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Prince William Sound Walleye Pollock: Current Assessment and 2000 Management Recommendations

By
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ABSTRACT

Prior to 1995, less than 4 metric tons (mt) of walleye pollock *Theragra chalcogramma* were annually harvested, mainly by jig and bottom trawl gears, from Prince William Sound (PWS), Alaska. An annual fishery using mid-water trawls first developed in 1995. This fishery occurs within internal waters of PWS and is managed by the Alaska Department of Fish and Game (ADF&G). Abundance and biomass data for walleye pollock in PWS are available from summer bottom trawl surveys, summer longline surveys, and summer and winter acoustic surveys. In addition to sampling pollock for length, weight, sex, maturity, and age from survey and commercial fishery catches in PWS, ADF&G has collected genetic samples and the Prince William Science Center collected tissue isotope samples from pollock caught in PWS and adjacent federal waters. The relationship between pollock in PWS and adjacent federal waters remains poorly understood and additional analysis is underway. Meanwhile, walleye pollock occurring in PWS during the summer have not been assessed as a part of the Gulf of Alaska trawl surveys conducted by the National Marine Fisheries Service (NMFS). Therefore, the harvest guideline for the PWS pollock fishery has been based on estimates of the pollock resource that resides in PWS in the summer and is not assessed by NMFS surveys in adjacent federal waters. The 1999 bottom trawl survey resulted in an estimated pollock biomass of 6,304 ±2,812 mt (95% confidence interval). Based on this recent summer survey, a guideline harvest level of 1,420 mt (3.1 million lb) is recommended for PWS pollock in 2000.

KEY WORDS: commercial fishery, groundfish management, Prince William Sound, *Theragra chalcogramma,* walleye pollock

INTRODUCTION

Prior to 1995, less than 4 mt of walleye pollock *Theragra chalcogramma* were commercially harvested annually, mainly by jig and bottom trawl gear, within Prince William Sound, Alaska (PWS; Bechtol 1995*a*, 1998*a*; Berceli et al. 1999). The annual harvest from this area increased dramatically in 1995 with the landing of 2,900 mt of walleye pollock, mainly by mid-water trawl gear. The objectives of this report are to: (1) provide a description and summary of commercial pollock harvests in PWS; (2) present updated assessment information on pollock resource of PWS; and (3) to make recommendations for the future management and research needs for pollock in PWS.

GENERAL BIOLOGY

Walleye pollock have been reported along the west coast of North American from Carmel, central California, through the Bering Sea to St. Lawrence Island, and on the Asia coast to Kamchatka, the Okhotsk Sea, and the southern Sea of Japan (Hart 1973; Bakkala et al. 1986). Walleye pollock are generally considered to be semidemersal, inhabiting continental shelf and slope waters to depths of 650 m, but they may also be pelagic in some areas. Genetic differences between walleye pollock of the eastern and western Pacific, as well as regional differences in age, growth, morphometric, and meristic characteristics, suggests that multiple stocks exist (Okada 1986).

Walleye pollock typically spawn in the first half of the calendar year, but may spawn later in the year at higher latitudes. The pelagic eggs are 1.35 to 1.45 mm in diameter. Age-0 walleye pollock in the Bering Sea typically occupy the upper 40 m of the water column until fall months when they begin a semidemersal existence (Traynor and Nelson 1983). Age-1 and -2 walleye pollock occupy discrete schools between 30 m and the bottom in the eastern Bering Sea. Age-1, -2, and -3 fish generally occur higher in the water column and are typically captured in pelagic trawls, while most fish age-4 and older are located closer to the bottom and are commonly captured in demersal trawls. In the Gulf of Alaska, age-1 and -2 walleye pollock are approximately 13 cm and 25 cm in length, respectively (Janusz 1986). Size at first maturity appears to be about 35 cm, which is usually attained at age-3.

The size, number, and variety of prey increase with walleye pollock size. Walleye pollock yolk-sac larvae, 3-6 mm in length, feed primarily on copepod nauplii (Nishiyama et al. 1986). Euphausiids and shrimp are important prey items for both juveniles and adults, particularly in the spring (Dwyer et al. 1986; Yang 1993). In summer, calanoid copepods and amphipods become an important component of the diet of small walleye pollock, while fishes are a major prey of large walleye pollock. In the Bering Sea during summer, age-0 walleye pollock were major prey items of larger walleye pollock (Livingston et al. 1993). By autumn cannibalism represented a major diet component of both large and small fish. In the Gulf of Alaska, a variety of fishes are

consumed by walleye pollock during the summer, with the most important prey item often being capelin *Mallotus villosus*. In winter, fish again composed the greatest portion of the diet of walleye pollock, but only the larger individuals commonly preyed upon other walleye pollock.

Walleye pollock are harvested in several fisheries and are also preyed upon by a variety of organisms. Population models for pollock resources occurring in federal waters incorporate a variety of data sources including recent efforts to model predation upon pollock (Hollowed et al. 1997).

MANAGEMENT AREA

Prince William Sound, Alaska, (PWS) is a complex fjord-type system located along the northern Gulf of Alaska (Muensch and Schmidt 1974). The commercial pollock fishery described in this report occurs within the Inside District of the PWS Management Area. The Inside District includes all waters enclosed by lines drawn from Point Whitshed to Point Bentinck, Cape Hinchinbrook to Zaikof Point, and Cape Cleare to Cape Puget (Figure 1). Because PWS is recognized as being internal waters of the State of Alaska, the Alaska Department of Fish and Game (ADF&G) manages harvests of groundfish, including pollock, within PWS.

CATCH HISTORY

Prior to 1995, annual commercial harvests of walleye pollock from PWS were less than 4 mt (Table 1; Bechtol 1995*a*, 1998*a*). These harvests were primarily taken incidentally by trawl or longline gear, although some directed effort with jig gear occurred in 1994. Little information on at-sea discards is available for PWS, but walleye pollock discards probably occur at low levels on longline gear (Bechtol and Vansant 1998).

In January 1995, mid-water trawl vessels transiting the southwest portion of PWS observed sonar echoes from what appeared to be walleye pollock aggregations. A harvest guideline had not previously been established for pollock in (Bechtol 1995*b*) although historical assessment surveys indicated that walleye pollock reside year-round within PWS (Parks and Zenger 1979; Haynes and Urban 1991; C. Wilson, NMFS, unpublished data). The most recent survey, a series of bottom trawl tows made during the summer of 1989 following the *T/V Exxon Valdez* oil spill, indicated that 9,500 mt of walleye pollock were in PWS at the time of the survey (Haynes and Urban 1991). Therefore, ADF&G set a guideline harvest range of 950-2,000 mt for the 1995 directed fishery of walleye pollock based on an exploitation rate of 10-20% of the 1989 biomass estimate. The 1995 trawl fishery lasted from 31 January until 16 February 1995 with a total of nine midwater trawl vessels delivering 2,857 mt (6.2 million lb). Following the trawl closure, walleye pollock fishing was not closed to other gear types because non-trawl catches were expected to be small. The total PWS walleye pollock harvest in 1995 was 2,960 mt (6.5 million

lb), which included about 4 mt landed by longline and jig gears and 98 mt landed by a combination test fishery and acoustic survey conducted by ADF&G in late February and early March (Table 1; Trowbridge 1996).

The 1996 midwater trawl fishery from 20-25 January yielded a harvest of 1,480 mt (3.3 million lb) by 11 vessels (Trowbridge 1996). The total harvest of pollock in 1996 was 1,672 mt (3.7 million lb), including 191 mt landed by an ADF&G test fishery and <1 mt landed as bycatch in pot, longline, and trawl fisheries (Table 1).

The 1997 midwater trawl fishery from 20-28 January yielded a harvest of 1,779 mt (3.9 million lb) by 10 vessels (Berceli et al. 1999). The total 1997 pollock harvest from PWS was 2,027 mt (4.5 million lb), including 244 mt landed by an ADF&G test fishery and 3.3 mt landed as bycatch in pot, longline, and trawl fisheries (Table 1).

The 1998 midwater trawl fishery from 20-26 January yielded a harvest of 2,022 mt (4.5 million lb) by 10 vessels. The total 1998 pollock harvest through 26 October was 2,310 mt (4.6 million lb), including 287 mt landed by an ADF&G test fishery and 1 mt landed as bycatch in pot and longline fisheries (Table 1).

The 1999 midwater trawl fishery from January 20 to February 25 yielded a pollock harvest of 2,342 mt (5.2 million lb) by 6 vessels, including 223 mt landed by an ADF&G test fishery (Berceli et al. 1999). Fishery catch rates were much lower than past years, although the fleet reported that densities of pollock aggregations increased as the season progressed. Pollock reported landed as byctach in pot, longline, and shrimp trawl fisheries totaled 5.4 mt (Table 1).

The directed pollock fishery typically involved midwater trawl vessels targeting dense aggregations of pre-spawning pollock in the southwest portion of the Inside District (Figure 1). In particular, the pollock fishery has occurred in the Port Bainbridge and southern Knight Island Passage areas (Figure 2). Vessels delivered to shore-based processing plants once every 2-3 days or to tender vessels on the grounds up to twice daily. Individual deliveries usually consisted of 70-140 mt of walleye pollock, captured in one or two tows, depending upon vessel size and capacity and fish aggregation density. Most of the directed fishery catch has been processed into fillets with some marketing of the roe. Winter acoustic surveys indicate pollock also aggregate seasonally in the eastern portion of PWS (Kirsch and Thomas 1998), although the timing of these aggregations is not well understood. However, the area of these eastern aggregations is currently closed to all groundfish fishing with trawls (Figure 2).

