Vessels fishing inside the Cook Inlet Registration Area are limited to operating a single dredge not more than 6 feet in width. Vessels fishing in the remainder of the state are limited to operating no more than 2 scallop dredges at one time and the scallop dredges may not be more than 15 feet wide. Vessels used in the weathervane scallop fishery range in size from 18 to 40m in length, with a maximum of 1,200 horsepower.

After the scallop fishery began to develop in 1967, increased participation led to several boom-and-bust cycles from 1967–1992 (Figure 22). Details of specific management actions over the history of the fishery are given in Barnhart (2000a). Currently, 100% onboard observer coverage is required in the fishery, along with regulations that limit efficiency and slow the pace of catch. The statewide regulatory season was established as July 1 through February 15, excluding the Cook Inlet Registration Area. Although the season dates were established to protect molting and mating crab they have the added benefit of not disturbing scallops prior to and during their spawning period. T Most fishing occurs in late summer to early fall (Figure 23).

The federal government has delegated authority to the state of Alaska to manage all aspects of the scallop fishery, except limited access, in federal waters (Barnhart 2000b).

Over the last five years, scallop harvest has come principally from upper Shelikof Strait, the east side of Kodiak Island, and the Bering Sea (Figure 24). Large areas of the central and western Gulf of Alaska and Bering Sea are now closed to scallop fishing as a conservation measure.

Commercial scallop fishing activities in the Alaska Peninsula Area have been documented since 1975. Closed areas included waters within three miles of shore and the offshore waters of Unimak Bight (to protect king crab stocks) and around Mitrofania Island (to protect Tanner crab stocks). The fishery has been sporadic and most catches prior to 1993 are confidential because too few boats fished in the area. Harvest peaked in 1982 when six vessels delivered 93 mt.

In the Bering Sea, significant commercial harvests have occurred since 1993, with harvests peaking at 229 mt in 1994–95. The principal fishing area is near the outer edge of the continental shelf, north of Unimak Island. Large areas of the Bering Sea, including the Pribilof Islands area, the red king crab savings area, and all waters east of long. 162º W. are closed to scallop fishing.

Because the large closed area includes all of Bristol Bay and remaining scallop effort occurs well offshore in the Bering Sea, vessel collisions with Steller's eiders are not likely while vessels are fishing. The only risk would appear to be from vessels at anchor or in port. Additionally, in the Bering Sea, most of the fishing effort occurs in July through September when the fishing grounds are relatively well lit.

Red and Blue King Crab Pot Fisheries

Red king crabs, *Paralithodes camtschaticus,* and blue king crabs, *P. platypus*, are distributed in Alaska from the southeast panhandle throughout the Aleutian Islands, and Bering Sea. Southwestern Bristol Bay and Kodiak Island have been historical centers of abundance for red king crab, with blue king crab being most abundant around St. Matthew and the Pribilof Islands. Red and blue king crabs can occur from the intertidal zone to more than 200 m. Adults move into shallower waters in the late winter and spring for mating and molting, followed by movements to feeding areas in deeper water, and may range up to 150 km in annual movements.

King crabs are commercially fished using large 250-300 kg steel-framed pots covered with nylon-webbing. Each pot is baited, usually with chopped herring, lowered to the bottom and allowed to soak, typically for one to two days when fishing red or blue king crabs. Buoys are attached to the pots with heavy line and pots are retrieved and lifted onto the vessel with a hydraulic puller. The catch is sorted on deck and all females and undersize males are tossed overboard. The retained catch of large males is held in large recirculating seawater tanks for live delivery, or are processed and frozen onboard the small fleet of catcher-processor vessels. King crab vessels fishing the Bering Sea usually exceed 30m in length, although smaller vessels have participated in Gulf of Alaska fisheries.

Fishing regulations for king crab were initially grounded in the concept of season, sex, and size limit ("3S") harvest policies which allowed only the harvest of large males. However, this harvest policy has been criticized in recent years because of the potential handling mortality on female and sublegal crabs. In addition, research on the reproductive capabilities of male king crabs now indicates that large males are more important to the brood stock than small males (Paul and Paul 1990). In the few areas where king crab fishing is still allowed, quota and sometimes threshold-based harvest policies are now used, in addition to the 3S harvest policy. Biodegradable escape mechanisms are required on crab pots so that if the pot is lost it will soon stop fishing, and pot limits are imposed on fishing vessels in an attempt to control fishing effort.

In most of Alaska, king crab may only be taken with pot gear. Pots must be no more than 10 feet long by 10 feet wide by 42 inches high with rigid tunnel eye openings that individually are no less than five inches (13 cm) in any one dimension, with tunnel eye opening perimeters that individually are more than 36 inches (91.4 cm), or pots must be no more than 10 feet long by 10 feet wide by 42 inches high and taper inward from the base to a top consisting of one horizontal opening of any size. King crab pots may be stored submerged under certain conditions, if they are unbaited and the doors are secured fully opened.

Pot limits are in effect in most king crab fisheries to attempt to control fishing effort and allow fishery managers to constrain the rate of harvest so that GHLs are not exceeded. The pot limit requirements vary by vessel size, area, and GHL level, and range from 75 pot limits in Cook Inlet (may be reduced to 40-pot limit with GHLs less than 680 mt) to 250 pot limits in Bristol Bay when GHLs are high.

The red king crab fishery can be described as a brief pulse of extremely intensive fishing activity in the 1960s and 1970s. Red king crab stocks crashed in almost all areas in the early 1980s, likely due to overfishing, with a lesser role played by the regime shift of 1977 (Kruse et al. 1996) and periods of high natural mortality (Zheng et al. 1997).. A relatively low level of catch continues in the Bering Sea areas (), primarily the Bristol Bay red king crab fishery. Advances in technology greatly increased the efficiency of the crab fishing fleet, which originally started out primarily as converted wooden salmon seine vessels. Vessel size increased, allowing more and larger pots to be carried, and hydraulic launchers and pullers allowed efficient handling of the large pots. LORAN navigation and chart plotters allowed pot locations to be precisely tracked and large numbers of pots to be managed. Bright sodium deck lights became available in the 1970s, allowing fishing around the clock.

Most of the king crab fishing effort and catch since 1985 has occurred in southwestern Bristol Bay (Figure 26), with king crab harvests are concentrated in a very small number of statistical areas. The top 15 of the 93 statistical areas in the EBS reporting some catch account for 93% of the king crab harvest over the period 1985 to 2001. The remaining statistical areas averaged 30 mt or less from 1985–2001 and are shown as “trace” amounts in Figure 26. Catch and effort occurs well offshore in Bristol Bay.

In recent years, the Bristol Bay red king crab fishery has been opening in mid-October. The bulk of the catch and effort occurs within 5 days of the initial opening (Figure 27), with a much lower level of catch and effort stretching into December from the Community Development Quota (CDQ) segment of the fleet.

A separate fishery for blue king crab has occurred just south and east of St. Matthew Island. The St. Mathew Island blue king crab fishery has been closed since 1998 due to low stock abundance, and the stock has not yet recovered.

Salmon Fisheries

Salmon fisheries nearly all occur during the well-lit period of summer (Figures 7-8) and therefore present minimal collision risk for eiders. However, eiders that summer along the Alaska Peninsula could possibly be subjected to some entanglement risk from gillnets in certain bays. Although net entanglement of eiders has not been reported, because other diving seabirds are ensnared in nets, the distribution of salmon fishing effort along the north Alaska Peninsula molting/summering areas was examined. Gillnets are the primary type of net fishery of concern for bird entanglements. Two types of gillnets are used along the Alaska Peninsula: set gillnets (setnets) and drift gillnets. Both types of gillnets are hung in panels with corks on the top and a leadline on the bottom (Figure 28) . The net does not sink; if water depth is sufficient, there is sufficient floatation in the corkline to float the leadline off of the bottom. Maximum gillnet size is limited by state regulations, which vary by region.

Set Gillnets

Set gillnets have been commercially fished for salmon in Alaska for at least a century, with some techniques dating back to millennia of subsistence utilization by indigenous cultures. Unlike most other fisheries in Alaska, set gillnet fisheries operate from specific sites, with the same location often being fished for generations within an extended family.

A salmon “setnet” is an anchored gillnet. Some setnets have a “lead” comprised of very large mesh seine webbing at the inshore end of the set gillnet to channel the fish toward the net during high tide periods. The inshore end of most set gillnets is anchored on the beach and the offshore end is secured to anchors and buoys. However, some setnets are not anchored to the shoreline, but held stationary with anchors on each end of the net. Set gillnets can be simply set in a straight line, or set to have a v-shaped hook at the end. Salmon become caught in the nets by their gills when they attempt to swim through the net. Fishermen may use small skiffs to tend the nets and pick the salmon, or the nets can be accessed by motor vehicles and picked at low tide in some shallow areas such as Bristol Bay. Running lines are sometimes used for setting out and retrieving the setnet, with a line manually dragged from the beach straight out to a pulley and screw anchor, and back to the beach. Setnet sites are often run as family operations, supported by fixed shore-based facilities. The State of Alaska Department of Natural Resources manages a permit system for shore fishery leases on the tidelands, which grants up to 10 years use for first priority access to the site. Many setnet sites are located in remote areas, accessibly only by boat or airplane.

For the three decades from 1970-2001, setnet landings in southwestern Alaska were concentrated primarily in Bristol Bay (Figure 29). Expanded detail for the north Alaska Peninsula for 1998-2003 shows significant setnet effort only in Nelson Lagoon (Figure 30).

Drift Gillnets

Drift gillnets are similar to setnets but may not be anchored to the bottom or fixed to the shore. Usually a larger vessel than the typical setnet tender is used to tend the net, which is set and retrieved entirely from the fishing vessel. Gillnet vessels tend to be relatively small, and are limited to a maximum length of 32 feet in Bristol Bay. Catch is delivered to tenders or nearby ports.

Most drift gillnet fishing along the north Alaska Peninsula occurs from Port Moller to Port Heiden (Figure 31). Relatively low numbers (less than 50 per statistical area) drift gillnet landings occur in statistical areas near the primary Steller's eider molting/summering area of Izembek lagoon.

Groundfish Fisheries

Groundfish fisheries in the Bering Sea are managed by the NMFS and the North Pacific Fisheries Management Council, currently regulated with target fisheries for ten different species groups (Table 2). Groundfish fishery distributions as they may intersect eider distributions are a complex interaction of optimal effort patterns for each of the groundfish target species groups, ice movements (in late winter and spring) which may constrain fishing activities, closures (for prohibited and protected species), and the timing and location of eider movements. The potential for groundfish vessel-eider interactions was examined by superimposing groundfish fleet distributions, closure areas, ice movements, and eider surveys. This report focuses on the spring 2003 eider migration period.

To examine groundfish fleet distributions in detail, groundfish observer information was obtained from the National Marine Fisheries Service. These voluminous records list the location and duration of each observed tow, and catch by species. Tows were classified by "target fisheries", based on the predominant species in the catch. For the spring eider migration period in the general vicinity of Bristol Bay, fishery classifications by "cod", "pollock", "yellowfin sole", "arrowtooth flounder and other flatfish", and "flatfish" were sufficient to characterize the targeting nature of the groundfish fishery. At other times of the year or in other locations the targeting classifications describing the groundfish fisheries could be considerably more complex, reflecting all the species in Table 2. Fishing effort by target class was summarized by the number of unique vessels fishing, hours fished, and location and month. Locations given for individual tows are both confidential and voluminous. To better summarize the pattern of fishing and protect confidentiality, smoothed fishing effort contours were created by target fishery for each month.

A number of fishery closure areas constrain the locations where groundfish fisheries can operate. The two most significant are the "Red King Crab Savings Area", a year-round closure from 56 to 57 degrees latitude and 162 to 164 west degrees longitude, and the Bristol Bay Nearshore Area. The Bristol Bay Nearshore Area includes all waters east of 162 degrees west longitude, and is closed year-round except for April 1 to June 15. A number of smaller closures are also extended outward from Steller sea lion haulouts and rookeries, and additional closures are possible if prohibited species catch limits for herring, crab, or salmon are reached during the season. Groundfish management measures can also be amended on an annual basis. Tables showing the current status of groundfish management measures are maintained by the Alaska Region of the NMFS at their website: http://www.fakr.noaa.gov.

Sea ice patterns vary dramatically from year to year. During years of extensive southerly ice movements, sea ice constrains the operating area of the groundfish vessels, as well as likely influencing the timing of the northward eider migrations. Sea ice information was obtained from the National Ice Center, summarized by amount of ice cover in ten percent increments and entered as a GIS layer as described in Tojo et al. (2007).

Eider distributions from spring aerial surveys given by Larned (2003) were digitized and entered as a GIS layer. The 2003 surveys were flown beginning on March 29 at Nunivak Island and proceeded clockwise and southward, with the final surveys completed April 9-11 at Izembek Lagoon and Cold Bay. While not comprehensive throughout the migration, these surveys provide a valuable "snapshot" of eider distributions as the spring migration is beginning.

By late March of 2003, sea ice had extended south of Cape Newenham and appears to have limited the northern extent of the small fleet (11 vessels) fishing for flatfish (Figure 32). A much larger fleet of approximately 150 vessels was fishing for cod and pollock off the north Alaska Peninsula, north and west of False Pass. Both the Red King Crab and Bristol Bay nearshore closure areas constrained the operating areas of the groundfish vessels. Eider aerial surveys began on March 29 at Nunivak Island, and located some eiders already moving northward in open areas within the mostly ice-covered Kuskokwim Bay.

At the April 11 completion of the eider aerial surveys, sea ice had mostly receded to the northern half of Kuskokwim Bay (Figure 33). Bristol Bay opened to trawling on April 1 through June 15, although trawl effort has not shifted eastward at all into Bristol Bay. The red king crab savings area remained closed to trawling. Off of the Alaska Peninsula north and west of False Pass the groundfish effort has shifted to Pacific cod, with similar overall effort levels to the mixed cod-pollock fleet in the same area in March. The flatfish fleet has shifted northward slightly, likely allowed by the northward retreat of the sea ice.

By May 9, the sea ice has almost completely retreated from the area (Figure 34). Trawl effort remains well outside of Bristol Bay. Near Kuskokwim Bay, a 13-vessel fleet is now targeting yellowfin sole, and has moved close to the northern shore of Kuskokwim Bay in areas that are used by Steller's eiders for migration. However, by May the daylight hours have extended substantially such that there is no longer any period of astronomical twilight (Figure 5). Therefore there is likely minimal risk of collisions between migrating eiders and lighted fishing vessels. During May 2003 groundfish fishing effort was drastically reduced along the Alaska Peninsula, with only a 6-vessel fleet targeting arrowtooth flounder and other flatfish offshore from False Pass.

An animation of Figures 32-34 with additional frames showing twice-weekly ice coverage is maintained at: http://www.backwater.org/eiders/.

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Table 1. Average number of landings for Bering Sea and northern Gulf of Alaska ports over the period 1998-2002 by port of landing, from ADF&G fish tickets (* indicates confidential data).

Port	Annual Landings	Landings: Sept. 1 to April 30
Kodiak	10,414	3,474
Dutch Harbor	2,444	1,757
Sand Point	2,930	986
Akutan	1,207	897
King Cove	4,424	884
Homer	1,924	858
Port Moller	3,565	311
St. Paul Island	209	194
Adak	232	136
Chignik	2,370	88
False Pass	91	86
Naknek	5,874	47
Nome	91	28
Alitak Bay	140	27
Wasilla	240	27
Anchorage	69	16
Egegik	2,933	15
Kenai	3,069	13
Ninilchik	193	5
Atka	10	*
Port Bailey	100	*
Ekuk	693	*
Seward	14	*
Unalakleet	187	*
Kasilof	392	*
Dillingham	4,064	0
Kotzebue	16	0
St. George Island	0	0
Soldotna	0	0
Old Harbor	0	0
Togiak	790	0
Ugashik	411	0
Nikiski	235	0
King Salmon	74	0
Seldovia	4	0

Table 2. Current Bering Sea groundfish fishery classifications and catch levels by species group (from National Marine Fisheries Service website: http://www.fakr.noaa.gov/sustainablefisheries/2008_09hrvstspecs.htm, Table 1).

