Prince William Sound Walleye Pollock: Current Assessment and 2003 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. However, the relationship between pollock in PWS and adjacent federal waters remains poorly understood and additional analysis continues. Meanwhile, walleye pollock occurring in PWS during the summer are not assessed as a part of summer trawl surveys conducted in the Gulf of Alaska by the National Marine Fisheries Service (NMFS). Therefore, the harvest guideline for the PWS pollock fishery is based only on estimates of the pollock resource that resides in PWS in the summer. ADF&G conducts a biennial bottom trawl survey within PWS. The 2001 bottom trawl survey yielded a pollock biomass estimate of 7,664 ±1,353 mt (95% confidence interval). Based on the 2001 summer survey, a guideline harvest level of 1,700 mt (3. million lb) was recommended for PWS pollock in 2002. Because no new summer biomass data is available, this is also the recommended GHL for the 2003 commercial fishery. Relative to previous assessment documents, the following report provides updated commercial harvest information through 2001 and updated age, length, and sex data.

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 gears, within Prince William Sound (PWS), Alaska (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) 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; Mecklenburg et al. 2002). 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 (Berceli et al. 1999). 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. In March 2000, the Alaska Board of Fisheries adopted regulations to: (1) open a portion of the eastern trawl exclusion area to pelagic trawl gear; and (2) divide the Inside District into three harvest sections with a maximum of 40% of the annual harvest allowed out of any single section (Figure 2).

CATCH HISTORY

Annual commercial harvests of walleye pollock from PWS were less than 4 mt prior to 1995 (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 2001*a*).

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 PWS (Bechtol 1995*b*), although historical assessment surveys indicated that walleye pollock reside year-round within PWS (Parks and Zenger 1979; C. Wilson, National Marine Fisheries Service, Seattle, unpublished data). The most recent comprehensive survey prior to 1995, 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 an exploratory 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

17 days, beginning 31 January, with a total of nine midwater trawl vessels delivering 2,857 mt (6.3 million lb). Following the trawl closure, retention of walleye pollock by other gear types was not prohibited because non-trawl catches were expected to be minor. Total PWS walleye pollock harvest in 1995 was 2,959 mt (6.5 million lb), including landings by longline and jig gears and also by a combination test fishery and acoustic survey coordinated by ADF&G in late February and early March (Table 1; Trowbridge 1996).

The season for the midwater trawl fishery in subsequent years has been quite variable, opening annually on 20 January concurrent with the trawl fishery opening in adjacent federal waters, and closing as early as 25 January and as late as 31 March (Berceli et al. 1999). Annual pollock harvest ranged from 1,193 to 2,348 mt (2.6-5.2 million lb) by 3-11 vessels (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, southern Knight Island Passage, and Hinchinbrook Entrance 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, although capture rates depended upon vessel size and capacity and fish density. Most of the directed fishery catch was processed for fillet and roe markets. Winter acoustic surveys indicate pollock also aggregate seasonally in the eastern portion of PWS from Hinchinbrook Entrance across the mouth of Orca Bay (Kirsch and Thomas 1998), although the timing of these aggregations is not well understood. The area of these eastern aggregations was historically closed to all groundfish fishing with trawls, but the 2000 Board of Fisheries action opened portions of this eastern area to pelagic trawl gear.

The 2002 midwater trawl fishery opened January 20 for each of three designated harvest sections. These management sections are part of relatively new management strategies intended to temporally and geographically distribute fishing effort (see below). The Hinchinbrook section closed at 2100 hrs on 2 March, and the Port Bainbridge and Knight Island sections closed at 2400 hrs on March 31. Total pollock harvest among sections during the midwater trawl fishery in 2002 was 1,152 mt (2.5 million lb) by 3 vessels, including 80 mt landed by an ADF&G test fishery. The timing of fish aggregations again appeared delayed in 2002. Pollock landed as bycatch in pot, longline, and shrimp trawl fisheries totaled <0.1 mt (Table 1).

FISHERY MANAGEMENT CONSIDERATIONS

The mid-water trawl fishery for walleye pollock in PWS remains a relatively new fishery within state managed waters, and management strategies for this fishery continue to evolve (Berceli et al. 1999). In 2000, the Alaska Board of Fisheries adopted regulations designed to distribute the fishery geographically, largely in response to concerns over the decline of Steller sea lions, and to expand fishing opportunities to observed pollock distributions. These changes: (1) opened a portion of the eastern trawl exclusion area in PWS to pelagic trawl gear; and (2) divided the PWS

Inside District into three harvest sections with a maximum of 40% of the annual harvest allowed out of any single section (Figure 2).

Although previous surveys indicated that walleye pollock occur year-round within PWS (Parks and Zenger 1979; Haynes and Urban 1991; Bechtol 1999*a*), the relationship between walleye pollock inside PWS and in adjacent Gulf of Alaska waters remains unclear. Stock assessment for pollock in federal waters was originally modeled using Stock Synthesis software (Methot 1990), but more recently parameters have been fit using AD Model Builder software (Dorn et al. 2001). 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) biennial trawl survey, previously a triennial 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 specific regulations established by the Alaska Board of Fisheries, groundfish fisheries in state waters typically occur through a miscellaneous groundfish permit issued by ADF&G. Permit conditions may specify area and gear restrictions, and seasons are often set to coincide with seasons for the target species in 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.

Some of the mixed quality data available for PWS pollock resources are described below. Future stock assessment efforts may use more intensive stock modeling to incorporate more of the available data.

Bycatch Considerations

Incidental catch of nontarget species, or bycatch, varies with the relative abundance of both the nontarget species and the target species, in this case pollock. Species catch rates may be affected by a wide variety of fishery factors, including geographic harvest location, harvest depth, gear specifications. In addition, catch rates are also affected by biological and oceanograhic aspects such as the migration or aggregation timing and location and population abundances. Both fishery and nonfishery factors exhibit dynamic interactions that are not necessarily consistent on an annual basis.

The directed fishery for pollock in PWS is seen as having low bycatch relative to many other fisheries. The most common species groups incidentally caught by midwater trawl are rockfish, salmon, sharks, and squid. Annual catch rates for these species in aggregate ranged from 15.9

lb/tow hr in 1999 to 328.1 lb/tow hr in 2002. Aggregate catches calculated as bycatch ranged from 0.4% to 0.7% of pollock catch during 1997 to 2000, but increased to 1.1% in 2001 and 10.4% in 2002 (Figure 3). By comparison, state regulations general restrict the retention of incidentally caught groundfish species to 20%, by weight, of the target species, unless other regulations have been adopted. The cause of the dramatic increase in fishery bycatch in 2002 is not clear, but likely relates to changes in the timing and locations of aggregations. Season duration has generally increased since 1995 as the timing of aggregations has occurred later in the winter in PWS. A similar change in aggregation timing has occurred in federal pollock fisheries of the Gulf of Alaska. Concurrently, pollock stock levels have declined as strong year classes declined in abundance. Recent management measures intended to reduce interactions between the PWS pollock fishery and Steller sea lions may have also exacerbated the catch of nontarget species by capping the effort that may be applied by fishing vessels on the most productive pollock fishing areas.