FISHERY MANAGEMENT CONSIDERATIONS

The mid-water trawl fishery for walleye pollock in PWS is a relatively new fishery within state managed waters. Management strategies are still being developed and the Alaska Board of Fisheries is addressing proposals for regulatory changes during their 1999-2000 meeting cycle. The proposals would: (1) open a substantial portion of the eastern trawl exclusion area in PWS to

pelagic trawl gear (Figure 2); and (2) divide PWS into three harvest sections with a maximum of 40% of the annual harvest allowed out of any single section. Although previous surveys indicated that walleye pollock occur year-round within PWS (Parks and Zenger 1979; Haynes and Urban 1991; Bechtol 1999), the relationship between walleye pollock inside PWS and pollock in adjacent Gulf of Alaska waters remains unclear. Even if walleye pollock occurring in PWS intermingle with the Gulf of Alaska stock, the PWS component is not assessed by the National Marine Fisheries Service (NMFS) triennial trawl survey conducted during summer months in the Gulf of Alaska (Chris Wilson, NMFS, Seattle, WA, personal communication). Groundfish resources off the coast of Alaska are co-managed by ADF&G and NMFS (Trowbridge 1996; Berceli et al. 1999). In the absence of area and gear specific regulations established by the Alaska Board of Fisheries or management measures developed by ADF&G through internal and public review, fisheries in state waters typically coincide with seasons in the adjacent federal waters. However, prosecuting the PWS pollock fishery as part of the total allowable catch (TAC) established for the adjacent federal waters of the Gulf of Alaska fails to accommodate resource levels in PWS and could lead to over- or under-utilization of the resource in PWS. In contrast, sustainability for the walleye pollock fishery in PWS may be established if: (1) estimates of walleye pollock biomass inside PWS are available, (2) a conservative harvest level is set for resources in PWS, (3) fishery management measures ensure harvests can be controlled, and (4) further research is conducted to explore the relationship between pollock in PWS and those in adjacent federal waters of the Gulf of Alaska. As an interim approach in view of continuing research on the research between pollock in PWS and the Gulf of Alaska, the current assessment model for Gulf of Alaska has incorporated biomass estimates of PWS pollock (Dorn et al. 1999).

Available Assessment Data

Longline Surveys

A longline survey for sablefish *Anoplopoma fimbria* has been conducted annually since 1996 with the research vessel *Montague* (Bechtol 1998*b*; Table 2). Gear configuration was similar to sablefish surveys conducted in federal waters by the National Marine Fisheries Service (Mike Sigler, NMFS, Juneau, Alaska, personal communication). One survey objective was to evaluate the relative abundance and distribution of all species caught on longline gear. Mean catch of pollock per longline set in the PWS survey ranged from 4.9 fish/set in 1998 to 3.6 fish/set in 1999 (Table 3). However, the longline survey is viewed as providing only an index of abundance for pollock caught in the target depths of 100 fathoms (183 m) and deeper. As additional data becomes available in the future, greater exploration of the utility of the longline data for more complex stock assessment models is anticipated.

Acoustic Surveys

1994 Spring Acoustic

During early and late May 1994, an acoustic survey was conducted in PWS as part of the *Exxon Valdez* Trustee Council Sound Ecosystem Assessment (SEA) project. Expansion of survey data resulted in a walleye pollock biomass estimate of 24,328 mt within the 40-125 m depth range of PWS (Table 2; Jay Kirsch, Prince William Sound Science Center, Cordova, AK, personal communication). However, several factors make it difficult to assess the accuracy of this estimate. First, although sampling conducted during the acoustic survey indicated that walleye pollock were widely distributed at depths greater than 20 m, pollock density (kg/surface area) shallower than 40 m could not be estimated due to echo scattering by a plankton layer. Second, while the acoustic survey did not assess pollock biomass below 125 m, ADF&G bottom trawl surveys in PWS with tows deeper than 125 m in have caught walleye pollock (Bechtol 1999). These two factors likely resulted in an underestimate of walleye pollock biomass in 1994. Furthermore, the acoustic survey only covered western PWS and errors introduced into the biomass estimate by extrapolating acoustic density estimates from western to eastern PWS are unknown.

Winter Acoustic Surveys

In cooperative projects, ADF&G worked with the Prince William Sound Science Center and the fishing industry to obtain more information on the prespawning biomass and distribution of walleye pollock in PWS. Commercial vessels, using biologists and acoustic equipment provided by the Prince William Sound Science Center and ADF&G, conducted acoustic surveys of pollock in PWS after the winter fisheries in 1995, 1997, and 1998 (Thomas and Stables 1995; Kirsch 1997; Kirsch and Thomas 1998). These surveys focused on prespawning walleye pollock aggregation in southwestern PWS, particularly Port Bainbridge, Knight Island Passage, and Montague Strait. All surveys were conducted with the *F/V Alaskan* operate by Jay Stinson of Kodiak.

The 1995 survey involved two survey legs: the first leg, conducted from 24 to 25 February, yielded a walleye pollock biomass estimate of 19,756 mt; the second leg, from 28 February to 1 March, provided an estimate of 37,953 mt (Thomas and Stables 1996). During the second leg, approximately 27,000 mt were observed in Port Bainbridge and 11,000 mt in Lower Knight Island Pass. The mean estimate of both legs was 28,855 mt. Despite a cursory examination of other areas of PWS, no other significant walleye pollock aggregations were found. This wide range in survey estimates over a relative short temporal scale may have indicated short-term spawning movements.

The 1997 PWS acoustic survey, conducted during 23-27 February, yielded a pollock biomass estimate of 37,894 mt (Kirsch 1997). The relative geographic distribution of pollock biomass was a virtual reversal of the distribution in the 1995 survey. In 1997, pollock biomass was distributed approximately 27,000 mt in Lower Knight Island Pass and 11,000 mt in Port Bainbridge. Smaller aggregations were assessed in Orca Bay and east of Green Island but totaled less than 1,000 mt and were excluded from the above 1997 total biomass estimate.

The 1998 acoustic survey, conducted during 8-13 March, yielded a maximum PWS pollock biomass estimate of 114,344 mt (Kirsch and Thomas 1998). This biomass was approximately distributed as follows: 9,800 mt in Port Bainbridge, 63,100 mt in the Lower Knight Island Pass, 39,400 mt extending from Hinchinbrook Entrance across the mouth of Orca Bay, and 2,100 mt in Montague Strait. The Lower Knight Island Pass estimate was a replicate assessment conducted 11 March; the pollock biomass estimate from the first assessment on 9 March was 42,500 mt. With the exception of Port Bainbridge, which yielded a biomass estimate lower than previous years, other areas contained substantially more pollock biomass than was observed in either the 1995 or 1997 acoustic surveys. In particular, the 39,400 mt aggregation extending from Hinchinbrook Entrance across Orca Bay had not been previously observed.

Bottom Trawl Surveys

1989 Trawl Surveys

Following the *M/V Exxon Valdez* oil spill, ADF&G and NMFS conducted two multi-species bottom trawl surveys of PWS in the summer of 1989 using a 400 mesh Eastern otter trawl (Haynes and Urban 1991). The first survey, designed to emulate a previous survey conducted in April 1978 (Parks and Zenger 1979), included 61 hauls during 17 May through 23 June 1989. The second survey, based on a random stratified sampling design, included 63 hauls during 7 August through 13 September 1989. The survey estimated a walleye pollock biomass of 9,500 mt. Actual pollock biomass was probably greater because the semi-pelagic habits of this species likely made some of the population unavailable to the bottom trawl survey gear. Furthermore, the 400-mesh Eastern gear has a lower rise opening than bottom trawls currently used in the NMFS triennial surveys (Eric Brown, NMFS, Seattle, WA, personal communication), so abundance data collected in PWS were not directly comparable to data collected in the Gulf of Alaska.

1995 Trawl Survey

A bottom trawl survey with the ADF&G research vessel *Pandalus* towing a 400 mesh Eastern bottom trawl has been conducted biennially since 1995. The 1995 survey had a limited geographic distribution that focused on crab habitat in the eastern portion of PWS and the utility of the trawl data for biomass estimation cannot be determined without additional analyses (unpublished data). However, pollock length data from the 1995 bottom trawl survey is provided in this report.

1997 Trawl Survey

For the 1997 survey, PWS was divided into potential sample stations, each measuring 6.25 square nautical miles. PWS was additionally sectioned into quadrants delineated at 147°00' W longitude and 60°30' N latitude. Historical crab survey stations in the Orca Bay, Port Fidalgo, and North Montague areas were systematically selected using historical tow paths. Additional

stations were randomly selected from the southwest area. Selected station was sampled by a 1.0 nautical mile long tow. Survey effort involved 53 tows, apportioned as 26 stations in the southwest quadrant, 25 stations in the northeast, and two stations in the southeast (Bechtol 1999). Due to vessel gear limitations, depth of tows was generally less than 109 m (200 fm). Average catches of pollock per nautical mile towed were 98.6 kg (217.4 lb) in the southwest, 74.3 kg (163.8 lb) in the northeast, and 1.8 kg (4.0 lb) in the southeast. No tows were made in the northeast area. The lack of tows in the northwest quadrant complicated calculation of biomass estimates. Exclusion of the northwest quadrant when PWS pollock biomass was considered, but would have likely to have substantially underestimated actual biomass.

Another approach with the trawl data involved post-stratification of PWS surface area according to 91.6 m (50 fathom) bottom depth contours. In this case, mean catch from trawl stations within a stratum was expanded by the stratum surface area. Four of the nine depth strata represented on a NOAA nautical chart were sampled by the 1997 trawl survey. After excluding unsampled strata, this approach yielded a 27% and 16% coverage of the available survey stations in the two largest depth strata; 11% of all potential survey stations were sampled in 1997. The pollock biomass estimate for the four sampled strata was 21,000 mt ± 9,491 mt (95% confidence interval; Table 2). This estimate incorporated some habitat from all PWS quadrants but was seen as conservative because the surveyed strata represented only 74% of the available PWS surface area. Full expansion to the entire surface area would yield an estimated pollock biomass of 28,676 mt but would incorporate unsurveyed depth strata.

