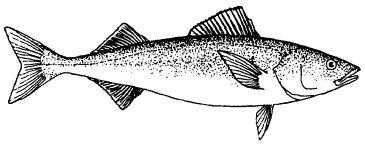
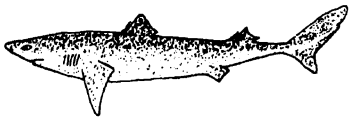
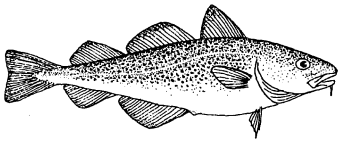
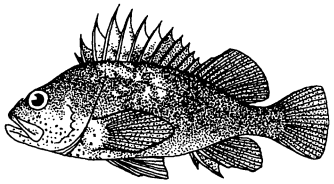




1995 STATUS OF PUGET SOUND BOTTOMFISH STOCKS





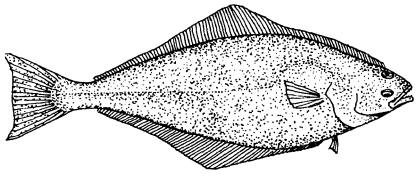
by

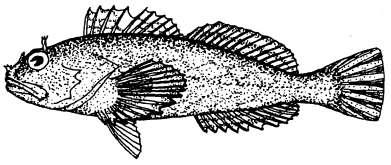
Wayne A. Palsson, James C. Hoeman, Gregory G. Bargmann, and Dwane E. Day

Washington Department of Fish and Wildlife

Olympia, Washington

December 1996





1995 STATUS OF PUGET SOUND

BOTTOMFISH STOCKS

Wayne A. Palsson, James C. Hoeman, Gregory G. Bargmann,
and Dwane E. Day

Washington Department of Fish and Wildlife

Olympia, Washington

November 1996

REPORT AVAILABILITY

In compliance with the federal Americans with Disabilities Act, this publication is available in alternate formats to accommodate individuals with disabilities. Please contact (360) 902-2700 or TDD (360) 902-2207, or write to:

Department of Fish and Wildlife
Fish Management Program
600 Capitol Way North
Olympia, WA 98501-1091

ABSTRACT

Stock assessments were conducted for thirty–six bottomfish stocks in Puget Sound. Catch, effort, and survey data were assembled for North and South Sound regions for each of 18 species or species complexes. Only 28 stocks had sufficient information to determine stock status and recent trend. The majority of these stocks were in below average, depressed, or critical abundance conditions. Thirteen of the 28 stocks were in decline while eight were increasing. North Sound had more stocks at average or above average conditions than South Sound, where eight of eleven stocks were at below average or critical conditions. South Sound had seven stocks which lacked recent information to assess stock status.

Spiny dogfish, skates, and ratfish appeared to be in satisfactory condition. In contrast, virtually all of the codfish stocks (Pacific cod, walleye pollock, and Pacific whiting) were in depressed or critical conditions or were in decline. Rockfishes and lingcod, species living in association with rocky reefs, showed mixed patterns of stock condition. Lingcod were declining in North and South Sound, and populations were depressed in North Sound but were at average levels in South Sound. Rockfish populations showed no trend in either area and were at average levels in North Sound and at below average conditions in South Sound. English sole and starry flounder, key flatfish stocks in North Sound, were increasing in abundance but the fisheries remove a substantial proportion of the adult population which are overutilized. In South Sound, the lack of recent fisheries precluded the determination of stock condition, but trawl survey data suggested the stocks are underutilized. A variety of species including greenlings, sculpins, and sablefish had very poor information to assess stock condition.

TABLE OF CONTENTS

INTRODUCTION

The inland marine waters of Washington State (here defined as Puget Sound) have a wide variety of marine fishes, many of which are caught in recreational and commercial fisheries. Some 221 fishes have been recorded in Puget Sound including anadromous, marine, and introduced species. Marine fishes include bottomfishes, forage fishes (Pacific herring, Pacific sand lance, Pacific sardine, and smelts), non–game fishes, and other groundfishes (pelagic groundfishes and miscellaneous marine fishes). Of the marine species, many are bottomfishes which live in marine waters and spend their lives near or on the bottom. In Washington State, bottomfish are legally defined by Washington Administrative Code (WAC 220-16-340) as food fishes including Pacific cod, Pacific tomcod, Pacific hake (whiting), walleye pollock, all species of dabs, soles, and flounders (except Pacific halibut), lingcod and all other species of greenling, ratfish, sablefish, cabezon, buffalo sculpin, great sculpin, red Irish lord, brown Irish lord, Pacific staghorn sculpin, wolf–eel, giant wrymouth, plainfin midshipman, all species of sharks and skates, rockfishes, rattails, and surfperches except shiner perch. Eighty–six species of fish which have been recorded in Puget Sound are included in the legal definition of bottomfish. Of these, some 36 species of bottomfish commonly occur in recreational or commercial fisheries and are of importance to management (Table 1). Pacific halibut is ecologically a bottomfish and is assessed by the International Pacific Halibut Commission and managed in conjunction with the Pacific Fishery Management Council.

A variety of work has been conducted on stock assessment and management of marine fishes in Puget Sound. The stock status of forage fishes has recently been reviewed (WDFW et al., 1995) and a number of marine fish stocks were evaluated by Schmitt (1990) and Schmitt et al. (1994). Several bottomfishes have received individual assessments such as Pacific whiting (Lemberg et al., 1990), Pacific cod (Palsson, 1990), lingcod (Bargmann, 1982a), and English sole (El Sayed, 1959). A number of theses and student projects have occurred in several areas of Puget Sound and have provided local information on stock status including lingcod in the San Juan Islands (LaRiviere, 1981), rockfishes and other reef fishes in the San Juan Islands (Barker, 1979), and rockfishes around Bainbridge Island (Gowan,1983). WDFW has conducted trawl surveys in Puget Sound with the goal of assessing bottomfish populations but the results of only one survey have been published to date (Quinnell and Schmitt, 1991). Catch statistics are generated annually by WDFW for the more common and economically important species of bottomfish. Methods of generating catch statistics are described by Palsson (1988) and Schmitt et al. (1991) for recreational and commercial fisheries. Some of this information has been integrated into fisheries management plans for Puget Sound groundfish (Pedersen and DiDonato, 1982; Pedersen and Bargmann, 1986) but these treatments are dated and limited to identifying allowable biological catches for fisheries management and did not determine the status of bottomfish stocks.

Table 1. Important species of bottomfish in Puget Sound.

Common Name	Scientific name
Spiny dogfish	*Squalus acanthias*
Skates	
Big skate	*Raja rhina*
Longnose skate	*Raja binoculata*
Spotted ratfish	*Hydrolagus colliei*
Pacific cod	*Gadus macrocephalus*
Walleye pollock	*Theragra chalcogramma*
Pacific whiting (hake)	*Merluccius productus*
Rockfish	
Brown rockfish	*Sebastes auriculatus*
Copper rockfish	*Sebastes caurinus*
Greenstriped rockfish	*Sebastes elongatus*
Widow rockfish	*Sebastes entomelas*
Yellowtail rockfish	*Sebastes flavidus*
Quillback rockfish	*Sebastes maliger*
Black rockfish	*Sebastes melanops*
China rockfish	*Sebastes nebulosus*
Tiger rockfish	*Sebastes nigrocinctus*
Bocaccio	*Sebastes paucispinis*
Canary rockfish	*Sebastes pinniger*
Redstripe rockfish	*Sebastes proriger*
Yelloweye rockfish	*Sebastes ruberrimus*
Sablefish	*Anoplopoma fimbria*
Greenlings	
Kelp greenling	*Hexagrammos decagrammus*
Whitespotted greenling	*Hexagrammos stelleri*
Lingcod	*Ophiodon elongatus*
Sculpins	
Cabezon	*Scorpaenichthys marmoratus*
Surfperches	
Pile perch	*Damalichthys vacca*
Striped seaperch	*Embiotoca lateralis*
Wolfeel	*Anarrhichthys ocellatus*
Flatfishes	
Pacific sanddab	*Citharichthys sordidus*
Pacific halibut	*Hippoglossus stenolepis*
Butter sole	*Isopsetta isolepis*
Rock sole	*Lepidopsetta bilineata*
Dover sole	*Microstomus pacificus*
English sole	*Parophrys vetulus*
Starry flounder	*Platichthys stellatus*
Sand sole	*Psettichthys melanostictus*

The purpose of this document was to review the stock status of bottomfish and Pacific halibut in Puget Sound. Eighteen single or composite taxa representing 61 species of bottomfish were reviewed for two subdivisions of Puget Sound. In most cases, the choice of the eighteen taxa represented constraints limiting data collection for generating catch statistics. This assessment of stock status did not include bottomfish stocks which lacked historical catch data. These species included wolf–eel, several flatfishes, and plainfin midshipman.

For each assessed species group, an evaluation was presented for two regions of Puget Sound as though the species were separate stocks. The North Sound region was defined by the United States–Canadian border on the north, a line due north of the Sekiu River on the west, the mainland on the east and a line drawn between Point Wilson (near Port Townsend) and Partridge Point on Whidbey Island on the south (Figure 1). North Sound included most waters of the Strait of Juan de Fuca, the San Juan Archipelago, Bellingham Bay, and the U.S. Strait of Georgia. The South Sound region was defined on the north by a line between Point Wilson–Partridge Point and encompassed all waters of Puget Sound to the south, including Port Susan, Saratoga Passage, Skagit Bay and Deception Pass.

The bottomfishes that live in these two regions were considered as two "stocks," a term that can be described in several manners. In principle, a stock is a biological term which refers to a group of fish which is reproductively isolated, or partially isolated, from other such groups (Smith and Jamieson, 1986). For bottomfish in Puget Sound, little work has been performed on biological stock identification (Palsson, 1990; El Sayed, 1959; Goni, 1988; Day, 1976) and a second concept of the stock was used for this stock status report. A "fishery stock" is a group of fish which is exploited in a specific area or by a specific fishing gear. The North and South Sound regions are geographically distinct and have fisheries characteristics that are unique to each. Narrow passages at Deception Pass and a sill in Admiralty Inlet separate the North and South Sound areas from each other as separate oceanographic water bodies. North Sound is more exposed to storms, receives more oceanic water, and contains much rocky reef habitat. The fisheries in this area tend to be more seasonal and directed for specific groups of bottomfish. The South Sound area is generally more protected, influenced more by freshwater, located near several large cities, and contains less reef habitat. Fisheries in South Sound are less focused and tend to occur throughout the year.

For the assessment of the stock status of Puget Sound bottomfish, each of eighteen species groups were profiled for North Sound and South Sound. For each species, information on catch history, fishing effort, and survey results were presented. Additionally, the best available series of stock abundance data was designated as a primary stock indicator for each stock. The magnitude and pattern of the stock indicator was evaluated for determining stock status and trend.

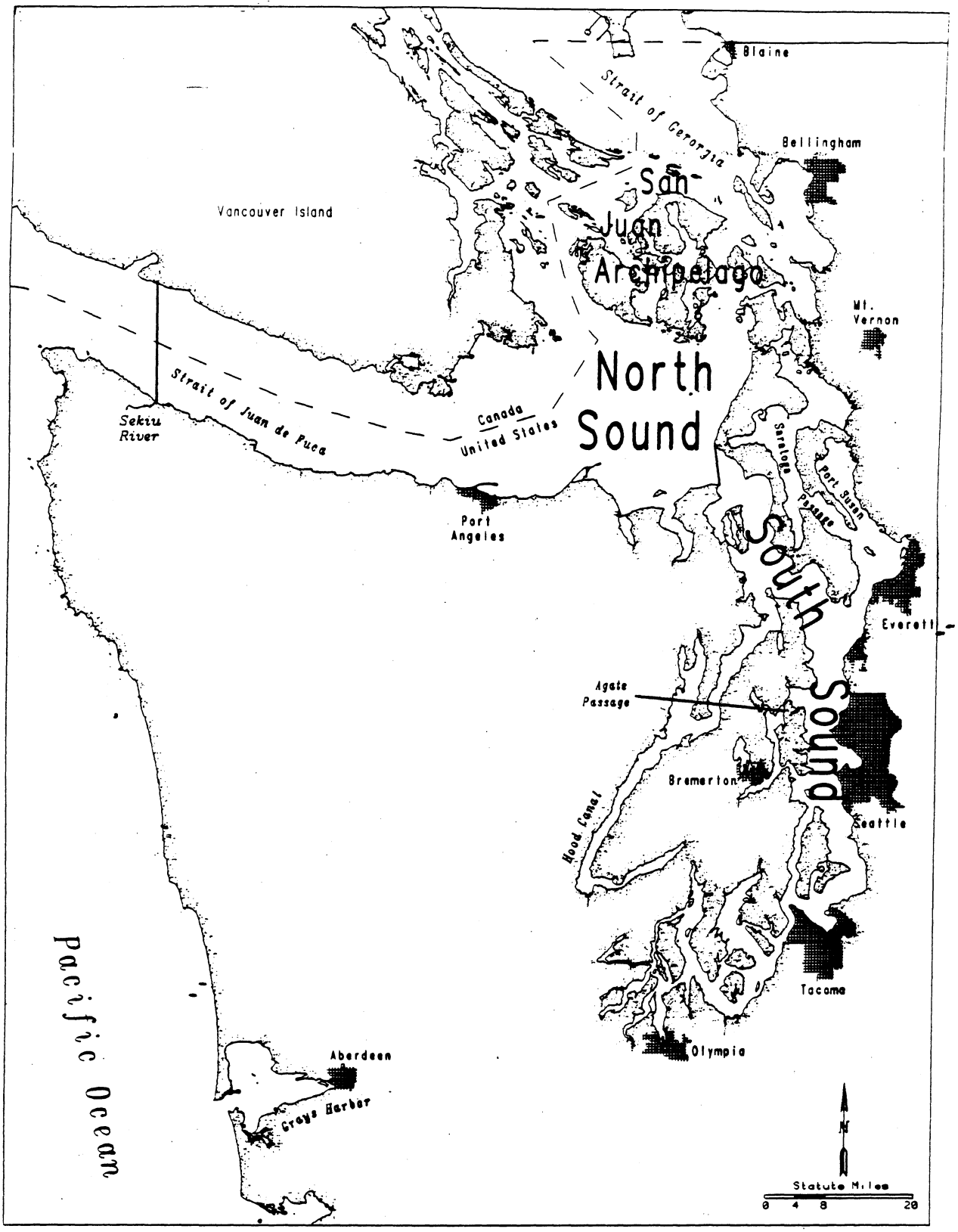


Figure 1. North and South stock regions of Puget Sound.

HISTORY OF BOTTOMFISH FISHERIES IN PUGET SOUND

Human use of Puget Sound's bottomfish resources has occurred for hundreds of years. Modern commercial fishing began in the 1920s with trawling and longline (set line) fishing (Smith, 1936, Alverson et al., 1964). At present, commercial fishing occurs using trawls, set nets, set lines, and beach seines. Commercial fishing using bottomfish troll and jig gear has been prohibited by regulation in recent years. Recreational fishing primarily occurs using hook and line and spears while skin diving.

The Puget Sound catch of bottomfish increased rapidly during the late 1930s (Figure 2), declined after World War 2, then rebounded rapidly during the late 1970s. In the mid–1970s, federal courts reallocated salmon harvests among tribal and non–tribal fishers. Non–tribal fishers then sought alternatives to salmon fishing which included fishing for bottomfish. Harvests peaked at over 25 million pounds annually during the late 1970s and early 1980s. Subsequently, catches declined sharply and dramatically to current levels of less than five million pounds annually. At present, landings of bottomfish are at their lowest level in fifty years.

Bottomfish harvests in Puget Sound have always been dominated by commercial fisheries, especially the bottom trawl fishery (Figure 3). The recreational fisheries were not monitored, or poorly monitored prior to the mid–1970s; and, it is likely that recreational landings were extremely small prior to the mid–1970s. During the period between 1970 and 1994, commercial fisheries accounted for more than 90 percent of the total bottomfish landings in Puget Sound (Figure 3).

Within Puget Sound, the Strait of Georgia has been the most productive area for fisheries in recent years (Figure 4) largely due to the year–round bottom trawl fishery which has operated in this area of North Sound. South Sound has been productive in the past, but production has declined significantly since the late 1980s. This decline is the result of a ban on bottom trawling in South Sound by the Washington Legislature in 1989 and drastic declines in the populations of Pacific cod, Pacific whiting, and walleye pollock (Palsson, 1990; Schmitt et al., 1994).

Quantitative measures of fishing effort were best represented for the years since 1970. For the dominant trawl fishery, the number of hours spent trawling reflected the best measure of effort. In North Sound, approximately 10,000 hours of trawling occurred each year in the early 1970s (Figure 5). Trawling increased to high levels during the late 1970s and through the 1980s when between 12,000 hours and 19,000 hours were spent trawling each year. Since then, North Sound trawling has decreased to less than 12,000 hours per year. In South Sound, trawling activity was relatively constant between 1970 and 1989 at about 4,000 hours per year. From 1989 to 1993, bottom trawling was restricted to Admiralty Inlet and since 1994 all trawling has been prohibited in South Sound.

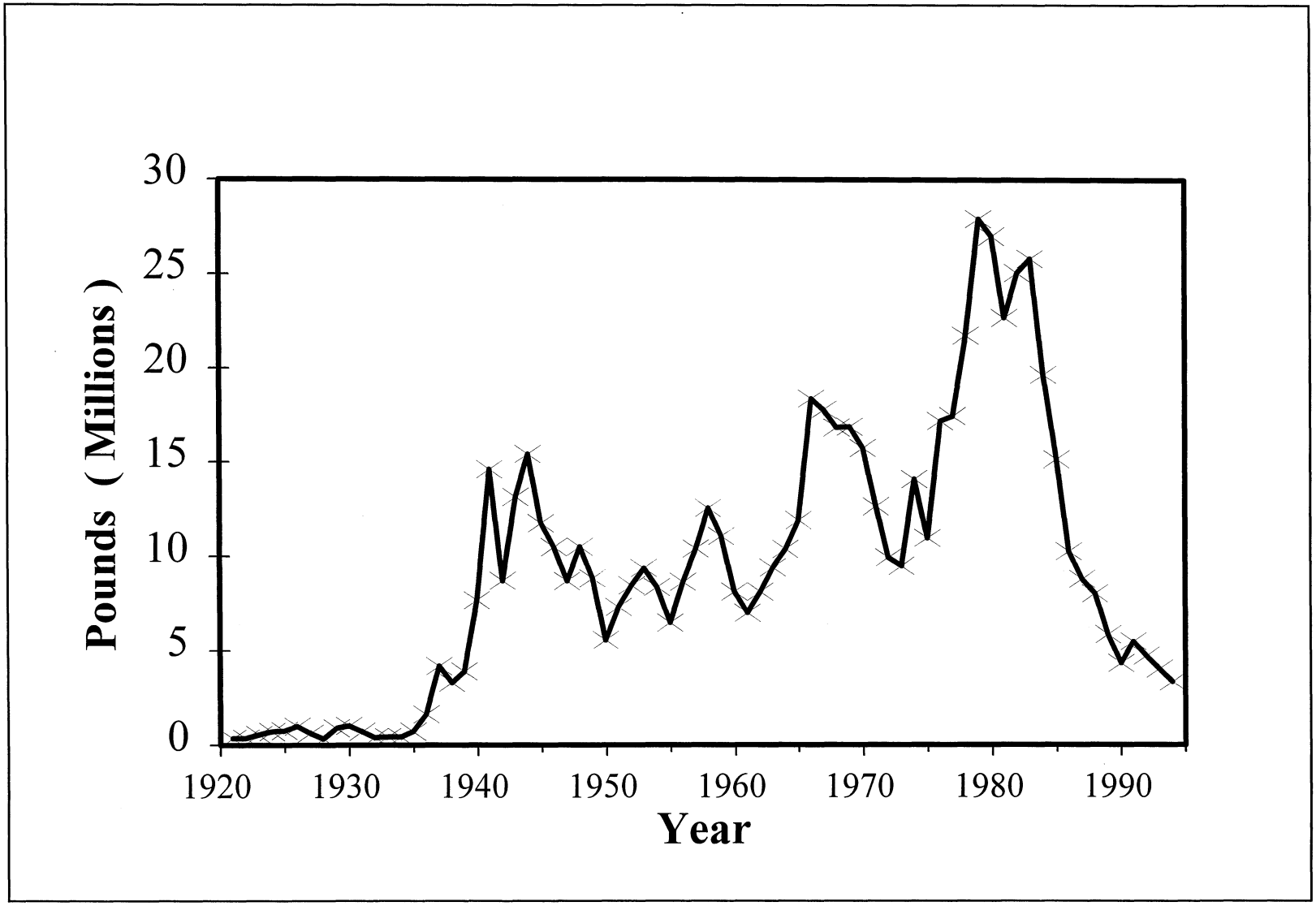


Figure 2. Puget Sound catch of bottomfish, 1920-1994.