Available Assessment Data

Longline Surveys

A longline survey for sablefish *Anoplopoma fimbria* has been conducted annually since 1996 with the research vessels *Montague* and *Pandalus*. 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 1.0 fish/set in 2001 (Table 2). However, the longline survey is viewed as providing only a weak index of abundance for pollock caught in the target depth 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 May 1994, an acoustic survey was conducted in PWS as part of the Sound Ecosystem Assessment (SEA) project with funding from the *Exxon Valdez* Oil Spill Trustee Council. 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 3; Jay Kirsch, Prince William Sound Science Center, Cordova, AK, personal communication). However, plankton noise shallower than 40 m and a lack of survey penetration deeper than 125 m may have compromised the accuracy of this estimate, likely resulting in an underestimate of walleye pollock biomass in 1994.

Winter Acoustic Surveys

The Prince William Sound Science Center (PWSSC), often in cooperation with ADF&G and the fishing industry, conducted acoustic surveys on the prespawning biomass and distribution of walleye pollock in PWS during 1995 to 2002 (Thomas and Stables 1995; Kirsch 1997; Kirsch and Thomas 1998; Thorne 2000; Thomas et al. 2001; R. Thorne, PWSSC, Cordova, pers. comm.). Surveys were conducted aboard the *F/V Alaskan* operated by Jay Stinson of Kodiak in 1995, 1997, and 1998, aboard the *R/V Pandalus* in 2000 and 2001, and aboard the *F/V Kyle David* in 2002. These surveys, typically occurring within the period of late February to mid March, focused on prespawning walleye pollock aggregations in southwestern PWS, particularly Port Bainbridge, Knight Island Passage, and Montague Strait. In some years, survey transects were replicated in areas where the highest pollock densities occurred. Pollock size data were obtained from survey catches with midwater trawl nets, from bottom trawl nets in 2000, and from commercial fishery samples in 2002.

A 2002 acoustic survey involved two survey legs, the first on 1 March and the second during 27 to 29 March (R. Thorne, PWSSC, Cordova, Ak, pers. comm.). Data pooled between survey legs resulted in a pollock biomass estimate of 16,900 mt.

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 (Von Szalay and Brown 1999), so abundance data collected in PWS were not directly comparable to data collected in the Gulf of Alaska.

ADF&G Summer Bottom Trawl Surveys

A summer bottom trawl survey with the ADF&G research vessel *Pandalus* towing a 400-mesh Eastern bottom trawl has been conducted biennially since 1995 (Table 3). Historical crab survey stations in the Orca Bay, Port Fidalgo, and North Montague areas were systematically selected using historical towpaths. For the 1997 and subsequent surveys, PWS was divided into potential sample stations, each measuring 6.25 square nautical miles. PWS was then sectioned into quadrants delineated at 147°00' W longitude and 60°30' N latitude and additional stations were randomly selected from target quadrants. Selected stations were sampled by a 1.0 nautical mile long tow. Due to vessel gear limitations, depth of tows was generally less than 366 m (200 fm).

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 summarized in previous reports (Bechtol 2000).

Effort in the 1997 PWS survey involved 53 tows, apportioned as 26 stations in the southwest quadrant, 25 stations in the northeast, and two stations in the southeast (Bechtol 1998*a*, 1999*a*). 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. Although no tows were made in the northeast area, catch data were post-stratificed by surface area according to 91.6 m (50 fathom) bottom depth contours. Four of the nine depth strata represented on a NOAA nautical chart were sampled by the 1997 trawl survey. Extrapolation to the entire PWS surface area, including the northwest area, and using a weighted mean catch rate to estimate biomass in unsampled strata, yielded an estimated pollock biomass of 28,676 mt (Table 3).

The 1999 survey involved 67 successful tows, representing 13.5% of the available survey station grids (Bechtol 1999*b*; unpublished data). Estimated biomass of walleye pollock was 6,304 +/- 2,812 (95% CI) metric tons. Average catches of pollock per nautical mile towed were 14.6 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.

The 2001 PWS bottom trawl survey included 51 successful tows, representing 10.2% of the available survey stations (Tables 3 and 4; Bechtol 2001*b*). This survey again occurred at approximately the same time of year as the biennial trawl survey conducted by NMFS in the adjacent federal waters. Pollock catch rates at individual stations in PWS ranged from 0 to 479.2 lb/nm. Average catches of pollock per nautical mile towed were 27.3 kg (60.3 lb) in the southwest area and 5.8 kg (12.7 lb) in the eastern area; mean survey catch was 16.3kg (35.9 lb) per nautical mile towed among areas. Estimated walleye pollock biomass was 7,664 ±1,353 (95% confidence interval) mt. Although pollock distribution appeared to be similar to previous summer bottom trawl surveys, standardized catch rates generally declined in all PWS areas relative to previous years and in only three stations did the catch rate exceed 45 kg (100 lb) per nautical mile towed (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 (Von Szalay and Brown 1999). 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. 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 1995-2002. Sample sources included the commercial fishery that opened January 20; the test fishery occurring immediately after, or near, 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, test fishery, and acoustic survey all occurred in both southwestern and eastern PWS, whereas longline and bottom surveys sampled throughout PWS. Sagittal otoliths were removed for aging of pollock during all years. To date, age data are available from the 1995 bottom trawl survey and from commercial and test fisheries in 1996-2000 (Figure 4). Substantial uncertainty exists regarding the appropriate techniques to determine the true age of pollock (Munk 2001). For this report, age data from commercial and test fisheries were pooled within years; pollock ages are reported as derived through standard techniques applied by the ADF&G Age Determination Unit.

Pollock in the 2002 commercial fishery ranged from 28 to 66 cm (n=626); male pollock comprised 61% of the samples (Figure 5). The most abundant lengths were 50-51 cm for males and 54 cm for females. Because the 2002 test fishery occurred as a component of the 2002 commercial landings, test fish samples were not collected independent of commercial samples. A summer bottom trawl survey was not conducted in 2002 but is scheduled for the summer of 2003. The September longline survey yielded pollock lengths of 52 to 67 cm (n=23), with 9% of the fish being male.

Pollock length among years ranged from 26-79 mm (Figure 6). A progression of strong year classes in evident in the distribution of pollock lengths among successive years. In general, bottom 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 (Bechtol 2001*b*). The development of a younger cohort can particularly be seen in the 1998 size data and this cohort appears to develop and play a greater role in the commercial harvest until becoming the most abundant cohort in 2000-2002. Based on the abundance of age-5 fish in 1999, this progressive cohort appears to be the 1994 age class (Figure 4). By the 2000 fishery, older strong cohorts had- died off substantially and the overall strength of the 1994 year class was apparent. Males contributed an average of 55% of commercial landings over the history of the fishery. However, the male contributions to the 2001 and 2002 fisheries were greater than for any other year (Figure 7).

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 (Iwata 1975*a*, 1975*b*; Grant and Utter 1980).

Olsen et al. (*in press*) used allozyme, microsatellite, and mitochondrial DNA (mtDNA) data to test for spatial and interannual genetic diversity in walleye pollock from six spawning aggregations representing three geographic regions: Gulf of Alaska, eastern Bering Sea, and eastern Kamchatka. Interpopulation genetic diversity was evident primarily from the mtDNA and two allozyme loci (*SOD-2**, *MPI**). Permutation tests indicated $\hat{F}_{ST}$ values for most allozyme and microsatellite loci did not differ significantly from zero. The microsatellite results suggest that high locus polymorphism may not be a reliable indicator of power for detecting population differentiation in walleye pollock. Because mtDNA revealed population structure and most nuclear loci did not, the effective size of most walleye pollock populations is likely large with weak genetic drift, and migration is a relatively strong homogenizing force. The allozymes and mtDNA provided mostly concordant estimates of patterns of spatial genetic variation. These data showed significant genetic variation between North American and Asian populations. In addition, spawning aggregations in PWS and near Middleton Island appeared genetically distinct from pollock spawning in Shelikof Strait. Finally, the occurrence of interannual genetic variation was suggested for two of three North American spawning aggregations, similar in magnitude to the spatial variation among North American walleye pollock. Olsen et al. (*in press*) suggest this interannual variation may result from one or more of the following factors: highly variable reproductive success, adult philopatry, source-sink metapopulation structure, and intraannual variation in spawn timing among genetically distinct but spatially identical spawning aggregates.