1999 Trawl Survey

During 28 June to 12 July 1999, the ADF&G vessel *Pandalus* made 67 successful tows within PWS with a 400 mesh eastern trawl. This represented 13.5% of the available survey station grids. Estimated biomass of walleye pollock was 6,304 +/-2,812 (95% CI) metric tons. Average catches of pollock per nautical mile towed were 14.7 kg (32.2 lb) in the southwest, 18.2 kg (40.2 lb) in the northeast, 2.2 kg (4.8 lb) in the southeast, and 7.2 kg (15.8 lb) in the northeast area. Mean survey catch was 29.5 lb/nm towed. Although distribution patterns of pollock appeared to be similar to the 1997 trawl survey, catch rates generally declined in all areas and substantially fewer large aggregations were observed than in previous surveys, as evidenced by a lack of large catches (e.g., >500 lb) of pollock in individual tows (Table 4).

Trawl Catchability Considerations

In October 1997, NMFS and ADF&G conducted a project off the southern end of Kodiak to compare bottom trawl catchabilities among the NMFS and ADF&G bottom trawl survey gears (Eric Brown, National Marine Fisheries Service, Seattle, WA, personal communication). NMFS used a four-seam, high-opening polyethylene Nor'eastern trawl equipped with roller gear and towed by a NMFS-chartered vessel, the *Peggy Jo*. ADF&G used standard 400 mesh Eastern nets towed by the ADF&G research vessels the *Resolution* and the *Pandalus*. Instrumentation attached to the nets indicated mean net widths were virtually identical at 13.8 m among all nets, while the vertical openings were substantially different at 6.9 m for the Nor'eastern trawl and 1.9 m for the Eastern trawls. Preliminary results indicated that standardized catch rates for walleye

pollock were 3.1 times greater with the NMFS Nor'eastern trawl than with ADF&G's Eastern trawl (Eric Brown, NMFS, Seattle, WA). As a result, the ADF&G survey likely underestimated summer pollock biomass in PWS when compared to what the NMFS trawl might have estimated.

Age, Weight, and Length Data

Length and sex composition data were collected from walleye pollock sampled from PWS during 1995-1999. Sample sources included the commercial fishery that opens January 20; the test fishery that occurs 1-2 weeks after the close of the commercial fishery; a semi-periodic acoustic survey in late February or early March; a biennial summer bottom trawl survey; and a fall annual longline survey. The fisheries and the acoustic survey targeted winter spawning aggregations whereas the bottom trawl and longline surveys captured fish that were generally less aggregated. Sample collections also varied geographically. The commercial fishery occurred in southwestern PWS; the test fishery and acoustic survey occurred in both southwestern and eastern PWS; and the surveys sampled throughout PWS. Sagittal otoliths were removed for aging of pollock in 1997-1999. To date, age data are available from the 1997 and 1998 commercial and test fisheries and the 1999 commercial fishery.

Length distribution in the 1995 PWS commercial fishery ranged from 44-65 cm (Figure 3), with males comprising 46% of all samples. The most abundant male pollock measured 51 cm, whereas the most abundant female pollock measured 56 cm. Lengths in the 1995 summer trawl survey ranged from 18-74 cm, with males comprising 46% of all samples. The most abundant fish measured 52 cm for both male and female pollock.

Males comprised 56% of all samples in the 1996 PWS commercial fishery. The length distribution ranged from 38-64 cm, with the most abundant male pollock being 52-cm fish and the most abundant female pollock being 56-cm fish (Figure 4). Length frequency data from the commercial pollock fisheries indicated PWS pollock were substantially larger than pollock caught in other GOA areas in 1996. Length distribution in the longline fishery range from 29-73 cm. Nearly 35% of the pollock from the longline survey were larger than 64 cm, the largest size that was observed in the commercial fishery.

In 1997, male pollock comprised 54% of commercial fishery samples but only 45% of test fishery samples and 42% of acoustic survey samples. For both male and female pollock, the 56-cm fish were the dominant size mode in the PWS commercial fishery (Figure 5). In test fishery samples, the most abundant pollock measured 55 cm for males and 59 cm for females. Acoustic survey samples were dominated by 54-cm fish for both male and female pollock. A mode of smaller fish, centered at 32-34 cm for male and female pollock, was also observed in the acoustic surveys. Length distribution in the bottom trawl survey ranged from 10-74 cm, with male pollock comprising 45% of the samples. The most abundant fish measured 55 cm for both male and female pollock. In the longline survey, pollock lengths ranged from 36-74 cm. Most of the longline samples were larger than 57 cm. Age data for 1997 indicated age-7 pollock were the most abundant age class in both the commercial and test fish samples (Figure 6). Age-7 males

and age-7 females contributed 17% and 15%, respectively, of commercial samples and 17% and 20%, respectively, of test fish samples.

In 1998 samples, male pollock comprised 52% of all commercial samples, 53% of the test fish samples and 68% of the acoustic survey samples. The most abundant size modes were 55 cm for males and 57 cm for females in the commercial fishery, and 55 cm for males and 56 for females in the test fishery (Figure 7). In the March acoustic survey, 57-cm fish were the most abundant male pollock and 60-cm fish were the most abundant females. A smaller-sized cohort, centered at 38 cm for males and 42 cm for females, was also observed in the 1998 acoustic survey. Age–8 pollock were the most abundant fish in the commercial fishery and the most abundant male pollock in the test fishery (Figure 6). Age-9 fish females were slightly more abundant than age-8 females in the test fishery.

Pollock in the 1999 commercial fishery ranged from 35-65 cm, with males pollock comprised 50% of the samples (Figure 8). Bottom trawl samples ranged from 10-74 cm, with males comprising 43% of the pollock catch. The most abundant size modes were 52 and 56 cm for males and 58 cm for females in the commercial fishery, and 51 cm for both males and in the bottom trawl survey. Age–5 pollock were the most abundant fish in the commercial fishery (Figure 6).

Length distributions of pollock sampled from the PWS commercial fisheries were generally similar during 1995 to 1999, although a shift toward slightly smaller fish was evident in the 1999 samples (Figure 9). In general, trawl surveys caught a greater proportion of small pollock, and longline surveys caught a greater proportion of larger pollock, when compared to commercial fishery catches (Figures 3-5, 7, and 8).

Biological Markers

Biological markers may yield data on the mixing or the lack of mixing between pollock in PWS and adjacent federal waters. Previous genetic studies of pollock indicated that heterogeneity exists across large areas, such as between the Eastern Bering Sea and the Sea of Japan. ADF&G biologists assessed three different types of genetic markers to evaluate differentiation among pollock stocks collected from PWS, the Western Gulf of Alaska, and the Eastern Bering Sea (Eric Kretschmer, ADF&G, Anchorage, AK, personal communication). Walleye pollock collected from PWS, Shelikof Strait, and near Bogoslof Island in the Bering Sea were assayed for genetic variation at microsatellite, mtDNA and allozyme loci. Of seven microsatellite loci developed in Atlantic cod *Gadus morhua*, four amplified in walleye pollock. Mendelian inheritance of the microsatellite loci was confirmed using three single-pair matings. The four microsatellite loci had a frequency for the most common allele ≤ 0.95. Five regions of walleye pollock mtDNA were amplified and digested with 33 restriction enzymes; ten enzymes produced polymorphisms. Finally, 31 allozyme loci were screened, and seven allozyme loci had a frequency for the most common allele ≤ 0.95. The mtDNA analysis showed significant differences between Gulf of Alaska samples, treated as collections pooled from PWS and

Shelikof, and Bering Sea samples collected near Bogoslof Island. The results indicate that these three types of genetic markers may be useful for future studies of walleye pollock populations.

In addition, Prince William Sound Science Center staff observed differences in the carbon isotope ratios of *Neocalanus* spp. from inside and outside PWS, and used these ratios to identify feeding habits of young-of-the-year (YOY) pollock (T. Kline, Prince William Sound Science Center, Cordova, AK, personal communication). YOY pollock were subsequently classified by carbon isotope ratios into the following geographic groups: (1) Gulf of Alaska and South Montague; (2) Eastern PWS; and (3) Western PWS. Although adult pollock showed similar C_{13} signatures, greater work is needed to understand uptake/response times.

Relative Change in the Eastern Gulf of Alaska Regulatory Area

Previous estimates of surplus production in the PWS pollock population relied on an assumption that large-scale processes that simultaneously affect many areas across the northern Gulf of Alaska direct changes in ecosystem productivity. Thus, ecosystem functions that cause changes to the pollock population of the Eastern Gulf of Alaska Regulatory Area might be expected to effect a similar relative change in the PWS pollock population. As a result, the relative scale of changes in the allowable biological catch (ABC) for pollock in adjacent federal waters of the Eastern Gulf of Alaska Regulatory Area has been used to scale changes in the PWS pollock guideline (Hollowed et al. 1995, 1996; Bechtol 1998*a*). Another approach would be to apply the change exhibited in the exploitable biomass between years. Estimate exploitable biomass of Gulf of Alaska pollock has continued to decline since in recent years, falling an estimated 20% from 1998 to 1999 (Dorn et al. 1999). Application of this approach to the 1999 PWS GHL would yield a 2000 GHL of 1,680 mt.

Fixed Harvest Level

A fixed annual harvest level may be applied for some fisheries to achieve sustainable yield amidst variable recruitment and fishing effort. This approach was used to set the 1999 GHL of 2,100 mt for PWS pollock (Bechtol 1998*b*). Under this approach, the 2000 GHL would again be 2,100 mt.

GUIDELINE HARVEST RECOMMENDATIONS

The 1995, 1997, and 1998 winter acoustic surveys of prespawning pollock aggregations in PWS yielded biomass estimates that were substantially greater than recent or historical summer population estimates. In particular, the 1998 survey observed a previously unassessed

aggregation in eastern PWS in the mouth of Orca Bay. Among all PWS survey sites, the 1998 acoustic biomass estimate was three times greater than the 1977 biomass estimate (Kirsch and Thomas 1998). However, the relationship between these prespawning aggregations and the summer population unassessed by the NMFS surveys is unknown. Genetic analyses of PWS pollock stock structure have been inconclusive and somewhat contradictory to date (J. Seeb, ADF&G, Anchorage, AK, personal communication). No winter assessment was conducted in 1999. Further research is needed to explore: (1) the utility of winter acoustic data in determining exploitable biomass for the PWS pollock resources; and (2) the relationship of PWS pollock to pollock in the Gulf of Alaska.