2008 AND 2009 OVERFISHING LEVEL (OFL), ACCEPTABLE BIOLOGICAL CATCH (ABC), TOTAL ALLOWABLE CATCH (TAC), INITIAL TAC (ITAC), AND CDQ RESERVE ALLOCATION OF GROUNDFISH IN THE BSAI[1]

[Amounts are in metric tons]

Species	Area	2008					2009				
		OFL	ABC	TAC	ITAC[2]	CDQ[3]	OFL	ABC	TAC	ITAC[2]	CDQ[3]
Pollock[3]	BS[2]	1,440,000	1,000,000	1,000,000	900,000	100,000	1,320,000	1,000,000	1,000,000	900,000	100,000
	AI[2]	34,000	28,200	19,000	17,100	1,900	26,100	22,700	19,000	17,100	1,900
	Bogoslof	58,400	7,970	10	10	0	58,400	7,970	10	10	0
Pacific cod[4]	BSAI	207,000	176,000	170,720	152,453	18,267	207,000	176,000	170,720	152,453	18,267
Sablefish[5]	BS	3,380	2,860	2,860	2,360	393	2,910	2,610	2,610	1,109	98
	AI	2,890	2,440	2,440	1,853	412	2,510	2,230	2,230	474	42
Atka mackerel	BSAI	71,400	60,700	60,700	54,205	6,495	50,600	47,500	47,500	42,418	5,083
	EAI/BS	n/a	19,500	19,500	17,414	2,087	n/a	15,300	15,300	13,663	1,637
	CAI	n/a	24,300	24,300	21,700	2,600	n/a	19,000	19,000	16,967	2,033
	WAI	n/a	16,900	16,900	15,092	1,808	n/a	13,200	13,200	11,788	1,412
Yellowfin sole	BSAI	265,000	248,000	225,000	200,925	24,075	296,000	276,000	205,000	183,065	21,935
Rock sole	BSAI	304,000	301,000	75,000	66,975	8,025	379,000	375,000	75,000	66,975	8,025
Greenland turbot.	BSAI	15,600	2,540	2,540	2,159	n/a	16,000	2,540	2,540	2,159	n/a
	BS	n/a	1,750	1,750	1,488	187	n/a	1,750	1,750	1,488	187
	AI	n/a	790	790	672	0	n/a	790	790	672	0
Arrowtooth flounder.	BSAI	297,000	244,000	75,000	63,750	8,025	300,000	246,000	75,000	63,750	8,025
Flathead sole	BSAI	86,000	71,700	50,000	44,650	5,350	83,700	69,700	50,000	44,650	5,350
Other flatfish[6]	BSAI	28,800	21,600	21,600	18,360	0	28,800	21,600	21,600	18,360	0
Alaska plaice	BSAI	248,000	194,000	50,000	42,500	0	277,000	217,000	50,000	42,500	0
Pacific ocean perch.	BSAI	25,700	21,700	21,700	19,198	n/a	25,400	21,300	21,300	18,845	n/a
	BS	n/a	4,200	4,200	3,570	0	n/a	4,100	4,100	3,485	0
	EAI	n/a	4,900	4,900	4,376	524	n/a	4,810	4,810	4,295	515
	CAI	n/a	4,990	4,990	4,456	534	n/a	4,900	4,900	4,376	524
	WAI	n/a	7,610	7,610	6,796	814	n/a	7,490	7,490	6,689	801
Northern rockfish.	BSAI	9,740	8,180	8,180	6,953	0	9,680	8,130	8,130	6,911	0
Shortraker rockfish.	BSAI	564	424	424	360	0	564	424	424	360	0
Rougheye rockfish.	BSAI	269	202	202	172	0	269	202	202	172	0
Other rockfish[7].	BSAI	1,330	999	999	849	0	1,290	968	968	823	0
	BS	n/a	414	414	352	0	n/a	414	414	352	0
	AI	n/a	585	585	497	0	n/a	554	554	471	0
Squid	BSAI	2,620	1,970	1,970	1,675	0	2,620	1,970	1,970	1,675	0
Other species[8].	BSAI	104,000	78,100	50,000	42,500	0	104,000	78,100	60,000	51,000	0
Total		3,205,693	2,472,585	1,838,345	1,639,009	174,989	3,191,843	2,557,944	1,814,204	1,597,810	170,751

[1] These amounts apply to the entire BSAI management area unless otherwise specified. With the exception of pollock, and for the purpose of these harvest specifications, the Bering Sea (BS) subarea includes the Bogoslof District.

[2] Except for pollock, the portion of the sablefish TAC allocated to hook-and-line and pot gear, and Amendment 80 species, 15 percent of each TAC is put into a reserve. The ITAC for these species is the remainder of the TAC after the subtraction of these reserves.

[3] Under § 679.20(a)(5)(i)(A)(*1*), the annual Bering Sea subarea pollock TAC after subtracting first for the CDQ directed fishing allowance (10 percent) and second for the incidental catch allowance (3.5 percent), is further allocated by sector for a directed pollock fishery as follows: inshore – 50 percent; catcher/processor – 40 percent; and motherships – 10 percent. Under § 679.20(a)(5)(iii)(B)(*2*)(*i*) and (*ii*), the annual Aleutian Islands subarea pollock TAC, after subtracting first for the CDQ directed fishing allowance (10 percent) and second for the incidental catch allowance (1,600 mt) is allocated to the Aleut Corporation for a directed pollock fishery.

[4] The Pacific cod TAC is reduced by three percent from the ABC to account for the State of Alaska's (State) guideline harvest level in State waters of the Aleutian Islands subarea.

[5] For the Amendment 80 species (Atka mackerel, flathead sole, rock sole, yellowfin sole, Pacific cod, and Aleutian Islands Pacific ocean perch), 10.7 percent of the TAC is reserved for use by CDQ participants (see §§ 679.20(b)(1)(ii)(C) and 679.31). Twenty percent of the sablefish TAC allocated to hook-and-line gear or pot gear, 7.5 percent of the sablefish TAC allocated to trawl gear, and 10.7 percent of the TACs for Bering Sea Greenland turbot and arrowtooth flounder are reserved for use by CDQ participants (see § 679.20(b)(1)(ii)(B) and (D)). Aleutian Islands Greenland turbot, "other flatfish," Alaska plaice, Bering Sea Pacific ocean perch, northern rockfish, shortraker rockfish, rougheye rockfish, "other rockfish," squid, and "other species" are not allocated to the CDQ program.

[6] "Other flatfish" includes all flatfish species, except for halibut (a prohibited species), flathead sole, Greenland turbot, rock sole, yellowfin sole, arrowtooth flounder, and Alaska plaice.

[7] "Other rockfish" includes all *Sebastes* and *Sebastolobus* species except for Pacific ocean perch, northern, shortraker, and rougheye rockfish.

[8] "Other species" includes sculpins, sharks, skates, and octopus. Forage fish, as defined at § 679.2, are not included in the "other species" category.

Figure 1. Breeding (spring/summer) and winter distribution of Steller's eiders. [a]

[a] (Modified from http://www.seaduckjv.org/rangemaps/stellers_eider.pdf).

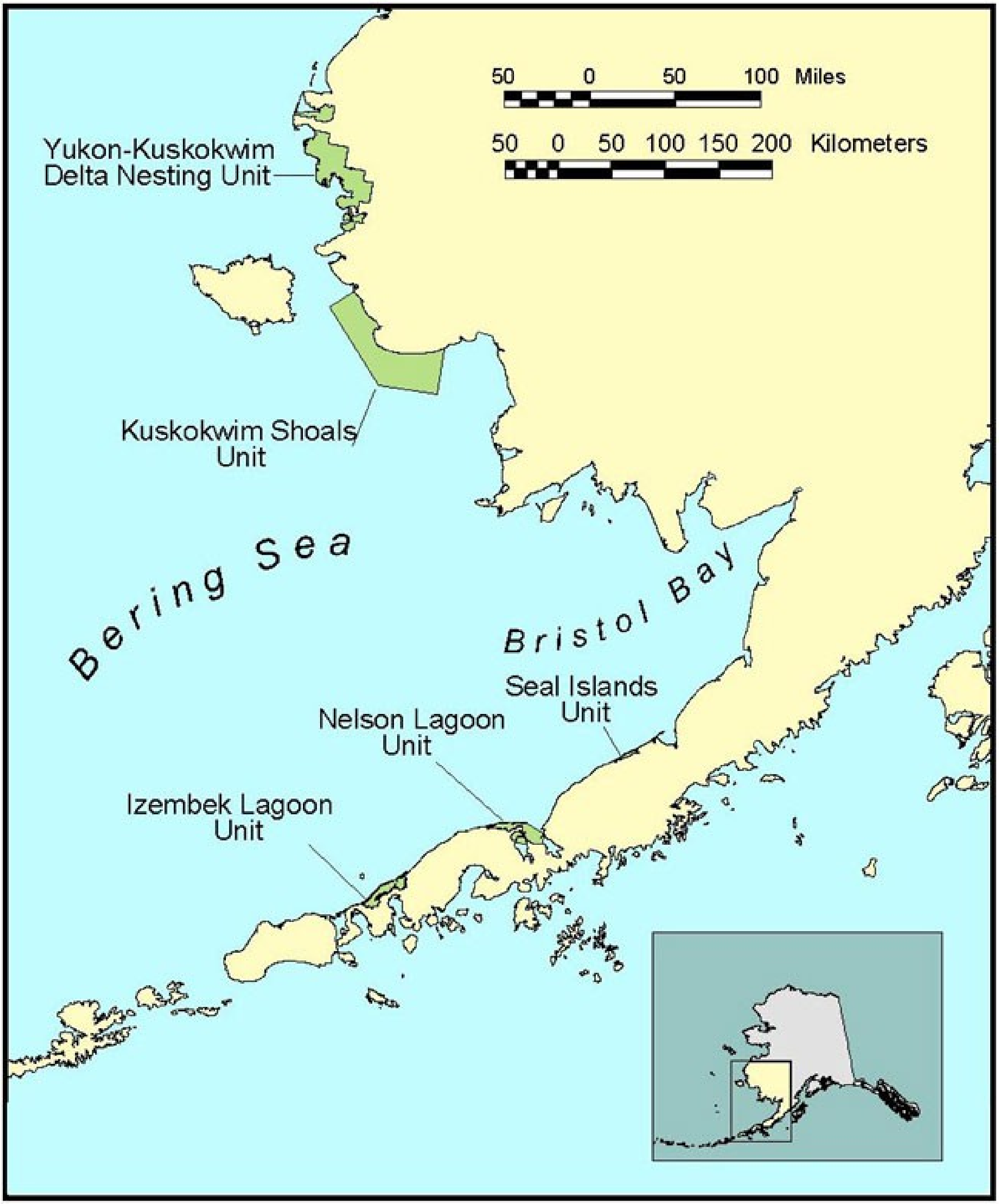

Figure 2. Critical habitat designated in federal regulations for Steller's eiders in Alaska.

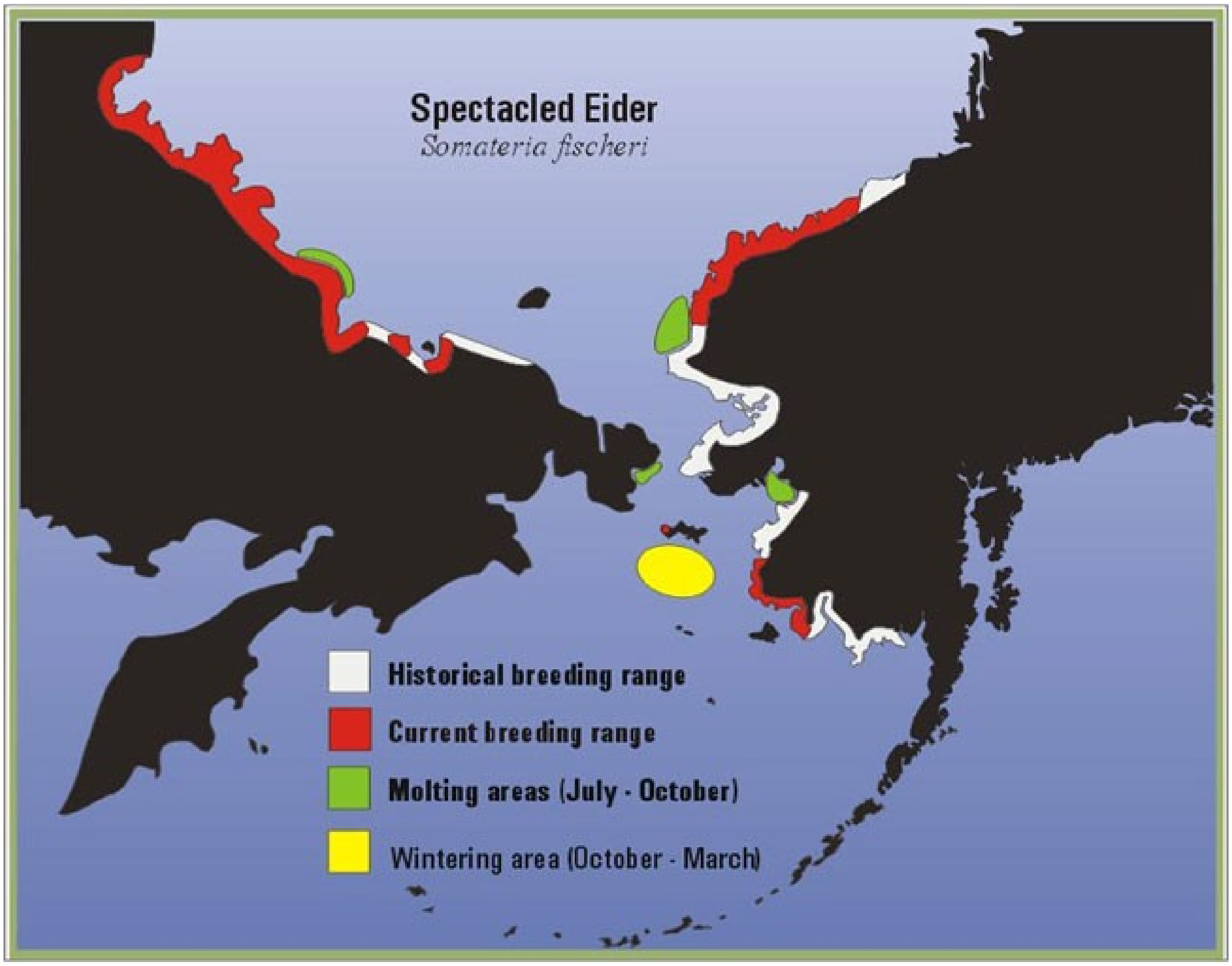

Figure 3. Range map for spectacled eiders breeding in Alaska and eastern Russia.[b]

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[b] Figure source: USFWS).

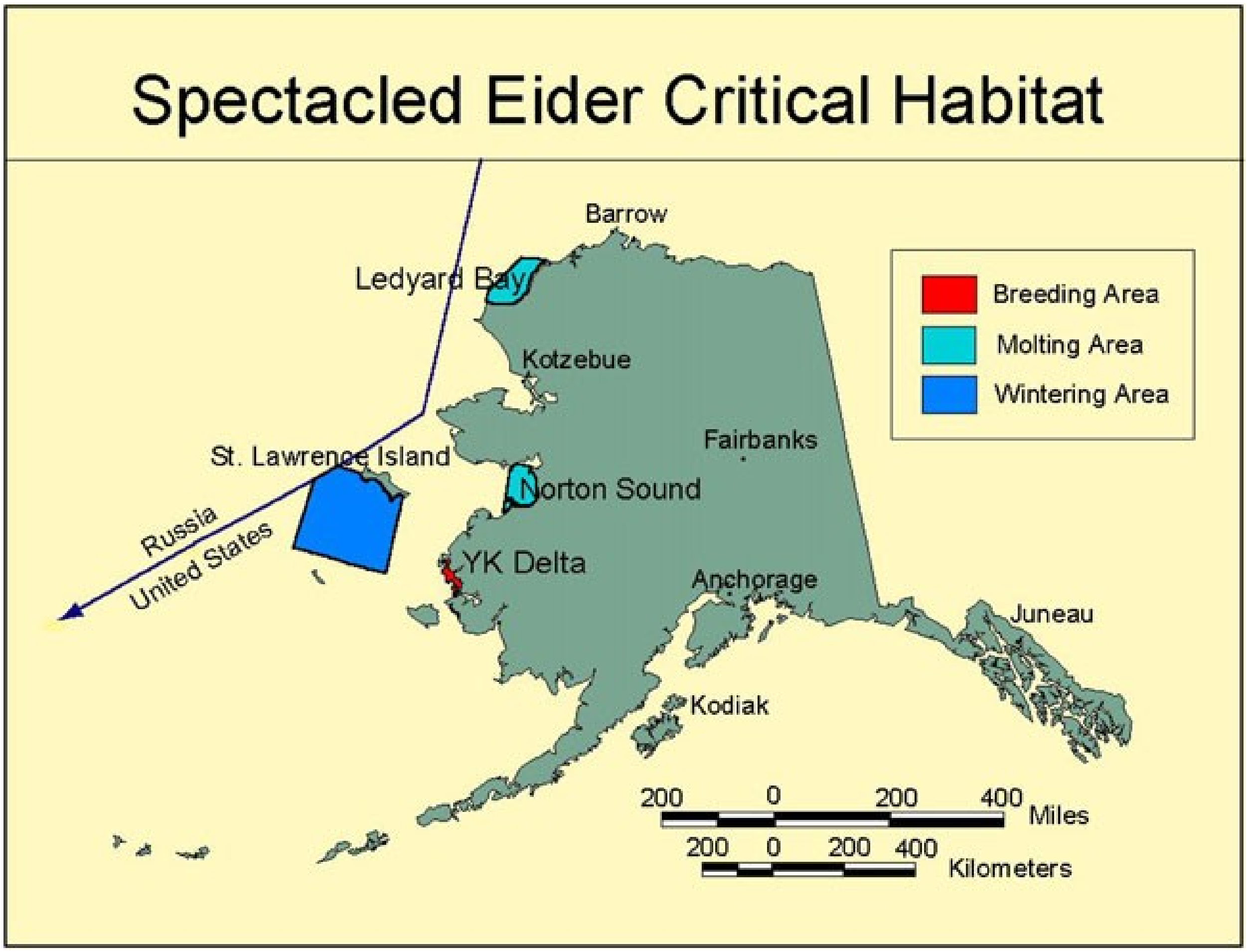

Figure 4. Critical habitat designated in federal regulations for spectacled eiders in Alaska. (Federal Register 2001).