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

For the 1996 fishery, 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 change from 1995 to 1996 in the allowable biological catch (ABC) for pollock in adjacent federal waters of the Eastern Gulf of Alaska Regulatory Area was used to scale changes in the PWS pollock guideline from 1995 to 1996 (Hollowed et al. 1995, 1996; Bechtol 1998*a*). Another approach would be to apply the relative change exhibited in the exploitable biomass between years. Estimated exploitable biomass of Gulf of Alaska pollock has declined in recent years, falling an estimated 20% from 1998 to 1999, but was projected to increase by 6% from 2000 to 2001 (Dorn et al. 1999, 2000). Part of this increase was attributed to assessment model improvements and part was attributed to the federal court order closing commercial fisheries in Steller sea lion critical habitat area, resulting in less than anticipated harvests during some of the 2000 federal pollock season. The preliminary assessment for 2001 suggested spawning biomass declined by 22%, primarily due to a 65% decline in biomass detected during the NMFS 2001 summer bottom trawl survey in the Gulf of Alaska. Application of a relative biomass change approach to the 2001 PWS GHL would have resulted in a 2002 GHL of 880 mt, based on a 22% decline in spawning biomass.

Fixed Harvest Level

A fixed annual harvest level may be applied for some fisheries to achieve sustainable yield amidst variable recruitment and fishing effort (Bechtol and Morrison 1997). This approach may also be used in the absence of new stock assessment information. A fixed harvest level was essentially used to set the 1999 GHL of 2,100 mt and the 2001 GHL of 1,420 mt for PWS pollock (Bechtol 1998*b;* 2000). In both cases, a bottom trawl survey had not been conducted in the preceding summer and new summer biomass estimates were not available for the pollock population. Because no bottom trawl survey occurred in the summer of 2002, the PWS GHL may be fixed across the 2002 and 2003 fishing seasons.

GUIDELINE HARVEST RECOMMENDATIONS

Winter acoustic surveys of prespawning pollock aggregations in PWS have 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 (Olsen et al. *in press*). In addition, size and sex data suggested a large component of the 1999 aggregation was new recruit pollock that should be allowed to further develop for optimal contribution to the fishery's target biomass. The 2001 winter assessment yielded a biomass estimate that suggested a continued decline in spawning biomass since 1998 (Table 3; Thomas et al. 2001; Thorne and Thomas *under review*). 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 (*EXXON Valdez* Oil Spill Trustee Council 1993), many of the studies encountering pollock focused on juvenile pollock interactions with rearing Pacific herring *Clupea pallasi* and salmonids *Ocorhynchus* species. 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, albeit conservative, 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 recent federal assessment models for the Gulf of Alaska (Dorn et al. 1999). It is thought unlikely that PWS pollock biomass has changed substantially since the most recent summer biomass estimate, the 7,664 mt estimated by the 2001 summer bottom trawl survey (Bechtol 1999*b*). Thus, the recommended guideline harvest level for Prince William Sound pollock is:

$$GHL = B \times M \times 0.75 = 7{,}664 \times 0.30 \times 0.75 \cong 1{,}700 \text{ mt.}$$

Continuing 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 will 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. ADF&G has scheduled another bottom trawl survey of PWS during 2003. The 2003 trawl survey would again occur in the summer at approximately the same time of year as the biennial trawl survey conducted by NMFS in the adjacent federal waters. Additional winter acoustic surveys by either ADF&G or the Prince William Science Center are contingent upon available funding. Finally, additional funding for pollock research throughout the Gulf of Alaska, including PWS, is being pursued by both federal and state biologists. Some specific potential research components include a comprehensive summer acoustic survey and further trawl comparison studies to develop fishing power corrections for ADF&G bottom trawl nets relative to NMFS bottom trawl nets.

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 to 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 2003 fishery:

Fishing Season - The fishery will open at 12:00 noon on 20 January 2003, 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.

Pollock are a prey item of endangered Steller sea lions. To provide against localized pollock depletion in an effort to address declining Steller sea lion stocks, the Board further adopted regulations to geographically distribute pollock harvests in the PWS pollock fishery.

Harvest Distribution Among Areas – No more than 40% of the total PWS GHL will be taken from any one of the following sections:

1. Bainbridge Section - Inside District waters west of 148° W. long.
2. Knight Island Section - Inside District waters between 148° W. long. and 147° 20' W. long.
3. Hinchinbrook Section - - Inside District waters east of 147° 20' W. long.

Regulatory change proposals for PWS groundfish fisheries will be considered during the December 2002 Alaska Board of Fisheries meeting in Cordova. Several proposals that are intended to generate discussion of the increased bycatch of squid observed in 2002 (Figure 3) may result in additional guidance for ADF&G staff managing the PWS pollock fishery.

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Table 1. Annual commercial walleye pollock harvest from Prince William Sound, Alaska during 1987-2002.

	Fishing Effort		Trawl	Longline	Other	Total
Year	Vessels	Landings	Round Weight (metric tons)			
1987			0.0	0.4	0.0	0.4
1988	2	2	0.0	0.7	0.0	0.7
1989	6	9	0.4	0.2	<0.1	0.7
1990	6	12	3.0	0.3	0.0	3.3
1991	0	0	0.0	0.0	0.0	0.0
1992	6	14	2.7	<0.1	0.0	2.7
1993	2	6	2.5	0.1	0.0	2.6
1994	3	5	0.0	<0.1	2.5	2.5
1995	19	56	2,954.5	1.6	2.7	2,958.8
1996	13	34	1,671.4	0.3	0.6	1,672.3
1997	15	49	2,023.6	3.2	0.1	2,026.9
1998	17	54	2,107.1	1.2	0.0	2,108.3
1999	15	66	2,342.3	5.4	0.0	2,347.7
2000	16	51	1,191.6	1.8	0.0	1,193.4
2001	4	20	1,592.0	<0.1	<0.1	1,592.0
2002[a/]	3	21	1,152.7	<0.1	<0.1	1,152.8

[a/] Preliminary data through 1 October 2002.

Table 2. Unweighted catch abundance and mean catch rates from the sablefish longline survey of Prince William Sound, 1996-2002.