The harvest guideline for the PWS pollock fishery has been based on estimates of the pollock resource not assessed by NMFS surveys in adjacent federal waters. Although a substantial summer pollock population was observed in PWS by numerous assessment studies that followed the *EXXON Valdez* Oil Spill, many of the studies encountering pollock focused on juvenile pollock interactions with rearing Pacific herring (*Clupea pallasi*) and salmonids (*Ocorhynchus* spp.). The wide variety of habitats, an extensive plankton bloom that inhibits acoustic assessments, and depth distributions that exceed 700 m have hampered acoustic assessments of the adult summer population in PWS. An alternative of extrapolating a previous PWS guideline by the relative change of the allowable biological catch in the adjacent federal waters fails to incorporate data on PWS pollock generated by more recent summer surveys.

Following standards for establishing harvest guidelines in federal water fisheries, PWS pollock would fall under Tier 5 because an estimate of the population biomass is available. Tier 5 standards set the harvest level as 75% of the product of the biomass estimate and estimated natural mortality. In this case, the natural mortality rate is assumed to be 0.30, which is applied for pollock in federal assessment models for the Gulf of Alaska (Dorn et al. 1999). Thus, the recommended guideline harvest level for Prince William Sound pollock is:

$$GHL = B \times M \times 0.75 = 6{,}304 \times 0.30 \times 0.75 = 1{,}420 \text{ mt.}$$

Cintinuing PWS Pollock Research

Genetic assessment to differentiate pollock from PWS, the Gulf of Alaska, and the Bering Sea is still in progress (J. Seeb, ADF&G, Anchorage, AK). In addition, staff from the Prince William Science Center continue to examine pollock from inside and outside of PWS for isotope signatures. ADF&G will continue to conduct annual longline surveys, with most of the survey effort focusing on the northwest quadrants of PWS and one third of the effort rotating among other areas of PWS. Finally, ADF&G is scheduled to coordinate another acoustic survey of spawning aggregations of pollock in the winter of 2000. ADF&G is also scheduled to conduct another bottom trawl survey of PWS during 2001. The 2001 trawl survey would again occur at approximately the same time of year as the biennial trawl survey conducted by NMFS in the adjacent federal waters.

Fishery Management Measures

The fishing power of mid-water trawl vessels makes it possible to harvest and even exceed the relatively small guideline harvest level within a short time frame. To meet stock conservation needs and allow for an orderly harvest, the Alaska Board of Fisheries adopted a registration deadline of 13 January for any vessel participating in the PWS pollock fishery. The Board also adopted a regulation to allow trawl fishing for pollock only under the terms of a permit issued by the commissioner of ADF&G. This permit may include requirements for logbooks, observers, harvest reporting procedures, and other specifications. The following measures will likely be implemented for the 2000 fishery:

Fishing Season - The fishery will open at 12:00 noon on 20 January 2000, and will remain open until the guideline harvest level (GHL) is taken. This opening will coincide with the opening of trawl fishing for pollock in adjacent federal waters. Time and area closures may be used to reduce the bycatch of non-target species.

Check-In/Check-Out procedures - Vessel operators are required to check-in and check-out with the Cordova ADF&G office prior to fishing.

Observer Coverage - All vessels must carry an ADF&G observer if requested.

Logbook Reporting - All vessels will be required to maintain logbooks while participating in this fishery.

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Table 1. Annual commercial walleye pollock harvest from Prince William Sound, Alaska during 1987-1998.

Year[a/]	Round Weight (metric tons)			
	Longline	Trawl	Other	Total
1987	0.4			0.4
1988	0.7			0.7
1989	0.2	0.4	<0.1	0.7
1990	0.3	3.0		3.3
1991				0.0
1992	<0.1	2.7		2.7
1993	0.1	2.5		2.6
1994	<0.1		2.5	2.5
1995	1.6	2,954.5	2.7	2,958.8
1996	0.3	1,671.4	0.6	1,672.3
1997	3.2	2,023.6	0.1	2,026.9
1998	1.2	2,107.1	0.0	2,108.3
1999	5.4	2,342	0.0	2,347.7

[a/] Preliminary data through 26 October 1999.

Table 2. Unweighted catch abundance and mean catch rates from the sablefish longline survey of Prince William Sound, 1996-1999.

	Sablefish	Pacific Cod	Pollock	Arrowtooth Halibut	Demersal Flounder	Slope Rockfish	Skates	Salmon Shark	Spiny Dogfish	Sleeper Shark	Other	Hooks Without Fish: Baited	Ineffective	Unbaited	Total Hooks
1996 - Northwest PWS (n = 31 stations)															
Abundance	1,652	239	129	841	70	4	109	451	1	27	35	9	15,674	369	1,360	20,970
% of Hooks	7.9%	1.1%	0.6%	4.0%	0.3%	<0.1%	0.5%	2.2%	<0.1%	0.1%	0.2%	<0.1%	74.7%	1.8%	6.5%	100.0%
Fish/Hook	0.46	0.07	0.04	0.24	0.02	<0.01	0.03	0.13	<0.01	0.01	0.01	<0.01				
Fish/Set	53.3	7.7	4.2	27.1	2.3	3.5	0.1	14.5	0.0	0.9	1.1	0.3				
1997 - Northwest and Southwest PWS (n = 34 stations)															
Abundance	1,559	260	138	945	104	3	92	339	0	91	59	32	17,275	536	1,517	22,950
% of Hooks	6.8%	1.1%	0.6%	4.1%	0.5%	<0.1%	0.4%	1.5%	0.0%	0.4%	0.3%	0.1%	75.3%	2.3%	6.6%	100.0%
Catch/Hook	0.43	0.07	0.04	0.26	0.03	<0.01	0.03	0.09	0.00	0.03	0.02	0.01				
Fish/Set	45.9	7.6	4.1	27.8	3.1	2.7	0.1	10.0	0.0	2.7	1.7	0.9				
1998 - Northwest and Eastern PWS (n = 38 stations)															
Abundance	2,698	476	187	975	111	2	99	622	1	1,948	103	11	16,147	1,322	948	25,650
% of Hooks	10.5%	1.9%	0.7%	3.8%	0.4%	<0.1%	0.4%	2.4%	<0.1%	7.6%	0.4%	<0.1%	63.0%	5.2%	3.7%	100.0%
Catch/Hook	0.37	0.07	0.03	0.13	0.02	<0.01	0.01	0.09	<0.01	0.27	0.01	<0.01				
Fish/Set	71.0	12.5	4.9	25.7	2.9	2.6	0.1	16.4	0.0	51.3	2.7	0.3				
1999 - Northwest and Southwest PWS (n = 30 stations)															
Abundance	1,833	169	107	668	83	0	64	179	0	51	128	7	14,735	1,092	1,134	20,250
% of Hooks	9.1%	0.8%	0.5%	3.3%	0.4%	0.0%	0.3%	0.9%	0.0%	0.3%	0.6%	<0.1%	72.8%	5.4%	5.6%	100.0%
Catch/Hook	0.56	0.05	0.03	0.20	0.03	0.00	0.02	0.05	0.00	0.02	0.04	<0.01				
Fish/Set	61.1	5.6	3.6	22.3	2.8	2.1	0.0	6.0	0.0	1.7	4.3	0.2				
Means Among Years															
% of Hooks	8.6%	1.3%	0.6%	3.8%	0.4%	<0.1%	0.4%	1.8%	<0.1%	2.4%	0.4%	<0.1%	71.1%	3.7%	5.5%	100.0%
Catch/Hook	0.44	0.06	0.03	0.19	0.02	<0.01	0.02	0.09	<0.01	0.12	0.02	<0.01				
Fish/Set	58.2	8.6	4.2	25.8	2.8	2.7	0.1	12.0	0.0	15.9	2.4	0.4				

Table 3. Walleye pollock biomass estimates from a variety of Prince William Sound surveys, 1989-1999.

Estimation Source	Survey Estimated Biomass (mt)		Comments
1989 Bottom Trawl Survey	9,500	Summer	Summer survey.
1994 Hydroacoustic Survey	24,328	Summer	Target discrimination problems >140 m and <20 m.
1995 Hydroacoustic Survey	28,855	Winter	Prespawning Aggregation.
1997 Hydroacoustic Survey	37,894	Winter	Prespawning Aggregation.
1997 Trawl Survey	21,220	Summer	Few stations in SE and no stations in NW
1998 Hydroacoustic Survey	114,344	Winter	Prespawning Aggregation.
1999 Trawl Survey	6,304	Summer	Few stations in SE and no stations in NW
1996-1999 Longline Surveys	NA	Fall	Relative abundance and distribution data

Table 4. Tow description and pollock catch in a bottom trawl survey of Prince William Sound, 1999.