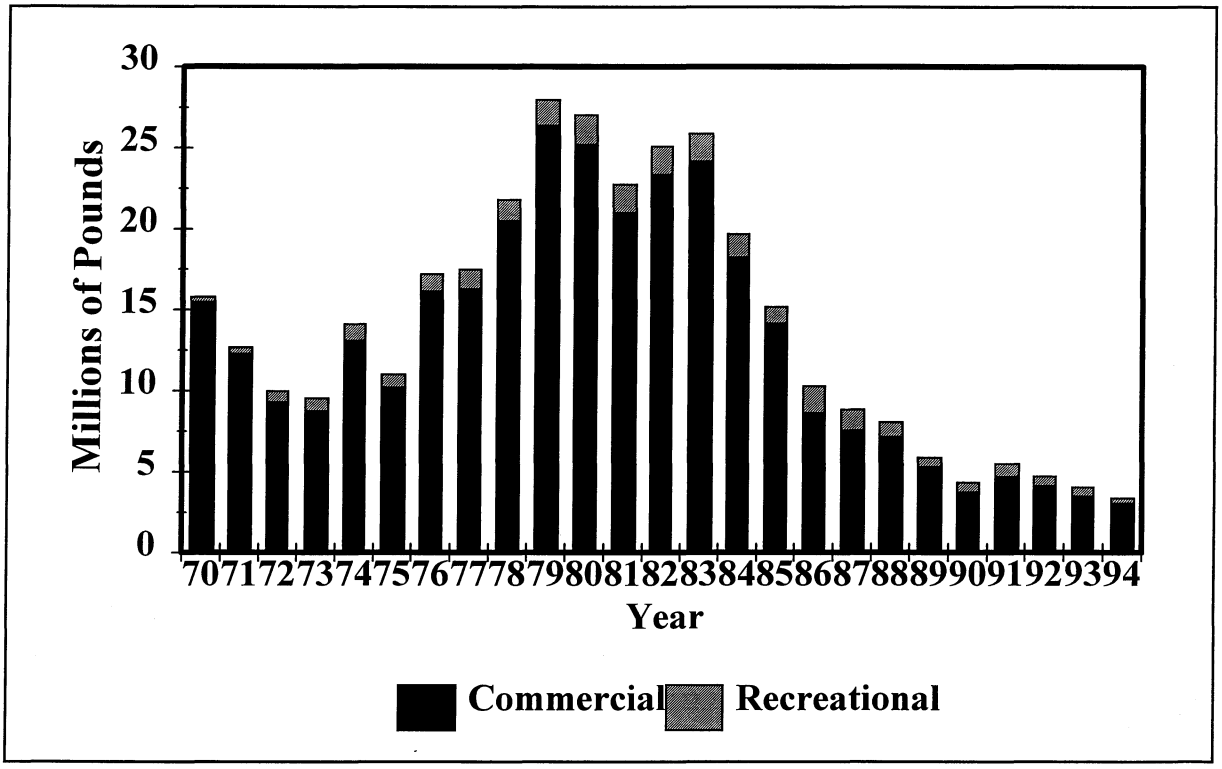


Figure 4. Commercial and recreational catch of bottomfish in Puget Sound, 1970-1994.

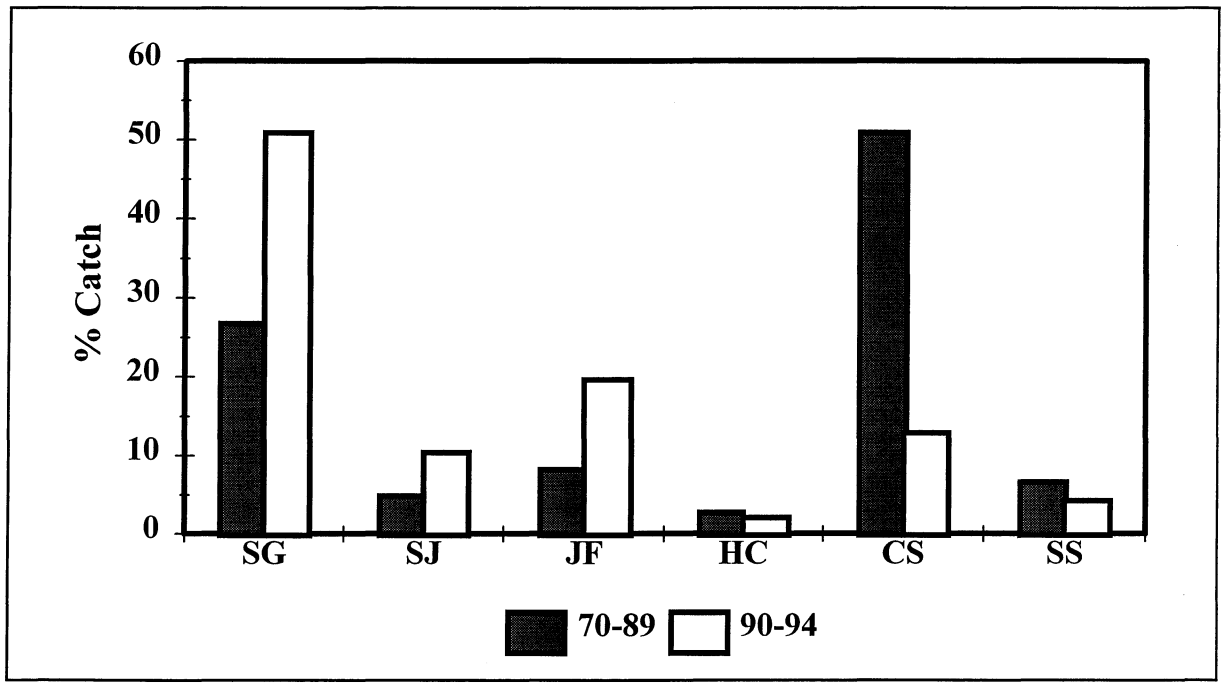


Figure 3. Percentage of catch, early and late years, for Puget Sound areas—SG: Strait of Georgia; SJ: San Juan Archipelago; JF: Strait of Juan de Fuca; HC: Hood Canal; CS: Central Sound; SS: South Sound.

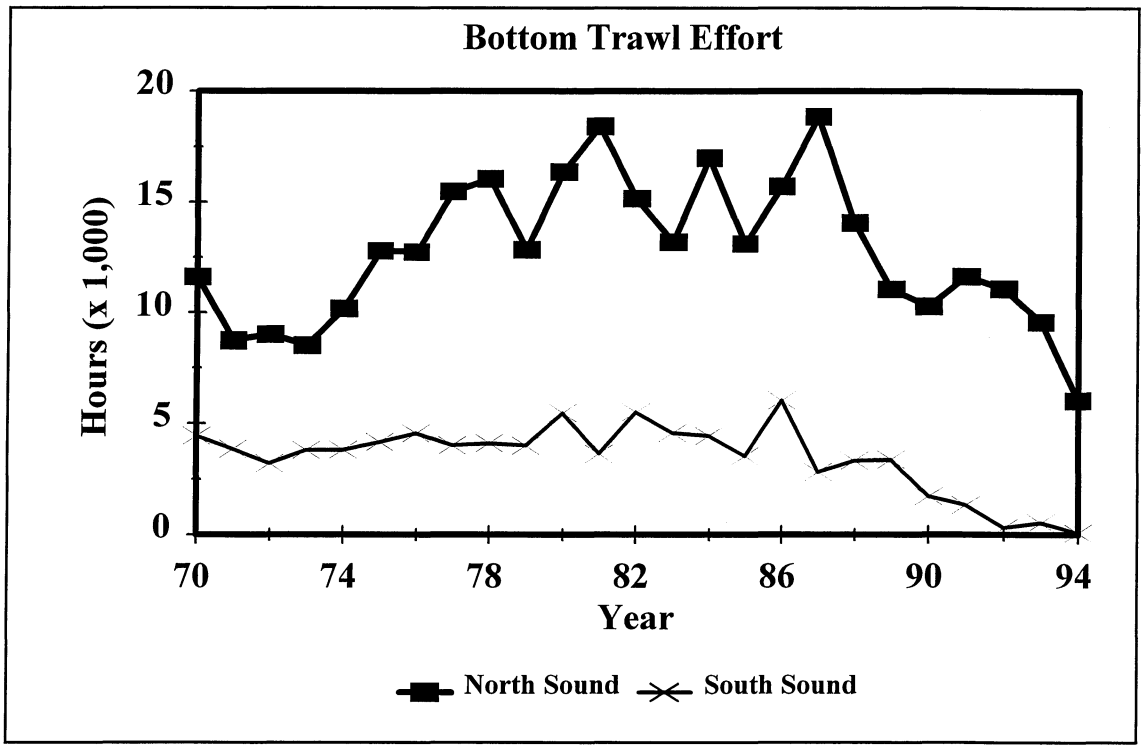


Figure 5 Number of bottom trawl hours in North and South Sound.

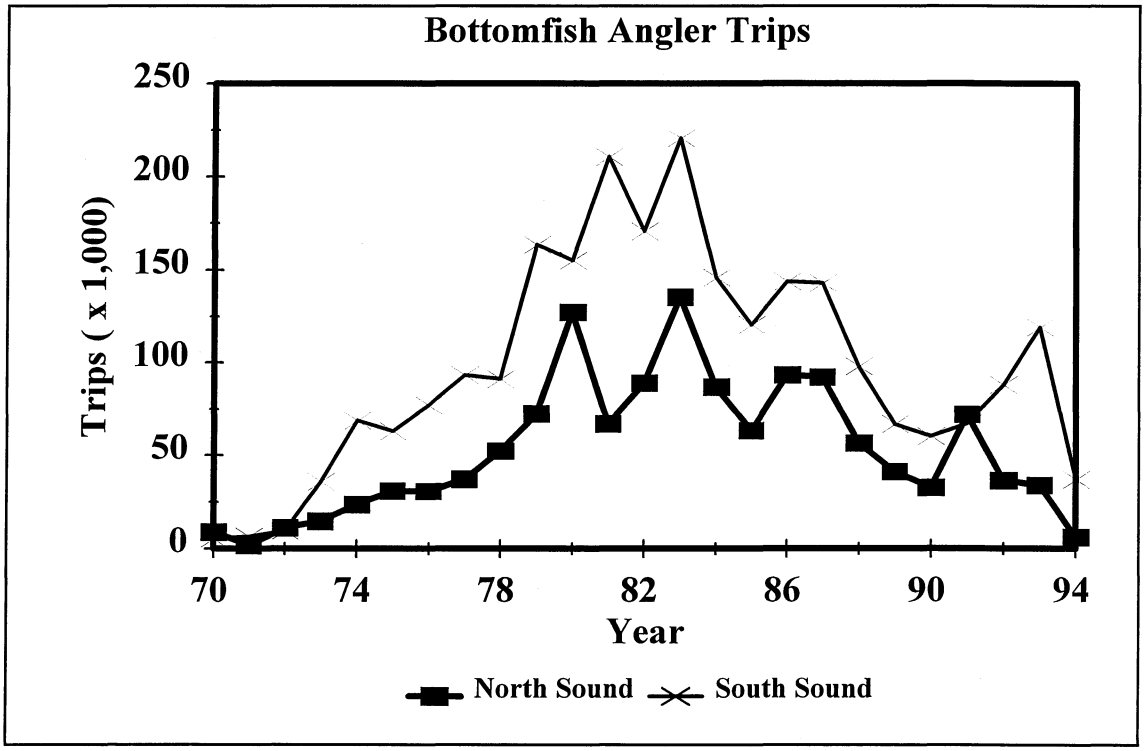


Figure 6. Number of boat–based bottomfish angler trips in North and South Sound.

For the recreational fishery, bottomfish effort was estimated by the number of boat–based fishing trips taken that were directed at bottomfish. Recreational effort estimates do not include shore–based and diving fisheries for bottomfish. North Sound showed a dramatic increase in bottomfishing effort from virtually no trips in 1970 to a peak of 140,000 trips in 1983 (Figure 6). Since then, bottomfishing activity has decreased and for the last several years has averaged about 50,000 trips. The low 1994 effort estimate was an underestimate due to an incomplete sampling program. In South Sound, a similar long–term pattern to the North Sound pattern was evident. Little bottomfishing activity occurred in the early 1970s but effort increased to over 200,000 bottomfishing trips in 1983. Effort subsequently decreased and in recent years averaged about 75,000 boat–based trips.

A number of significant regulation changes have occurred that affect historical catch and effort trends in both the commercial and recreational fisheries. The major regulation changes since 1970 include:

1978 Lingcod moratorium in South Sound south of Admiralty Inlet.

1982 4.5 inch mesh size requirement for bottom trawls.

1983 Lingcod moratorium ends. Six week lingcod season in South Sound. Institution of ten fish bag limit of rockfish for recreational anglers in North Sound, five fish in South Sound. Twelve inch minimum commercial landing size for English sole. Fourteen inch minimum commercial landing size for starry flounder.

1984 Permanent closure in San Juans to bottomfish jig and troll gears.

1985 Limited entry for trawlers fishing for Pacific whiting in areas of South Sound. Depth and area restrictions for the bottom trawl fishery.

1987 Closure of the commercial fishery for Pacific cod.

1989 Bottom trawling south of Admiralty Inlet banned by Washington Legislature.

1991 Agate Passage winter closure to protect Pacific cod spawning, daily bag limit reduced from fifteen fish to two fish. Directed commercial fisheries for rockfish and lingcod prohibited by banning roller gear on trawls. Winter closure of bottom trawl fishery near Port Townsend and Protection Island.

1992 Further lingcod restrictions including reduced season from seven months to six weeks in North Sound and minimum/maximum size limits. Reduction of daily bag limit for walleye pollock from fifteen fish to five fish. Ban on bottomfish jig and troll gears east of Sekiu enacted.

1994 Rockfish daily bag limit reduced to five rockfish in North Sound and three in South Sound. Bottom trawling prohibited in Admiralty Inlet, the eastern Strait of Juan de Fuca, and the San Juan Archipelago.

METHODS

The determination of the stock status for Puget Sound bottomfishes primarily relied upon fishery–dependent methods. Most primary stock indicators were developed from catch histories or catch rates estimated from commercial and recreational fisheries. In a few special circumstances, fishery–independent methods such as trawl, acoustic, scuba, and video surveys provided estimates of total or relative stock abundance.

Sources of Catch Data

The amount of fish landed by commercial fishers has been censused and well documented. Regulations require commercial fishers to land and sell their catch. When the fish are landed, fish processors record the date, the area of capture, gear, and species on fish receiving tickets. Copies of the fish tickets are sent to WDFW and entered on to a computer. These computer records are further processed with several modifications (Schmitt et al. 1991) and converted into other databases for easier use. For trawl fisheries, a special, secondary data system is in place to provide further detail for this major fishery. Regulations require commercial fishers using otter trawls to fill out a logbook for every tow they make, recording specific information on time, place, depth, an approximate weight (in pounds) and species composition. The Coastal Trawl Logbook System (Clark, 1986a, 1986b) takes these data, reconciles the catch information with the corresponding fish tickets and allows for the estimation of the hours spent trawling and other detailed catch information. The logbook system has been extensively used for the estimation of catch rates for the trawl fishery and for several modifications of the catch database (Schmitt et al., 1991). Commercial catch data do not include fish that are caught but discarded alive or dead (also termed "bycatch").

The catch of bottomfish by recreational anglers is not censused as the commercial catch but is estimated for the dominant boat–based, hook–and–line fishery. The catch and number of angler trips was estimated with a system of catch record cards and a creel survey (Hoines et al., 1983). When anglers catch salmon in Puget Sound, they must record their catch on a catch record card which must subsequently be returned to WDFW at the end of the year. The salmon catch is estimated by a subsample of the returned cards which is then used as a scaling factor for catch rates obtained from the creel survey. The creel survey is conducted at boat ramps, marinas and other fishing access points and catch per trip is estimated for each month and areal subdivision of Puget Sound (Palsson, 1988). Bottomfish catch and the number of fishing trips are estimated from this system and processed into a catch and effort database similar to the commercial bottomfish database. The recreational catch estimates are made in

terms of numbers of fish while the commercial catches are recorded in pounds. To unify these two catch databases, average weights per fish (Wildermuth, 1983) were multiplied by the recreational catch in numbers to arrive at the recreational catch in pounds.

There are a number of limitations to the recreational catch estimates and time series. In 1994, large–scale closures occurred for the recreational salmon fishery preventing successful bottomfish catch and effort estimates in many areas of Puget Sound. Consequently, bottomfish catch and effort were severely underestimated for that year. Another limitation is that recreational catch estimates included in this report represented only those of the hook–and–line fishery from boats. Spearfishing and angling from piers and docks are not regularly included in the recreational catch estimation scheme. These fisheries may have substantial catches which are not reported. Examples are surfperch by pier anglers (Bargmann, 1982b) and lingcod and rockfish by spearfishers (Bargmann, 1984). As with commercial catch data, the recreational data did not include bycatch.

Sources of Assessment Data

Surveys. – From time to time, WDFW has undertaken a variety of fishery–independent surveys to estimate the populations of various bottomfishes. The foremost of these surveys has been the bottom trawl survey of Puget Sound that targets the bottomfishes that live in trawlable habitats. Three trawl surveys have been conducted including the fall of 1987, the spring of 1989, and the spring of 1991. The trawl survey employed a commercial fishing vessel that towed a standard commercial otter trawl fitted with a half–inch mesh liner in the cod end of the net. Trawls were made following a stratified, random survey design in all regions of Puget Sound except the San Juan Archipelago. The archipelago was not included in these trawl surveys because the frequent occurrence of reef habitat prevented successful trawling. The methods and results of the 1987 survey were documented by Quinnell and Schmitt (1991) and similar methods were used during the subsequent surveys. The results of these later surveys have not been published but were used in this report.

Another series of surveys that have been conducted every year since 1983, are the acoustic–trawl surveys to assess the spawning population of Pacific whiting in Port Susan and Saratoga Pass. The methods, documented by Lemberg et al. (1990), involved a systematic, acoustic survey of the areas at least once during the winter spawning period of the whiting. A calibrated, scientific echosounder operated from a 36 ft vessel provided an estimate of the pelagic biomass of fishes. To obtain the biomass of whiting, a chartered trawler followed the acoustic vessel and a midwater trawl was set on pelagic targets. The resulting catch was used as a species composition to apportion the pelagic biomass into whiting and other species. The data were then averaged over the transects made during the survey and expanded to the entire survey area.

The Video–Acoustic Technique (VAT) was a new survey method developed by WDFW to estimate the fish populations living in association with rocky and high–relief reefs in Puget

Sound (Palsson, 1996). The technique used a video camera to quantitatively estimate the density of fishes living within two meters of reef habitat. A second survey using a scientific echosounder was conducted simultaneously to estimate the density of fishes living from two meters above the reef to just below the surface. The VAT surveys were planned with a stratified, systematic design of potential reef habitat. Potential reef habitat was defined as charted reefs, artificial structures and other such habitats that had a likelihood of containing rockfish, lingcod, greenling and other reef species. The charts and reef areas were stratified by regions, depth zones, and the potential for containing suitable habitat. Only reefs from the tidal datum to a depth of 120 ft were surveyed. Surveyed areas were identified from detailed nautical charts and quantified by computer. Once average fish densities were estimated from the video and acoustic surveys, they were multiplied by the area of identified habitat, resulting in abundance estimates for the reef species. Estimates were available for 1994 representing the San Juan Archipelago and the Strait of Juan de Fuca. A pilot survey was was conducted in the San Juan Archipelago in 1993.

Visual censuses using scuba strip transects have provided relative estimates of rockfish populations at several sites in South Sound. Transect methods were developed by Matthews (1990) to evaluate the relative habitat use by rockfishes. The method was modified by Palsson and Pacunski (1995) who used the transect technique to evaluate marine refuges and interannual changes in rockfish densities. The method entailed setting three, 30 m, permanent transect lines at selected index sites. Long–term index sites included artificial reefs at Boeing Creek and Blake Island and natural, rocky reefs at Port Blakely and Orchard Rocks. Fish were identified, counted, and measured by divers swimming on either side of the transect line. Fish were only included if they were within 1.5 m of the transect line, thus each transect encompassed 90 m^2. Densities were determined for each transect line and then averaged for the three transects of each site. Data were compared interannually by using analysis of variance techniques.