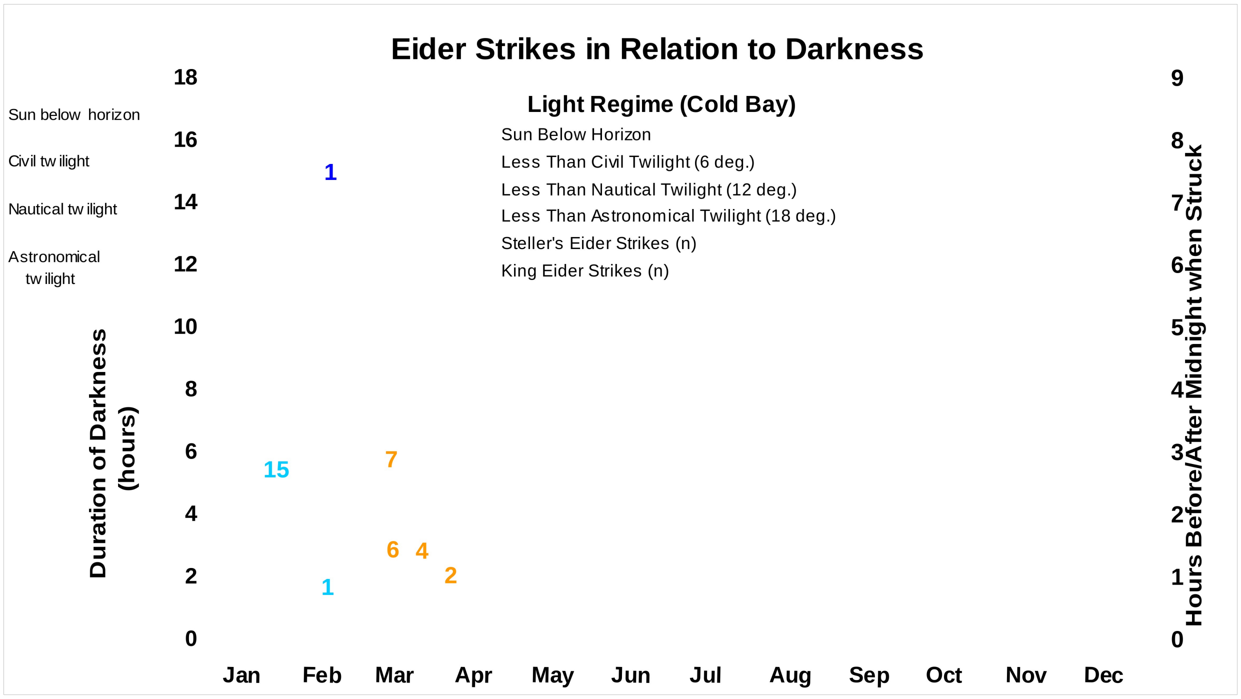

Figure 5. Annual light regime at Cold Bay, Alaska, and reported eider strikes by species and time of day.

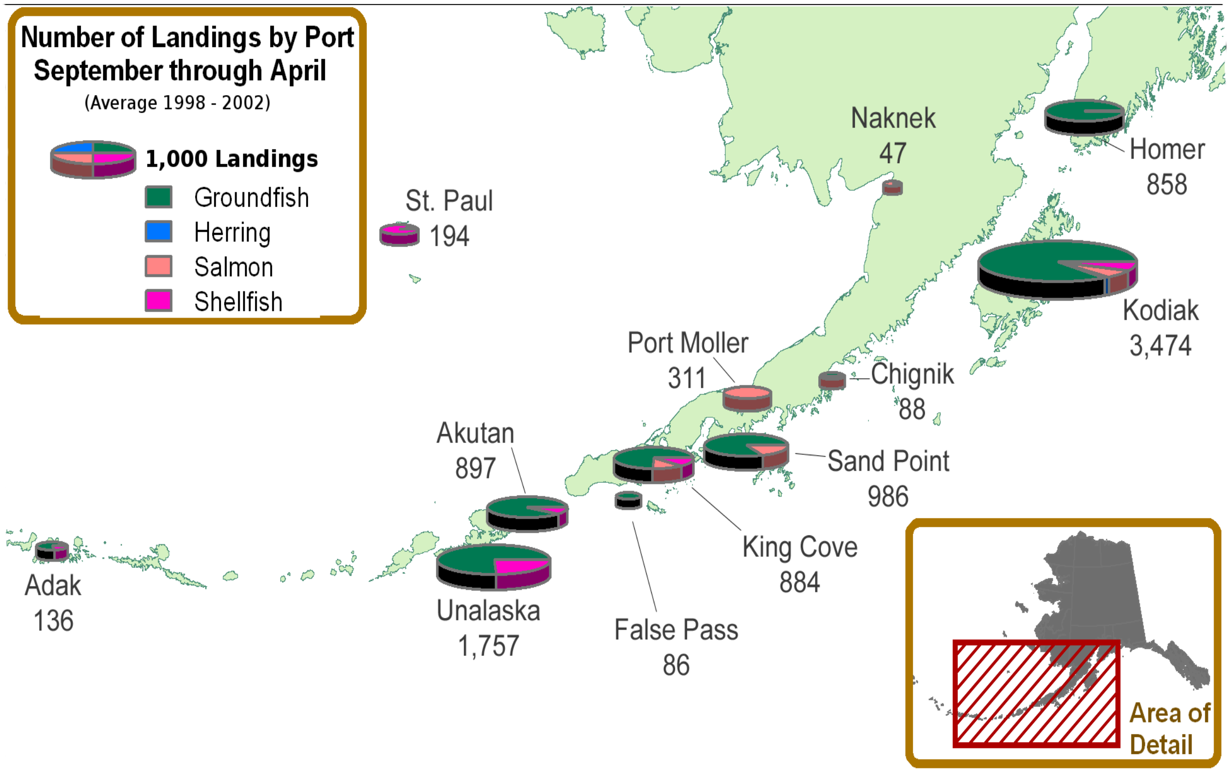

Figure 6. Average (1998-2002) landings by port and fishery for September through April from ADF&G fish ticket landing receipts in the general wintering area of Steller's eiders.

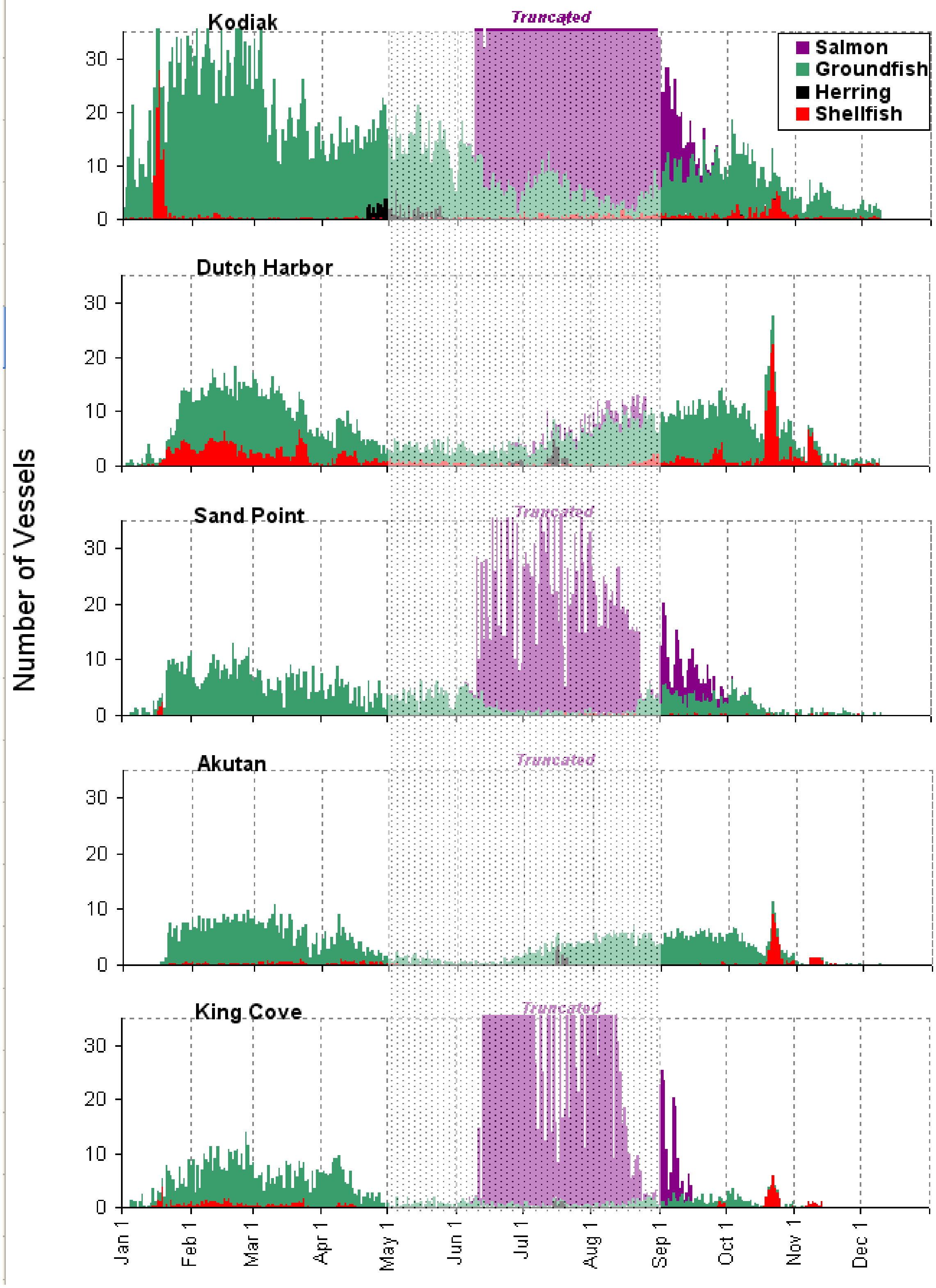

Figure 7. Average number of landings by day and fishery, 1998-2002, for the top 5 ranked ports, with stippled area representing landings from May through August when eider collisions are least likely.

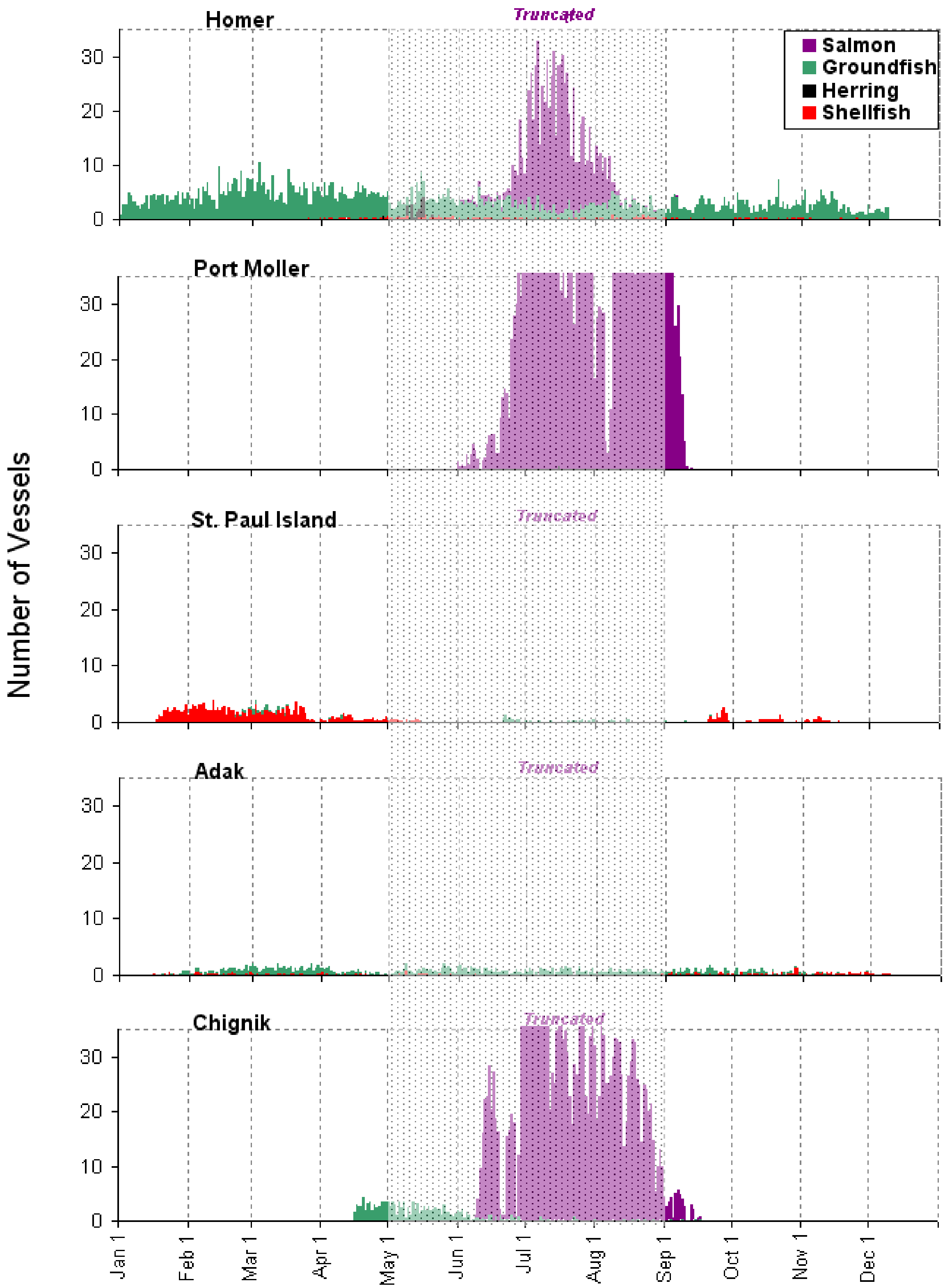

Figure 8. Average number of landings by day and fishery, 1998-2002, for the ports ranked 6 through 10, with stippled area representing landings from May through August when eider collisions are least likely.