Tow No.	Station	Date	Tow Midpoint Latitude	Tow Midpoint Longitude	Distance (nm)	Depth (fathoms) Minimum	Depth (fathoms) Maximum	Scope (fathoms)	Pollock Catch (lb)
99101	AD13	6/28/99	60.07	147.62	1.04	50	77	175	16
99102	AE12	6/28/99	60.03	147.68	0.61	85	89	200	6
99103	AE11	6/28/99	60.02	147.78	0.98	149	150	350	8
99104	AF11	6/28/99	59.97	147.79	1.07	116	123	275	0
99105	U15	6/29/99	60.43	147.46	1.09	84	86	200	38
99106	V15	6/29/99	60.39	147.49	0.97	86	93	210	30
99107	W14	6/29/99	60.38	147.57	0.98	101	105	250	42
99108	102	6/29/99	60.45	147.26	0.97	115	132	300	42
99109	111	6/30/99	60.41	147.08	1.01	86	91	250	32
99110	112	6/30/99	60.43	147.02	1.04	118	127	300	6
99111	110	6/30/99	60.45	147.11	1.02	101	104	300	30
99112	109	6/30/99	60.48	147.13	1.09	103	104	300	50
99113	106	6/30/99	60.49	147.19	1.02	99	101	300	18
99114	107	6/30/99	60.42	147.23	1.0	91	96	275	28
99115	108	6/30/99	60.38	147.19	1	56	60	150	122
99116	105	7/1/99	60.30	147.29	1.03	63	74	175	62
99117	104	7/1/99	60.35	147.29	1	77	78	175	56
99118	103	7/1/99	60.40	147.26	0.99	62	69	175	0.44
99119	101	7/1/99	60.47	147.30	0.99	101	105	250	50
99120	U22	7/1/99	60.42	146.89	1.01	174	175	375	8
99121	Y24	7/1/99	60.26	146.73	0.99	100	102	225	12
99122	X24	7/1/99	60.30	146.73	1.03	98	108	225	14
99123	x25	7/1/99	60.32	146.61	1.01	40	46	100	4
99124	21	7/3/99	60.59	146.13	1.03	72	77	175	40
99125	18	7/3/99	60.59	146.22	0.98	75	76	175	26
99126	16	7/3/99	60.60	146.39	0.99	63	65	175	6
99127	15	7/3/99	60.65	146.34	1.01	71	72	175	22
99128	14	7/3/99	60.69	146.26	1.00	75	77	200	26
99129	13	7/3/99	60.71	146.15	1.03	103	107	275	48
99130	11	7/4/99	60.61	146.47	1.03	54	64	150	12
99131	5	7/4/99	60.59	146.55	1.02	68	70	200	22
99132	1	7/4/99	60.65	146.71	0.61	65	74	225	2
99133	2	7/4/99	60.51	146.68	1.05	99	104	300	50

Table 4. (Continued)

Tow No.	Station	Date	Tow Midpoint Latitude	Tow Midpoint Longitude	Distance (nm)	Depth (fathoms) Minimum	Depth (fathoms) Maximum	Scope (fathoms)	Pollock Catch (lb)
99134	3	7/4/99	60.47	146.68	1.06	91	94	275	0
99135	4	7/4/99	60.40	146.74	1.06	117	121	350	0
99136	6	7/5/99	60.56	146.65	1.05	54	56	175	0.946
99137	7	7/5/99	60.54	146.62	1.04	65.5	70	200	0
99138	T23	7/5/99	60.47	146.78	1.01	172	173	375	4
99139	8	7/5/99	60.50	146.61	1.01	73	82	200	2
99140	10	7/5/99	60.53	146.54	1.06	64	64	200	24
99141	9	7/6/99	60.56	146.52	1.06	73	74	225	0
99142	12	7/6/99	60.55	146.46	1.00	64	73	200	6.05
99143	17	7/6/99	60.56	146.40	1.02	57	67	200	6
99144	19	7/6/99	60.56	146.30	0.97	65	69	200	10
99145	20	7/6/99	60.56	146.22	1.04	75	76	225	26
99146	22	7/6/99	60.56	146.13	1.07	81	82	250	56
99147	23	7/6/99	60.57	146.05	1.03	93	107	275	128
99148	24	7/6/99	60.61	146.91	0.96	99	100	275	
99149	28	7/7/99	60.78	146.68	1.02	88	91	250	32
99150	27	7/7/99	60.78	146.62	1.01	93	96	275	22
99151	26	7/7/99	60.80	146.49	1.01	107	108	300	26
99152	25	7/7/99	60.81	146.32	1	108	112	300	56
99153	I25	7/8/99	60.94	146.63	0.96	52	64	150	408
99154	H23	7/8/99	60.97	146.81	0.99	205	211	450	20
99155	G24	7/8/99	61.03	146.68	1.03	164	181	425	4
99156	E26	7/8/99	61.10	146.55	0.95	132	133	350	0
99157	E27	7/9/99	60.11	146.47	0.76	130	130	300	4
99158	L18	7/9/99	60.81	147.22	1.03	213	220	425	0
99159	Q18	7/9/99	60.62	147.18	1.06	126	135	325	2
99160	N08	7/9/99	60.71	148.07	0.98	237	237	450	6
99161	I7	7/9/99	60.92	148.16	1.03	210	215	450	64
99162	M2	7/11/99	60.76	148.57	0.97	193	195	450	24
99163	AB09	7/11/99	60.15	147.92	1.02	158	160	425	12
99164	AA09	7/11/99	60.18	147.94	1.02	183	216	450	26
99166	AE04	7/12/99	60.03	148.37	1.02	145	148	375	20
99167	AC05	7/12/99	60.10	148.33	0.93	144	144	350	14
99168	AD04	7/12/99	60.06	148.35	1.02	146	146	375	40

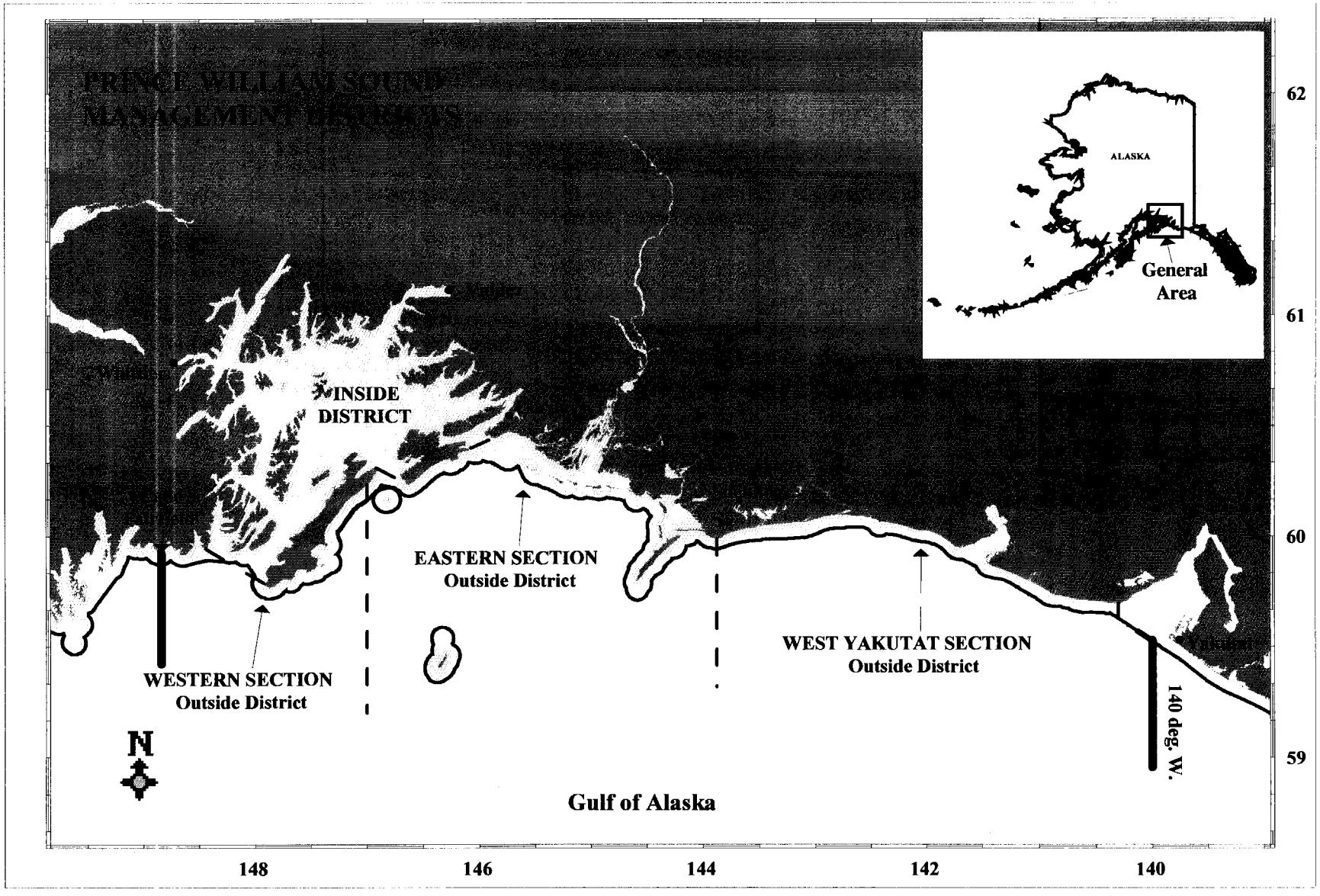

Figure 1. Groundfish management districts of the Prince William Sound Management Area.