Catch rates. – Catch and effort data from the commercial and recreational fisheries were combined into indices of catch rates over time. Recreational catch rates were estimated from the WDFW creel survey of recreational fishers. The number of bottomfish anglers and their bottomfish catch for each sampled day and site were available from the survey from 1977 through 1994. The catch per bottomfish angler was calculated for each site and day sampled within each catch reporting area for Puget Sound. An annual, effective catch rate was then calculated for each area by averaging all the site–day catch rate observations when at least one bottomfish angler was interviewed. Site–day observations were averaged over the entire year regardless of month for all species except Pacific cod and lingcod. Since sampling effort was allocated in proportion to anticipated angler effort on a monthly basis, the resulting catch rates were effectively weighted by angler effort. For Pacific cod, only those months during which significant catches occurred were used to estimate the annual value. For lingcod, only the legal, open seasons common to all years were used in the estimates. These dates were from May 1 to May 31.

Commercial catch rates were estimated in a different manner. For trawl catch rates, the trawl logbook system (Clark 1986a, 1986b) was queried for species, time and area combinations of interest. The catch and number of hours fished reported by the skipper were then aggregated and the catch was divided by hours to arrive at a catch rate in terms of pounds per hour. Two other commercial catch rates were estimated by tabulating commercial catches for species, areas, and gears of interest and dividing the catches by the respective number of landings (fish tickets). This method was used to estimate the catch per landing of pile perch in the drag seine fishery and of dogfish in the set net fishery.

Age–structured assessments. – For most Puget Sound bottomfish stocks, age structures have either not been collected or not verified for use in stock assessments. In one instance age structures were collected and a catch–at–age analysis was conducted for walleye pollock exploited in the recreational fishery in South Sound. Sagittal otoliths were obtained from randomly–selected pollock collected during the peak fishery years between 1980 to 1986. Ages were determined reading the surface of the otoliths using a light microscope. Annual age frequencies were applied to annual catches and corresponding measures of total catch and effort entered into a catch–at–age model (CAGEAN, Deriso et al., 1985). Estimates of year class strength of recruiting three year olds, annual fishing mortality, and annual abundance were obtained from the results of the model.

Stock Profiling Methods and Definitions

Stock profiles consisted of an overview for each species and region and a presentation of catch, effort, trawl survey, and stock indicator information. In the overview, the nature of the fishery was briefly described, followed by a description of the major catch trends since 1970. For each species and region, a primary stock indicator was identified. Long–term trends in the primary stock indicator were summarized, and an objective characterization of the recent stock trend was presented. In addition, the stock status was characterized along with an evaluation of how much the stock has been utilized. For some profiles, a secondary stock indicator was available and analyzed in comparison to the primary indicator.

For each species and area, a primary stock indicator was the best time series of long–term and recent stock abundance data. In most cases, the primary indicator was the time series of catch rate data either from commercial or recreational fisheries. This assessment method only provided a relative index of stock abundance subject to a variety of assumptions discussed later. For the South Sound whiting analysis, the acoustic–trawl survey for whiting provided an absolute abundance time series for the primary stock indicator. In a number of instances, the total annual catch unadjusted for effort was the only continuous time series of relative abundance information. Secondary stock indicators were other time series that offered complete or partial series of abundance data for the stock. However, the overall stock trends and status were only determined from the primary stock indicator.

Data quality. – The nature and quality of the data used in evaluating stock status was characterized into three categories based upon the completeness of the time series, the number of indicators, and the ability of the indicators to predict the population abundance:

Poor: Only one time series of catch or catch rate data was available or recent data were lacking.

Fair: One or more series of complete catch rate data were available in addition to at least one fishery–independent abundance estimate.

Good: A complete, long–term series of survey or catch–at–age data were available providing total estimates of abundance.

Fishery impact. – The likely impact of the fishery was evaluated by contrasting trawl or other survey data and the total annual catch for the year of the survey. Only the 1989 and 1991 trawl surveys were used to assess utilization because the 1987 survey was conducted in a different season and by a different vessel that made fewer tows than the subsequent surveys. For English sole and starry flounder, only the population of fish above the respective legal limits of 12 inches and 14 inches was considered.

The analysis of utilization was based upon Gulland's (1983) approximation for yields estimated from surveys:

$$\textbf{Yield} = 0.5\ Z\ B$$

where **Z** is the instantaneous mortality rate and **B** is the survey biomass. Most marine fishes have instantaneous natural mortality rates ranging from 0.2 to 0.5, equating to maximum annual yields of 10 percent to 20 percent of the survey biomass. Full utilization was defined as annual harvests that equaled 10 percent to 20 percent of the average trawl survey estimates from 1989 and 1991. For rockfish, which have lower natural mortality rates, a 1 percent to 5 percent criterion was used. Trawl survey and catch information were compared in metric tons. One metric ton is equivalent to 1.1 short (U.S.) tons. Until population dynamic models and estimation parameters can be refined, the following conventions were adopted for evaluation the fishery impact:

Overutilized: Overutilization occurred when the percentage of the annual catch exceeded 20 percent (5% for rockfish) of the survey population biomass (5% for rockfish), averaged over comparable survey years.

Fully utilized: The stock was fully utilized when the percentage of the annual catch ranged between 10 percent and 20 percent (1% and 5% for rockfish) of the average survey population biomass.

Under-utilized: The stock was undertuilized when the percentage of the annual catch was less than 10 percent (1% for rockfish) of the average survey population biomass.

Stock trend. – The trend of stock abundance was characterized by the pattern of the primary indicator during the most recent five years. The stock trend was defined as the rate of change in the primary indicator, estimated as the linear regression slope of the most recent five years, divided by the mean of the indicator over the same five–year period. In order to minimize slight relations from being categorized as increasing or decreasing trends, only rates of change that increased or decreased by more than 5 percent of the five year mean were considered to be significant. When only catch data served as the primary indicator and recreational harvests were significant, the 1994 catch estimate was not used and trend analysis was shifted to the years 1989 to 1993. Stock trend was not evaluated in South Sound when trawl catch rates were the primary indicator because the trawl closure precluded recent information. The following criteria were established for stock trend characterization:

Increasing: The slope was positive and exceeded the five year mean by 5 percent.

None: The slope was either positive or negative but was within 5 percent of the five year mean.

Declining: The slope was negative and was less than the five year mean by 5 percent.

Unknown: A lack of recent data for the primary stock indicator prevented a determination

Stock status. – The stock status was defined as the average of the most recent and complete two years of the primary stock indicator divided by the long–term mean of the indicator. The long–term mean included the longest available time series of the primary stock indicator to a maximum of twenty years. When catch data were used as the primary indicator, the 1994 catch estimate was not used when the recreational fishery was the dominant harvest mode. The degree of difference between the two–year mean and the long–term mean defined the stock status as follows:

Above average: The two year mean exceeded the long–term mean by more than 5 percent.

Average: The two year mean was within 5 percent of the long–term mean.

Below average: The two year mean was below the long–term mean by 6 percent to 35 percent.

Depressed: The two year mean was below the long–term mean by 36 percent to 75 percent.

Critical: The two year mean was below the long–term mean by more than 76 percent, or the fishery or population was not detectable.

Unknown: A lack of recent data for the primary stock indicator prevented a determination.

LIMITATIONS

The methods and data sources used to assess the status of bottomfish stocks in Puget Sound had a variety of limitations which must be considered for stock and fishery management and improvements in future stock assessments.

The determination of stock status was based upon the fishery–stock concept. The relationship between fishery stocks and biological stocks is virtually unknown for most Puget Sound marine fishes. Conventional techniques using meristic characters, movement patterns, and parasite markers have shown some degree of biological stock structure. Goni (1988) used growth information to separate whiting between North and South Sound. Palsson (1990) distinguished three stocks of Pacific cod in Puget Sound based upon movement patterns and spawning sites. Walleye pollock grow at different rates between North and South Sound (WDFW, unpublished data) and demonstrate spatial separation during spawning periods, indicating they are discrete stocks.

Genetic techniques have been found useful for stock separation with freshwater and anadromous species but are usually poor at resolving biological stocks with marine species (Utter and Ryman, 1993). In general, marine fishes have life history characteristics that reduce barriers to gene flow and typically do not reveal genetic differentiation. In some instances, electrophoresis has revealed stock differences among broad regions but little genetic differentiation within a region. For example, Pacific cod and yellowfin sole south of the Aleutian Islands and Alaskan Peninsula are genetically homogeneous but differ from populations north of the peninsular and island barriers (Grant et al. 1983, Grant et al. 1987). Some marine fishes have shown moderate genetic stock structure. Pacific whiting and lingcod from Puget Sound form distinct stocks from coastal populations (Utter and Hodgins, 1971; Jagielo et al., 1996). The lack of genetic differentiation for marine fishes may be an artifact of using electrophoresis techniques. As DNA techniques improve and become affordable, greater genetic discreteness among marine fish stocks in Puget Sound may become known and more detailed stock assessments will be required.

Other limitations hinder the population assessment and management of Puget Sound bottomfishes. In a recent review of biometrical methods of the Marine Resources Division of WDFW, Tagart et al. (1996) identified a variety limitations including the lack of a comprehensive estimation method for recreational fisheries, the lack a sampling program to estimate the species composition of flatfish, rockfish, and other species complexes, and the lack of a sampling program for age structures that would provide the basis of age–structured stock analysis. While aspects of recreational sampling are currently being solved, increased sampling can only be achieved when new priorities and funding are established for such activities.

The most common primary indicator used in the stock assessments was the trend in catch rates. The critical assumption in this analysis is that the trend in catch rates is proportional to the population abundance (Gulland, 1983). For this assumption to be valid, the catchability of the fish in the population must not change over time. Catchability is constant when searching effort is randomly directed (Hilborn and Walters, 1992). However, searching is rarely random and factors can change searching efficiency such as interactions with other fishers and improvements in sonar and navigation technology over time. Many of these factors have likely affected the catchability of Puget Sound bottomfishes and may make catch rates as stock indicators problematical. Changes in searching and catchability over time are also compounded with factors such as the distribution and patchiness of exploited resources. Schooling and sedentary species which can be found and fished easily can lead to a circumstance where the catch rates are "hyperstable" (Hilborn and Walters, 1992): The catch rate trend remains relatively constant while the population is actually declining. Interpretation of the catch rate trend is also affected by the "fishing down" process whereby unexploited populations will naturally result in lowered catch rates as the surplus production is removed and an equilibrium is reached between standing stock and fishery removals. Catch rate trends are also limited in their use as relative population indicators because they have not been compensated for regulation changes and limitations during the time series.

For several stocks, the only available primary indicator was the trend in total catch. This indicator is the least desirable and can easily lead to false conclusions about the relative magnitude and trend of a population. Without compensating for effort, factors such as changing market conditions and increases or decreases in the popularity of a species may influence the total catch more than a change in population abundance. Every effort should be made to find alternative stock assessment measures for the stocks with limited catch and effort data.

The stock assessments may be further limited by the somewhat arbitrary criteria established for determining stock status, trend, and utilization. For consistency, the criteria for stock status and trend were patterned after the stock assessments for baitfishes (WDFW et al., 1995) but may not be appropriate for longer–lived bottomfishes. The method of determining recent stock trend was also arbitrary and ad hoc; more formal methods of time series analysis may be warranted in the future. Although, the limits for stock declines, increases, depression, and

other conditions of status and trend may not have related well to the actual stock conditions, they did offer an objective means for comparison and evaluation of management actions in the future.

At present, the 10 percent–20 percent levels of harvest for full utilization were based on a general relationship between yield, mortality and survey biomass (Gulland, 1983). This model is one of the simplest yield relationships. Given more data and resources, refined harvest models can be developed in the future. The major limitation in using Gulland's relationship is knowing the mortality rates for the eighteen assessed species. Future assessments must strive to incorporate the most current estimates of mortality into the analysis of utilization. The assessment of utilization may also be limited by the assumptions of the trawl survey. The main assumption is that all fish in the path of a trawl are captured and those outside the path are not vulnerable. Recent experimental work suggests this assumption is not valid and that significant herding and avoidance of trawl gear can occur (Gunderson, 1993). The trawl survey estimates of biomass must also be discounted for selectivity of younger fish caught in the fine–mesh research trawl that are not typically caught by commercial trawls.

The causes of abundance changes in marine fish populations are poorly understood. Natural fluctuations are common in marine fish populations (Gulland, 1983), and recent work on marine fishes in the northeastern Pacific has demonstrated cycling in marine fish stocks which may relate to fluctuations in climatic variables. Hollowed and Wooster (1995), examined marine fish stock off the West Coast of North America finding synchronies for strong recruitment in groups of marine species that related to either warm or cool climatic phases. Parker et al. (1995) examined recruitment fluctuations of Pacific halibut and identified an 18.6 year lunar nodal cycle which may affect recruitment by tidal mixing and climate forcing. Warmer ocean climates apparently cause coastal hake to move farther north where they may influence the populations of other marine fishes (Ware and McFarlane, 1995). Warmer climatic regimes may inhibit cod populations in Puget Sound (Palsson, 1990). Changes in marine mammal abundance is another natural cause of abundance fluctuations of marine fish. An increase in the sea lion population is suspected as suppressing the recovery of the whiting population in South Sound (Schmitt et al., 1995), and burgeoning populations of harbor seals in British Columbia consume large quantities of marine species and may compete with fisheries (Olesiuk et al., 1990). Similar interactions may be occurring in Puget Sound. Human–induced climate change and more direct anthropogenic changes such as habitat loss, fishing, and pollution may affect the abundance of Puget Sound stocks (Schmitt et al., 1994). Before effective management can occur, all these factors should be identified and incorporated into harvest and management models.

STOCK PROFILES

Overview

Eighteen species of marine bottomfishes were assessed for the two stock areas of Puget Sound. For the 28 stocks which had available data, the majority (15) were in below average, depressed, or critical conditions of stock status (Table 2). Fifteen stocks exhibited increasing trends or showed no trend during the most recent five years, while thirteen stocks were in decline. The status and trends of eight stocks were unknown due to a lack of recent information. Ten of the sixteen North Sound stocks were at average or above average status abundance, but one was below average, four were depressed and two were at critical levels. South Sound had seven species with unknown status and trends, but most of the assessed stocks (8 of 11) were below average or at critical levels of abundance. The majority of North Sound stocks were increasing in abundance or showed no trend, but six out of sixteen species had declining population levels.

Table 2. Summary of stock status and trend for bottomfish stocks in North and South Sound.

	North Sound		South Sound	
Species Group	Trend	Status	Trend	Status
Spiny dogfish	none	above average	none	above average
Skates	increasing	above average	unknown	unknown
Spotted ratfish	unknown	unknown	unknown	unknown
Pacific cod	none	depressed	declining	critical
Walleye pollock	declining	critical	declining	critical
Pacific whiting	increasing	above average	declining	critical
Rockfish	none	average	none	below average
Sablefish	increasing	above average	declining	critical
Greenlings	increasing	above average	declining	below average
Lingcod	declining	depressed	declining	above average
Sculpins	increasing	average	increasing	above average
Pile perch	declining	critical	none	below average
Pacific halibut	declining	below average	declining	below average
Rock sole	declining	depressed	unknown	unknown
Dover sole	declining	depressed	unknown	unknown
English sole	increasing	above average	unknown	unknown
Starry flounder	none	above average	unknown	unknown
Sand sole	increasing	above average	unknown	unknown

Fifteen stocks were at fully–utilized or overutilized exploitation conditions (Table 3). Fifteen stocks were underutilized and six stocks had unknown levels of exploitation. North and South Sound each had four stocks that were overutilized and North Sound had four stocks that were

fully utilized. The lack of a recent trawl fishery in South Sound resulted in eight underutilized stocks.

For the assessed species, several trends and generalizations can be made. Spiny dogfish, presently the most valuable commercial fishery, appeared to be fully utilized, stable, and at above average levels of abundance. Little is known about skates, but their populations appeared to be stable and underutilized. The other cartilaginous fish, spotted ratfish, was in great abundance, but their level of bycatch was unknown so the fishery impact could not be evaluated.

Table 3. Summary of data quality and fishery impact (utilization) for bottomfish stocks in North and South Sound.

	Data Quality		Fishery Utilization	
Species Group	North	South	North	South
Spiny dogfish	fair	fair	fully	under
Skates	fair	poor	under	under
Spotted ratfish	poor	poor	unknown	unknown
Pacific cod	fair	fair	over	over
Walleye pollock	fair	fair	under	over
Pacific whiting	poor	good	under	over
Rockfish	fair	fair	fully	over
Sablefish	poor	poor	unknown	unknown
Greenlings	poor	poor	under	unknown
Lingcod	fair	fair	fully	fully
Sculpins	poor	poor	under	under
Pile perch	poor	poor	unknown	fully
Pacific halibut	fair	fair	fully	fully
Rock sole	fair	poor	under	under
Dover sole	fair	poor	under	under
English sole	fair	poor	over	under
Starry flounder	fair	poor	over	under
Sand sole	fair	poor	over	under

Sablefish and sculpin stocks were underutilized, increasing and above average in North Sound. In South Sound, the same conditions existed for sculpins but sablefish stocks appeared to be declining and at critically low levels. Pile perch, once an important commercial stock in South Sound was at a below average abundance and was fully utilized. In North Sound, the pile perch stock was declining and at critically low levels.

The commercially–exploited flatfishes had a mixed pattern of exploitation and abundance. Three flatfishes important to the commercial fishery, English and sand soles and starry

flounder were overharvested in North Sound, but their recent population trends were stable or increasing. North Sound stocks of rock and Dover soles were not overutilized but were at depressed levels and in decline. The status of flatfishes in South Sound could not be determined without recent fishery information, however, the trawl survey data indicated they are underutilized. Based on assessments by the International Pacific Halibut Commission, the recreationally important Pacific halibut populations were declining and at below average levels.

The reef fishes consisting of rockfish, lingcod, and greenlings showed several different patterns. Lingcod stocks were declining in both North and South Sound and were depressed in North Sound but at above average levels in South Sound. Rockfish populations showed no trend in either region, and were at average or below average abundance in North and South Sound, respectively. Greenlings were increasing and in high abundance in North Sound but were declining and below average in South Sound.

Both rockfish and lingcod stocks were fully utilized but North Sound greenling stocks were underutilized.

All codfish stocks were at alarmingly low levels. Despite several years of little or no exploitation, South Sound stocks of Pacific cod, Pacific whiting, and walleye pollock were at critically low abundance and declining. In North Sound, Pacific cod were overutilized, declining and at depressed levels.

The data used for stock assessments and trend analysis used in this report were only fair at best (Table 3). Only one of the 36 stock assessments had data that was rated as good. The majority of the assessments were based on fair data usually consisting of a catch rate trend and at least one survey estimate. A number of species assessments were based on catch data alone which were subject to changes in effort and not necessarily abundance. These assessments were rated as poor. The lack of any recent fishery dependent or independent time series in South Sound prevented adequate assessments of many bottomfish stocks in the southern region.

Stock Profiles by Species

NORTH SOUND—SPINY DOGFISH

OVERVIEW

Spiny dogfish is a medium–sized shark that is common throughout North Sound and is part of a transboundary stock shared with British Columbia. It is the most commonly caught bottomfish by commercial fishers who use bottom trawls, set nets, and set lines. They have landed as much as five million pounds in one year. The fishery began in 1974 and peaked in 1979. Since then landings have decreased but have been stable for the last five years at about two million pounds per year. Dogfish are commonly encountered as bycatch in recreational fisheries.

Several indices are available for stock indicators. The primary stock indicator is the set net catch rate. Since the inception of the fishery in the mid 1970s, the catch per landing peaked twice and had one long–term decline in the mid 1980s. Catch rates recovered after the low 1986 value and has not recently shown a trend. The stock status is above average. The secondary indicator, the trawl catch rate, shows very stable long–term catch rates and a recent average stock status. Dogfish appear to be fully utilized.

CATCH

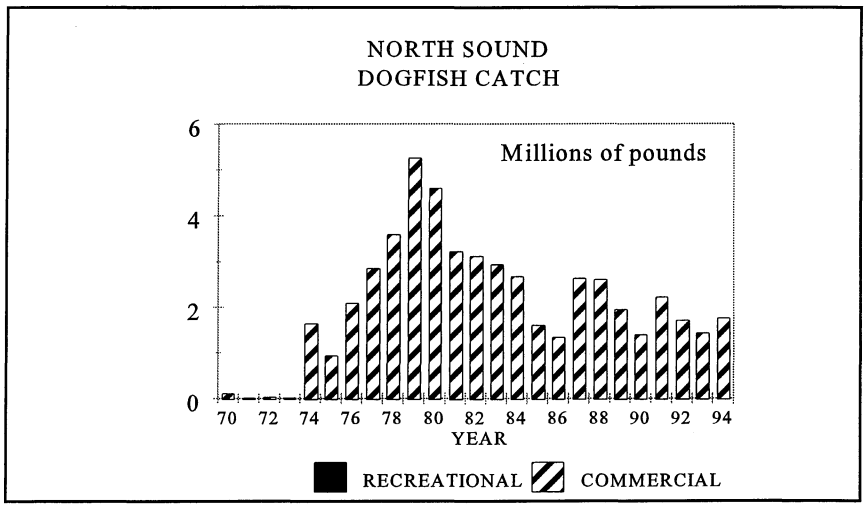


Figure 7. Recreational and commercial catch of dogfish in North Sound.