	Sablefish	Pacific Cod	Polloc	Halibut	Arrowtooth Flounder	Demersal Rockfish	Slope Rockfish	Skates	Salmon Shark	Spiny Dogfish	Sleeper Shark	Other	Hooks Without Fish: Baite	Hooks Without Fish: Ineffective	Hooks Without Fish: 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%
% of Catch	46.3%	6.7%	3.6%	23.6%	2.0%	0.1%	3.1%	12.6%	<0.1%	0.8%	1.0%	0.3%				
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%
% of Catch	43.0%	7.2%	3.8%	26.1%	2.9%	0.1%	2.5%	9.4%	0.0%	2.5%	1.6%	0.9%				
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%
% of Catch	37.3%	6.6%	2.6%	13.5%	1.5%	0.0%	1.4%	8.6%	0.0%	26.9%	1.4%	0.2%				
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%
% of Catch	55.7%	5.1%	3.3%	20.3%	2.5%	0.0%	1.9%	5.4%	0.0%	1.6%	3.9%	0.2%				
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				
2000 - Northwest and Eastern PWS (n = 36 stations)																
Abundance	3,101	146	47	513	50	0	80	432	0	47	92	4	17,666	1,543	579	24,300
% of Hooks	12.8%	0.6%	0.2%	2.1%	0.2%	0.0%	0.3%	1.8%	0.0%	0.2%	0.4%	0.0%	72.7%	6.3%	2.4%	100.0%
% of Catch	68.7%	3.2%	1.0%	11.4%	1.1%	0.0%	1.8%	9.6%	0.0%	1.0%	2.0%	0.1%				
Fish/Set	86.1	4.1	1.3	14.3	1.4	0.0	2.2	12.0	0.0	1.3	2.6	0.1				

- Continued -

Table 2. (page 2 of 2)

	Sablefish	Pacific Cod	Polloc	Halibut	Arrowtooth Flounder	Demersal Rockfish	Slope Rockfish	Skates	Salmon Shark	Spiny Dogfish	Sleeper Shark	Other	Hooks Without Fish: Baite	Hooks Without Fish: Ineffective	Hooks Without Fish: Unbaited	Total Hooks
2001 - Northwest and Southwest PWS (n = 35 stations)																
Abundance	2,739	192	35	378	116	1	122	426	4	332	102	113	17,310	1,389	366	23,625
% of Hooks	11.6%	0.8%	0.1%	1.6%	0.5%	0.0%	0.5%	1.8%	0.0%	1.4%	0.4%	0.5%	73.3%	5.9%	1.5%	100.0%
% of Catch	60.1%	4.2%	0.8%	8.3%	2.5%	0.0%	2.7%	9.3%	0.1%	7.3%	2.2%	2.5%				
Fish/Set	76.1	5.3	1.0	10.5	3.2	0.0	3.4	11.8	0.1	9.2	2.8	3.1				
2002 - Northwest PWS (n = 27 stations)[a/]																
Abundance	1,228	262	36	326	65	0	66	182	0	13	77	12	14549	980	429	18,225
% of Hooks	6.7%	1.4%	0.2%	1.8%	0.4%	0.0%	0.4%	1.0%	0.0%	0.1%	0.4%	0.1%	79.8%	5.4%	2.4%	100.0%
% of Catch	54.2%	11.6%	1.6%	14.4%	2.9%	0.0%	2.9%	8.0%	0.0%	0.6%	3.4%	0.5%				
Fish/Set	45.5	9.7	1.3	12.1	2.4	0.0	2.4	6.7	0.0	0.5	2.9	0.4				
Means Among Years																
% of Hooks	9.5%	1.1%	0.4%	3.0%	0.4%	0.0%	0.4%	1.7%	0.0%	1.6%	0.4%	0.1%	72.7%	4.6%	4.1%	100.0%
% of Catch	51.0%	6.0%	2.3%	16.0%	2.1%	0.0%	2.2%	9.1%	0.0%	8.6%	2.1%	0.6%				
Fish/Set	64.1	7.5	2.9	20.1	2.6	0.0	2.7	11.4	0.0	10.9	2.6	0.8				

[a/] Data from three stations sampled in the Eastern Area in 2002 excluded from summary.

Table 3. Walleye pollock biomass estimates from several Prince William Sound surveys, 1989-2002.

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 Bottom Trawl Survey	28,676	Summer	Few stations in SE and no stations in NW
1998 Hydroacoustic Survey	114,344	Winter	Prespawning aggregation.
1999 Bottom Trawl Survey	6,304	Summer	Few stations in SE and no stations in NW
2000 Hydroacoustic Survey	28,227	Winter	Prespawning aggregation.
1996-2000 Longline Surveys	NA	Fall	Relative abundance, distribution, and size data
2001 Hydroacoustic Survey	26,676	Winter	Prespawning aggregation; multiple survey legs.
2001 Bottom Trawl Survey	7,664	Summer	No stations in NW.
2002 Hydroacoustic Survey	16,900	Winter	Prespawning aggregation; multiple survey legs.

Table 4. Bottom trawl survey catch of walleye pollock in Prince William Sound, Summer 2001.

Tow No.	Station	Date	Tow Midpoint Latitude	Tow Midpoint Longitude	Distance (nmi)	Depth (fathoms) Minimum	Depth (fathoms) Maximum	Scope (fathoms)	Pollock (lb/nmi)
01501	AG10	7/17	59.9424	147.888	0.99	114	103	350	163.6
01502	AE11	7/17	60.0142	147.779	1.00	150	145	450	4.0
01503	AC14	7/17	60.1018	147.569	1.01	70	67	210	479.2
01504	105	7/17	60.2994	147.29	0.99	75	68	210	294.9
01505	104	7/18	60.3498	147.288	1.01	79	78	225	15.8
01506	109	7/18	60.4727	147.139	1.00	104	103	300	0.0
01507	112	7/18	60.435	147.018	0.99	133	119	350	16.2
01508	106	7/18	60.487	147.183	0.82	100	95	300	3.7
01509	101	7/18	60.4754	147.307	0.70	101	98	300	51.4
01510	111	7/19	60.4138	147.059	1.01	90	86	275	4.0
01511	110	7/19	60.45	147.112	1.00	106	101	300	0.0
01512	107	7/19	60.42	147.228	1.00	95	90	275	0.0
01513	102	7/19	60.45	147.257	0.99	127	118	350	6.1
01514	103	7/19	60.40	147.262	0.99	73	65	210	0.0
01515	108	7/19	60.38	147.179	1.01	66	57	200	0.0
01516	12	7/20	60.56	146.46	0.99	70	62	200	0.0
01517	17	7/20	60.57	146.397	1.05	70	67	210	3.8
01518	19	7/20	60.56	146.299	0.99	70	64	200	3.3
01519	20	7/20	60.57	146.245	1.01	75	74	225	4.0
01520	22	7/20	60.56	146.138	0.99	83	82	225	4.0
01521	23	7/20	60.57	146.056	1.00	106	93	300	2.3
01522	24	7/21	60.61	145.912	1.02	101	99	300	68.6
01523	21	7/21	60.79	146.124	0.94	82	75	225	0.0
01524	13	7/22	60.72	146.152	1.00	103	100	300	24.0
01525	14	7/22	60.69	146.263	1.00	74	75	225	38.0
01526	15	7/22	60.65	146.343	0.98	70	69	210	6.1

- Continued -

Table 4. (page 2 of 2)