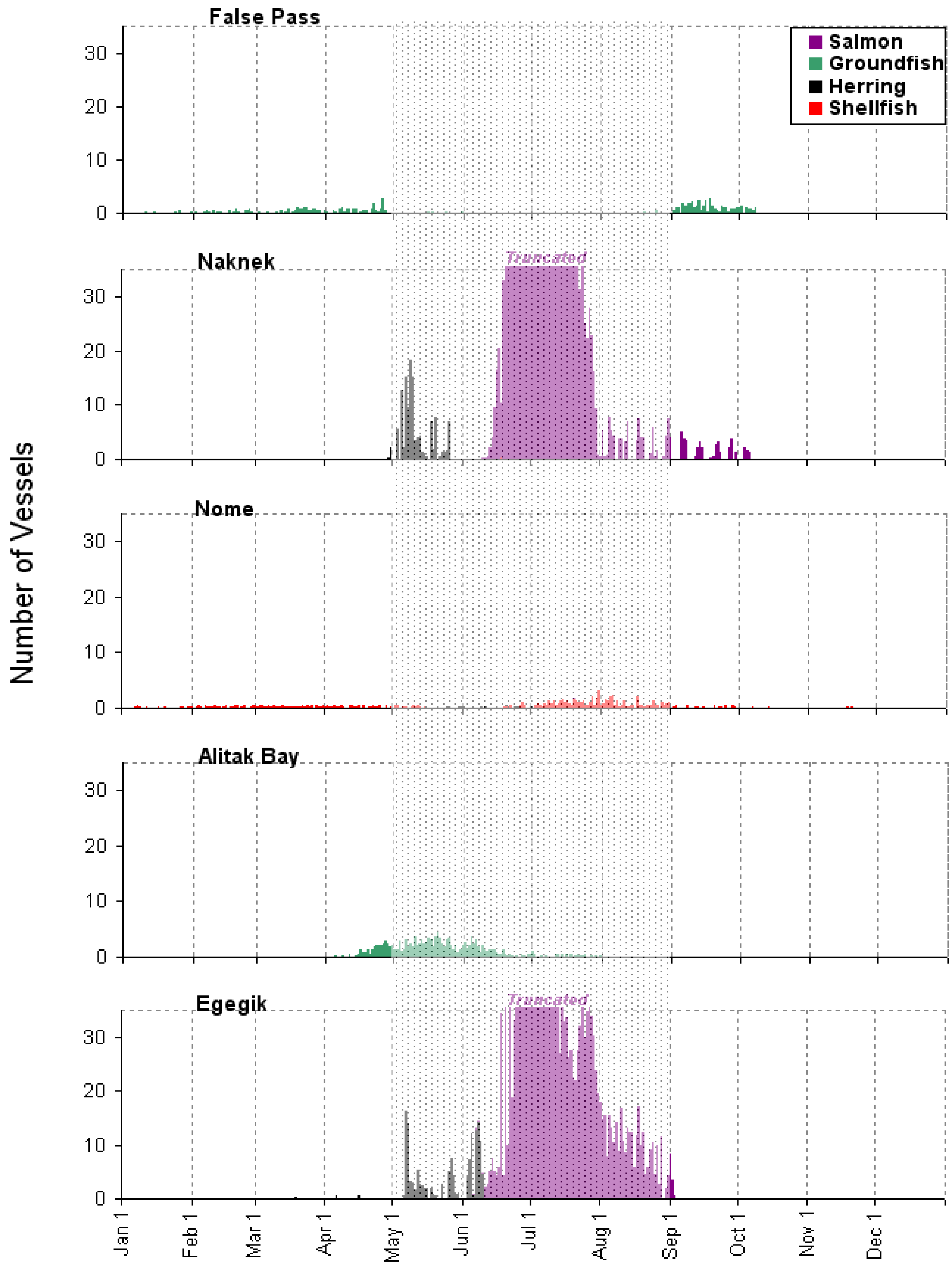

Figure 9. Average number of landings by day and fishery, 1998-2002, for ports ranked 11 through 15, with stippled area representing landings from May through August when eider collisions are least likely

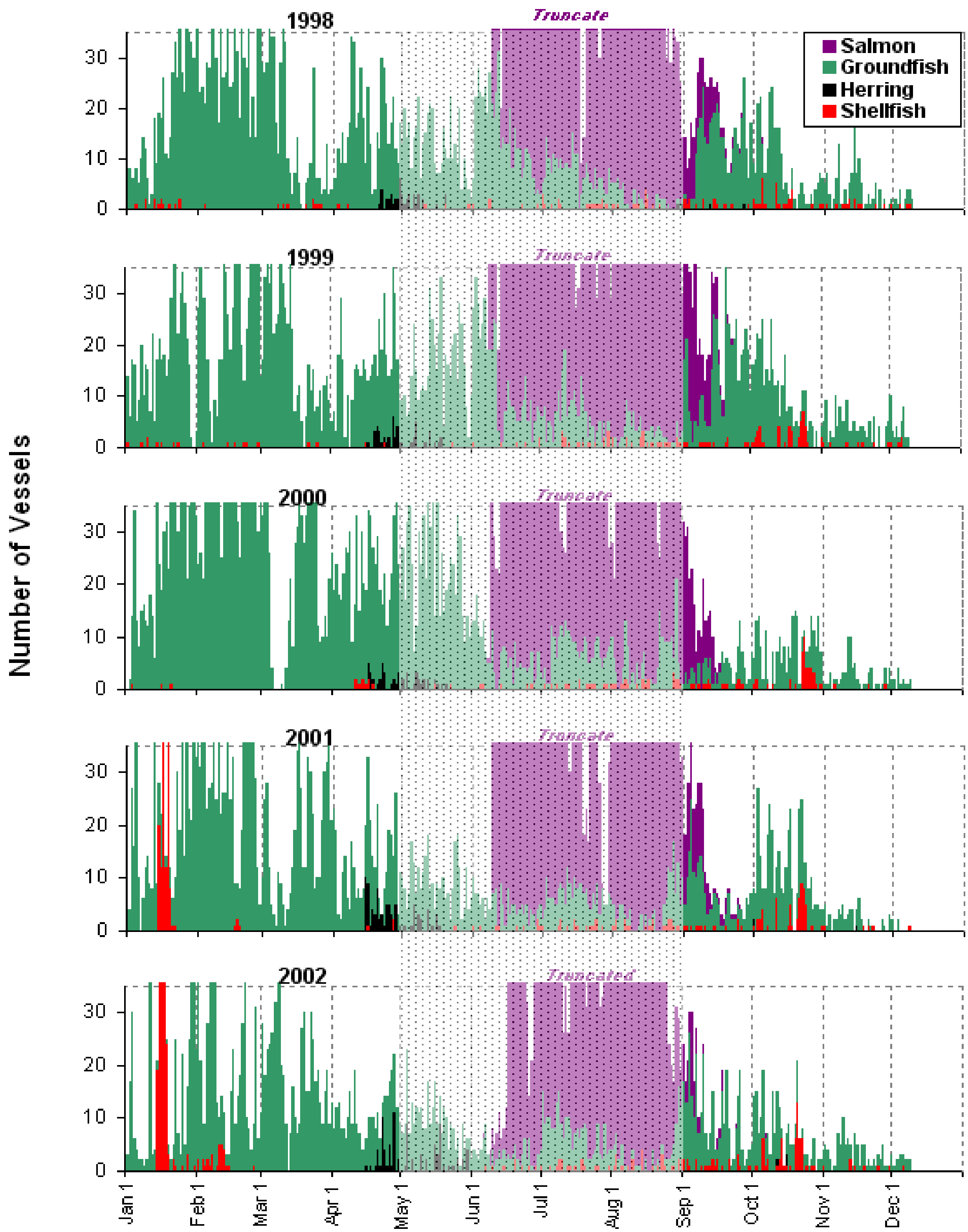

Figure 10. Number of vessels by day and fishery delivering to Kodiak, averaged over 1998-2002, from ADF&G fish ticket landing receipts.

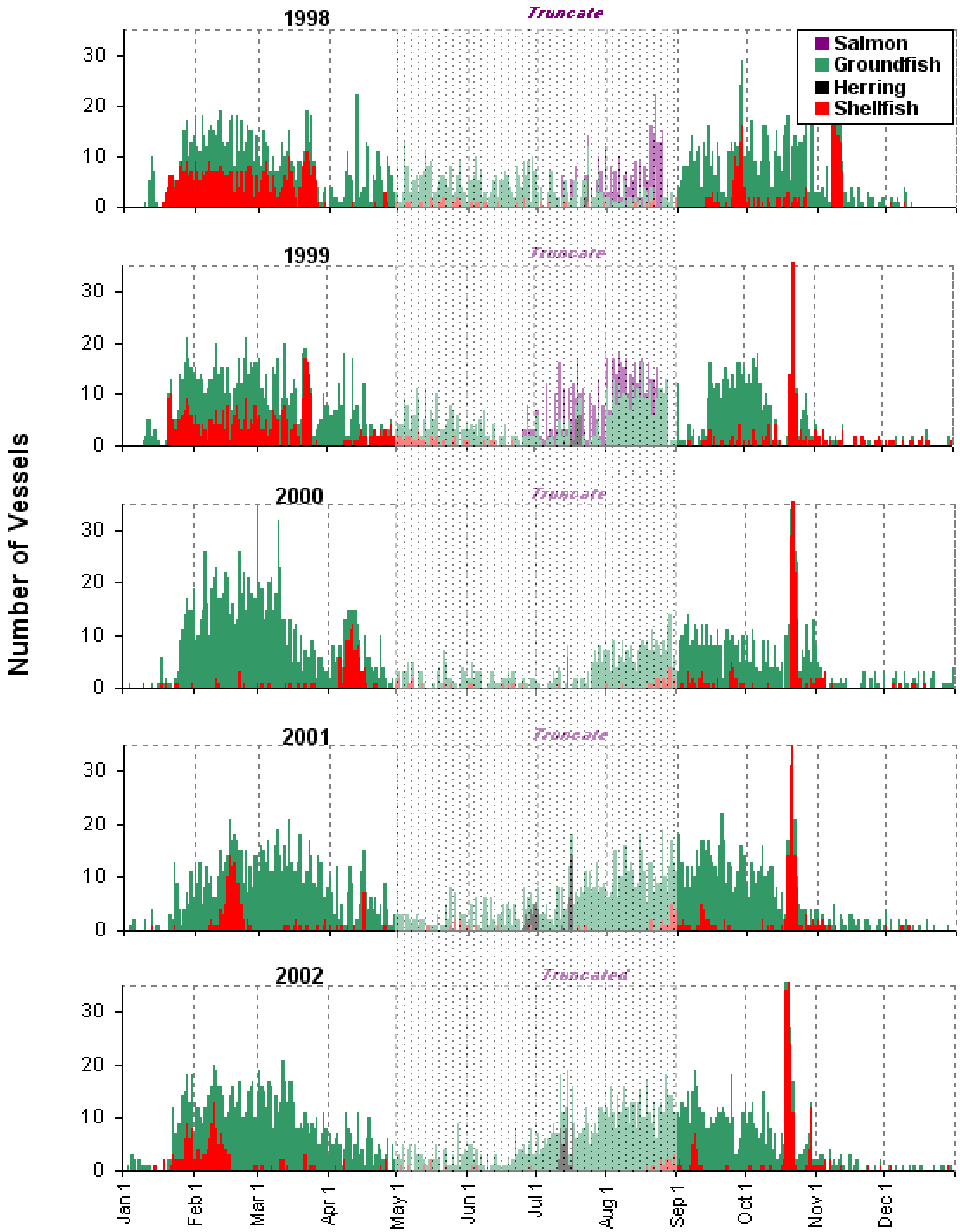

Figure 11. Number of vessels by day and fishery delivering to Dutch Harbor, 1998-2002, from ADF&G fish ticket landing receipts.

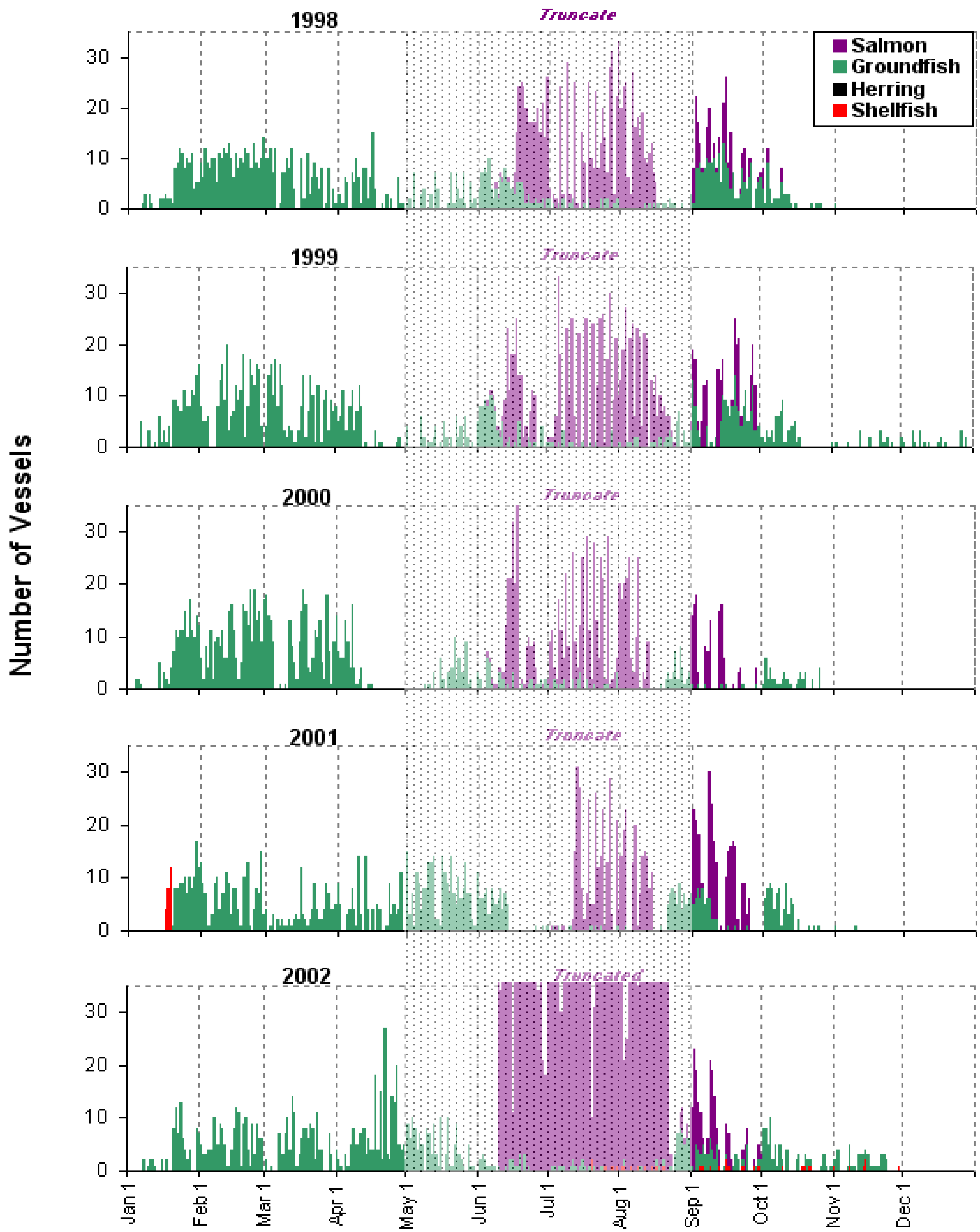

Figure 12. Number of vessels by day and fishery delivering to Sand Point, 1998-2002, from ADF&G fish ticket landing receipts.

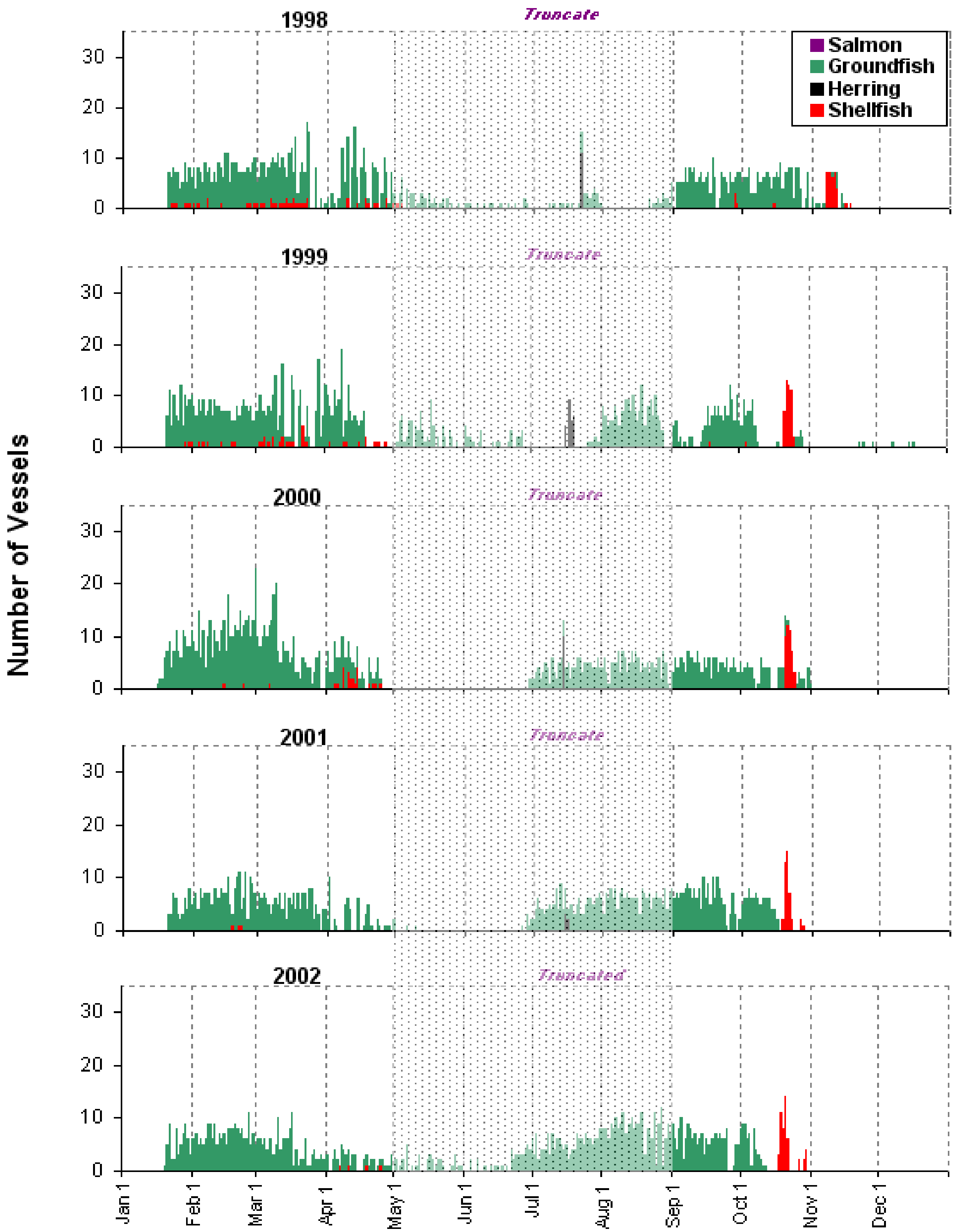

Figure 13. Number of vessels by day and fishery delivering to Akutan, 1998-2002, from ADF&G fish ticket landing receipts