EFFORT

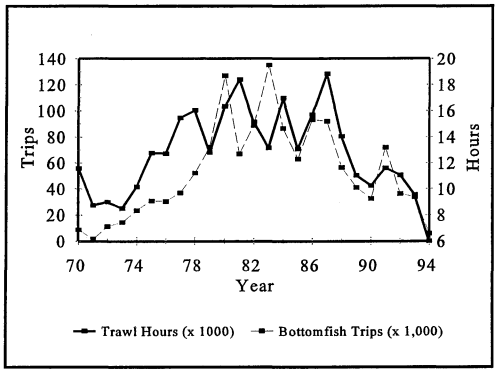


Figure 8. North Sound commercial effort in trawl hours and recreational effort in number of bottomfish trips.

STOCK STATUS PROFILE for NORTH SOUND—SPINY DOGFISH

YR	Set Net Catch Rate (lbs/landing	Recreational Catch Rate (fish/trip)	Trawl Catch Rate (lb/hr)
70	0.0		4.4
71	0.0		0.3
72	0.0		2.3
73	0.0		0.0
74	295.0		136.8
75	18.8		62.9
76	1,852.0		58.0
77	1,468.8		47.0
78	1,339.1		52.8
79	1,233.0		96.6
80	1,024.8		42.7
81	1,464.9		73.6
82	1,282.5		73.3
83	1,042.6		73.3
84	779.3		62.0
85	518.5		77.9
86	460.5		36.8
87	1,736.0		45.6
88	1,356.1		56.3
89	1,841.4		52.2
90	1,146.0		74.6
91	2,519.0		45.9
92	1,509.8		57.6
93	1,873.9		51.9
94	1,739.5		71.2

PRIMARY STOCK INDICATOR

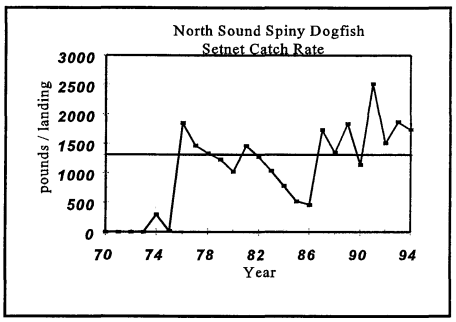


Figure 9. Dogfish set net catch rates and long–term mean.

SECONDARY STOCK INDICATOR

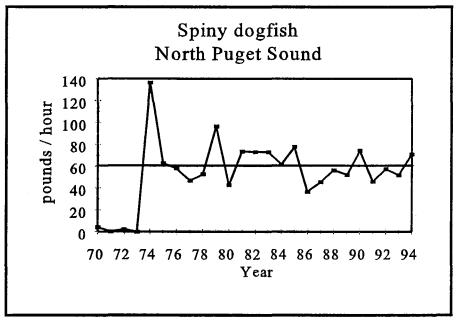


Figure 10. Commercial trawl catch per unit effort and long–term mean.

TRAWL SURVEY DATA

North Sound

SPINY DOGFISH	1987	1989	1991
Abundance (N x 1000)	15,547	7,297	9,266
Biomass (mt)	13,312	8,068	10,911
Catch (mt)	1,189	882	1,006
% Catch/Biomass	8.9	10.9	9.2

STOCK SUMMARY

FISHERY IMPACT
Fully utilized
DATA QUALITY
Fair
RECENT TREND (5 Year)
None
STOCK STATUS (2 Year)
Above average

SOUTH SOUND—SPINY DOGFISH

OVERVIEW

Spiny dogfish is a slow growing and late maturing shark that is common throughout South Sound, often schooling near the surface when pursuing forage fish. Dogfish in South Sound are part of a common stock with North Sound and parts of British Columbia. Most of the recorded catches of dogfish in South Sound are by commercial fishers using trawls, set nets, and set lines, however many dogfish are caught but not landed in recreational fisheries. The commercial fishery began in 1975 and catches immediately peaked the following year at 3.6 million pounds. Since then catches have declined but have stabilized during the last ten years at about 400,000 pounds per year.

The primary indicator is the set net catch rate which has shown a two–step, long–term increase. From the mid 1970s to the mid 1980s, the catch rate was slightly below the long–term mean, but then quickly increased and has remained stable and above average in recent times. The secondary stock indicator is the trawl catch rate which has shown a similar long–term increase as the primary indicator. Because of the trawl closure, recent trawl catch rates are unreliable as a stock indicator. Dogfish were not quite fully exploited during 1989 and 1991.

CATCH

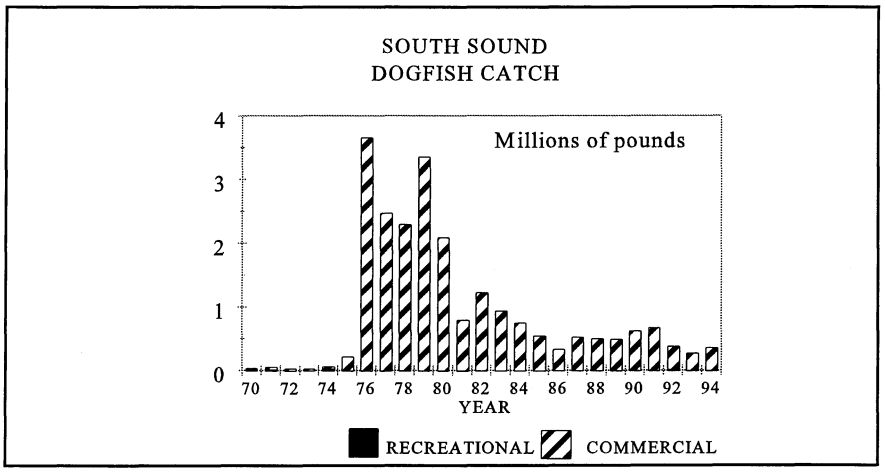


Figure 11. Recreational and commercial catch of dogfish in South Sound.

EFFORT

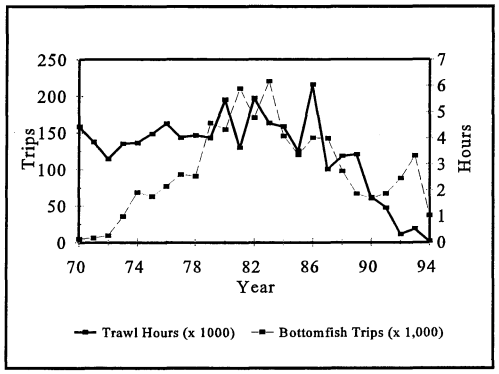


Figure 12. South Sound commercial effort in trawl hours and recreational effort in number of bottomfish trips.

STOCK STATUS PROFILE for SOUTH SOUND—SPINY DOGFISH

YR	Set Net Catch Rate (lb/landing)	Recreational Catch Rate (fish/trip)	Trawl Catch Rate (lb/hr)
70	0.0		0.0
71	0.0		3.2
72	0.0		5.7
73	0.0		1.2
74	0.0		4.3
75	17.8		24.4
76	2,233.6		19.7
77	1,544.7		24.0
78	1,270.6		36.9
79	1,284.8		18.0
80	950.7		21.8
81	1,100.4		16.1
82	2,099.9		39.7
83	1,159.6		25.2
84	1,226.9		17.9
85	1,158.0		9.1
86	964.1		11.7
87	3,927.3		22.5
88	2,030.6		72.8
89	2,012.5		132.4
90	2,837.0		186.7
91	2,494.4		172.1
92	2,318.2		148.3
93	2,810.7		140.7
94	2,869.2		0.0

PRIMARY STOCK INDICATOR

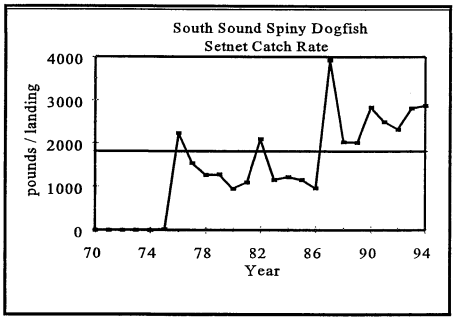


Figure 13. Set net dogfish catch rates and long–term mean.

SECONDARY STOCK INDICATOR

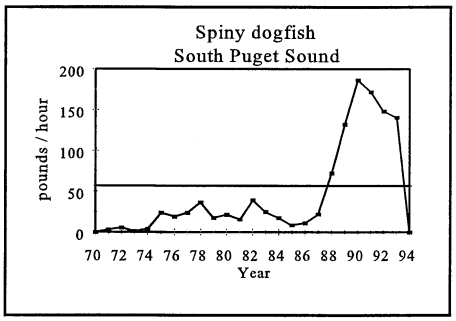


Figure 14. Commercial trawl catch per unit effort and long–term mean.

TRAWL SURVEY DATA

South Sound

SPINY DOGFISH	1987	1989	1991
Abundance (N x 1000)	11,742	7,234	3,400
Biomass (mt)	10,765	4,368	3,793
Catch (mt)	235	217	299
% Catch / Biomass	2.2	5.0	7.9

STOCK SUMMARY

FISHERY IMPACT
Underutilized
DATA QUALITY
Fair
RECENT TREND (5 Year)
None
STOCK STATUS (2 Year)
Above average

NORTH SOUND—SKATES

OVERVIEW

Big and longnose skates dominate the skate catches of North Sound and are the most common skates throughout the area. Skates are harvested primarily in the commercial fishery but landings were very low until the late 1970s when new markets were developed for skates. Until then, skates were probably caught but not harvested. Since the 1980s, catches have ranged between 100,000 pounds and 225,000 pounds per year with catches in many years exceeding 200,000 pounds.

The trawl catch rate is the primary stock indicator for North Sound skates. The stock has shown a cyclical pattern since the development of the fishery in the late 1970s with peaks and nadirs occurring approximately every five years. More recently, the stock indicator has been on the increase and the catch rates show a stock status that is above average. The trawl survey data show the stock is likely underutilized, but production rates of skate populations are poorly known.

CATCH

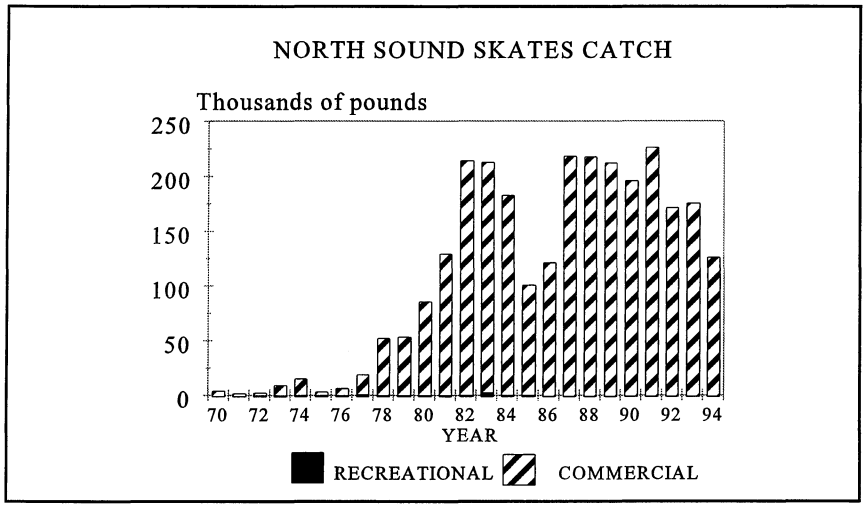


Figure 15. Recreational and commercial catch of skates in North Sound.

EFFORT

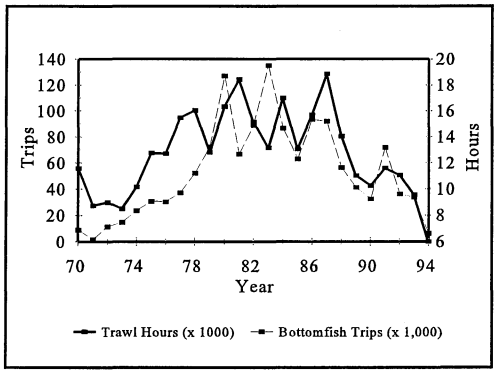


Figure 16. North Sound commercial effort in trawl hours and recreational effort in number of bottomfish trips.

STOCK STATUS PROFILE for NORTH SOUND—SKATES

YR	Trawl Catch Rate (lb/hr)	Recreational Catch Rate (fish/trip)	Other
70	0.2		
71	0.2		
72	0.2		
73	1.0		
74	0.8		
75	0.2		
76	0.3		
77	0.7		
78	3.3		
79	1.9		
80	3.8		
81	5.2		
82	10.5		
83	11.7		
84	8.5		
85	2.3		
86	3.4		
87	3.2		
88	9.9		
89	1.2		
90	2.8		
91	7.8		
92	19.2		
93	18.5		
94	21.7		

PRIMARY STOCK INDICATOR

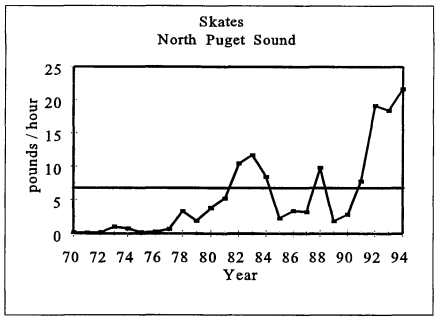


Figure 17. Trawl catch rates of skates in North Sound and long–term mean.

SECONDARY STOCK INDICATOR

TRAWL SURVEY DATA

North Sound

SKATES	1987	1989	1991
Abundance (N x 1000)	1,367	1,171	1,676
Biomass (mt)	3,102	4,705	4,246
Catch (mt)	99	96	103
% Catch/Biomass	3.2	2.0	2.4

STOCK SUMMARY

FISHERY IMPACT
Underutilized
DATA QUALITY
Fair
RECENT TREND (5 Year)
Increasing
STOCK STATUS (2 Year)
Above average

SOUTH SOUND—SKATES

OVERVIEW

Two species of skates, big skate and longnose skate, dominate the skates catches of South Sound and are important members of the bottomfish community. Skates are harvested primarily in the commercial fishery, but landings were very low until the late 1970s when new markets for skates were developed. Until then, skates were probably caught but not harvested. Beginning in the late 1970s catches built up from 20,000 pounds per year to a peak catch of 100,000 pounds in 1982. Catches decreased after this peak to about 10,000 pounds before the trawl fishery was closed in South Sound. Since closure, only a few thousand pounds have been harvested per year.

The primary stock indicator is the trawl catch rate which is only useful for years prior to the trawl closure. The stock showed cyclical patterns in abundance after the fishery was developed with peaks in the catch rate in 1982 and 1988 intervened by a low year in 1986. Trawl survey data indicate skates are underutilized in South Sound, but production rates are poorly known.

CATCH

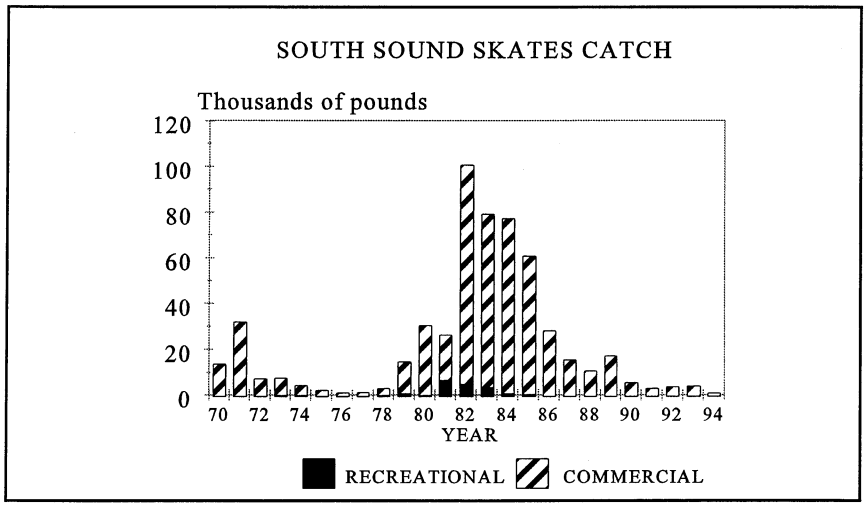


Figure 18. Recreational and commercial catch of skates in South Sound.

EFFORT

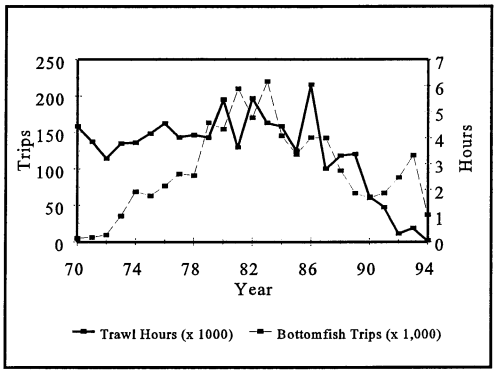


Figure 19. South Sound commercial effort in trawl hours and recreational effort in numbers of bottomfish trips.

STOCK STATUS PROFILE for SOUTH SOUND—SKATES

YR	Trawl Catch Rate (lb/hr)	Recreational Catch Rate (fish/trip)	Other
70	1.4		
71	6.6		
72	1.5		
73	1.0		
74	2.0		
75	0.4		
76	0.0		
77	0.2		
78	0.2		
79	0.3		
80	1.3		
81	2.5		
82	14.9		
83	5.6		
84	5.3		
85	5.5		
86	1.1		
87	12.8		
88	21.8		
89	13.7		
90	2.3		
91	1.0		
92	0.0		
93	4.6		
94	0.0		

PRIMARY STOCK INDICATOR

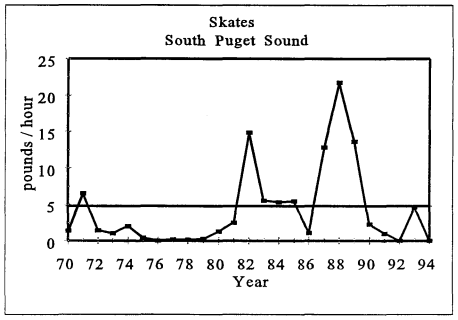


Figure 20. Trawl catch rates of skates in South Sound and long–term mean.

SECONDARY STOCK INDICATOR

TRAWL SURVEY DATA

South Sound

SKATES	1987	1989	1991
Abundance (N x 1000)	1,384	977	647
Biomass (mt)	1,717	1,344	692
Catch (mt)	7	8	1
% Catch / Biomass	0.4	0.6	0.2

STOCK SUMMARY

FISHERY IMPACT
Underutilized
DATA QUALITY
Poor

RECENT TREND (5 Year)
Unknown
STOCK STATUS (2 Year)
Unknown

NORTH SOUND—SPOTTED RATFISH

OVERVIEW

In terms of biomass, spotted ratfish is the most abundant bottomfish in North Sound where between 46,000 tons and 55,000 tons were living in 1989 and 1991. Spotted ratfish, related to sharks and skates, are often caught by commercial trawlers but few are landed at processing plants. Most are discarded as bycatch. High landings of 225,000 pounds and nearly 350,000 pounds occurred in 1974 and 1979, respectively, but were usually near zero for most years. Commercial landings are dependent upon markets, not upon the abundance of ratfish. Ratfish are frequently caught in trawl fisheries and occasionally by recreational anglers.

There is no primary catch indicator for ratfish in North Sound since they are only sporadically landed. Trawl survey data indicate ratfish are underutilized but the bycatch levels are poorly known. The stock appears to be thriving.

CATCH

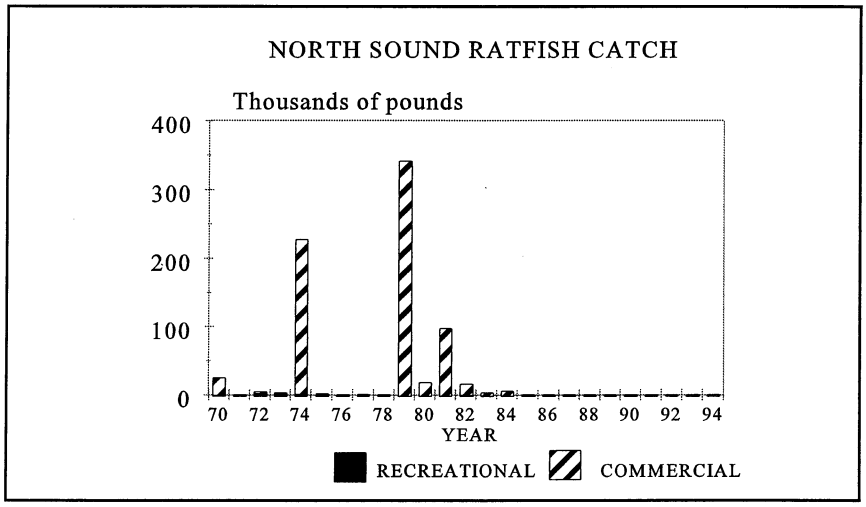


Figure 21. Recreational and commercial catch of ratfish in North Sound.