Tow No.	Station	Date	Tow Midpoint Latitude	Tow Midpoint Longitude	Distance (nmi)	Depth (fathoms) Minimum	Depth (fathoms) Maximum	Scope (fathoms)	Pollock (lb/nmi)
01527	18	7/22	60.59	146.221	1.00	76	74	225	5.0
01528	16	7/22	60.60	146.393	1.01	66	64	200	2.0
01529	11	7/22	60.61	146.468	1.02	66	55	200	0.0
01530	10	7/23	60.53	146.54	0.99	64	63	200	2.7
01531	9	7/23	60.56	146.523	1.01	72	72	200	5.9
01532	5	7/23	60.59	146.551	1.01	70	68	210	0.0
01533	6	7/23	60.57	146.629	0.99	64	60	200	0.0
01534	7	7/23	60.54	146.623	1.00	68	65	210	2.0
01535	8	7/23	60.50	146.607	1.00	83	73	250	0.0
01536	4	7/23	60.43	146.737	0.99	122	118	375	10.1
01537	3	7/24	60.47	146.684	1.02	92	89	275	39.2
01538	2	7/24	60.51	146.683	1.01	104	95	300	2.0
01539	1	7/24	60.65	146.714	0.99	78	70	225	2.0
01540	27	7/25	60.78	146.624	1.00	96	93	300	5.0
01541	26	7/25	60.80	146.492	0.99	106	107	325	10.1
01542	25	7/25	60.81	146.322	1.01	112	107	335	23.8
01544	28	7/25	60.78	146.701	1.01	91	86	275	2.0
01545	I25	7/26	60.94	146.636	0.98	63	56	150	51.0
01546	H23	7/26	60.97	146.811	0.91	210	164	500	8.8
01547	E26	7/26	61.11	146.516	1.00	134	130	325	26.0
01548	E27	7/26	61.11	146.469	1.03	132	130	325	17.5
01549	E25	7/26	61.10	146.641	0.99	137	135	350	50.5
01550	AB11	7/27	60.14	147.818	0.99	170	160	475	16.2
01551	AB09	7/27	60.16	147.932	1.02	177	160	475	11.8
01552	AA09	7/28	60.18	147.948	1.02	226	189	550	17.6
Total					50.47				1,509.3

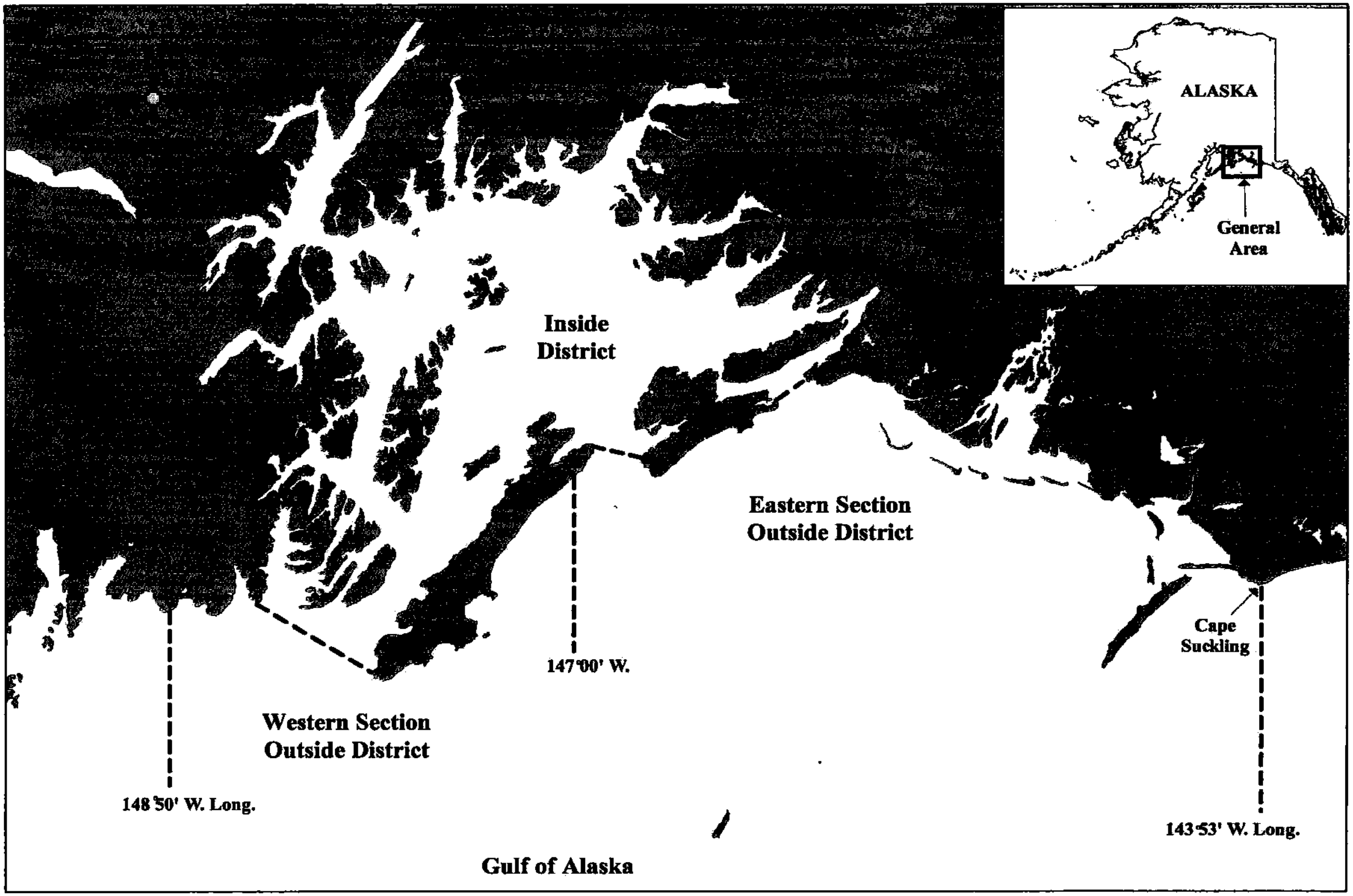

Figure 1. Groundfish management districts of the Prince William Sound Management Area.