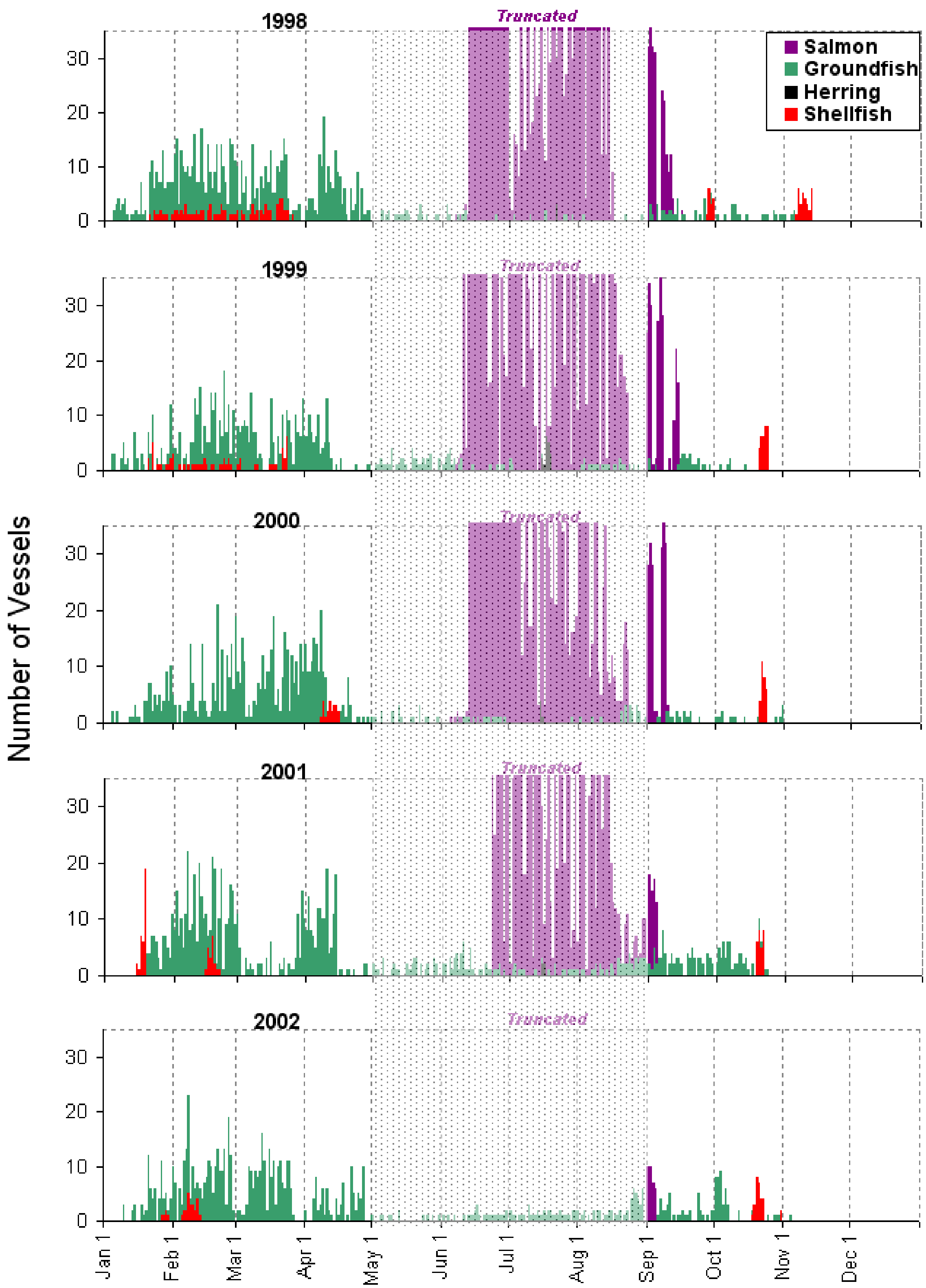

Figure 14. Number of vessels by day and fishery delivering to King Cove, 1998-2002, from ADF&G fish ticket landing receipts.

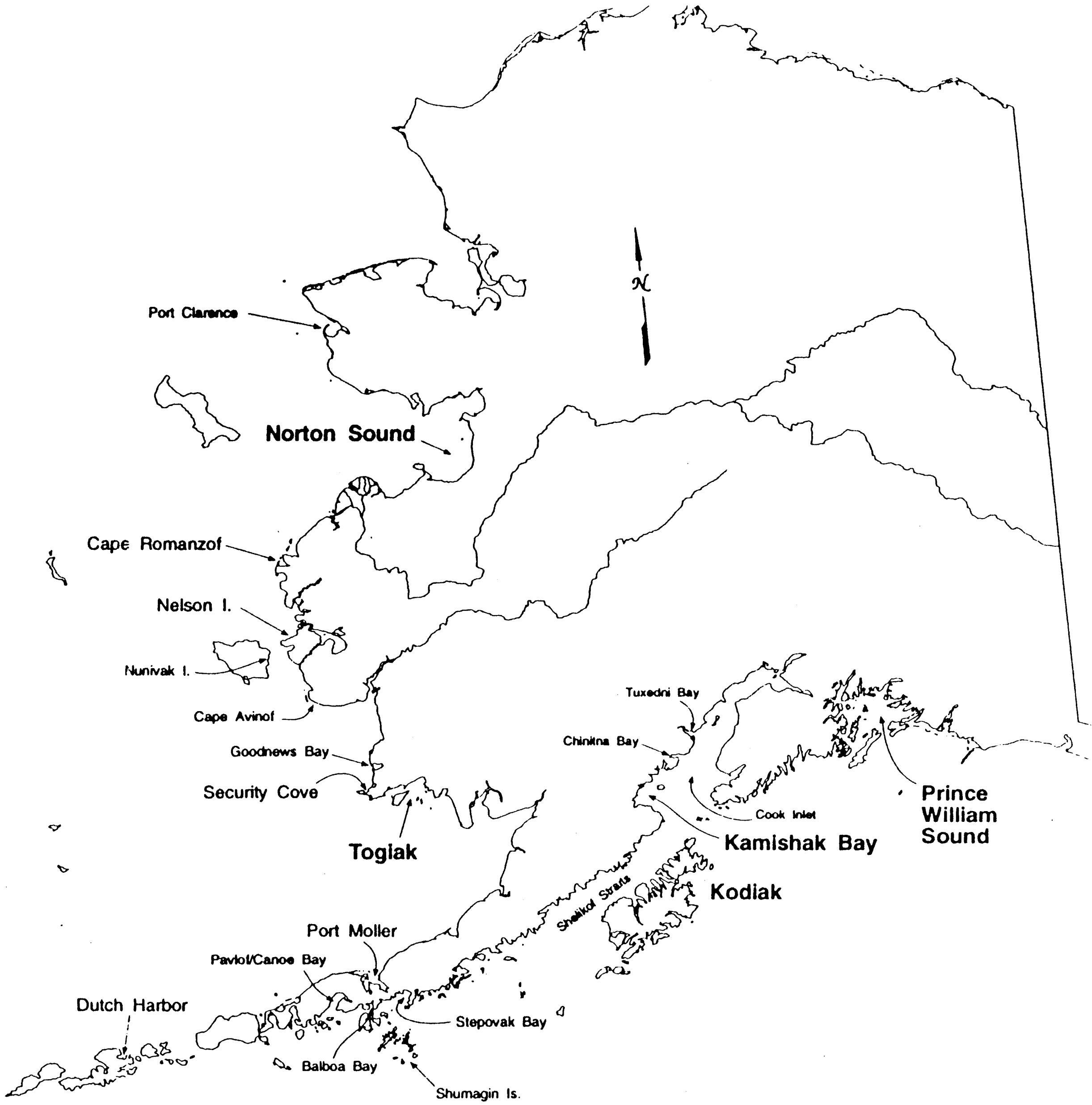

Figure 15. Locations of Pacific herring fisheries in central and western Alaska

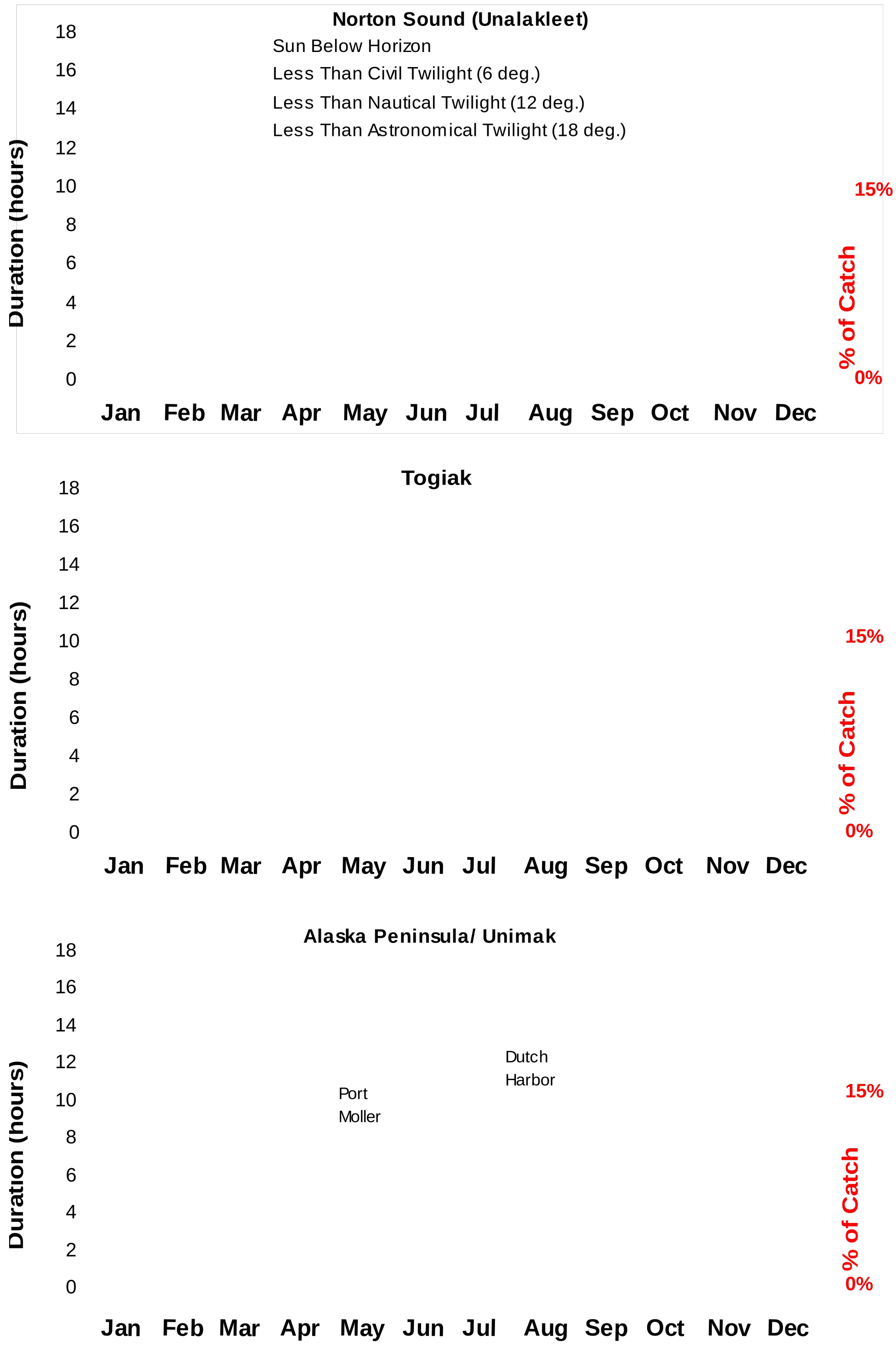

Figure 16. Light regime and temporal distribution of herring catch, 1990-99, at the locations of three herring fisheries along the Steller's eider spring migration route.

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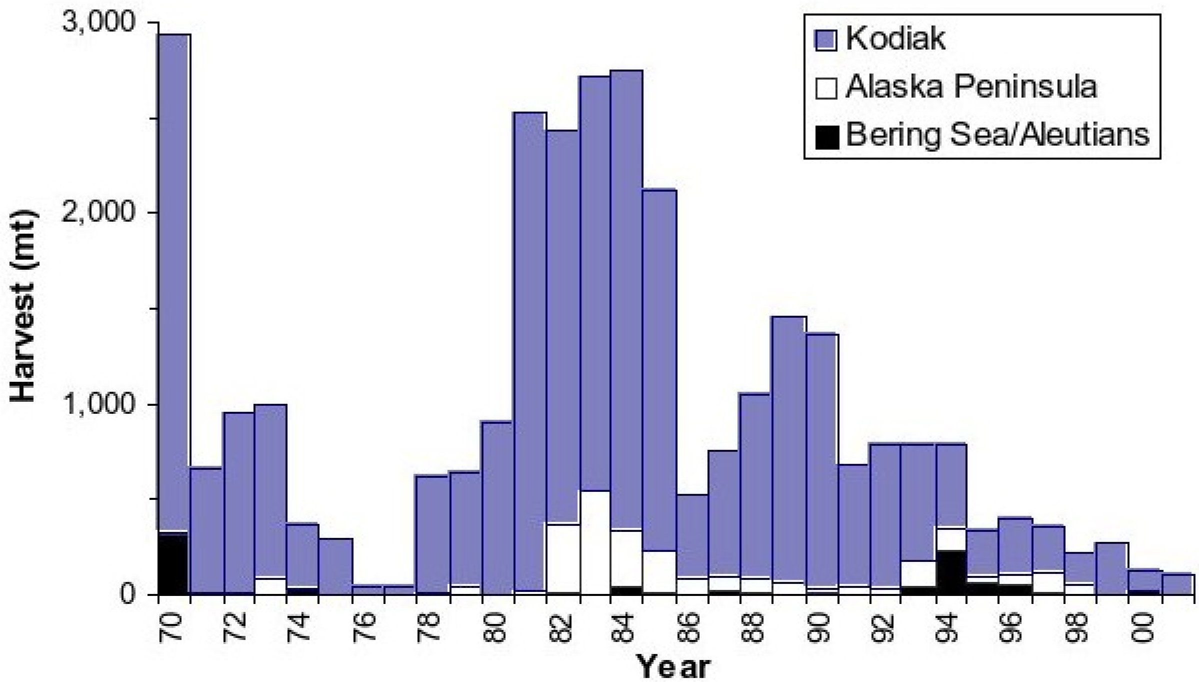

Figure 17. Harvests of Dungeness crabs in western Alaska, 1970–2001.