EFFORT

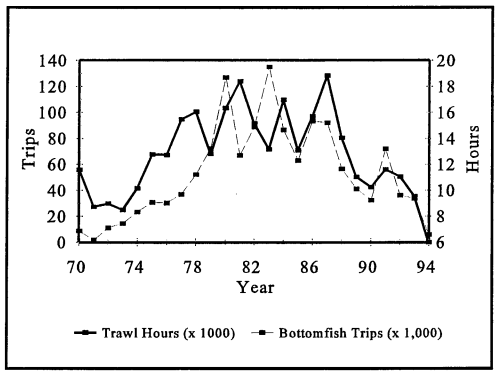


Figure 22. North Sound commercial effort in trawl hours and recreational effort in number of bottomfish trips.

STOCK STATUS PROFILE for NORTH SOUND—RATFISH

YR	Trawl Catch Rate (lb/hr)	Recreational Catch Rate (fish/trip)	Other	PRIMARY STOCK INDICATOR
70				
71				
72				
73				
74				
75				
76				
77				
78				
79				
80				
81				
82				
83				SECONDARY STOCK INDICATOR
84				
85				
86				
87				
88				
89				
90				
91				
92				
93				
94				

TRAWL SURVEY DATA

North Sound

RATFISH	1987	1989	1991
Abundance (N x 1000)	75,793	98,482	134,417
Biomass (mt)	26,760	42,738	50,530
Catch (mt)	0	0	0
% Catch / Biomass	0.0	0.0	0.0

STOCK SUMMARY

FISHERY IMPACT
Unknown

DATA QUALITY
Poor

RECENT TREND (5 Year)
Unknown

STOCK STATUS (2 Year)
Unknown

SOUTH SOUND—SPOTTED RATFISH

OVERVIEW

Spotted ratfish are the most abundant bottomfish in South Sound in terms of biomass and a key member of the bottomfish community. About 13,000 mt were estimated in South Sound during trawl surveys in 1989 and 1990, but catch data show few are ever landed. Commercial trawlers frequently catch ratfish and recreational anglers occasionally catch them, but they are considered inedible and are not harvested. Only once, in 1970, were ratfish landed in significant quantities when some 240,000 pounds were harvested. The livers of ratfish, when rendered, make an excellent machinery oil.

There is no primary stock indicator since ratfish are not harvested and landed. Trawl data indicate that ratfish are underutilized without a trawl fishery in the area. The trawl survey data suggest the stocks are thriving.

CATCH

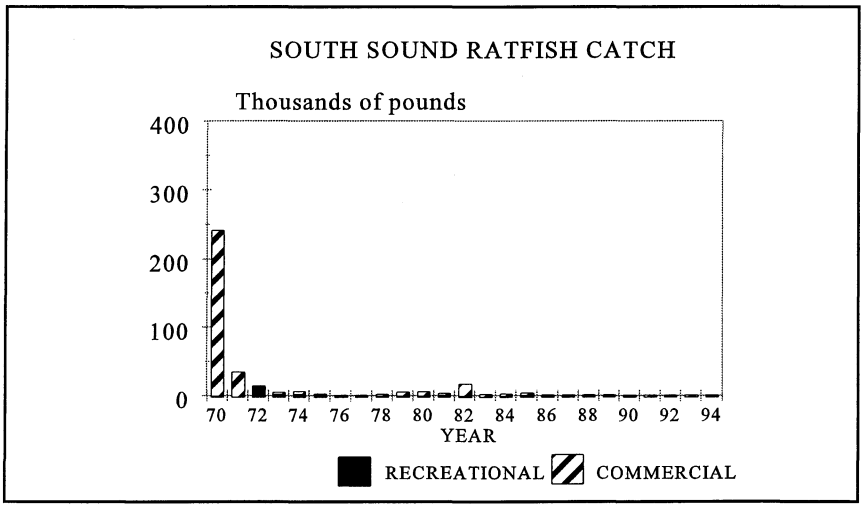


Figure 23. Recreational and commercial catch of ratfish in South Sound.

EFFORT

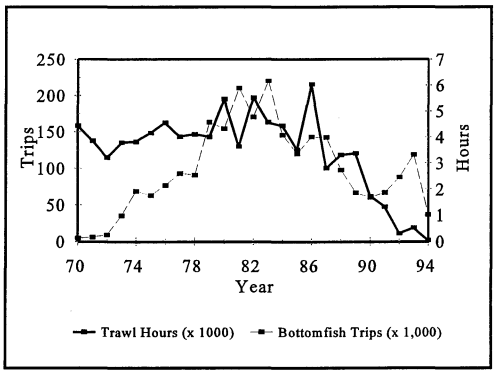


Figure 24. South Sound commercial effort in trawl hours and recreational effort in number of bottomfish trips.

STOCK STATUS PROFILE for SOUTH SOUND—RATFISH

YR	Trawl Catch Rate (lb/hr)	Recreational Catch Rate (fish/trip)	Other	PRIMARY STOCK INDICATOR
70				
71				
72				
73				
74				
75				
76				
77				
78				
79				
80				
81				
82				
83				SECONDARY STOCK INDICATOR
84				
85				
86				
87				
88				
89				
90				
91				
92				
93				
94				
95				

TRAWL SURVEY DATA

South Sound RATFISH	1987	1989	1991
Abundance (N x 1000)	86,016	31,967	36,422
Biomass (mt)	27,816	12,398	14,195
Catch (mt)	0	0	0
% Catch / Biomass	0.0	0.0	0.0

STOCK SUMMARY

FISHERY IMPACT
Underutilized
DATA QUALITY
Poor
RECENT TREND (5 Year)
Unknown
STOCK STATUS (2 Year)
Unknown

NORTH SOUND—PACIFIC COD

OVERVIEW

Pacific cod is a fast–growing species which can be abundant in North Sound and is probably comprised of multiple stocks. Cod are primarily a subarctic, cold–water species which does not regularly occur and spawn south of Washington. Commercial fishers using otter trawls account for virtually all of the cod caught in North Sound. More than one million, and up to three million pounds of cod were landed each year in North Sound between 1970 and 1988. Since 1989, the catch of Pacific cod has declined to less than 30,000 pounds in 1994.

The primary stock indicator is the catch rate from the bottom trawl fishery. The catch rate has been on a long–term decline since the mid 1970s. The recent five year trend shows no pattern, but the stock status is depressed with the catch rates of the last two years being well below the 20 year mean. Although not many cod are caught by recreational fishers in North Sound, the recreational catch rates show the same long–term decline as the trawl catch rate. The trawl survey information shows that cod are overutilized in North Sound. Depressed stocks may be related to warm water conditions in Puget Sound (Palsson, 1990).

CATCH

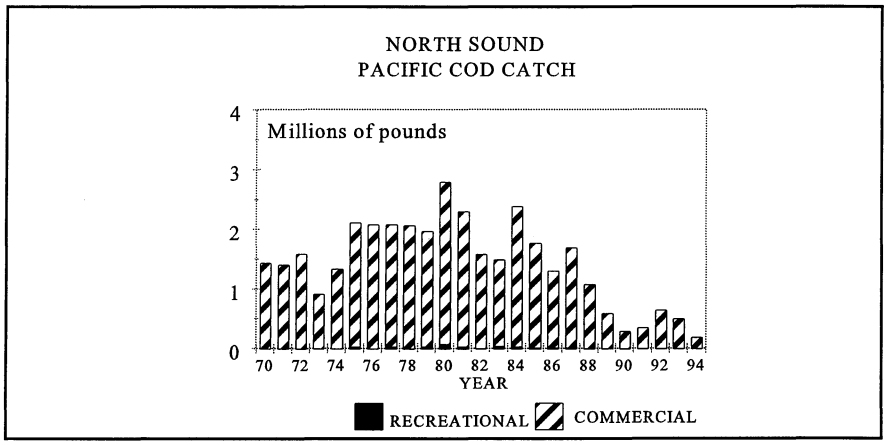


Figure 25. Recreational and commercial catch of Pacific cod in North Sound.

EFFORT

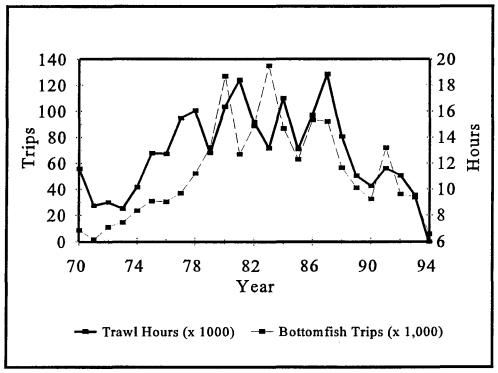


Figure 26. North Sound commercial effort in trawl hours and recreational effort in number of bottomfish trips.

STOCK STATUS PROFILE for NORTH SOUND—PACIFIC COD

YR	Trawl Catch Rate (lb/hr)	Recreational Catch Rate (fish/trip)	Other
70	111.1		
71	139.5		
72	162.4		
73	100.1		
74	126.8		
75	147.4		
76	141.8		
77	120.9	0.29	
78	100.6	0.04	
79	92.8	0.41	
80	138.5	0.79	
81	105.1	0.50	
82	85.3	0.05	
83	88.7	0.29	
84	122.2	0.17	
85	89.2	0.18	
86	82.2	0.02	
87	91.5	0.16	
88	74.6	0.00	
89	52.9	0.02	
90	29.8	0.06	
91	32.3	0.01	
92	55.8	0.00	
93	50.7	0.00	
94	27.2	0.00	

PRIMARY STOCK INDICATOR

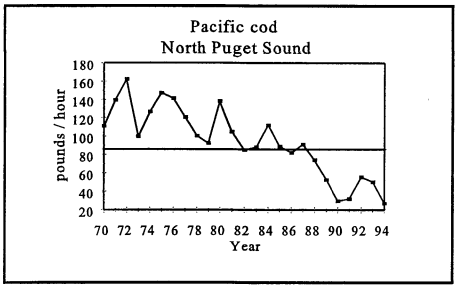


Figure 27. Commercial trawl catch per unit effort and long–term mean.

SECONDARY STOCK INDICATOR

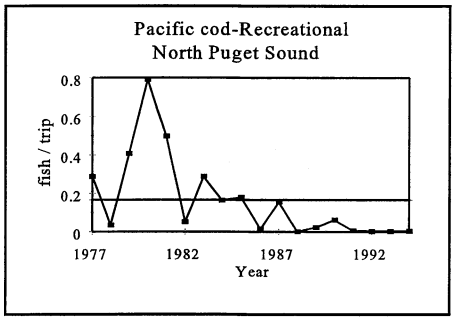


Figure 28. Recreational catch per unit effort and long–term mean.

TRAWL SURVEY DATA

North Sound

PACIFIC COD	1987	1989	1991
Abundance (N x 1000)	1,546	1,642	313
Biomass (mt)	1,736	991	260
Catch (mt)	762	261	152
% Catch / Biomass	43.9	26.3	58.5

STOCK SUMMARY

FISHERY IMPACT
Overutilized
DATA QUALITY
Fair
RECENT TREND (5 Year)
None
STOCK STATUS (2 Year)
Depressed

SOUTH SOUND—PACIFIC COD

OVERVIEW

Pacific cod in South Sound have some of the highest growth and egg production rates of any cod stock on the Pacific Coast. Cod is a cold–water species, and South Sound may be the most southern area of spawning. South Sound includes Port Townsend Bay where otter trawling and set nets once harvested cod in great numbers and includes Agate Passage where a popular sport fishery once harvested cod on their spawning grounds. Cod production exceeded one million pounds per year in the 1970s. Since then, cod catches have progressively declined and are presently negligible after regulations were enacted to protect the stocks.

The recreational catch rate is the primary stock indicator in South Sound and has progressively declined since 1977. The recent five year trend indicates a declining stock, but the time period transcends the reduction in the recreational bag limit and Agate Passage closure. However, recent near zero catch rates where limits of two fish are rarely obtained and special surveys of the Agate Passage spawning area identify a stock at a critical or near extinct level. Trawl survey data indicate cod stocks are overutilized in South Sound. Critical stock conditions may be a result of warm water conditions in Puget Sound (Palsson, 1990).

CATCH

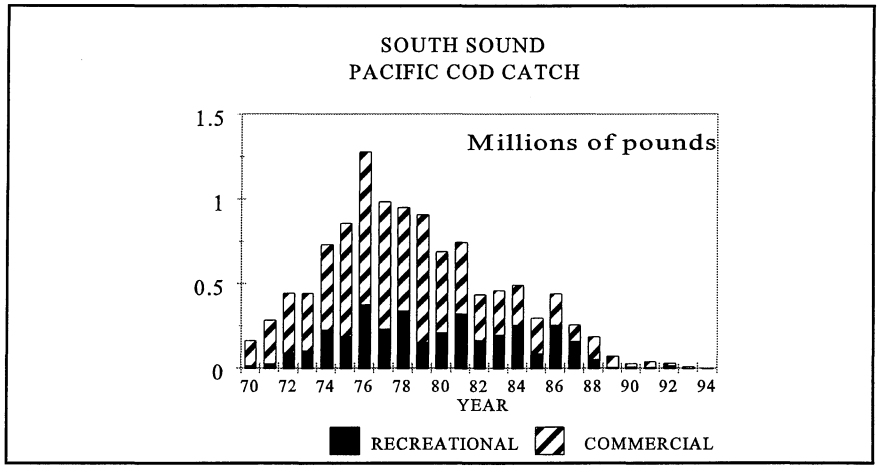


Figure 29. Recreational and commercial catch of Pacific cod in South Sound.

EFFORT

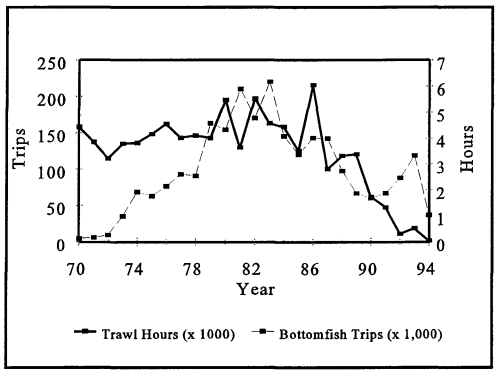


Figure 30. South Sound commercial effort in trawl hours and recreational effort in number of bottomfish trips.

STOCK STATUS PROFILE for SOUTH SOUND—PACIFIC COD

YR	Trawl Catch Rate (lb/hr)	Recreational Catch Rate (fish/trip)	Other
70	37.3		
71	66.9		
72	107.3		
73	84.5		
74	121.8		
75	136.3		
76	124.6		
77	95.3	0.78	
78	63.6	1.02	
79	27.7	0.42	
80	25.4	0.65	
81	60.6	0.57	
82	29.0	0.59	
83	21.7	0.34	
84	32.9	0.56	
85	21.2	0.28	
86	20.2	0.42	
87	27.2	0.30	
88	39.2	0.16	
89	17.7	0.08	
90	9.1	0.01	
91	21.4	0.02	
92	14.9	0.05	
93	6.6	0.00	
94	0.0	0.01	

PRIMARY STOCK INDICATOR

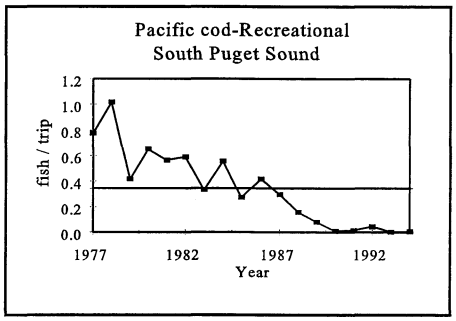


Figure 31. Recreational catch per unit effort and long–term mean.

SECONDARY STOCK INDICATOR

TRAWL SURVEY DATA

South Sound

PACIFIC COD	1987	1989	1991
Abundance (N x 1000)	1,606	208	47
Biomass (mt)	1,280	152	44
Catch (mt)	115	31	16
% Catch / Biomass	9.0	20.5	37.3

STOCK SUMMARY

FISHERY IMPACT
Overutilized
DATA QUALITY
Fair
RECENT TREND (5 Year)
Declining
STOCK STATUS (2 Year)
Critical

NORTH SOUND—WALLEYE POLLOCK

OVERVIEW

Walleye pollock is a subarctic codfish on the extreme southern end of its Pacific coast distribution. Pollock in North Sound primarily reside in the Strait of Georgia and are part of a transboundary stock shared with British Columbia. In the late 1970s and early 1980s, spawning pollock occurred in the Washington Strait of Georgia and favorable market conditions for pollock roe prompted a bottom and midwater trawl fishery. From 1978 to 1981, over 800,000 pounds were harvested each year. After 1981, market conditions became unfavorable and the pollock were not as readily available. Annual catches subsequent to 1981 have been 10,000 pounds or less.

The primary stock indicator is the bottom trawl catch rate, which shows that stock level was high during the late 1970s and early 1980s after which the stock was almost nonexistent. The recent five year trend indicates a declining stock, and the low catches of the last two years suggest a population that is critically depressed. Whether the stock is depressed, not targeted, or simply unavailable is unclear. Canadian assessments indicate pollock in the Strait of Georgia are relatively healthy. The trawl survey data suggest pollock are underutilized in North Sound.

CATCH

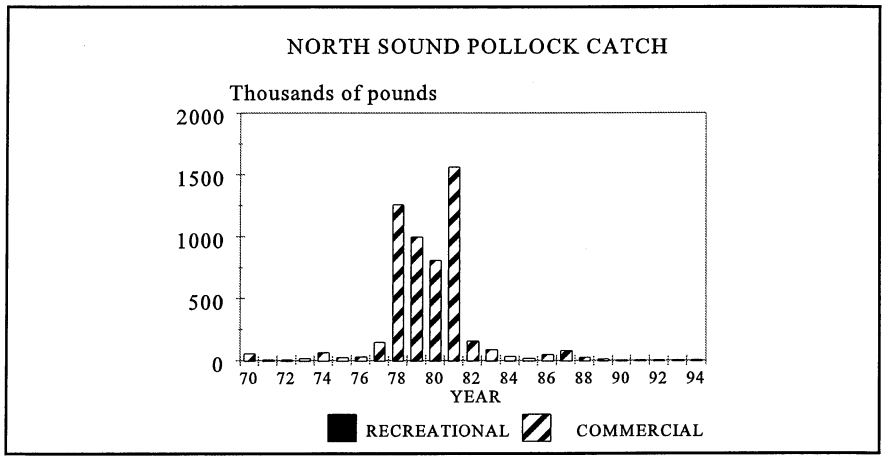


Figure 32. Recreational and commercial catch of walleye pollock in North Sound.

EFFORT

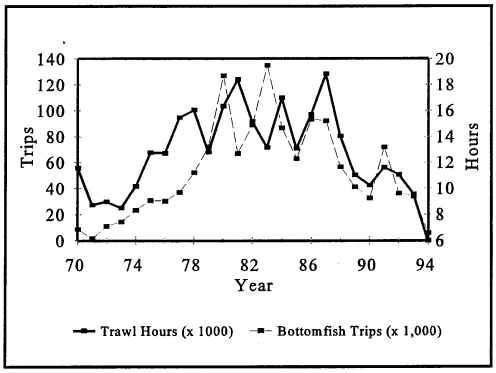


Figure 33. North Sound commercial effort in trawl hours and recreational effort in number of bottomfish trips.

STOCK STATUS PROFILE for NORTH SOUND—WALLEYE POLLOCK

YR	Trawl Catch Rate (lb/hr)	Recreational Catch Rate (fish/trip)	Other
70	4.5		
71	0.2		
72	0.2		
73	1.8		
74	6.7		
75	1.6		
76	2.5		
77	8.6	0.0	
78	101.4	0.0	
79	83.6	0.0	
80	47.1	0.0	
81	94.6	0.0	
82	15.1	0.0	
83	2.4	0.0	
84	1.6	0.0	
85	0.7	0.0	
86	3.1	0.0	
87	4.0	0.0	
88	1.9	0.0	
89	1.4	0.0	
90	0.6	0.0	
91	0.5	0.0	
92	0.1	0.0	
93	0.0	0.0	
94	0.0	0.0	

PRIMARY STOCK INDICATOR

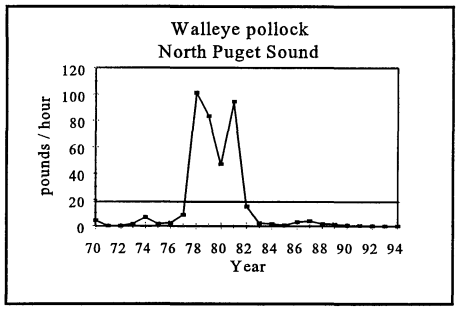


Figure 34. Commercial trawl catch per unit effort and long–term mean.