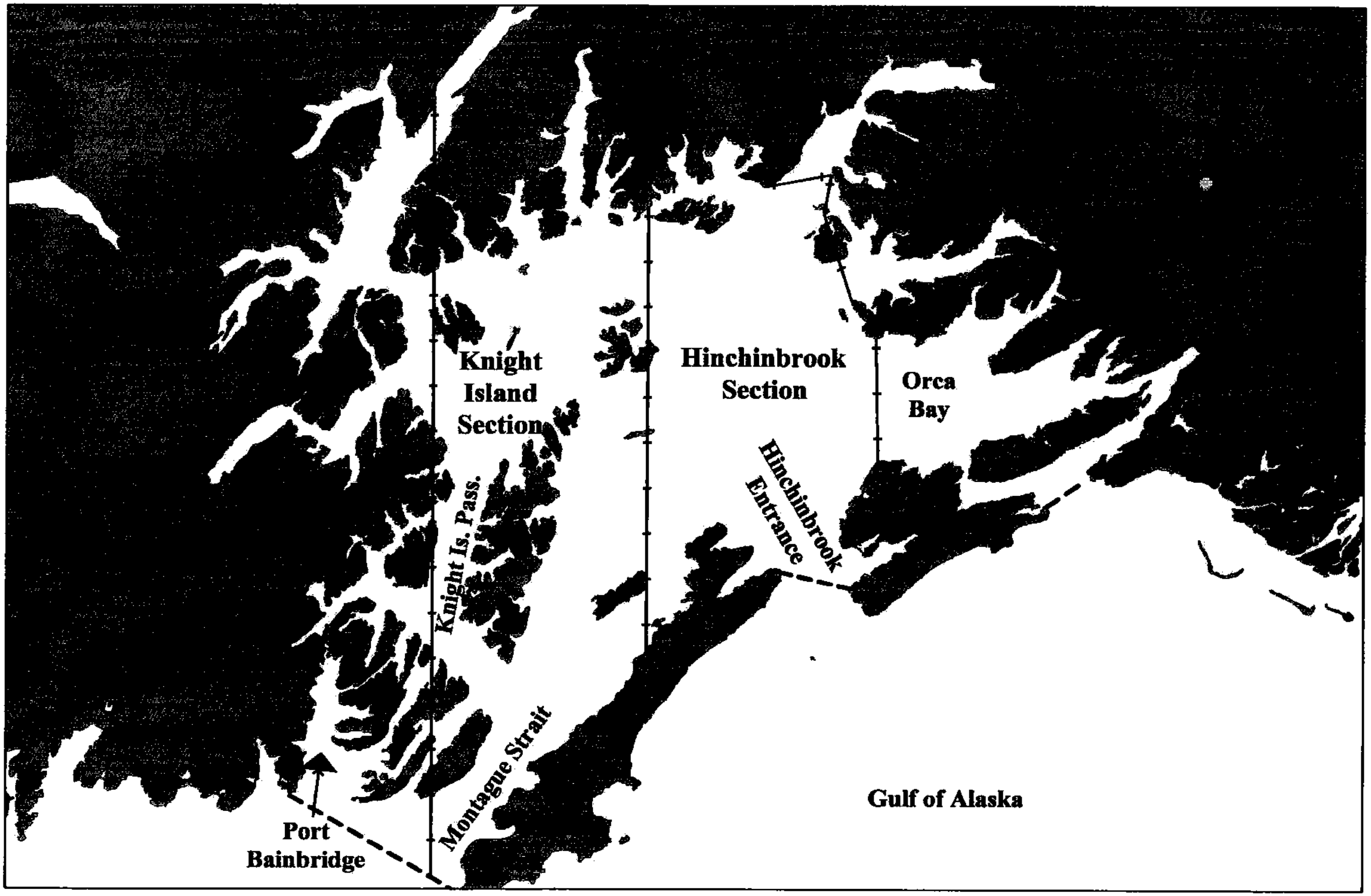

Figure 2. Pollock management sections in the Inside District of Prince William Sound.

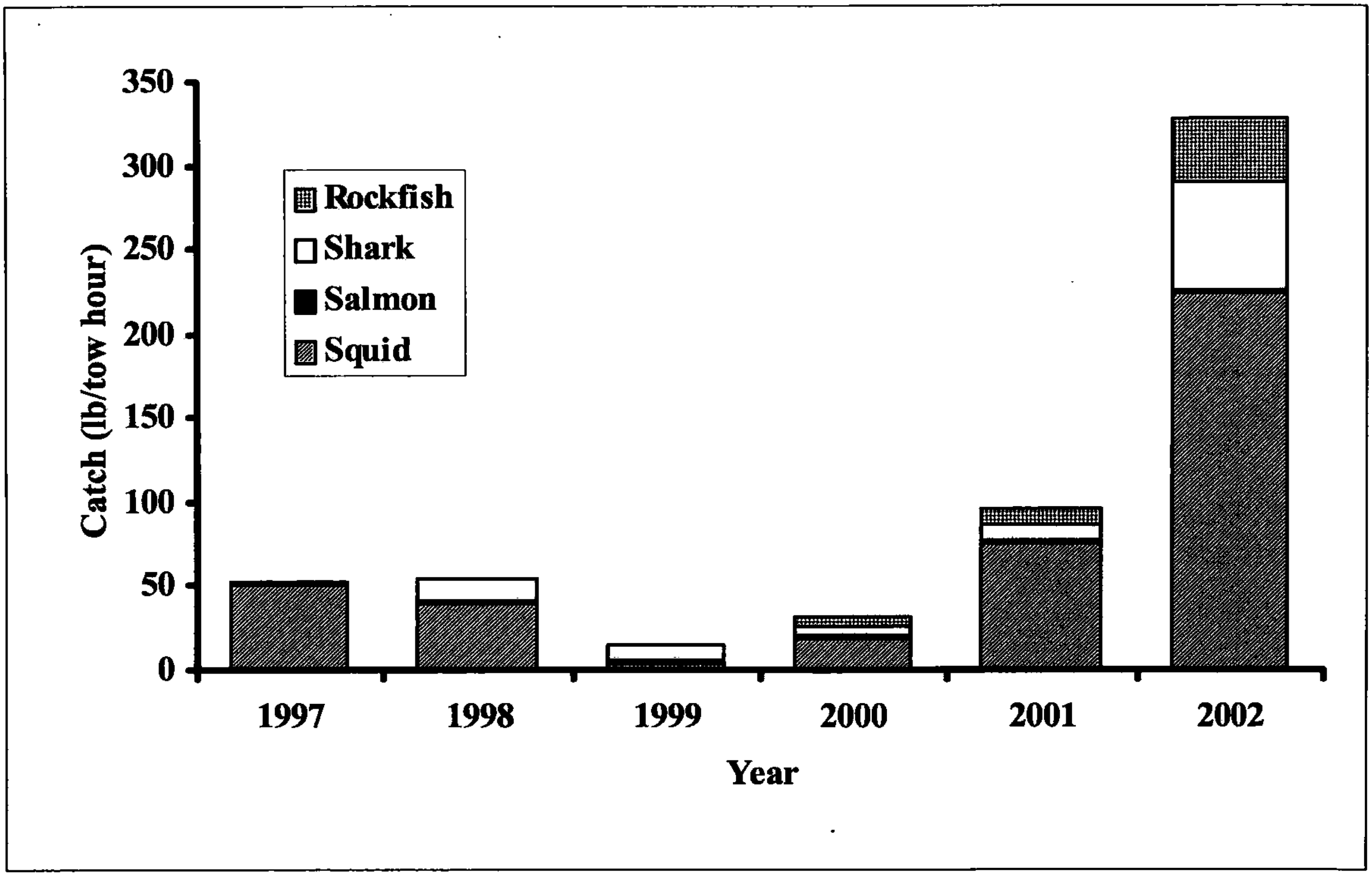

Figure 3. Predominate catch of incidental species groups in the Prince William Sound pollock fishery, 1997-2002.