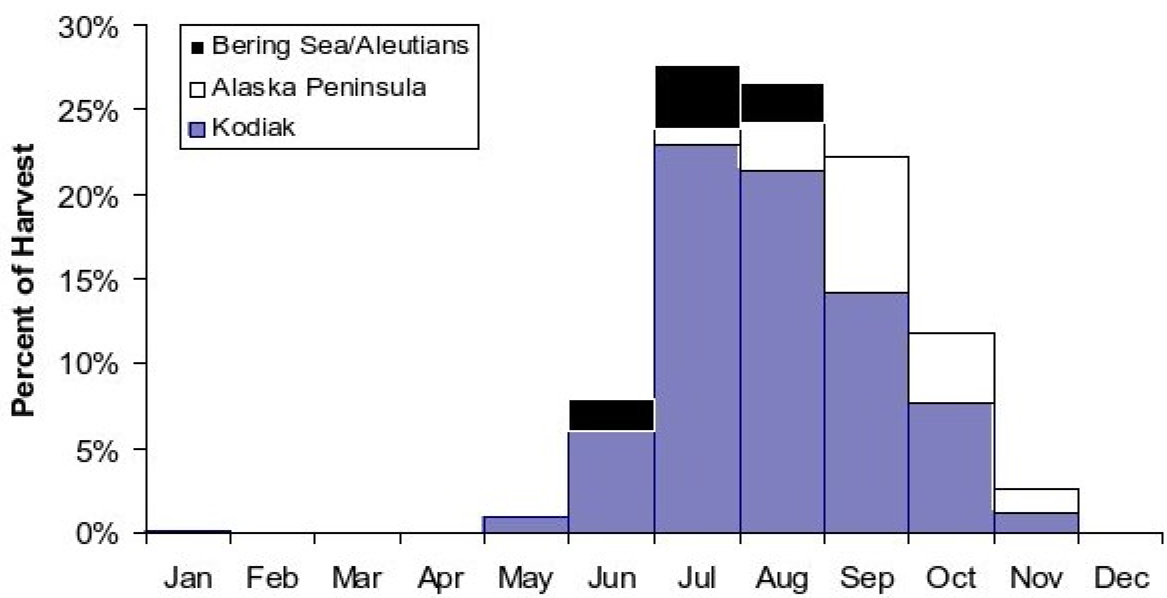

Figure 18. Temporal distribution of Dungeness crab harvest in western Alaska, 1997–2001.

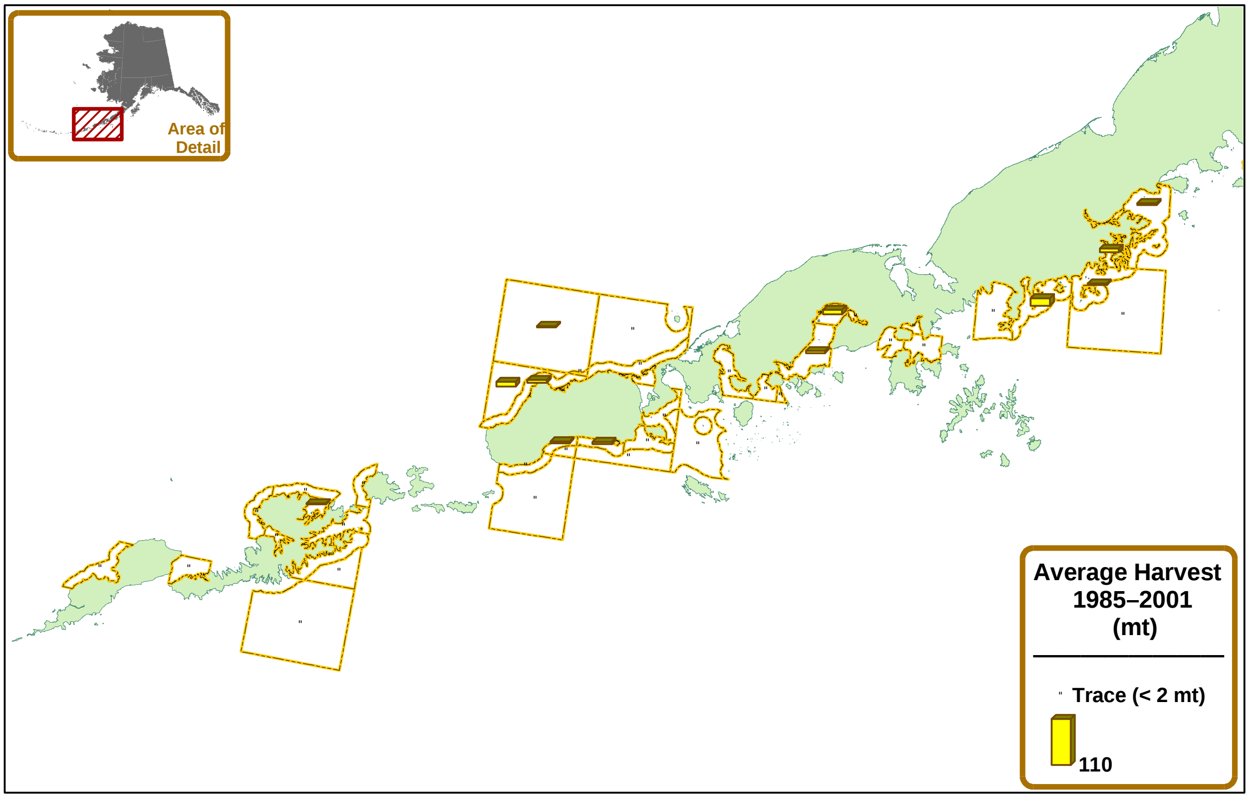

Figure 19. Spatial distribution of average Dungeness crab harvest along the western Alaska Peninsula, 1985–2001.

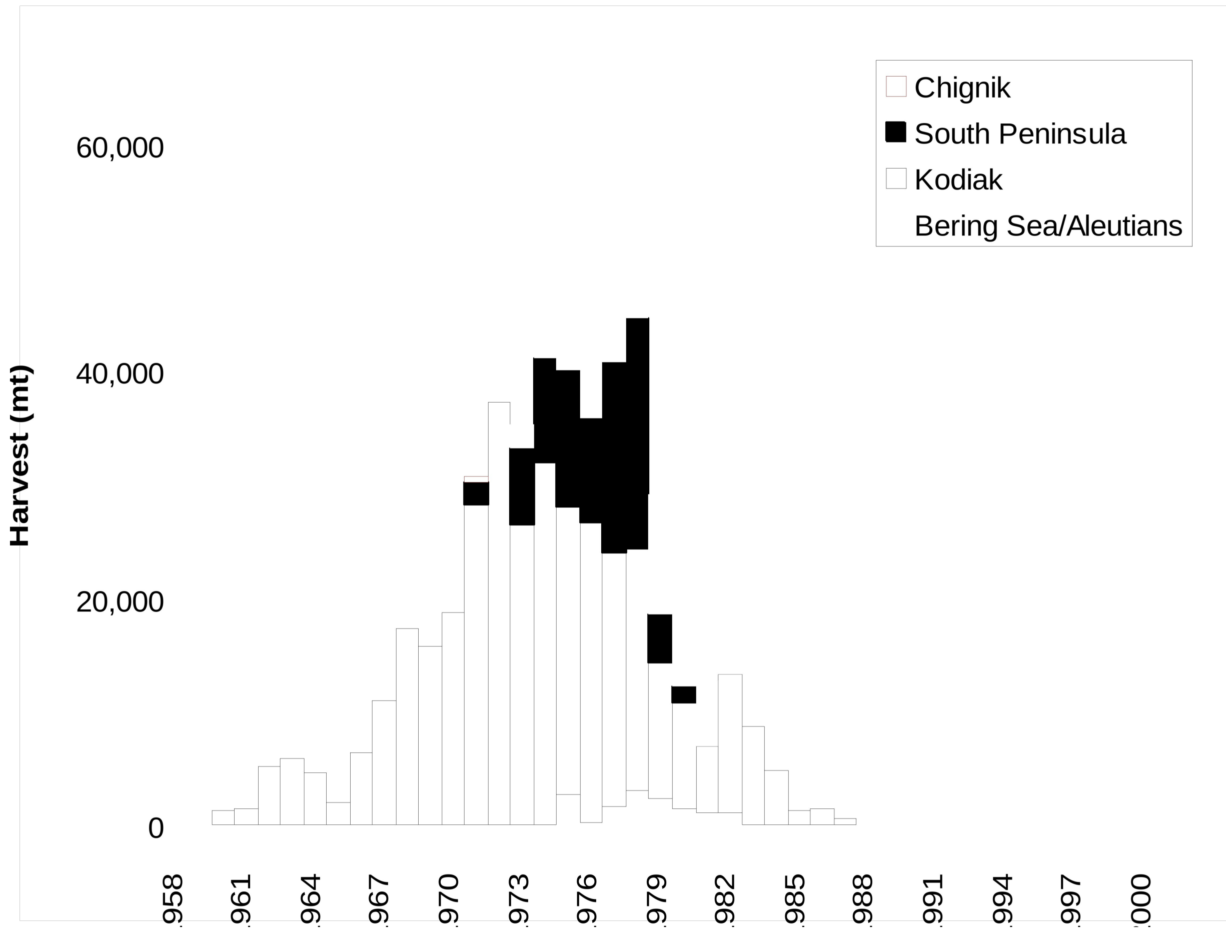

Figure 20. Harvest of all species of shrimp in western Alaska, 1958–2001.

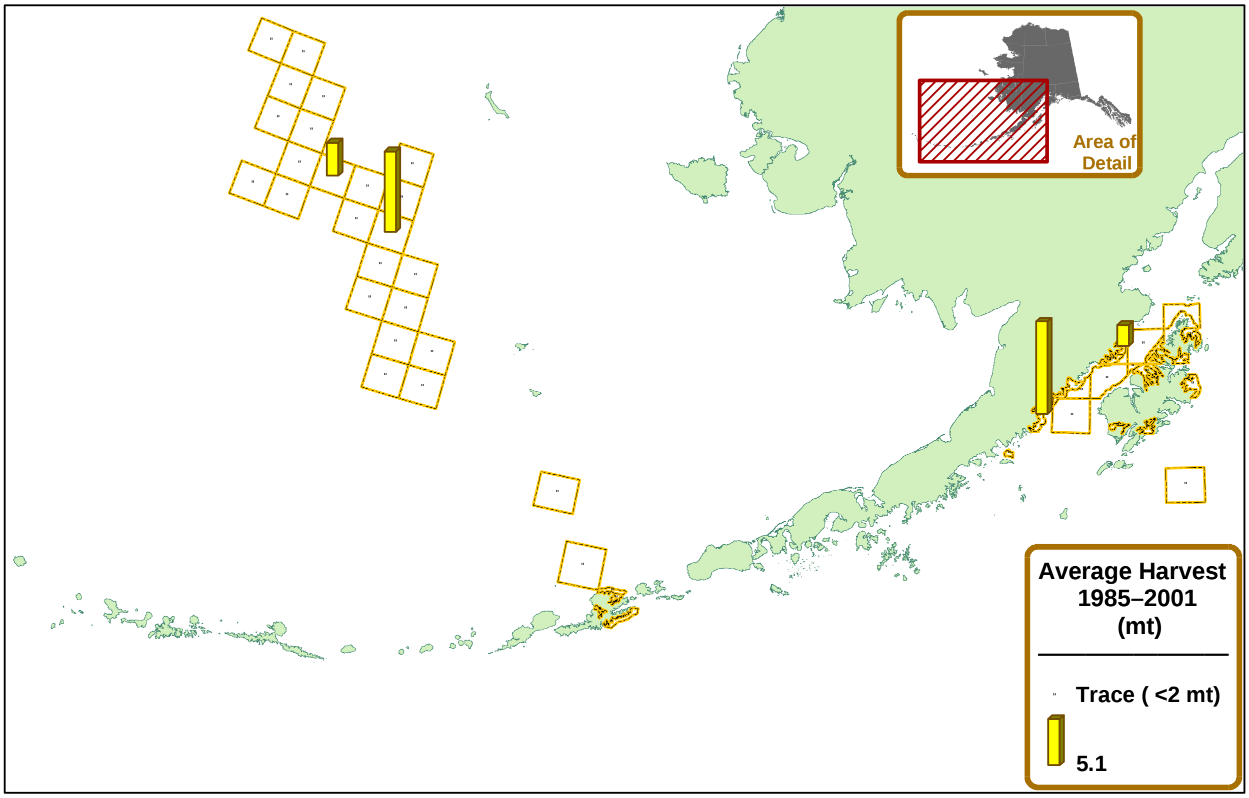

Figure 21. Spatial distribution of average shrimp harvest, for the years 1985–2001.

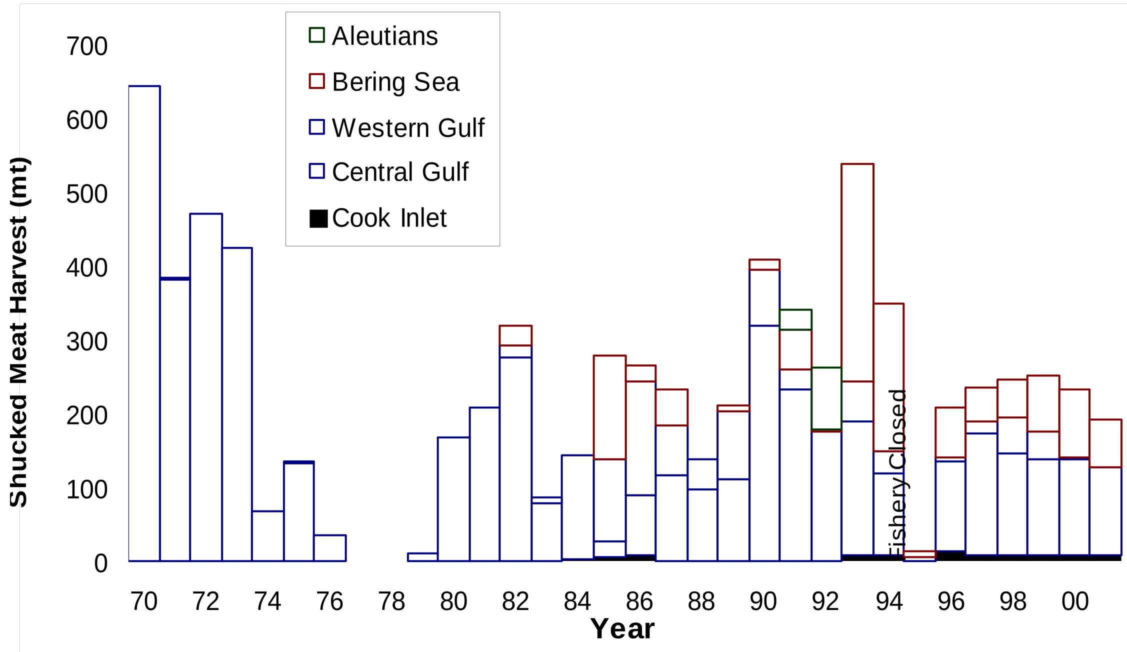

Figure 22. Harvests of weathervane scallops in Alaska, 1970–2001.