SECONDARY STOCK INDICATOR

TRAWL SURVEY DATA

North Sound

WALLEYE POLLOCK	1987	1989	1991
Abundance (N x 1000)	62,417	3,652	15,759
Biomass (mt)	1,663	469	658
Catch (mt)	34	3	0
% Catch / Biomass	2.1	0.7	0.0

STOCK SUMMARY

FISHERY IMPACT
Underutilized
DATA QUALITY
Fair
RECENT TREND (5 Year)
Declining
STOCK STATUS (2 Year)
Critical

SOUTH SOUND—WALLEYE POLLOCK

OVERVIEW

Walleye pollock in South Sound are on the extreme southern end of its Pacific coast distribution, and a unique recreational fishery near Tacoma once made pollock the most common bottomfish harvested in Puget Sound recreational fisheries. Anglers harvested the great majority of pollock in South Sound and catches exceeded 400,000 pounds per year from 1977 to 1986. After 1986, catches diminished and the fishery collapsed after 1988. Growth and other biological data indicate South Sound pollock are of a different biological stock than those in North Sound.

The primary stock indicator is the recreational catch rate, which shows the stock was abundant in the late 1970s but then declined until the fishery collapsed in the late 1980s. The recent five years show a declining trend, and the recent two years demonstrate that the population is at a critical, possibly extinct, status. A secondary indicator, the population of pollock estimated from a cohort analysis, details the decline of the population in the early 1980s. The most current trawl survey data suggest an underutilized population but these surveys occurred after the collapse and include juveniles. The cohort analysis showed an overutilized population in the 1980s.

CATCH

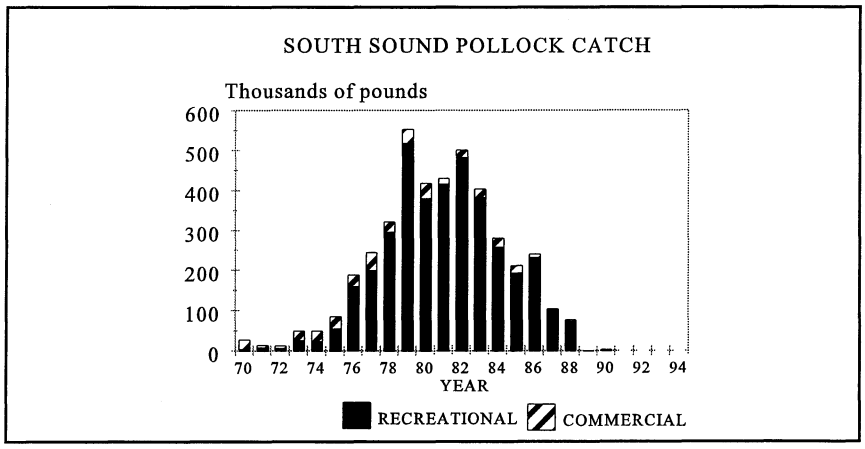


Figure 35. Recreational and commercial catch of walleye pollock in South Sound.

EFFORT

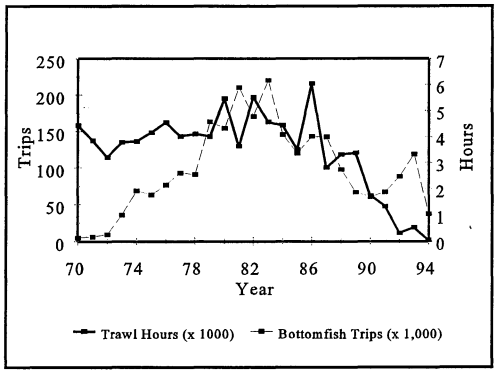


Figure 36. South Sound commercial effort in trawl hours and recreational effort in number of bottomfish trips.

STOCK STATUS PROFILE for SOUTH SOUND—WALLEYE POLLOCK

YR	Trawl Catch Rate (lb/hr)	Recreational Catch Rate (fish/trip)	Other
70	0.9		
71	1.0		
72	0.8		
73	6.0		
74	3.3		
75	4.7		
76	4.3		
77	3.6	0.71	
78	2.5	1.31	
79	9.1	1.37	
80	8.0	0.97	
81	2.7	0.88	
82	2.1	0.85	
83	1.2	0.59	
84	0.4	0.99	
85	0.1	0.52	
86	2.1	0.49	
87	1.1	0.26	
88	0.9	0.25	
89	0.2	0.02	
90	0.0	0.01	
91	0.0	0.00	
92	0.0	0.00	
93	0.0	0.00	
94	0.0	0.00	

PRIMARY STOCK INDICATOR

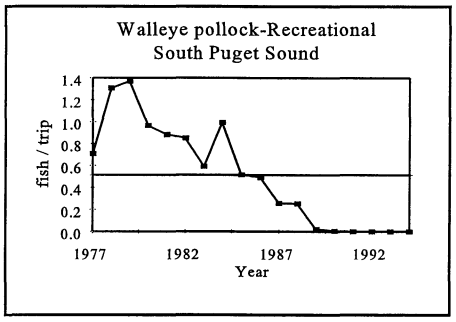


Figure 37. Recreational catch per unit effort and long–term mean.

SECONDARY STOCK INDICATOR

TRAWL SURVEY DATA

South Sound

WALLEYE POLLOCK	1987	1989	1991
Abundance (N x 1000)	3,537	172	99
Biomass (mt)	452	50	17
Catch (mt)	47	1	0
% Catch / Biomass	10.3	1.8	0.0

STOCK SUMMARY

FISHERY IMPACT
Overutilized
DATA QUALITY
Fair
RECENT TREND (5 Year)
Declining
STOCK STATUS (2 Year)
Critical

NORTH SOUND—PACIFIC WHITING

OVERVIEW

Pacific whiting, also called "hake," is a schooling member of the cod family. Although an abundant and highly migratory stock occurs off the West coast, the whiting in North Sound, especially those in the Strait of Georgia, are a smaller, resident transboundary stock shared with Canada. Whiting catches are sporadic and low in North Sound, rarely exceeding 50,000 pounds in any year. However, in 1978, over 1.5 million pounds were harvested. Whiting in North Sound are almost exclusively caught by trawlers.

The primary stock indicator is the bottom trawl catch rate of whiting. The population trend shows a high peak in 1978 corresponding to the anomalous catch that year. Most years until 1992 have had very low catch rates. In the last three years, catch rates have been increasing reaching average or above average levels. The most recent two years of catch rates indicate the population status is above average. The trawl survey indicates whiting are underutilized in North Sound. Contrary to the catch rate trend, the trawl survey suggests the population is declining.

CATCH

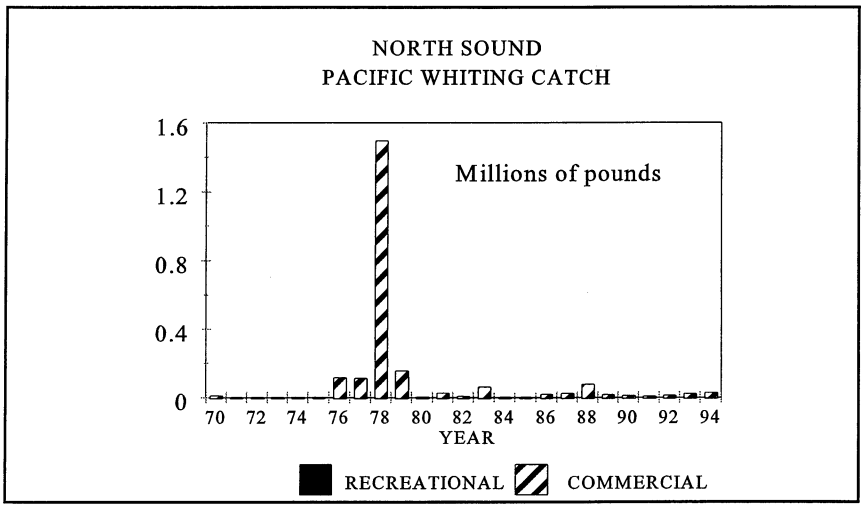


Figure 38. Recreational and commercial catch of Pacific whiting in North Sound.

EFFORT

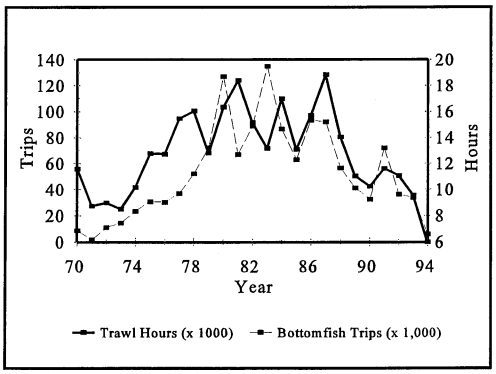


Figure 39. North Sound commercial effort in trawl hours and recreational effort in number of bottomfish trips.

STOCK STATUS PROFILE for NORTH SOUND—PACIFIC WHITING

YR	Trawl Catch Rate (lb/hr)	Recreational Catch Rate (fish/trip)	Other
70	0.7		
71	0.0		
72	0.0		
73	0.0		
74	0.0		
75	0.0		
76	6.8		
77	2.7		
78	33.1		
79	4.5		
80	0.7		
81	0.7		
82	0.4		
83	6.3		
84	0.0		
85	0.3		
86	1.7		
87	0.5		
88	2.9		
89	1.2		
90	1.6		
91	0.4		
92	3.3		
93	7.7		
94	4.2		

PRIMARY STOCK INDICATOR

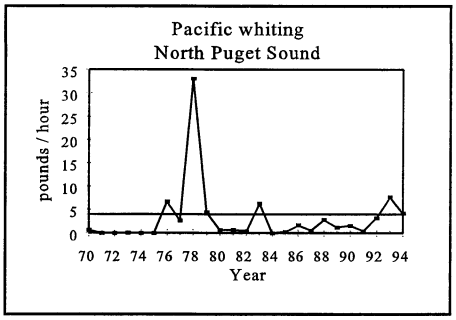


Figure 40. Commercial trawl catch per unit effort and long–term mean.

SECONDARY STOCK INDICATOR

TRAWL SURVEY DATA

North Sound

PACIFIC WHITING	1987	1989	1991
Abundance (N x 1000)	490	212	159
Biomass (mt)	340	190	80
Catch (mt)	11	6	3
% Catch / Biomass	3.1	3.4	3.4

STOCK SUMMARY

FISHERY IMPACT
Underutilized
DATA QUALITY
Poor
RECENT TREND (5 Year)
Increasing
STOCK STATUS (2 Year)
Above average

SOUTH SOUND—PACIFIC WHITING

OVERVIEW

Pacific whiting in South Sound are a distinct stock from the migratory West coast population and are probably distinct stock from whiting in North Sound. Most South Sound whiting spawn in Port Susan and a commercial midwater trawl fishery once harvested up to 15 million pounds of spawning whiting per year. The catch declined rapidly after the 1983 peak, and by 1990, low abundance resulted in a closure of the directed fishery.

The primary stock indicator is a fishery–independent acoustic and midwater trawl survey conducted during the winter in Port Susan. Spawning whiting in Port Susan once had an estimated adult biomass of 40 million pounds, but this biomass steadily declined between 1982 to 1994 when barely one million pounds were surveyed. The stock status is at a critical level. The midwater trawl catch rate, a secondary stock indicator, mirrored the survey population trend. Although the bottom trawl survey indicates whiting were fully utilized, the fishery overutilized the stock in the 1980s when the annual exploitation rate reached of 40 percent of the adult population. High predation by marine mammals may be preventing recovery of the population (Schmitt et al., 1995).

CATCH

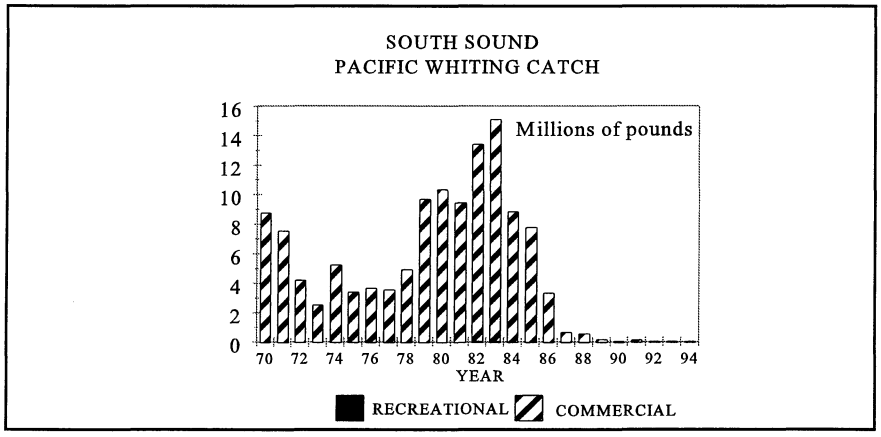


Figure 41. Recreational and commercial catch of Pacific whiting in South Sound.

EFFORT

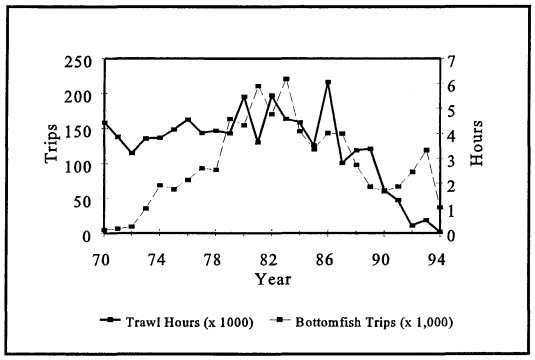


Figure 42. South Sound commercial effort in trawl hours and recreational effort in number of bottomfish trips.

STOCK STATUS PROFILE for SOUTH SOUND—PACIFIC WHITING

YR	Midwater Trawl Catch Rate (1,000 lb/hr)	Recreational Catch Rate (fish/trip)	Survey Biomass (Million lbs)
70	6.0		
71	3.3		
72	3.0		
73	3.5		
74	6.5		
75	7.8		
76	17.0		
77	10.6		
78	18.0		
79	22.6		
80	21.8		
81	12.1		
82	9.6		
83	6.4		45.1
84	4.7		27.1
85	5.4		16.0
86	3.3		16.0
87	7.2		11.9
88	9.3		12.8
89	2.4		12.1
90	0.3		13.5
91	10.0		11.7
92	0.0		8.9
93	0.0		1.1
94	0.0		1.3

PRIMARY STOCK INDICATOR

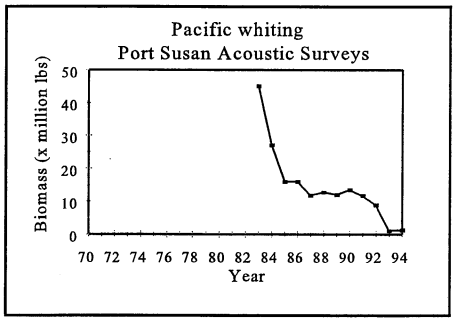


Figure 43. South Sound acoustic survey for Pacific whiting.

SECONDARY STOCK INDICATOR

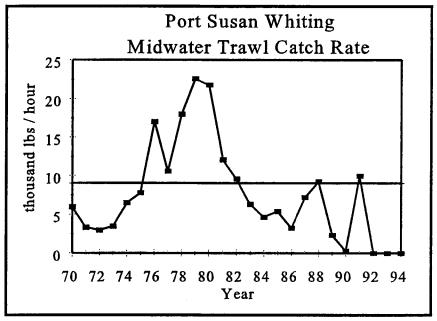


Figure 44. Midwater trawl catch rate of whiting in South Sound and long–term mean.

TRAWL SURVEY DATA

South Sound

PACIFIC WHITING	1987	1989	1991
Abundance (N x 1000)	4,377	5,257	23,469
Biomass (mt)	1,535	604	1,041
Catch (mt)	294	58	43
% Catch / Biomass	19.2	9.6	4.2

STOCK SUMMARY

FISHERY IMPACT
Overutilized
DATA QUALITY
Good
RECENT TREND (5 Year)
Declining
STOCK STATUS (2 Year)
Critical

NORTH SOUND—ROCKFISH

OVERVIEW

Over 20 species of rockfish inhabit North Puget Sound, but only five are commonly caught in commercial or recreational fisheries. In recent years, recreational fishers have caught more than half of the 100,000 pounds to 250,000 pounds of the recorded annual catch. Rockfish harvests are likely higher than the estimated catch because rockfish speared by divers are not included in catch estimates, and divers can harvest significant numbers of rockfish (Bargmann, 1984).

The primary stock indicator is the recreational catch rate which has declined since 1977. Despite a reduction in the daily bag limit in 1994, from ten rockfish to five rockfish, the recent five years show no trend in the catch rate. The catch rates of the last two years are near the long–term average and the stock status is average. A 1994 video assessment of nearshore rockfish suggests the rockfish are fully utilized. Other biological data show the average size of rockfish in the recreational catch has declined by several inches since the 1970s and that several species have become rare in the catch.

CATCH

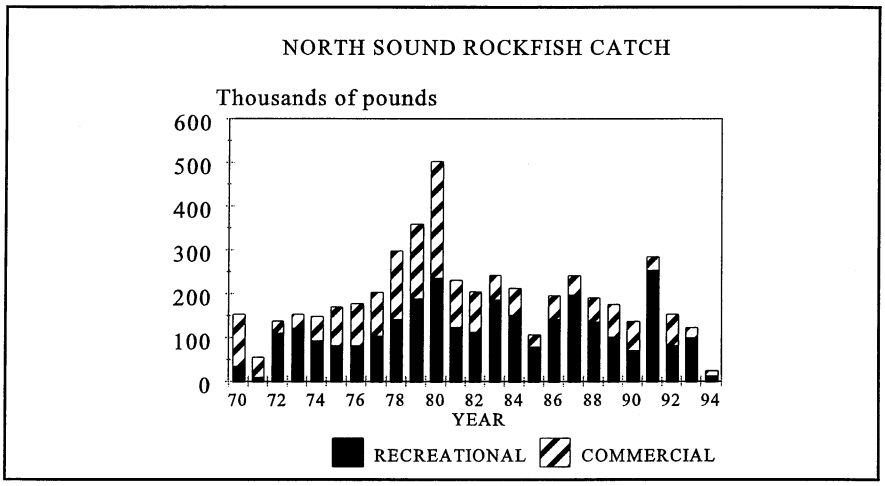


Figure 45. Recreational and commercial catch of rockfish in North Sound

EFFORT

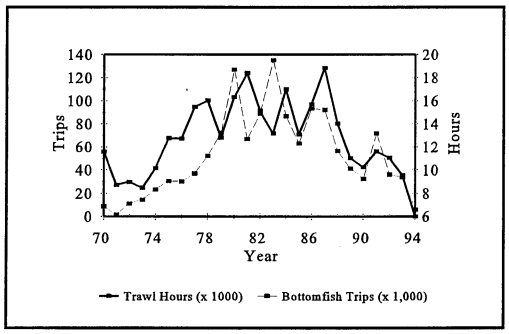


Figure 46. North Sound commercial effort in trawl hours and recreational effort in number of bottomfish trips.

STOCK STATUS PROFILE for NORTH SOUND—ROCKFISH

YR	Commercial Catch Rate (lb/hr)	Recreational Catch Rate (fish/trip)	Video–Acoustic Survey (mt)
70			
71			
72			
73			
74			
75			
76			
77		1.75	
78		1.21	
79		1.51	
80		1.15	
81		1.00	
82		0.93	
83		0.82	
84		0.75	
85		0.79	
86		0.56	
87		0.62	
88		0.61	
89		0.87	
90		0.77	
91		0.69	
92		0.90	
93		1.07	
94		0.71	7,300

PRIMARY STOCK INDICATOR

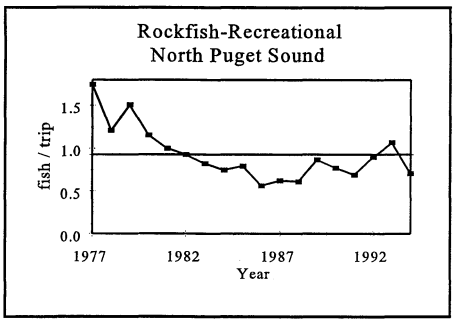


Figure 47. Recreational catch per unit effort and long–term mean.

SECONDARY STOCK INDICATOR

TRAWL SURVEY DATA

North Sound ROCKFISH	1987	1989	1991
Abundance (N x 1000)			
Biomass (mt)			
Catch (mt)			
% Catch / Biomass			

STOCK SUMMARY

FISHERY IMPACT
Fully utilized
DATA QUALITY
Fair
RECENT TREND (5 Year)
None
STOCK STATUS (2 Year)
Average

SOUTH SOUND—ROCKFISH

OVERVIEW

Recreational fishers have always harvested the majority of the 20 or more species of rockfish in South Sound. Annual catches have ranged from 100,000 pounds to almost 400,000 pounds between 1970 and 1993 with a peak catch in 1989 when commercial catches were above average. The 1994 catch is likely an underestimate due to the effects of salmon harvest restrictions on the catch estimation process.