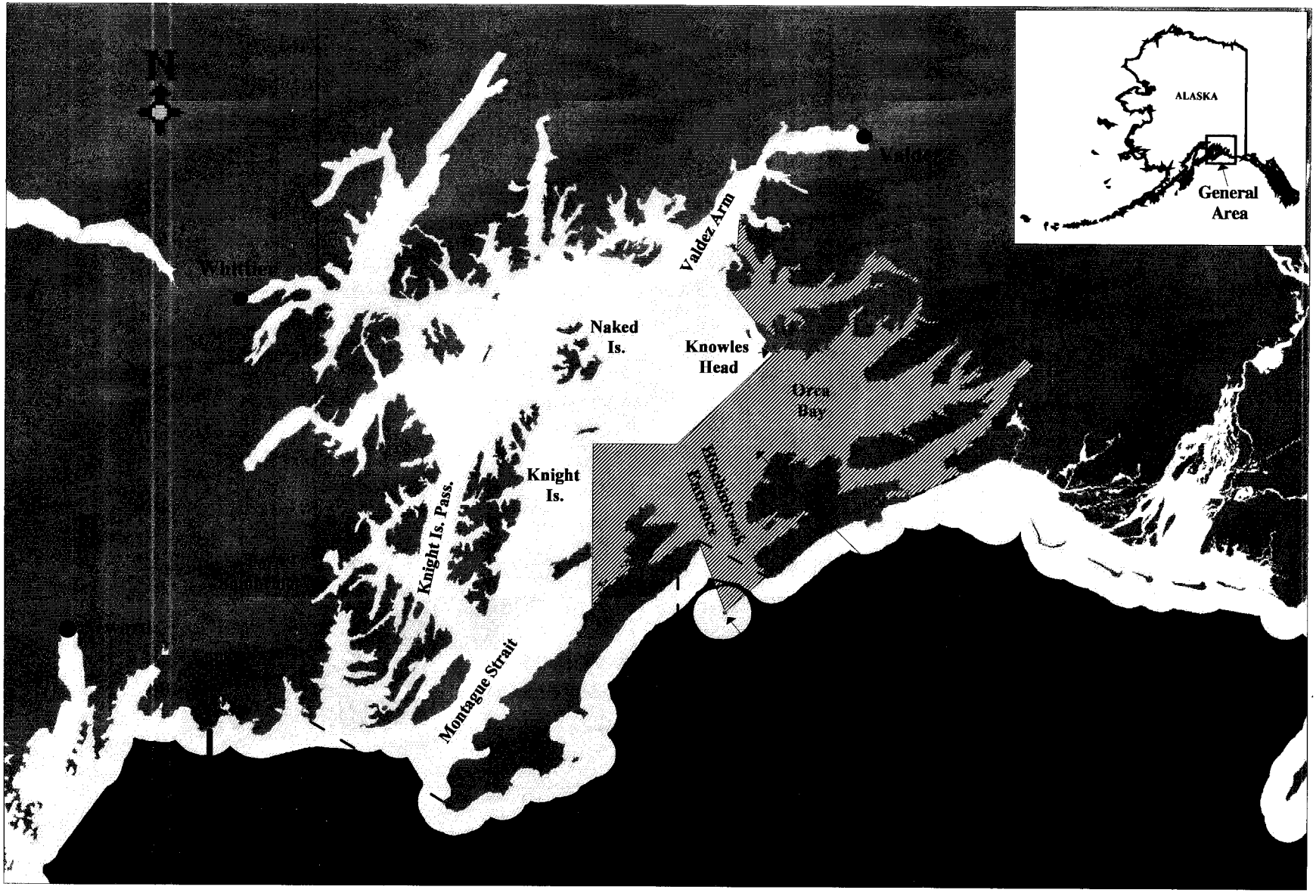

Figure 2. Locations of interest in Prince William Sound.

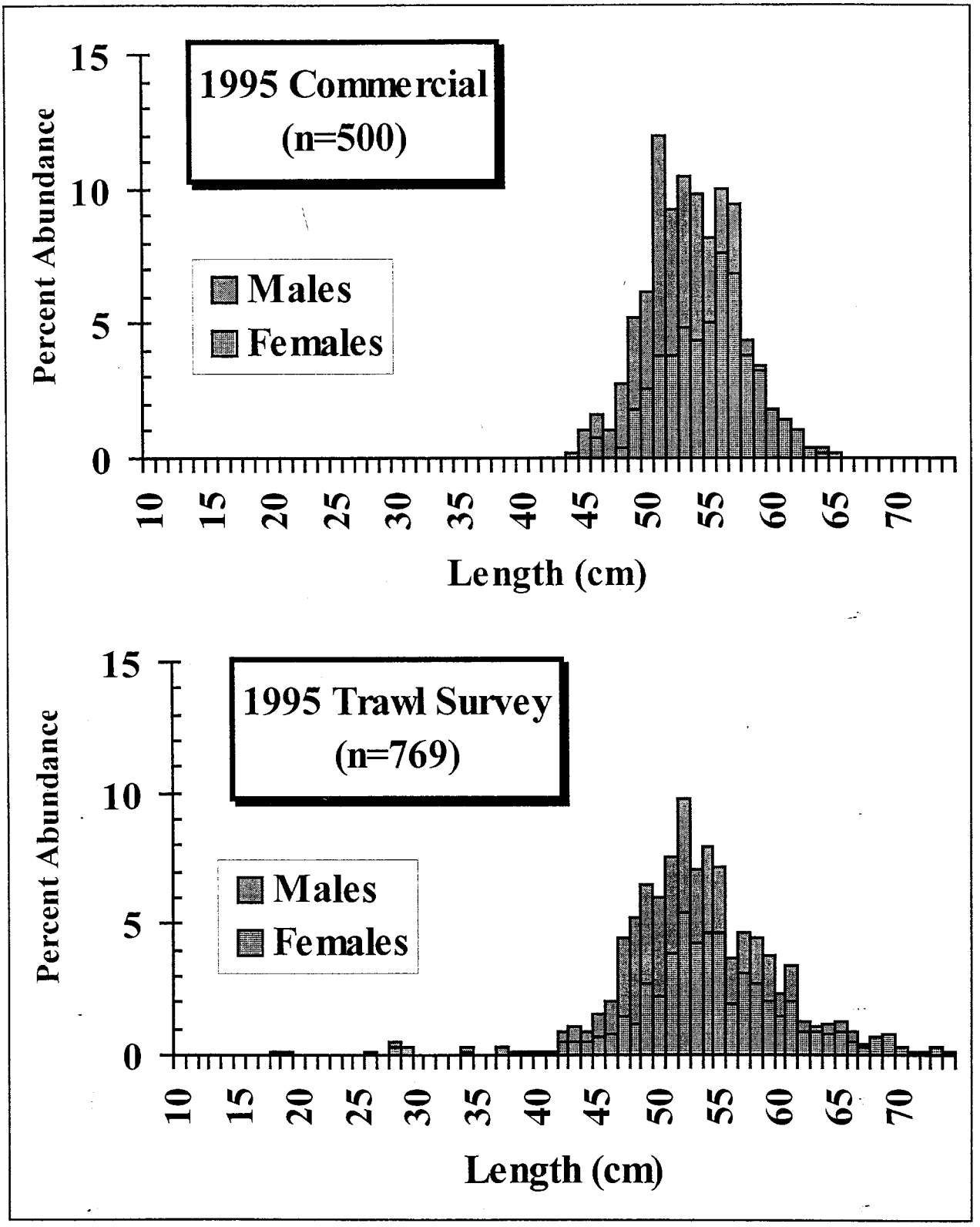

Figure 3. Length distribution of Prince William Sound pollock, 1995.

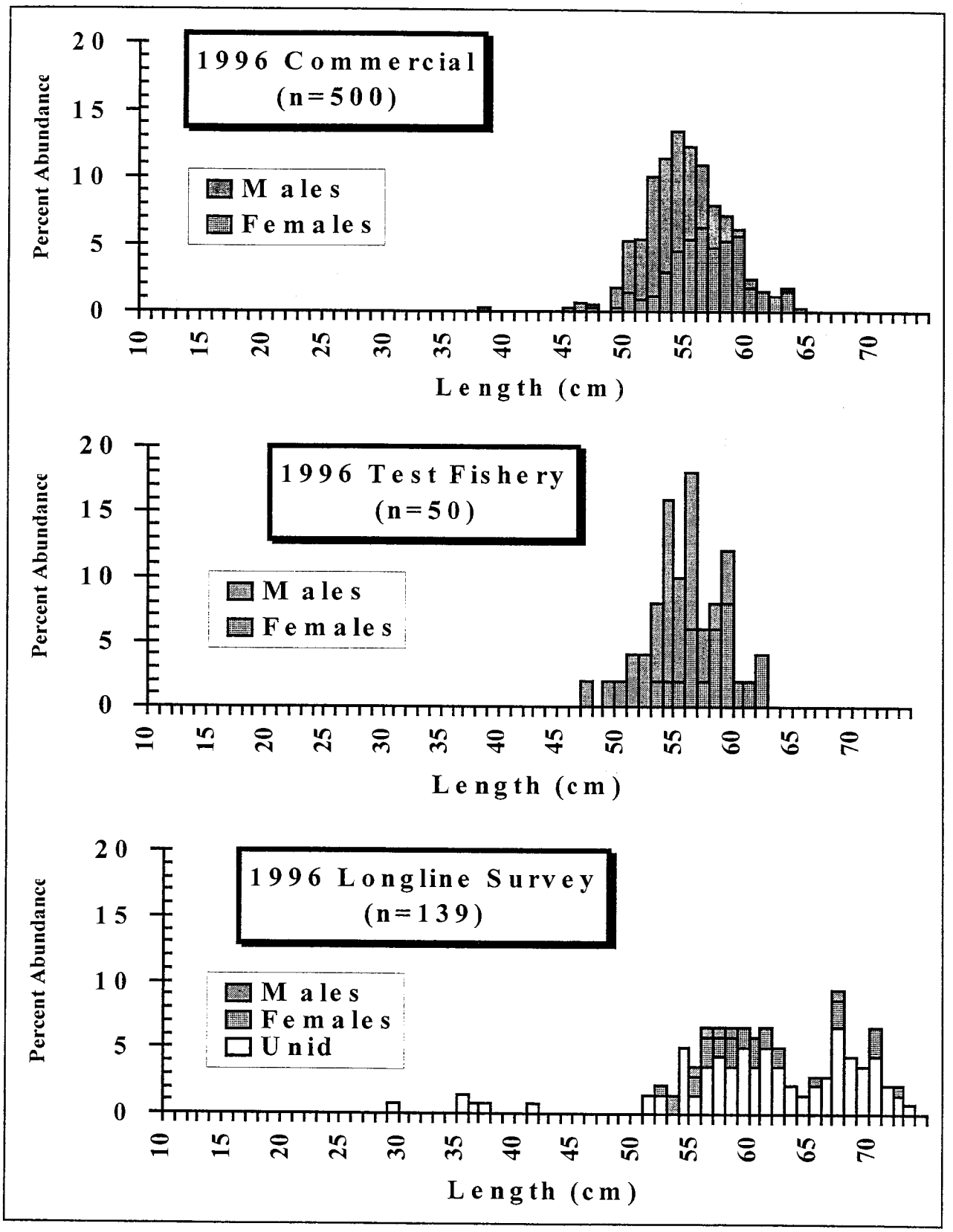

Figure 4. Length distribution of Prince William Sound pollock, 1996.