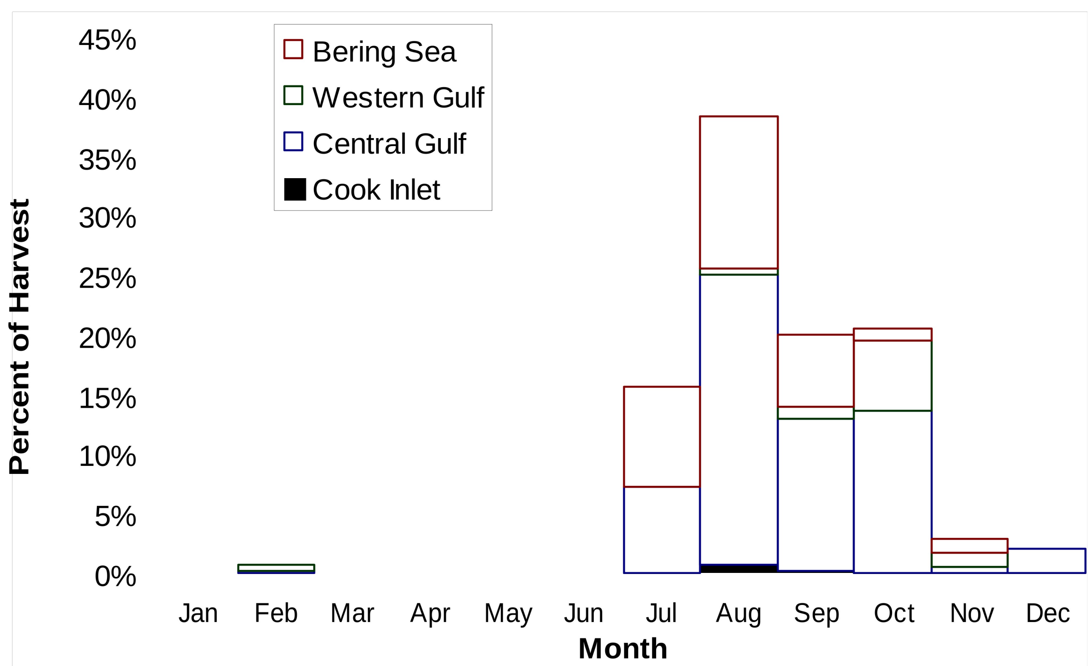

Figure 23. Temporal Distribution of scallop harvest, 1970–2001

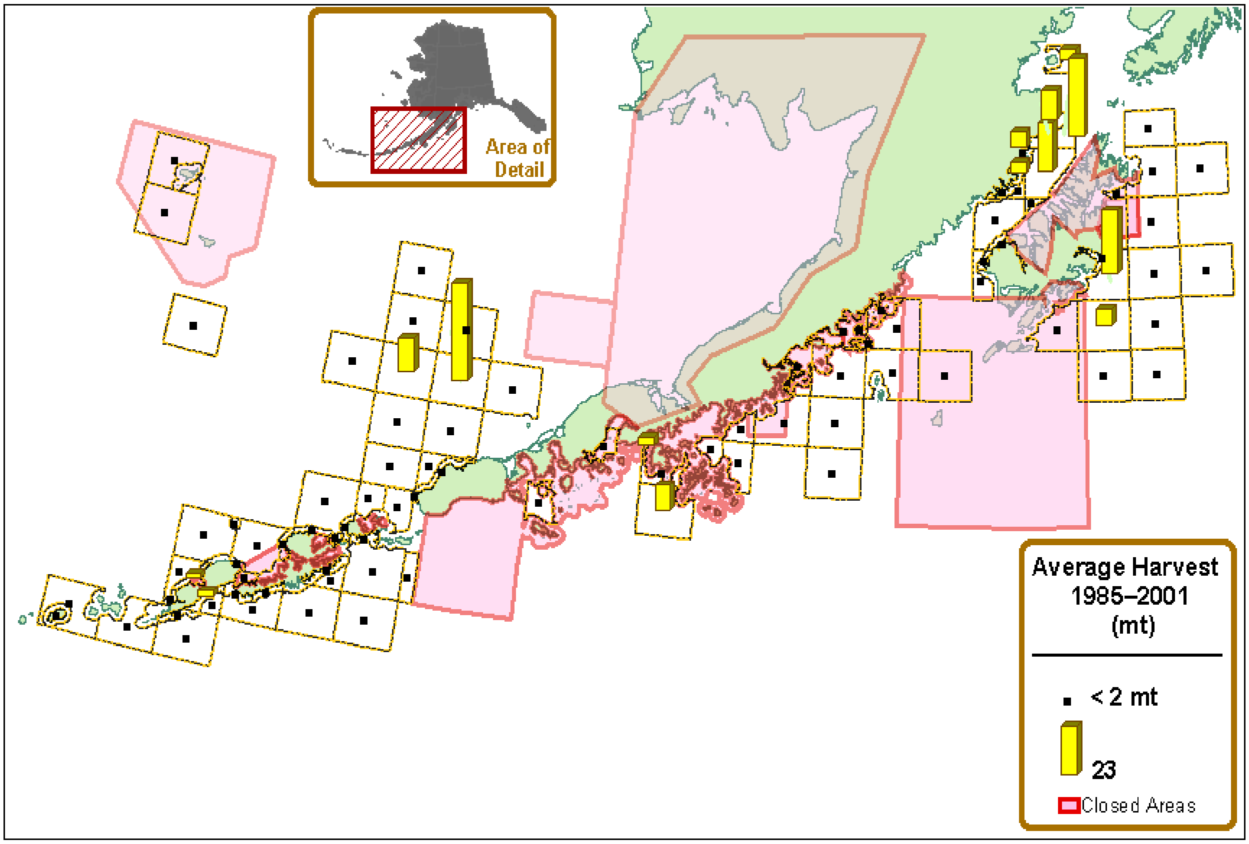

Figure 24. Spatial distribution of average scallop harvest, 1997–2001, showing areas closed to scallop fishing.

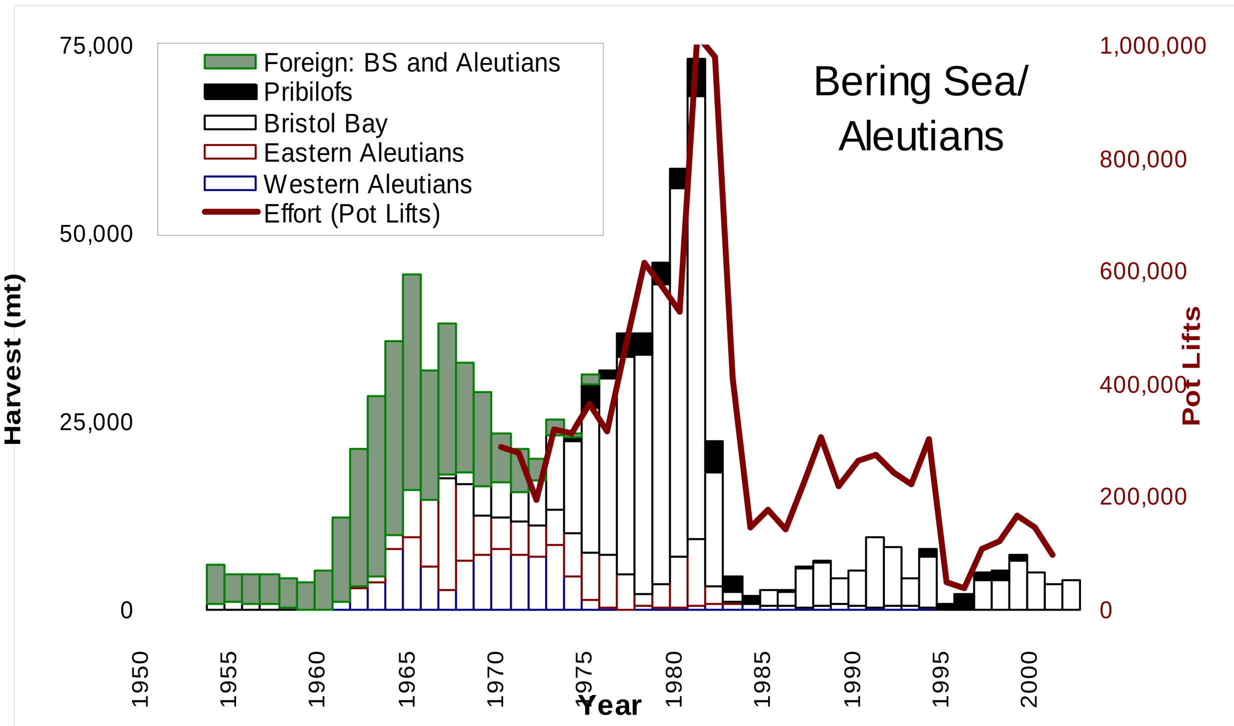

Figure 25. Harvest of red king crabs in the Bering Sea and Aleutian Islands, 1950–2001.[c]

[c] Pribilof Islands and foreign harvests include both red and blue king crabs. Effort in pot lifts does not include the foreign fishery. Foreign harvest data from Otto (1990).

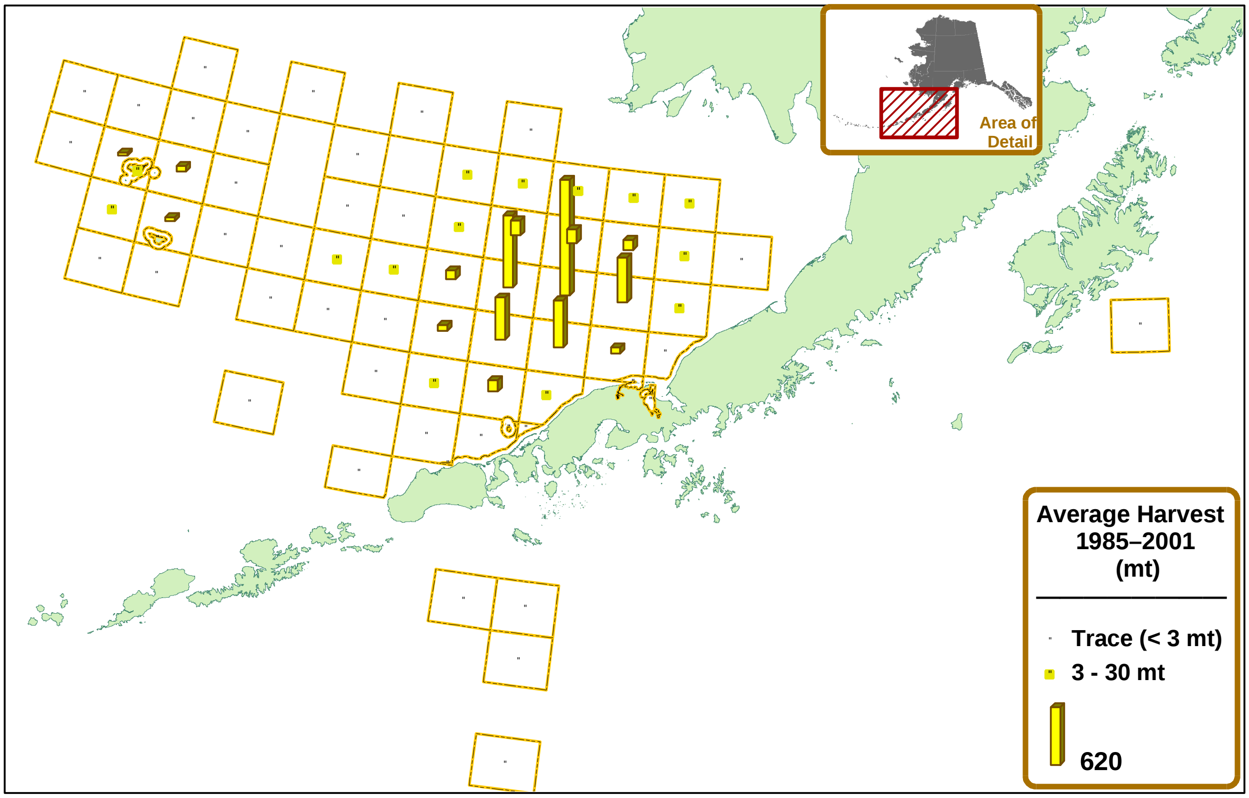

Figure 26. Spatial distribution of average red king crab harvests in the eastern Bering Sea, 1985–2001.

Figure 27. Timing of the Bristol Bay red king crab fishery (2001-2005 average number of landings by day), with respect to the light regime at Cold Bay.

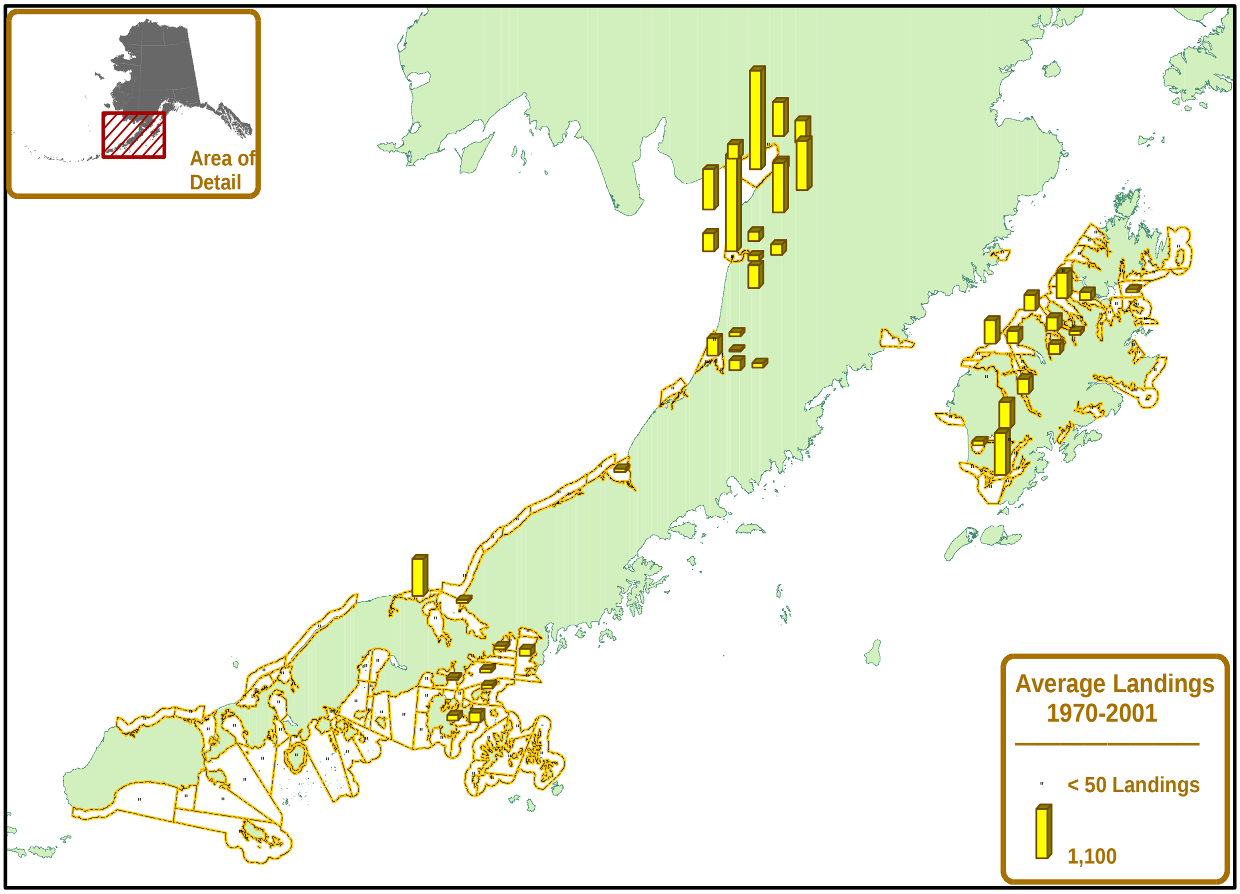

Figure 28. Large-scale distribution of the average number of salmon setnet landings by statistical area, 1970–2001, for southwestern Alaska.

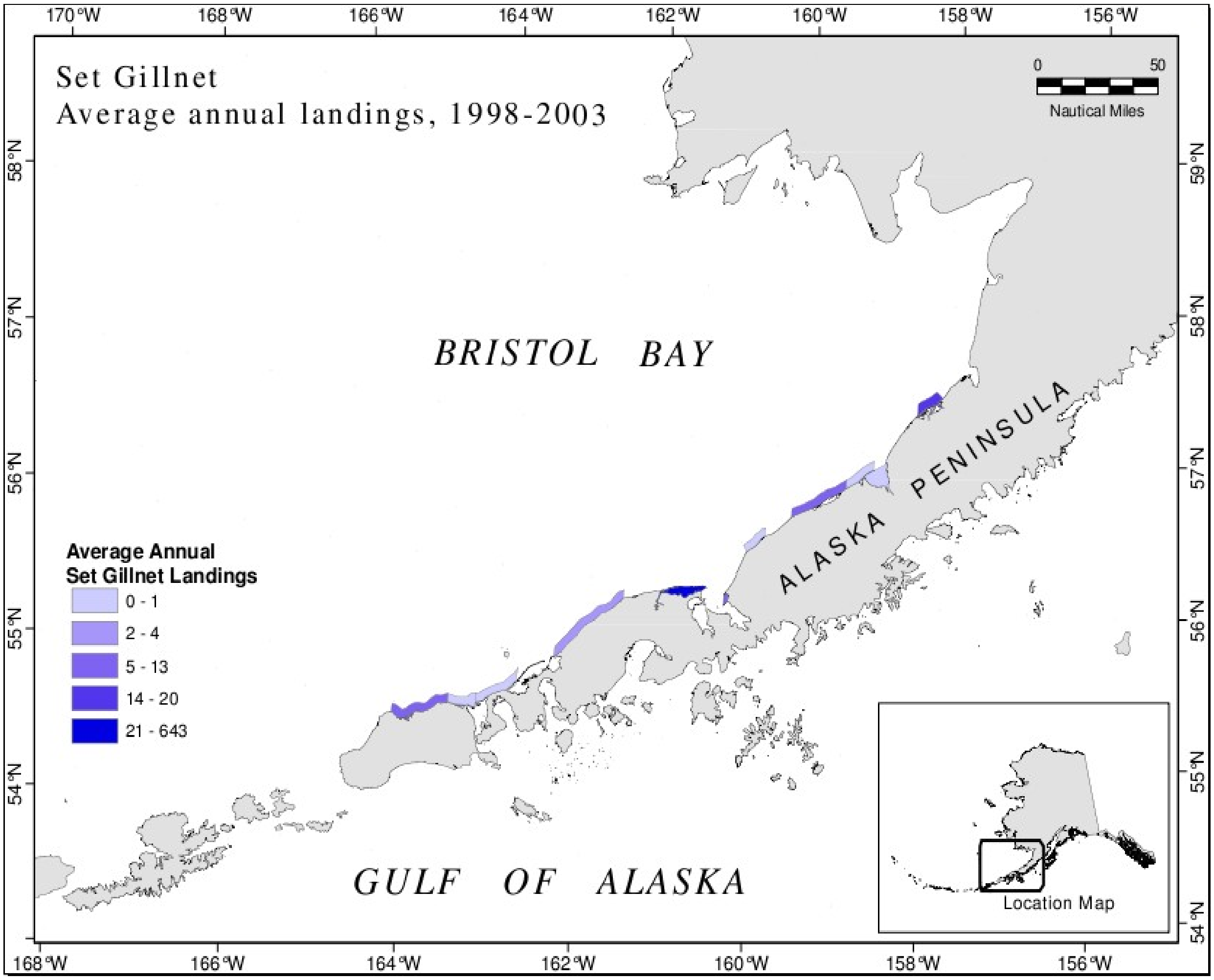

Figure 29. Detailed distribution of average annual setnet landings by statistical area along the north Alaska Peninsula, 1998-2003.