The primary stock indicator is the recreational catch rate which shows the rockfish stocks have undergone long–term declines in abundance since 1977. However, there is no trend during the recent five years despite a reduction in the daily bag limit for recreational anglers in 1994. Fishery–independent scuba surveys also indicate a decline in rockfish densities between the late 1980s and early 1990s. The low catch rates of the last two years of data are less than the long–term mean indicating a below average rockfish population. The lowered catch rates appeared to be unaffected by the lowered bag limit in 1994 because low catch rates were observed in 1993 before the change from five fish per day to three fish per day occurred. The trawl survey data show unexpectedly high biomasses of rockfish in trawlable habitat. The trawl surveys also indicate rockfish are overutilized in South Sound.

CATCH

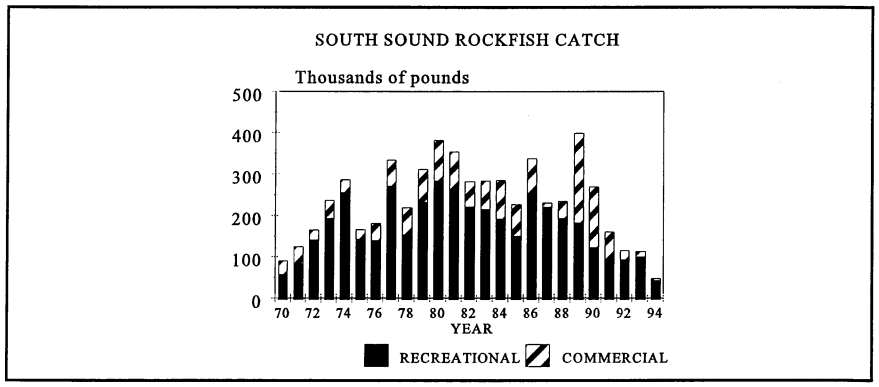


Figure 48. Recreational and commercial catch of rockfish in South Sound.

EFFORT

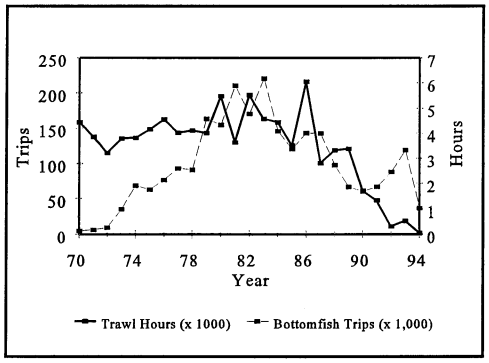


Figure 49. South Sound commercial effort in trawl hours and recreational effort in number of bottomfish trips.

STOCK STATUS PROFILE for SOUTH SOUND—ROCKFISH

YR	Trawl Catch Rate (lb/hr)	Recreational Catch Rate (fish/trip)	Scuba Densities (fish/ha)
70			
71			
72			
73			
74			
75			
76			
77		1.01	
78		0.78	
79		0.75	
80		0.79	
81		0.71	
82		0.76	
83		0.41	
84		0.63	
85		0.55	
86		0.50	
87		0.50	4,967
88		0.58	9,422
89		0.66	
90		0.57	
91		0.47	
92		0.62	2,555
93		0.45	1,978
94		0.50	1,867

PRIMARY STOCK INDICATOR

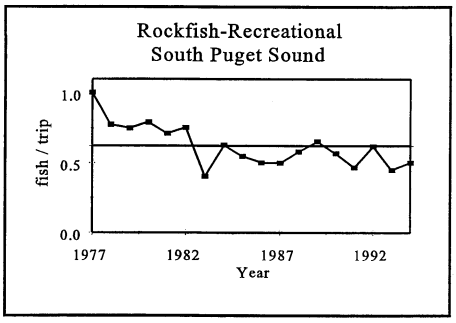


Figure 50. Recreational catch per unit effort and long–term mean.

SECONDARY STOCK INDICATOR

TRAWL SURVEY DATA

South Sound

ROCKFISH	1987	1989	1991
Abundance (N x 1000)	2,146	3,180	1,103
Biomass (mt)	1,368	1,853	550
Catch (mt)	104	181	73
% Catch / Biomass	7.6	9.8	13.2

STOCK SUMMARY

FISHERY IMPACT
Overutilized
DATA QUALITY
Fair
RECENT TREND (5 Year)
None
STOCK STATUS (2 Year)
Below average

NORTH SOUND—SABLEFISH

OVERVIEW

Sablefish, also known as "black cod," are found along the West coast from Mexico to Alaska. In most areas of North Sound, sablefish occur as juveniles that are occasionally caught by recreational and commercial fishers. North Sound sablefish are migratory and probably part of the coastal stock. The sablefish catches were low and variable during the 1970s and 1980s from almost none to 10,000 pounds per year. After 1989, annual catches increased and usually exceeded 30,000 pounds and peaked at 100,000 pounds in 1992. These increased catches were primarily a result of a commercial setline fishery in the western areas of the Strait of Juan de Fuca.

The primary stock indicator is the catch trend which shows long–term and recent increasing trend (excluding the incomplete 1994 catch estimates). The last two years of complete catch data are above the long–term mean, suggesting an above average stock status. The occurrence of sablefish in the trawl surveys is erratic making the data unuseable for fishery evaluation.

CATCH

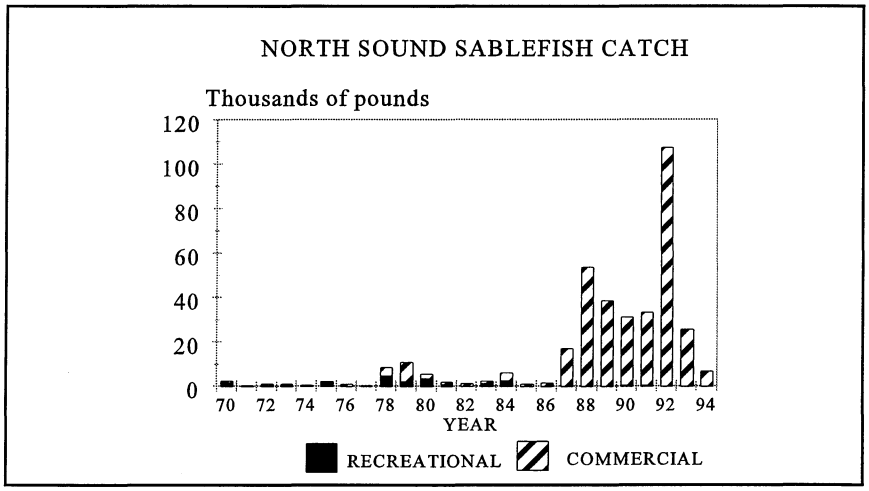


Figure 51. Recreational and commercial catch of sablefish in North Sound.

EFFORT

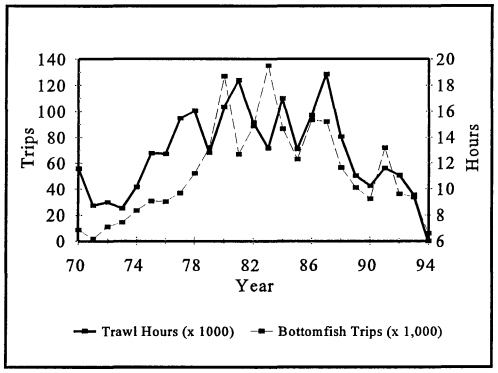


Figure 52. North Sound commercial effort in trawl hours and recreational effort in number of bottomfish trips.

STOCK STATUS PROFILE for NORTH SOUND—SABLEFISH

YR	Trawl Catch Rate (lb/hr)	Recreational Catch Rate (fish/trip)	Other	PRIMARY STOCK INDICATOR
70				
71				
72				
73				
74				
75				
76				
77				
78				
79				
80				
81				
82				
83				SECONDARY STOCK INDICATOR
84				
85				
86				
87				
88				
89				
90				
91				
92				
93				
94				

TRAWL SURVEY DATA

North Sound SABLEFISH	1987	1989	1991
Abundance (N x 1000)			
Biomass (mt			
Catch (mt)			
% Catch / Biomass			

STOCK SUMMARY

FISHERY IMPACT
Unknown
DATA QUALITY
Poor
RECENT TREND (5 Year)
Increasing
STOCK STATUS (2 Year)
Above average

SOUTH SOUND—SABLEFISH

OVERVIEW

Sablefish, also known as "black cod," are found along the West coast from Mexico to Alaska. In South Sound, sablefish are migratory juveniles that are probably part of the coastal stock. Sablefish in South Sound are caught by recreational anglers, usually when fishing for salmon. Annual catches of sablefish were high during the late 1970s and mid 1980s when they often exceeded 30,000 pounds. Since then, annual catches have progressively declined to almost zero.

The catch trend is the primary stock indicator. The long–term catch trend indicates the population had a high period in the 1980s but has subsequently declined. The recent five years of complete catch data shows a declining stock trend, and the most recent low catches indicate the population is critically depressed in South Sound. Sablefish are too infrequent in the trawl surveys to evaluate the impact of the fishery.

CATCH

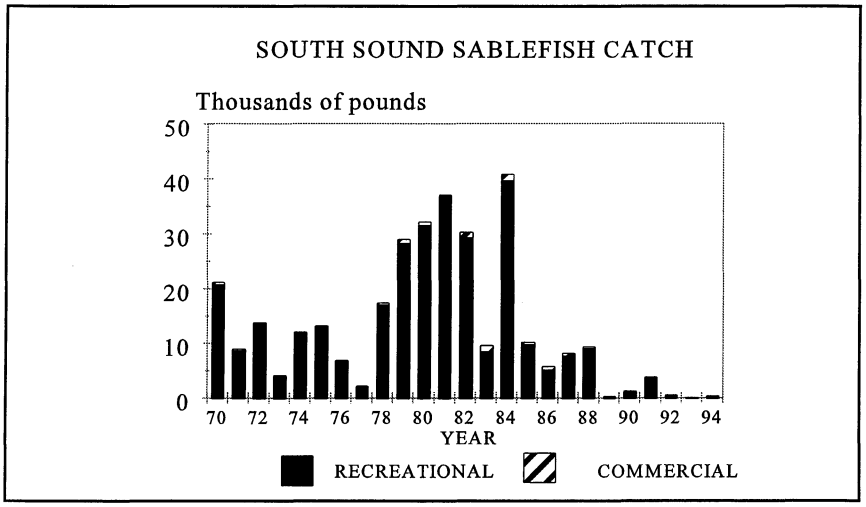


Figure 53. Recreational and commercial catch of sablefish in South Sound.

EFFORT

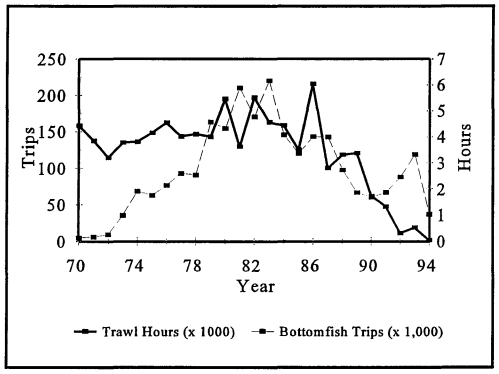


Figure 54. South Sound commercial effort in trawl hours and recreational effort in number of bottomfish trips.

STOCK STATUS PROFILE for SOUTH SOUND—SABLEFISH

YR	Trawl Catch Rate (lb/hr)	Recreational Catch (fish/trip)	Other	PRIMARY STOCK INDICATOR
70				
71				
72				
73				
74				
75				
76				
77				
78				
79				
80				
81				
82				
83				SECONDARY STOCK INDICATOR
84				
85				
86				
87				
88				
89				
90				
91				
92				
93				
94				

TRAWL SURVEY DATA

South Sound SABLEFISH	1987	1989	1991
Abundance (N x 1000)			
Biomass (mt)			
Catch (mt)			
% Catch / Biomass			

STOCK SUMMARY

FISHERY IMPACT
Unknown
DATA QUALITY
Poor
RECENT TREND (5 Year)
Declining
STOCK STATUS (2 Year)
Critical

NORTH SOUND—GREENLINGS

OVERVIEW

Greenlings (several species) inhabit North Sound. The kelp greenling is the dominant species of the catch. Recreational anglers account for virtually all of the harvested greenling, and until recently, anglers have harvested from 5,000 pounds to 10,000 pounds in a typical year. Catches have more than doubled during the early 1990s than during the previous time period. The estimated catch does not include the harvest by scuba divers which can be substantial in North Sound.

The catch trend is the primary stock indicator. The recent high catches prior to 1994 show an increasing stock trend. Using the last two complete years of catch estimates, the stock status appears to be above average. A 1994 video survey in North Sound estimated that there were at least 3.3 million pounds of greenling in North Sound. Using the two–year average catch of 18,000 pounds, the annual exploitation rate is much below one percent indicating that greenling are underutilized in North Sound.

CATCH

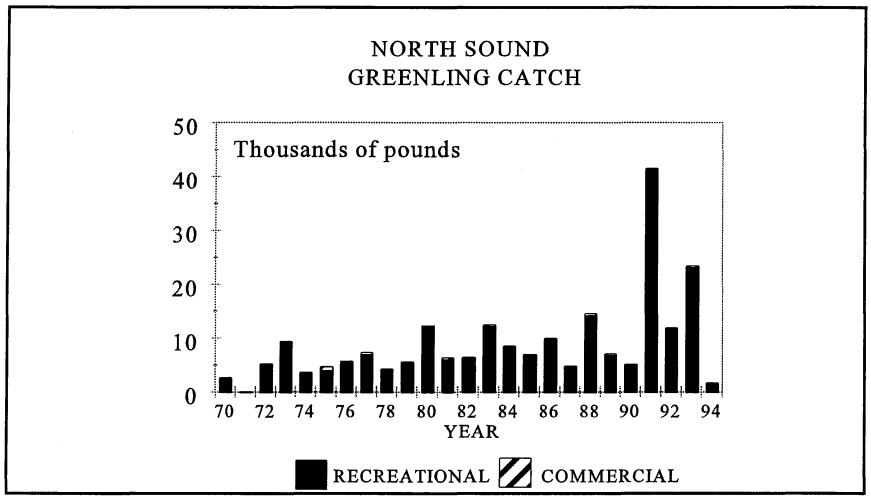


Figure 55. Recreational and commercial catch of greenlings in North Sound.

EFFORT

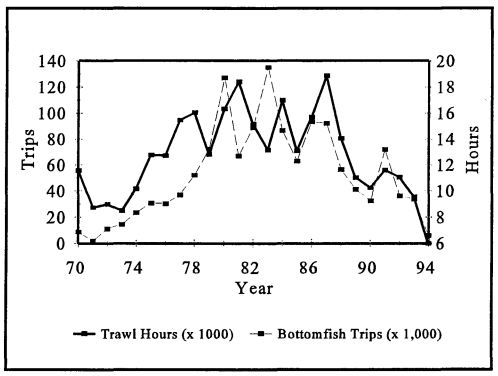


Figure 56. North Sound commercial effort in trawl hours and recreational effort in number of bottomfish trips.

STOCK STATUS PROFILE for NORTH SOUND—GREENLINGS

YR	Trawl Catch (lb/hr)	Recreational Catch Rate (fish/trip)	Other	PRIMARY STOCK INDICATOR
70				
71				
72				
73				
74				
75				
76				
77				
78				
79				
80				
81				
82				
83				SECONDARY STOCK INDICATOR
84				
85				
86				
87				
88				
89				
90				
91				
92				
93				
94				

TRAWL SURVEY DATA

North Sound GREENLINGS	1987	1989	1991
Abundance (N x 1000)			
Biomass (mt)			
Catch (mt)			
% Catch / Biomass			

STOCK SUMMARY

FISHERY IMPACT
Underutilized
DATA QUALITY
Poor
RECENT TREND (5 Year)
Increasing
STOCK STATUS (2 Year)
Above average

SOUTH SOUND—GREENLINGS

OVERVIEW

Several species of greenling inhabit South Sound, and kelp and white–spotted greenling are the most common greenlings in the recreational catch. Recreational fishers account for most of the greenling harvested in any year, and catches are generally low, ranging between 1,000 pounds and 6,000 pounds per year. The catch estimates do not include the harvest by scuba divers and shore based anglers which can be significant in South Sound.

The primary stock indicator is the trend in the catch. The recent five year trend (excluding 1994 catch estimates) shows a declining stock of greenling in South Sound. The mean catch of the last two years of compete data is below the 20 year mean indicating the status of the greenling stock is below average. There is no useful information at present to evaluate the impact of the fishery.

CATCH

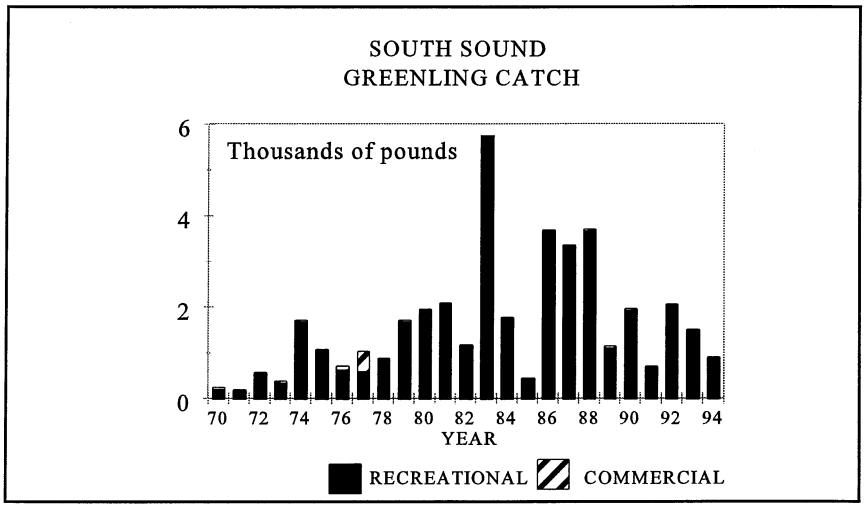


Figure 57. Recreational and commercial catch of greenlings in South Sound.

EFFORT

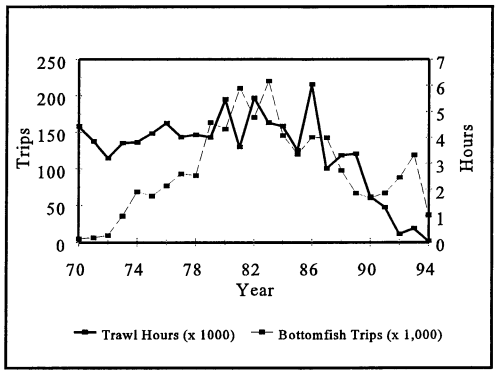


Figure 58. South Sound commercial effort in trawl hours and recreational effort in number of bottomfish trips.

STOCK STATUS PROFILE for SOUTH SOUND—GREENLINGS

YR	Trawl Catch Rate (lb/hr)	Recreational Catch Rate (fish/trip)	Other	PRIMARY STOCK INDICATOR
70				
71				
72				
73				
74				
75				
76				
77				
78				
79				
80				
81				
82				
83				SECONDARY STOCK INDICATOR
84				
85				
86				
87				
88				
89				
90				
91				
92				
93				
94				

TRAWL SURVEY DATA

South Sound GREENLINGS	1987	1989	1991
Abundance (N x 1000)			
Biomass (mt)			
Catch (mt)			
% Catch / Biomass			

STOCK SUMMARY

FISHERY IMPACT
Unknown
DATA QUALITY
Poor
RECENT TREND (5 Year)
Declining
STOCK STATUS (2 Year)
Below average

NORTH SOUND—LINGCOD

OVERVIEW

Lingcod are a large predatory fish inhabiting rocky reef habitats in North Sound. Commercial fishing once accounted for the majority of the lingcod harvest, but since 1992, directed commercial fishing for lingcod has been prohibited. From 1970 to 1988, annual catches were relatively constant, ranging between 180,000 pounds and 300,000 pounds. Catches were higher in the 1980s but since the late 1980s have declined to 10,000 pounds in 1993. The lingcod harvest by scuba divers which can be significant is not included in the catch estimation process.

The primary stock indicator is the recreational catch rate, which shows both long–term and recent declines in the stock. A shortened season, reduction in the daily bag limit, and restricted size regulations were established in 1992, but the catch rates have continued to decrease. The catch rate trend shows that lingcod stocks are depressed. This evaluation may be affected by the recent and previous regulation changes. Trawl survey data indicate lingcod are fully utilized, and the 1994 video–acoustic survey estimated that there were at least 440,000 lingcod in North Sound.