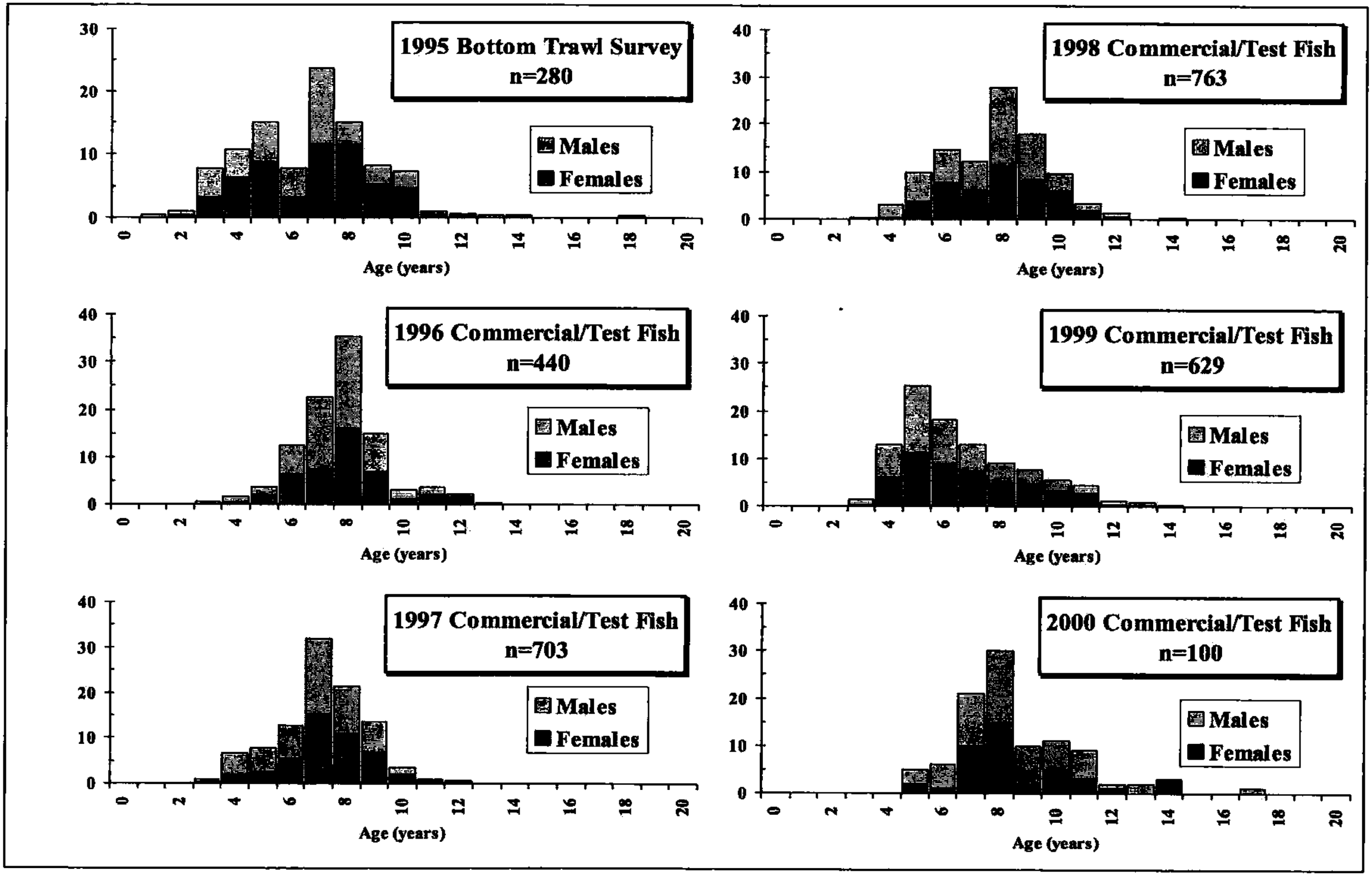

Figure 4. Age composition of pollock sampled from Prince William Sound, 1995-2000.

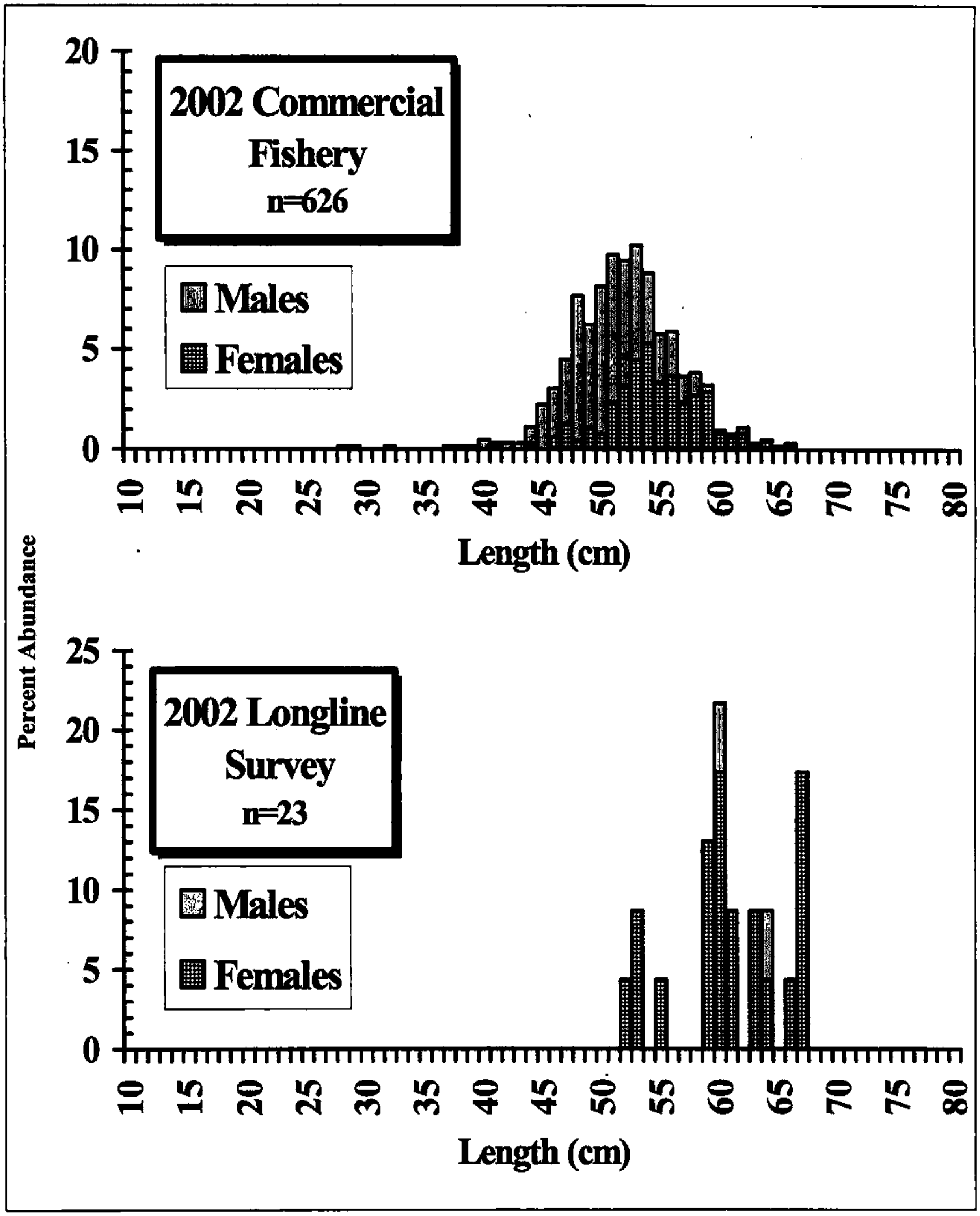

Figure 5. Length distribution of Prince William Sound pollock, 2002.