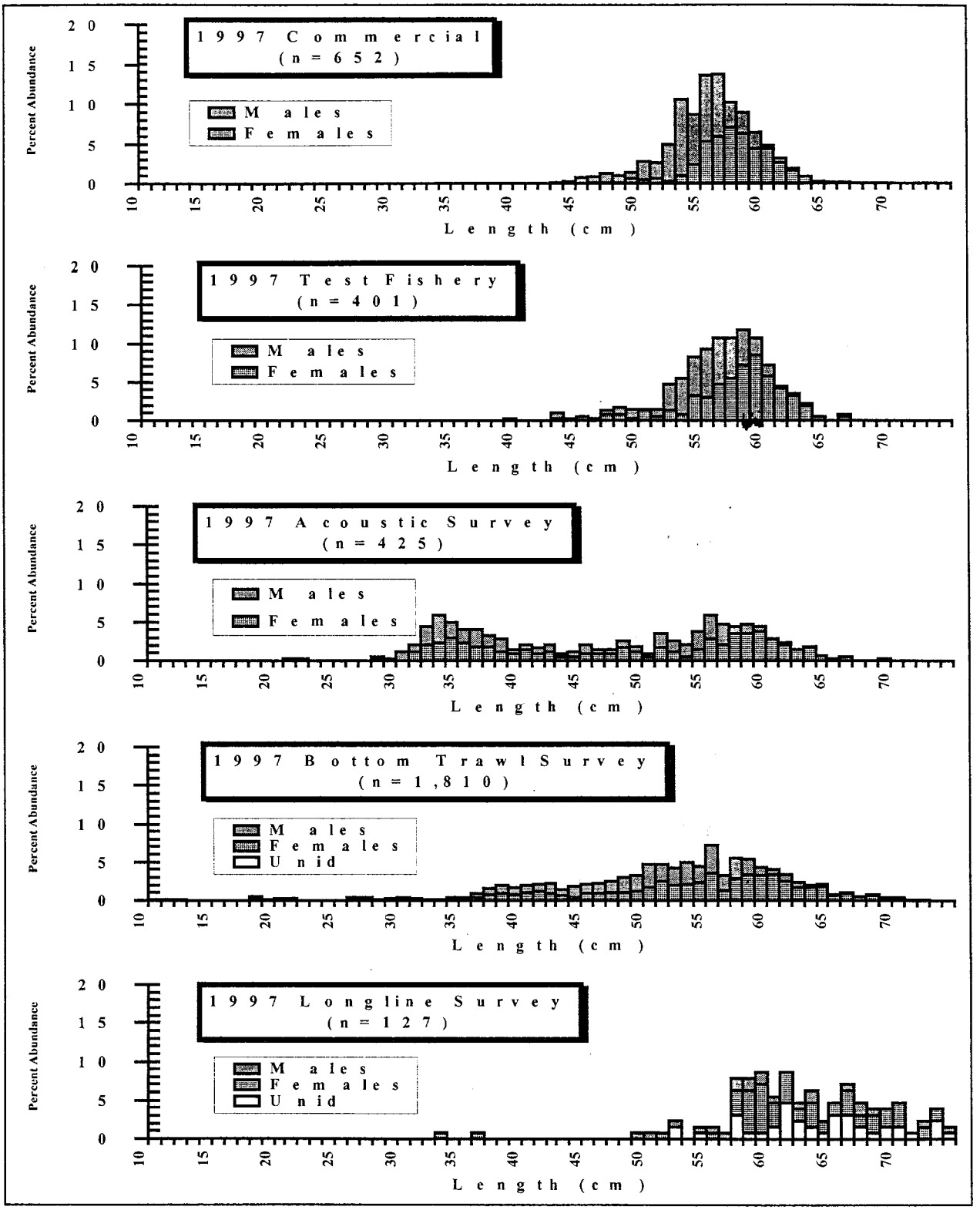

Figure 5. Length distribution of Prince William Sound pollock, 1997.

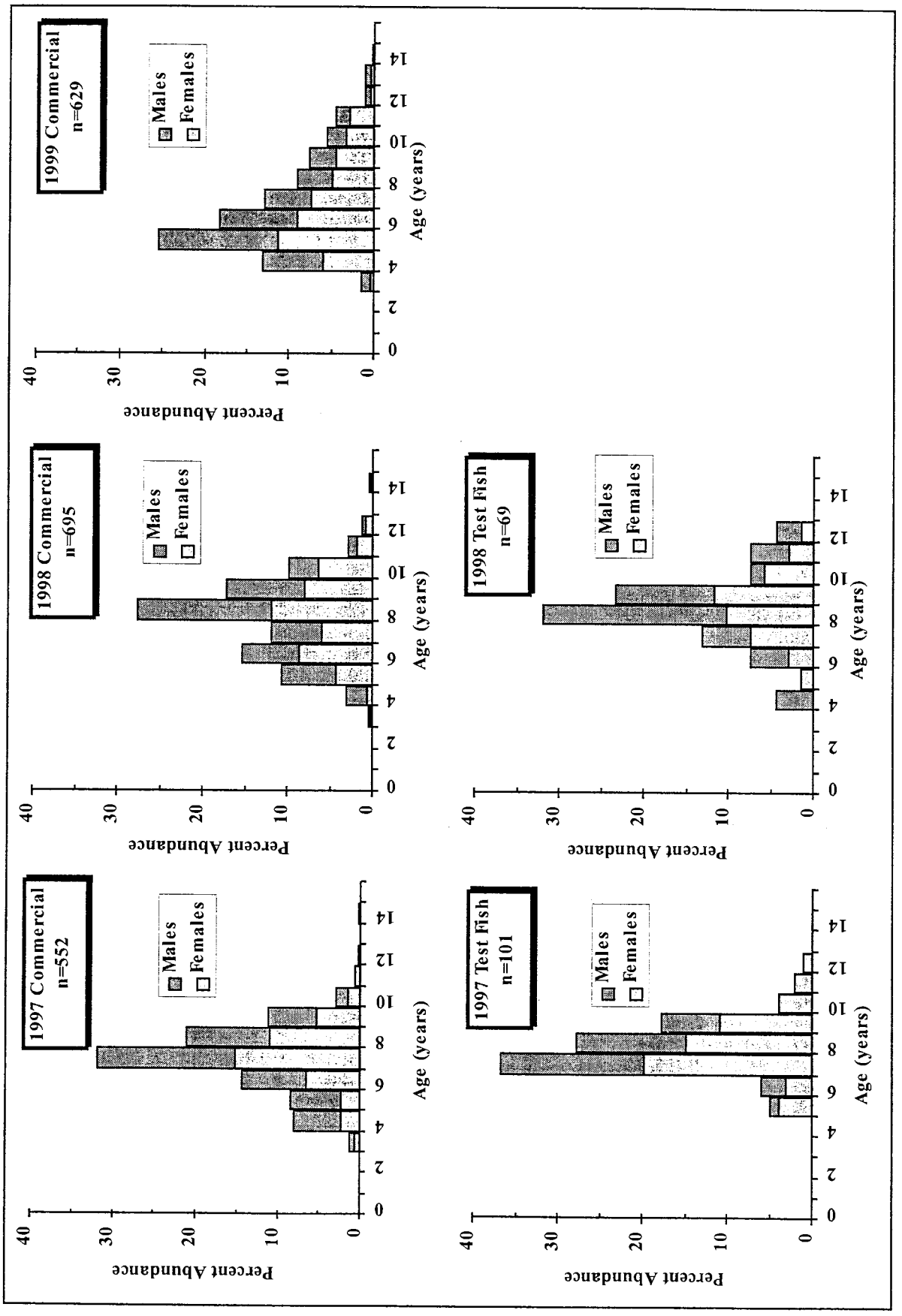

Figure 6. Age composition of pollock sampled from Prince William Sound, 1997-1999.