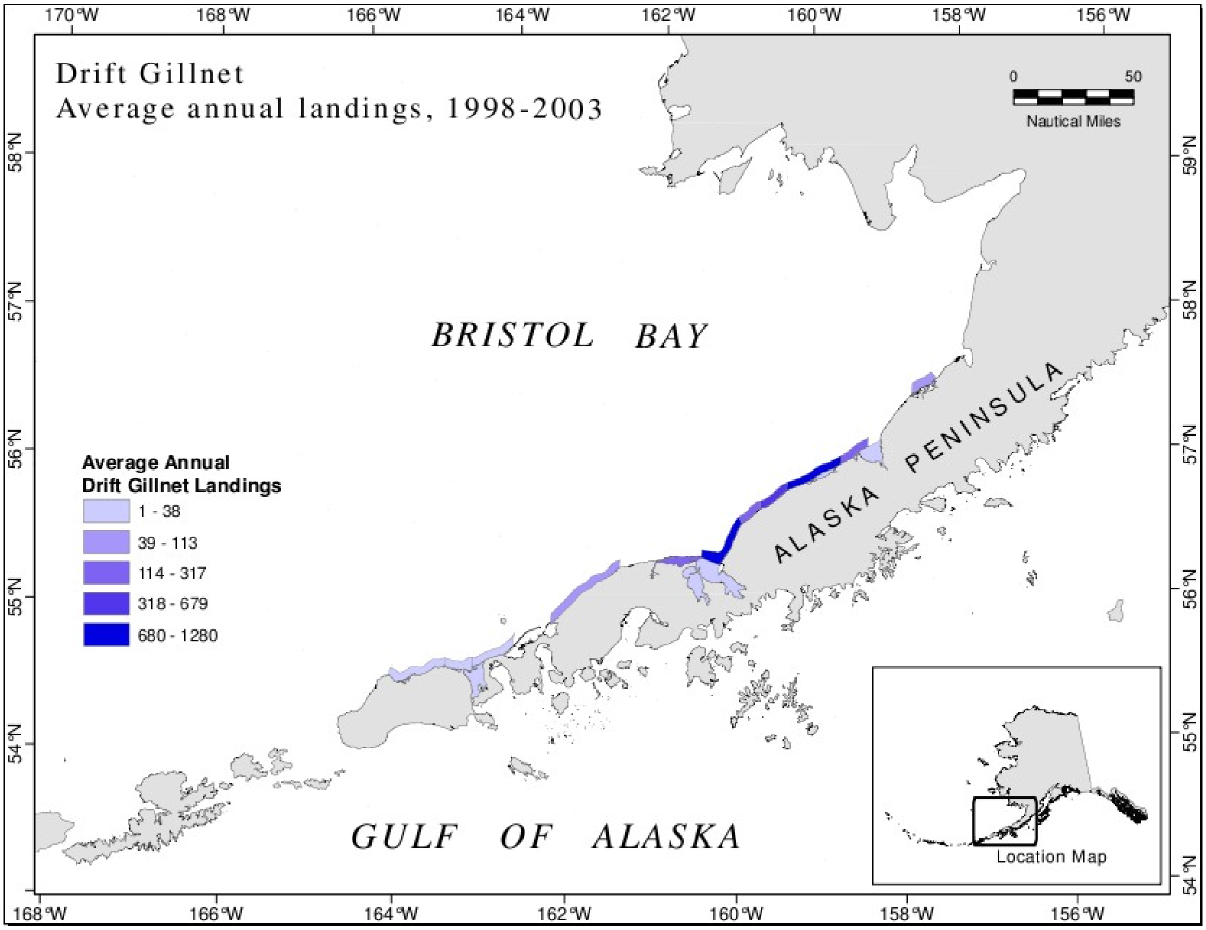

Figure 30. Distribution of average annual drift gillnet landings by statistical area along the north Alaska Peninsula, 1998-2003.

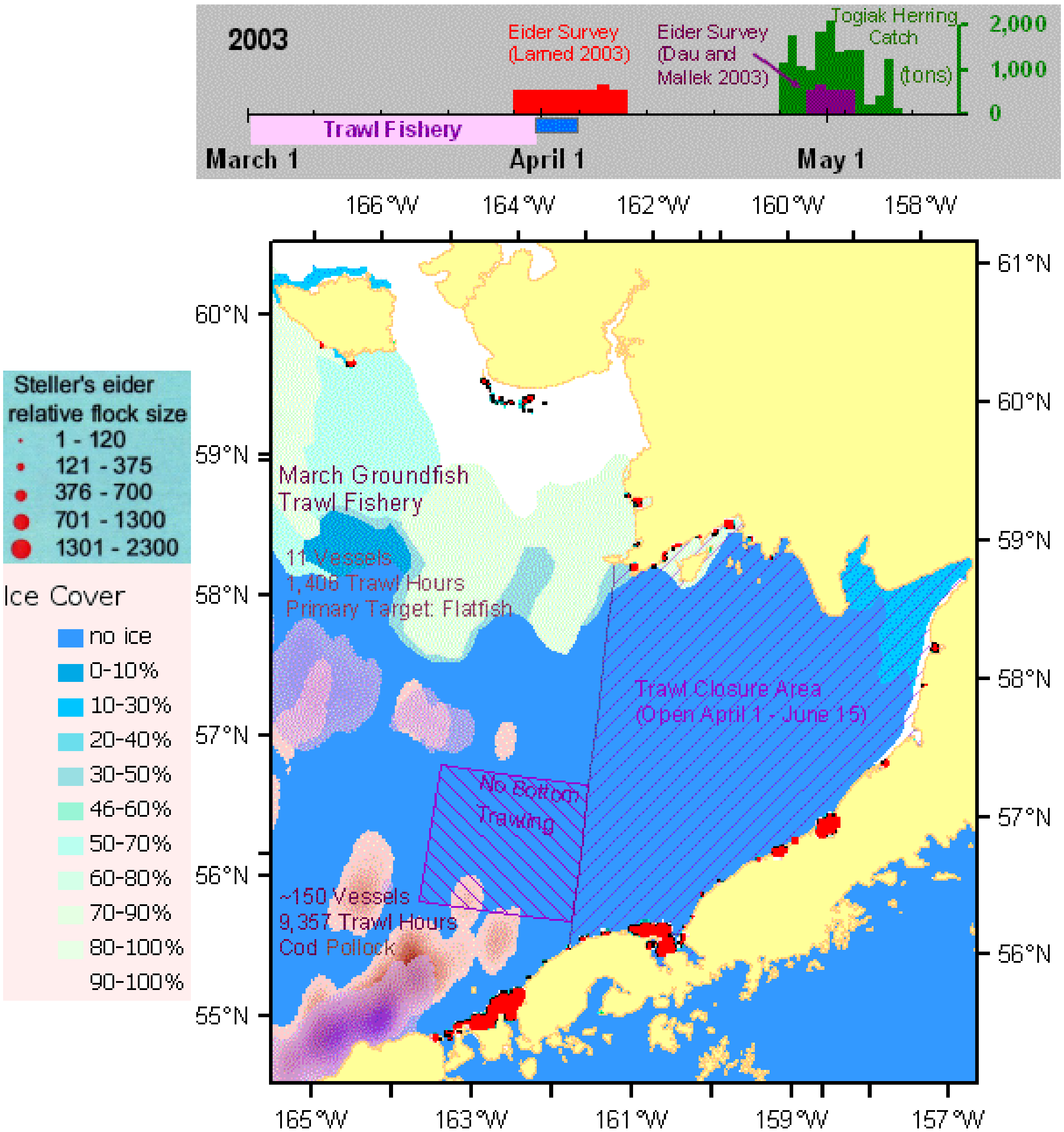

Figure 31. March 2003 groundfish fleet distribution and effort by target fishery, March 31 sea ice coverage (maximum extent), groundfish closure areas in effect for March, and March 29-April 11, 2003 Steller's eider distribution from aerial surveys (Larned 2003).

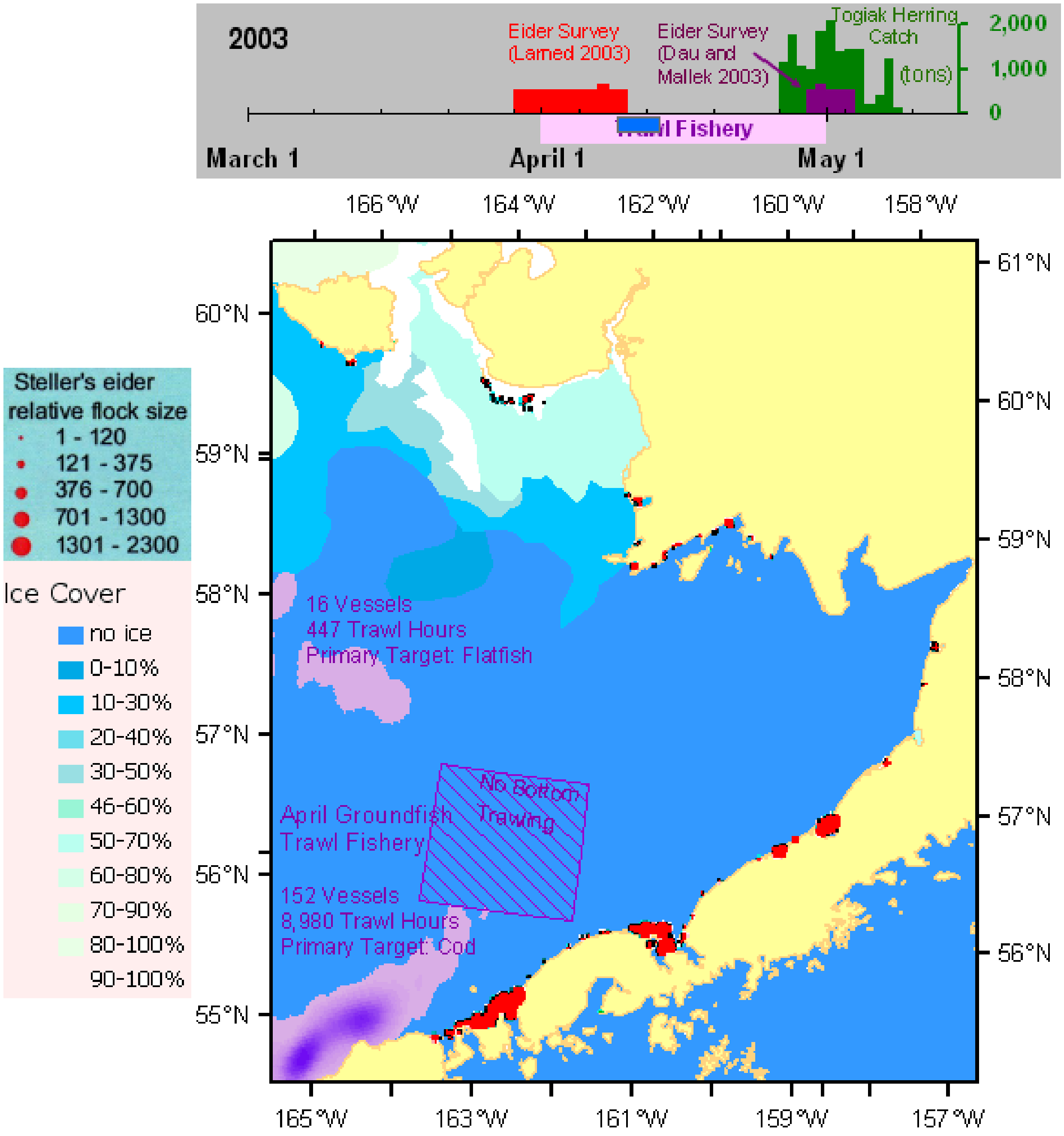

Figure 32. April 2003 groundfish fleet distribution and effort by target fishery, April 11 sea ice coverage, groundfish closure areas in effect for April, and March 29-April 11, 2003 Steller's eider distribution from aerial surveys (Larned 2003).

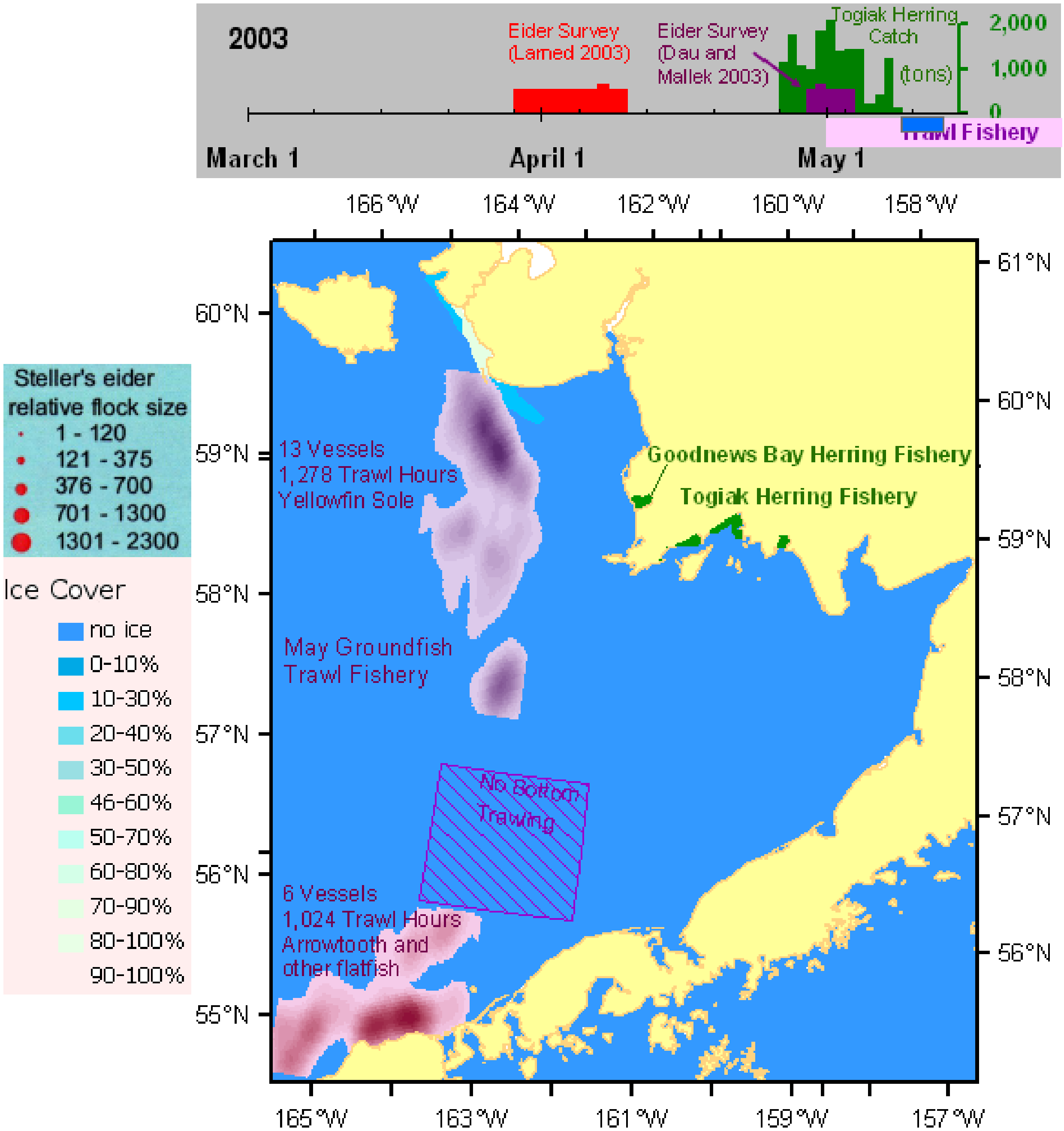

Figure 33. May 2003 groundfish fleet distribution and effort by target fishery, May 9 sea ice coverage, groundfish closure areas in effect for May. Also shown are the locations of the Togiak and Goodnews Bay herring fisheries, which were ongoing in early May, 2003.