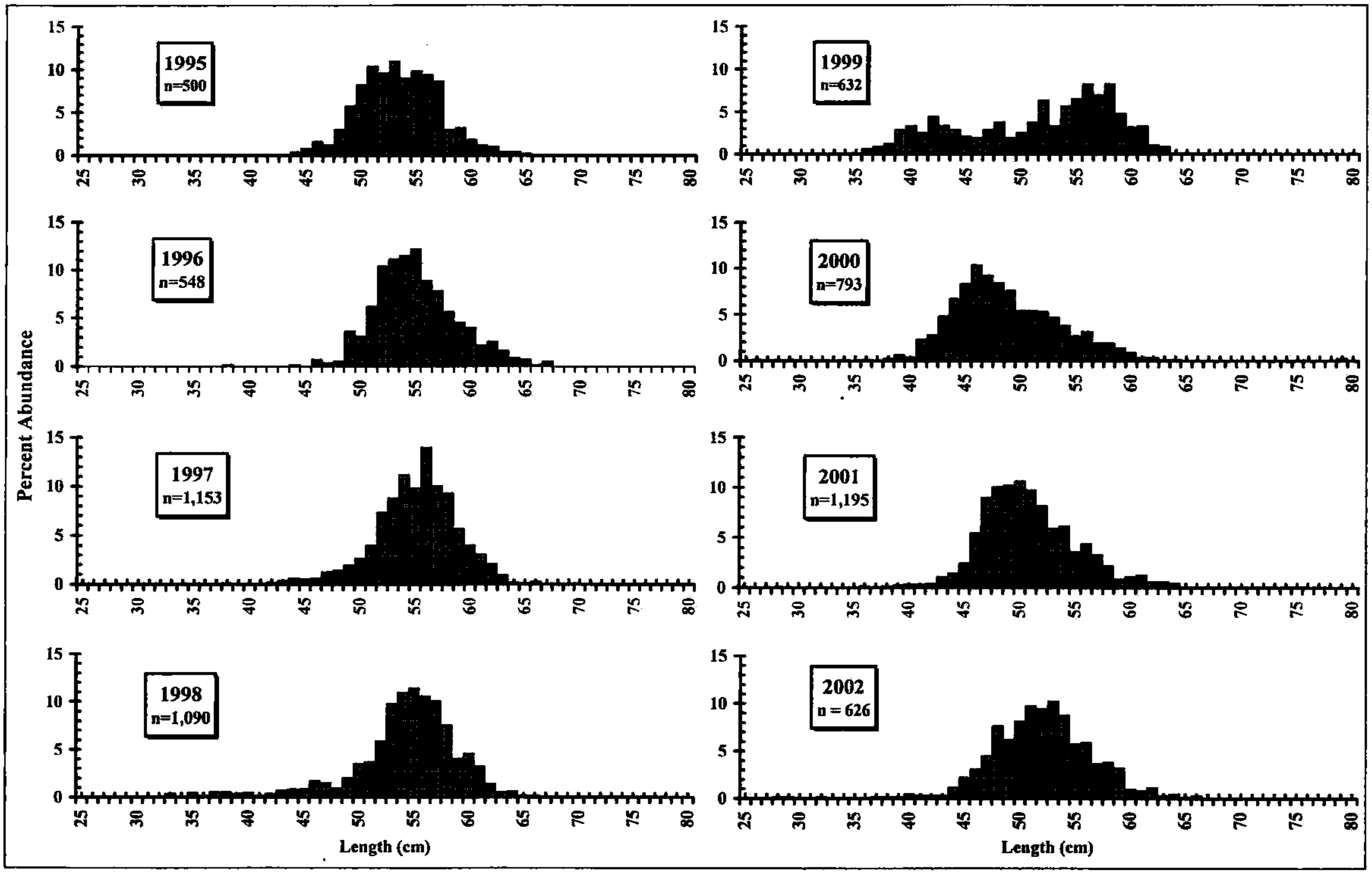

Figure 6. Length distribution (percent abundance) of walleye pollock in commercial harvests from Prince William Sound, 1995-2002.

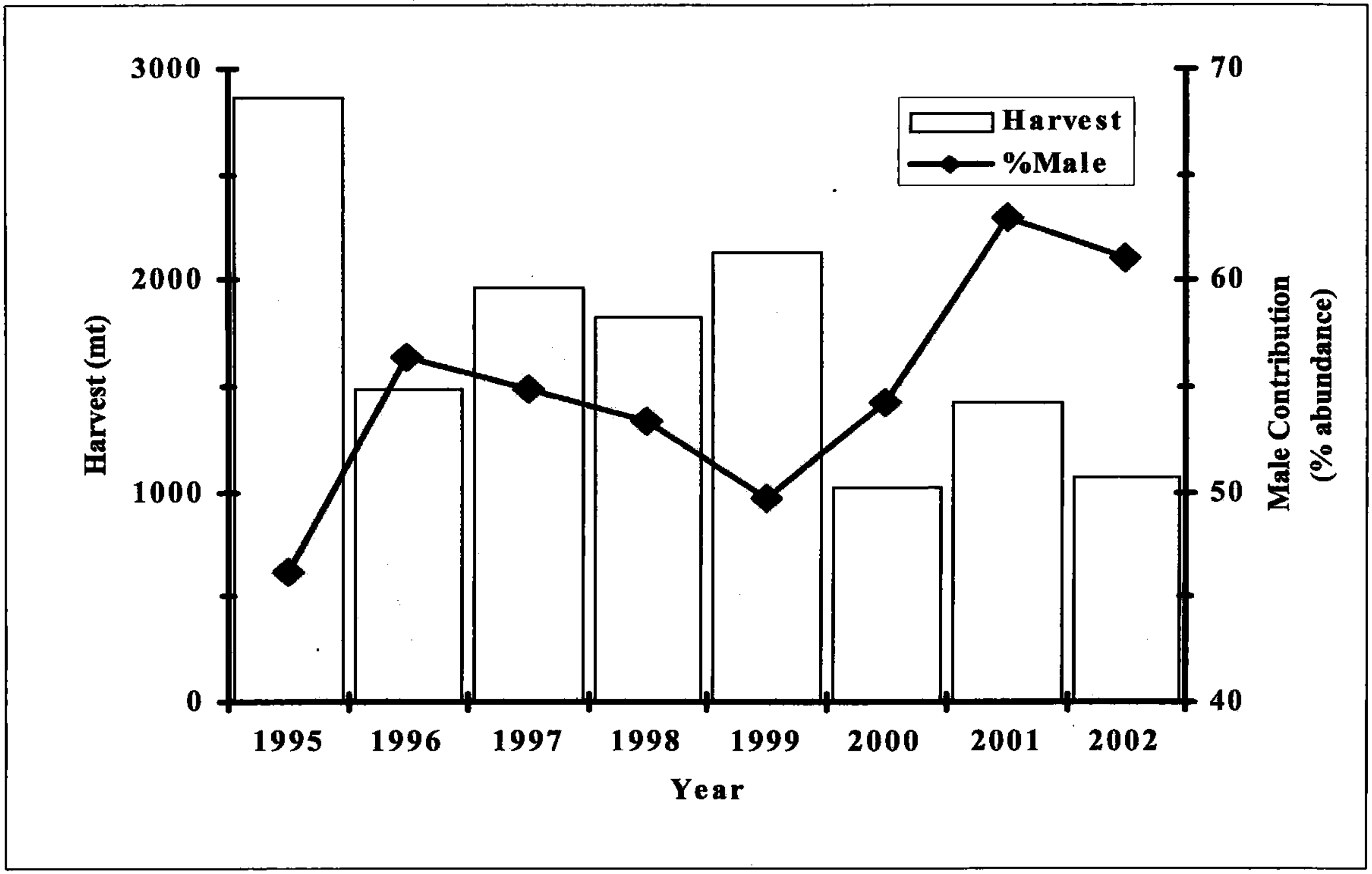

Figure 7. Contribution of male pollock to annual harvests, 1995-2002.

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