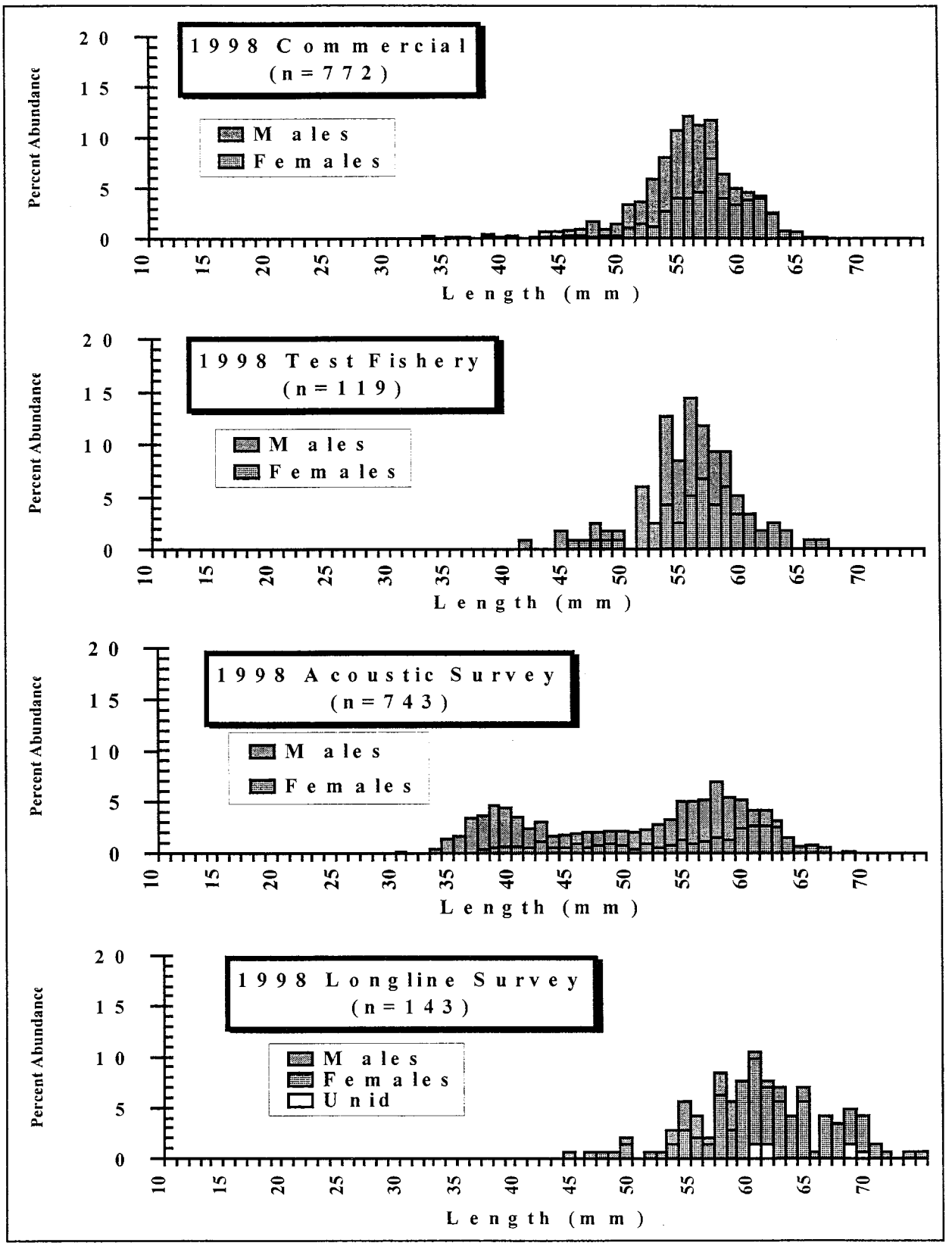

Figure 7. Length distribution of Prince William Sound pollock, 1998.

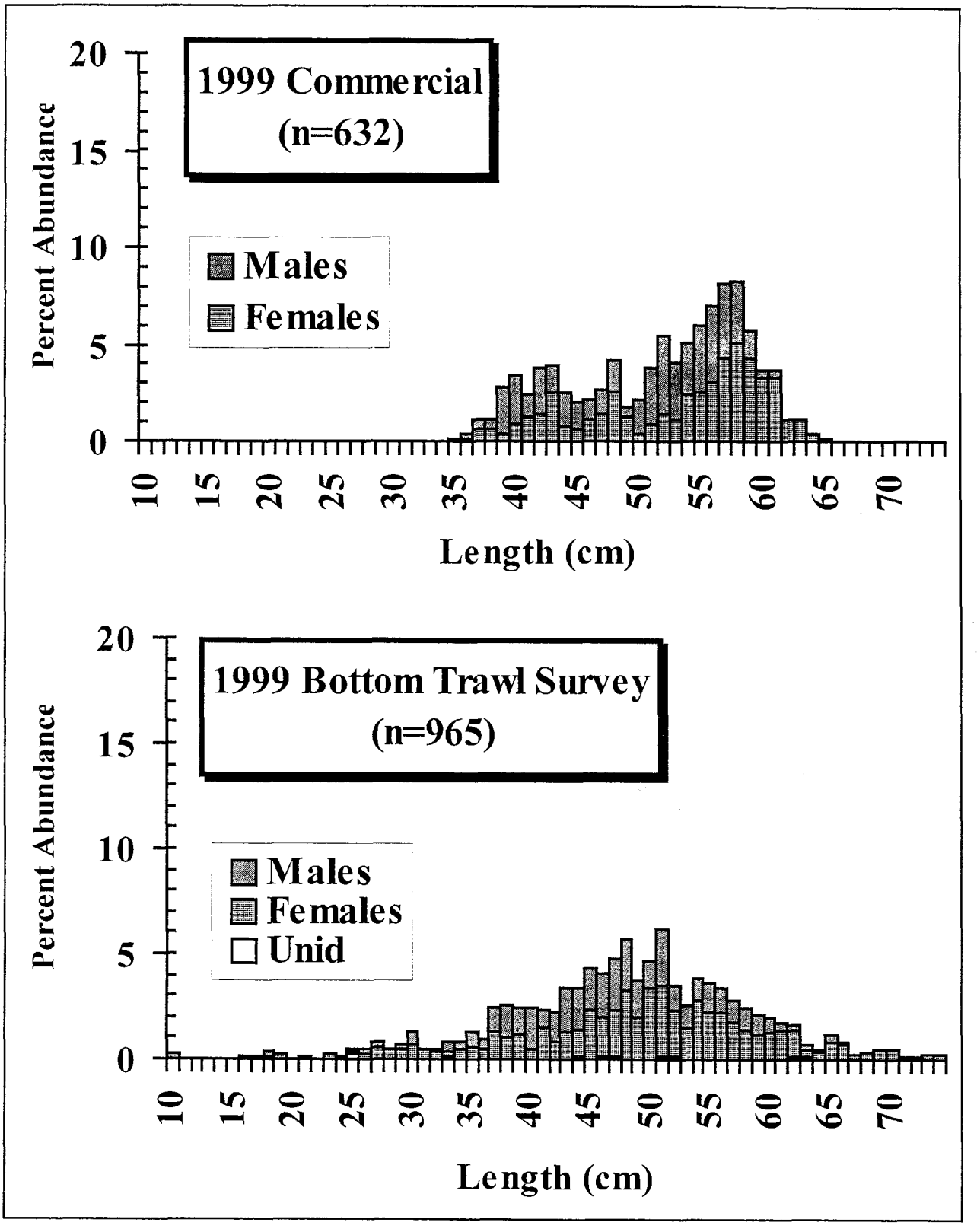

Figure 8. Length distribution of Prince William Sound pollock, 1999.

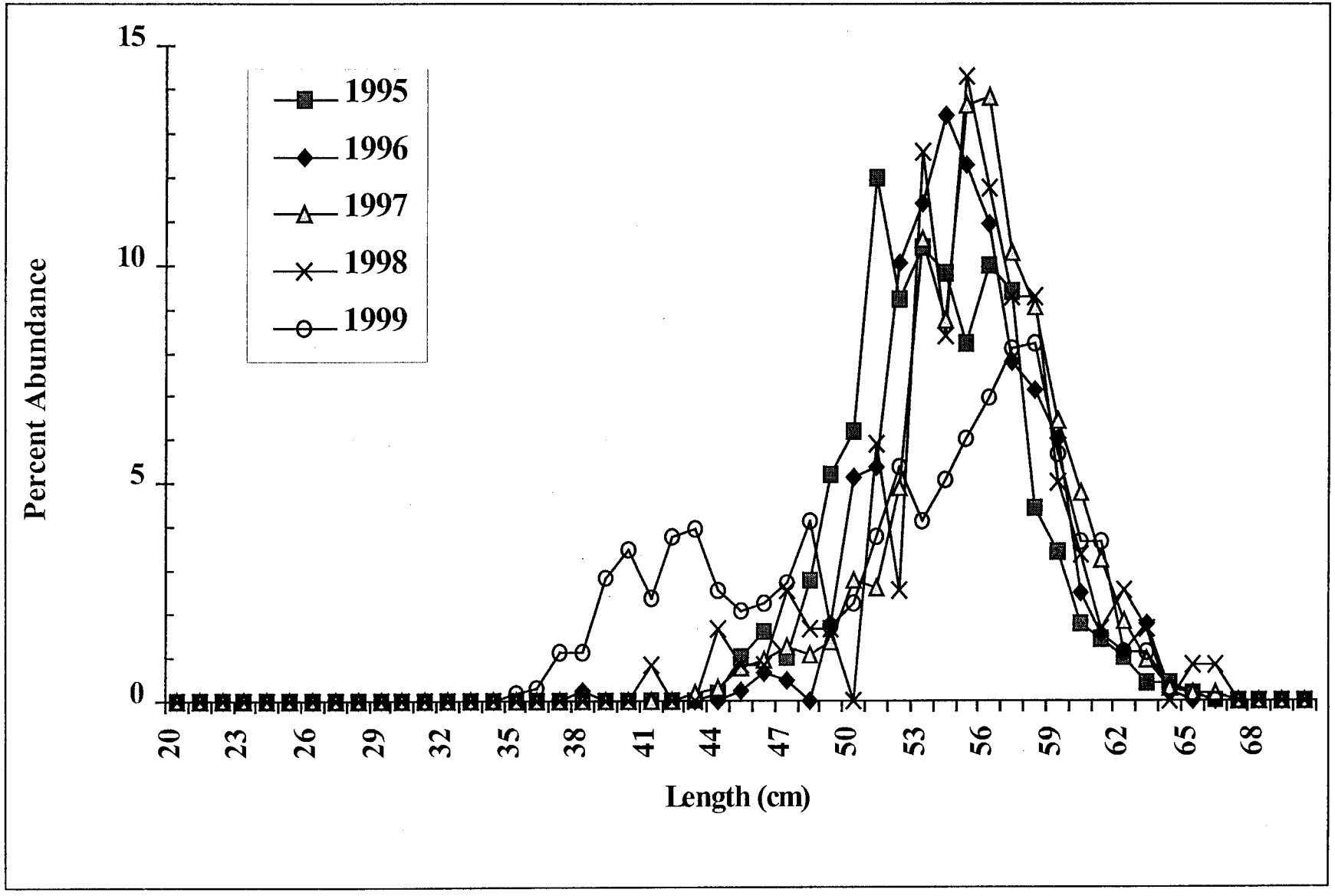

Figure 9. Size composition of pollock caught in the commercial fishery of Prince William Sound, 1995-1999.

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