CATCH

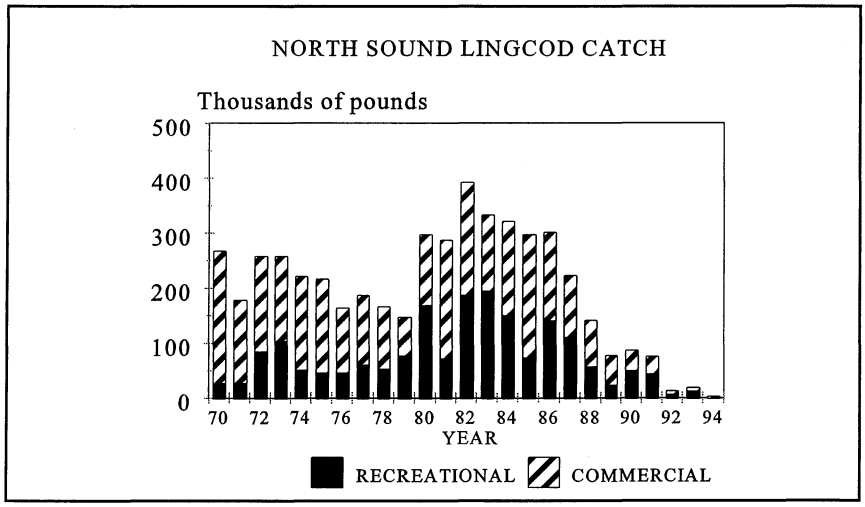


Figure 59. Recreational and commercial catch of Lingcod in North Sound.

EFFORT

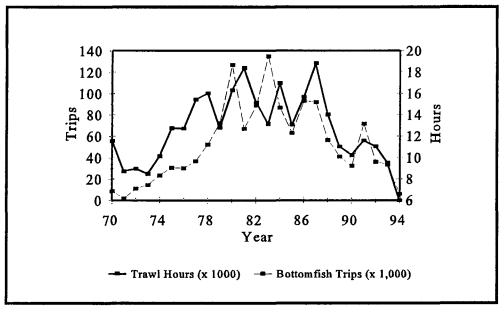


Figure 60. North Sound commercial effort in trawl hours and recreational effort in number of bottomfish trips.

STOCK STATUS PROFILE for NORTH SOUND—LINGCOD

YR	Trawl Catch Rate (lb/hr)	Recreational Catch Rate (fish/trip)	Other
70			
71			
72			
73			
74			
75			
76			
77		0.21	
78		0.16	
79		0.19	
80		0.29	
81		0.23	
82		0.31	
83		0.35	
84		0.30	
85		0.17	
86		0.11	
87		0.12	
88		0.08	
89		0.09	
90		0.06	
91		0.05	
92		0.03	
93		0.06	
94		0.03	

PRIMARY STOCK INDICATOR

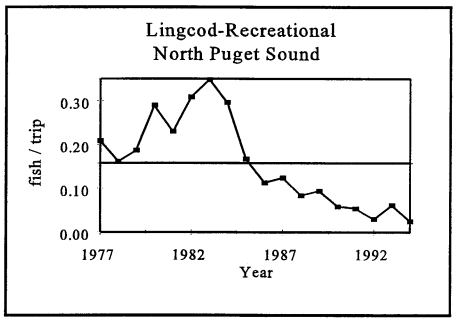


Figure 61. Recreational catch per unit effort and long–term mean.

SECONDARY STOCK INDICATOR

TRAWL SURVEY DATA

North Sound

LINGCOD	1987	1989	1991
Abundance (N x 1000)	43	39	0
Biomass (mt)	211	261	0
Catch (mt)	101	35	34
Catch / Biomass	47.7	13.3	
% Catch / Adult Biomass	51.3	13.3	

STOCK SUMMARY

FISHERY IMPACT
Fully utilized
DATA QUALITY
Fair
RECENT TREND (5 Year)
Declining
STOCK STATUS (2 Year)
Depressed

SOUTH SOUND—LINGCOD

OVERVIEW

Lingcod are a large predatory fish inhabiting the natural and artificial reefs in South Sound. Recreational fishers have harvested the majority of lingcod since 1980. Catches have ranged from a peak catch of 70,000 pounds in 1970 to 5,000 pounds in 1982 and most of the recent years. There was a lingcod moratorium from 1978 to 1982 in most areas of South Sound, but fishing continued in Admiralty Inlet. Catch estimates do not include the harvest by divers.

The primary stock indicator is the recreational catch rate. The catch rates were virtually zero from 1978 to 1982 during the moratorium, but were relatively high just after the resumption of fishing in 1983. Since then, the stock trend has been erratic. The recent trend of the population is declining but the status of the stock is above average. The secondary indicator is the catch rate from the specially monitored fishery at Tacoma Narrows. In contrast to the primary trend, the secondary trend shows no recent trend in the population but also indicates a below average population status. Lingcod are fully utilized in South Sound.

CATCH

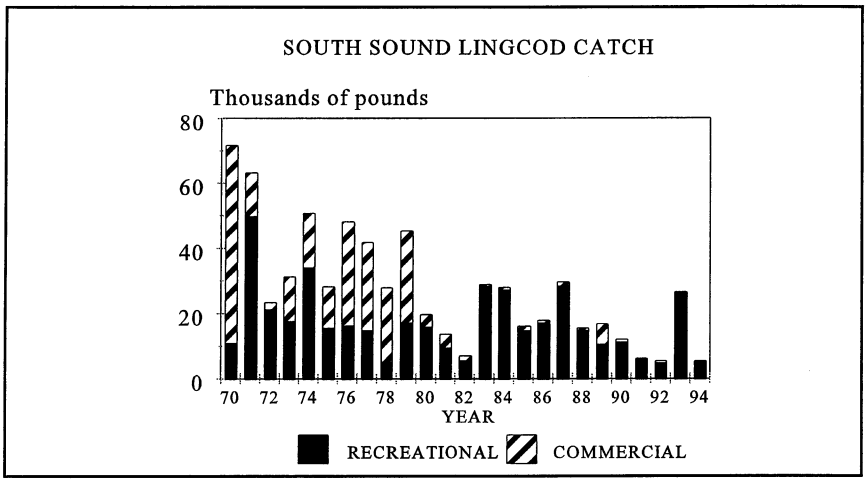


Figure 62. Recreational and commercial catch of lingcod in South Sound.

EFFORT

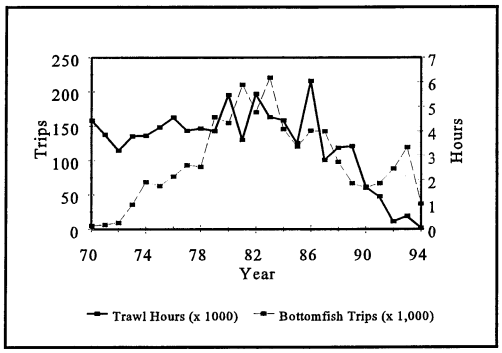


Figure 63. South Sound commercial effort in trawl hours and recreational effort in number of bottomfish trips.

STOCK STATUS PROFILE for SOUTH SOUND—LINGCOD

YR	Trawl Catch Rate (lb/hr)	Recreational Catch Rate (fish/trip)	Tacoma Narrows Catch Rate (lingcod/trip)
70			
71			
72			
73			
74			
75			
76			
77		0.03	
78		0.01	
79		0.01	
80		0.00	
81		0.00	
82		0.00	
83		0.07	0.27
84		0.14	0.33
85		0.11	0.43
86		0.05	0.42
87		0.06	0.37
88		0.05	0.22
89		0.10	0.23
90		0.16	0.20
91		0.06	0.19
92		0.04	0.21
93		0.05	0.19
94		0.11	0.18
95			

PRIMARY STOCK INDICATOR

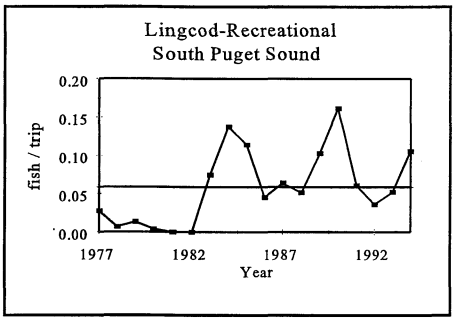


Figure 64. Recreational catch per unit effort and long–term mean.

SECONDARY STOCK INDICATOR

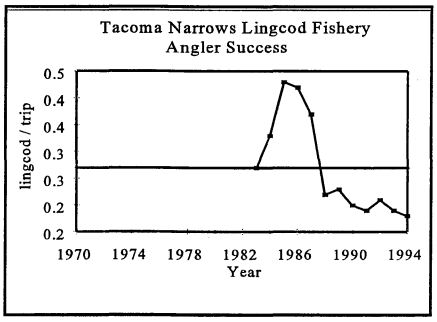


Figure 65. Lingcod catch rate by anglers fishing at Tacoma Narrows and long–term mean.

TRAWL SURVEY DATA

South Sound

LINGCOD	1987	1989	1991
Abundance (N x 1000)	7	11	7
Biomass (mt)	28	82	4
Catch (mt)	13	8	3
% Catch / Biomass	47.8	9.2	63.8
% Catch / Adult Biomass	51.4	12.8	

STOCK SUMMARY

FISHERY IMPACT
Fully utilized

DATA QUALITY
Fair

RECENT TREND (5 Year)
Declining

STOCK STATUS (2 Year)
Above average

NORTH SOUND—SCULPINS

OVERVIEW

Over thirty species of sculpins inhabit North Sound, but only a few, usually referred to as "bullheads" are ever landed. Many of these are discarded. The most harvested sculpin is the cabezon which can weigh over 20 pounds. Sculpins are mainly harvested by recreational anglers and catches have been variable over time. During most years since 1970, no more than 5,000 pounds of sculpins have been landed. However, several peak years stand out, including years during the late 1970s, the early 1980s, and 1991 when catches peaked at 8,000 pounds.

The primary catch indicator is the catch trend which has shown several increases and declines over the long–term. The most recent five years of catch data (excluding 1994) have shown an increasing trend in the stock, and the recent two years of complete catch data indicate a stock at average abundance. Trawl survey data show sculpins are underutilized.

CATCH

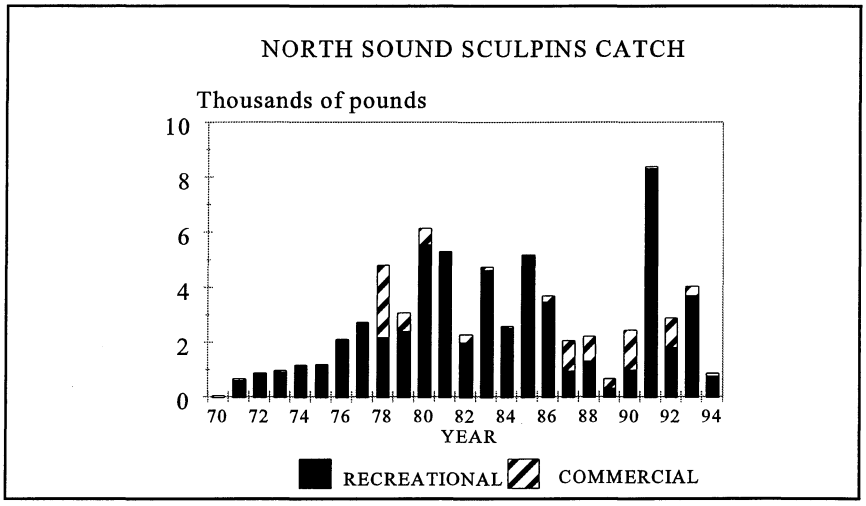


Figure 66. Recreational and commercial catch of sculpins in North Sound.

EFFORT

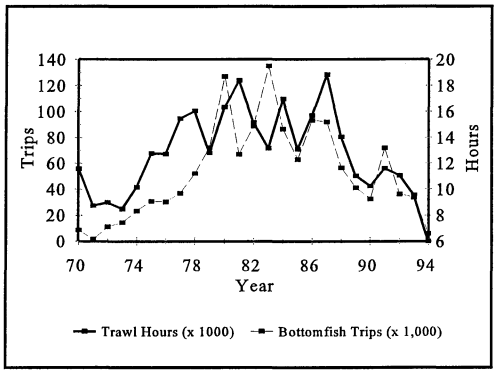


Figure 67. North Sound commercial effort in trawl hours and recreational effort in number of bottomfish trips.

STOCK STATUS PROFILE for NORTH SOUND—SCULPINS

YR	Trawl Catch Rate (lb/hr)	Recreational Catch Rate (fish/trip)	Other	PRIMARY STOCK INDICATOR
70				
71				
72				
73				
74				
75				
76				
77				
78				
79				
80				
81				
82				
83				SECONDARY STOCK INDICATOR
84				
85				
86				
87				
88				
89				
90				
91				
92				
93				
94				

TRAWL SURVEY DATA

North Sound SCULPINS	1987	1989	1991
Abundance (N x 1000)	3,494	767	135
Biomass (mt)	241	197	24
Catch (mt)	1	3,494	767
% Catch / Biomass	0.4	0.2	15.7

STOCK SUMMARY

FISHERY IMPACT
Underutilized
DATA QUALITY
Poor
RECENT TREND (5 Year)
Increasing
STOCK STATUS (2 Year)
Average

SOUTH SOUND—SCULPINS

OVERVIEW

Over thirty species of sculpins inhabit South Sound, but only a few, usually referred to as "bullheads" ever are landed. Most of the catch is probably discarded. The most frequently landed sculpin is the cabezon which can weigh over 20 pounds. The majority of harvested sculpins are harvested by recreational anglers, and catches have been increasing over time. For most of the 1970s, catches ranged between 5,000 and 10,000 pounds. During the 1980s catches consistently averaged 10,000, but in the early 1990s, catches have exceeded 10,000 pounds and peaked at 24,000 pounds in 1992.

The catch trend is the primary stock indicator. The long–term and short–term trends have been for an increasing stock, and the stock status is above average. The trawl survey data reveal an underutilized resource of sculpins.

CATCH

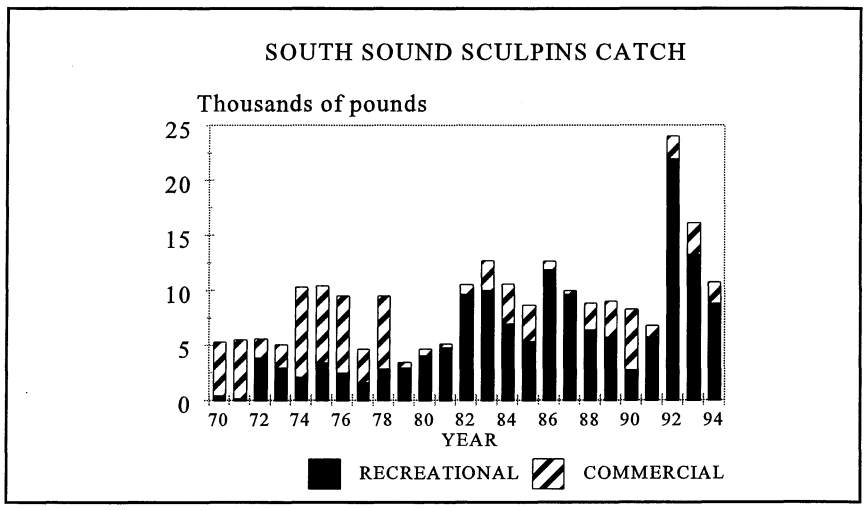


Figure 68. Recreational and commercial catch of sculpins in South Sound.

EFFORT

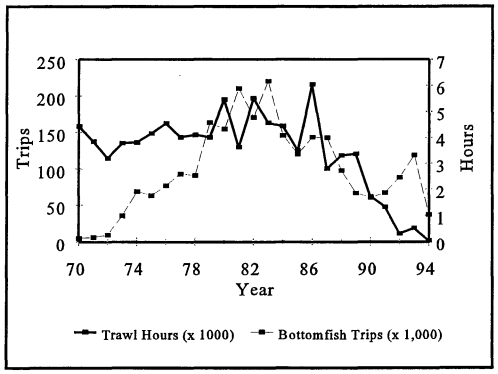


Figure 69. South Sound commercial effort in trawl hours and recreational effort in number of bottomfish trips.

STOCK STATUS PROFILE for SOUTH SOUND—SCULPINS

YR	Trawl Catch Rate (lb/hr)	Recreational Catch Rate (fish/trip)	Other
70			
71			
72			
73			
74			
75			
76			
77			
78			
79			
80			
81			
82			
83			
84			
85			
86			
87			
88			
89			
90			
91			
92			
93			
94			

PRIMARY STOCK INDICATOR

SECONDARY STOCK INDICATOR

TRAWL SURVEY DATA

South Sound SCULPINS	1987	1989	1991
Abundance (N x 1000)	3,632	3,117	1,054
Biomass (mt)	318	432	116
Catch (mt)	5	4	3
% Catch / Biomass	1.4	1.0	2.6

STOCK SUMMARY

FISHERY IMPACT
Underutilized
DATA QUALITY
Poor
RECENT TREND (5 Year)
Increasing
STOCK STATUS (2 Year)
Above average

NORTH SOUND—PILE PERCH

OVERVIEW

Pile perch is one of several surfperches that occur in North Sound. Pile perch is a schooling species that occurs in nearshore waters especially during the spring and summer months. Pile perch are seldom caught in the boat–based recreational fishery, but are caught either by anglers fishing from docks, piers, and jetties or by commercial fishers using drag (beach) seines. In North Sound the recorded catch is primarily from the commercial fishery, and catches were higher in the 1970s and early 1980s when they usually ranged between 4,000 pounds and 9,000 pounds per year. Since 1983, annual catches have not exceeded 1,000 pounds and in the last two years have been negligible.

The primary stock indicator is the catch trend, and the recent five year trend shows a declining trend. The low catches of the last two years suggest the population is critically depressed, however, it is unclear whether market conditions, access to seining sites, or other factors have influenced recent harvests. Pile perch were not encountered in the 1994 video survey of North Sound. The trawl survey data are not useful in determining utilization levels for this species.

CATCH

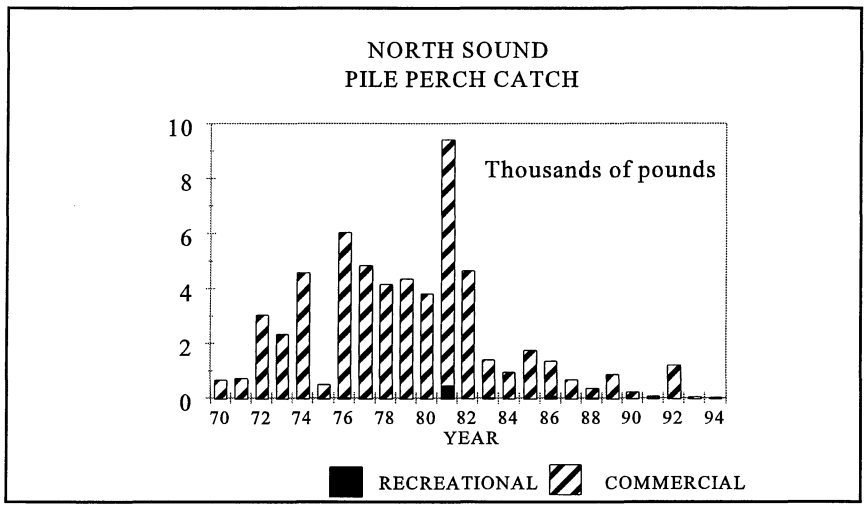


Figure 70. Recreational and commercial catch of pile perch in North Sound.

EFFORT

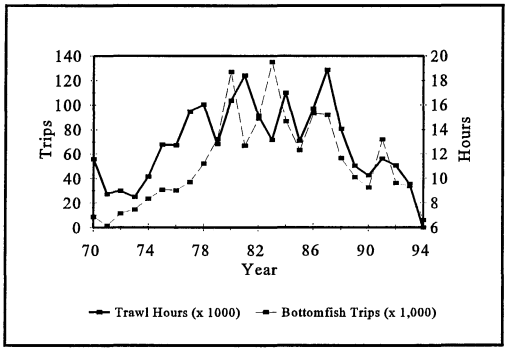


Figure 71. North Sound commercial effort in trawl hours and recreational effort in number of bottomfish trips.

STOCK STATUS PROFILE for NORTH SOUND—PILE PERCH

YR	Drag Seine Catch Rate (lb/hr)	Recreational Catch Rate (fish/trip)	Other
70			
71			
72			
73			
74			
75			
76			
77	0		
78	94		
79	0		
80	0		
81	0		
82	120		
83	282		
84	0		
85	1,230		
86	0		
87	156		
88	0		
89	0		
90	0		
91	0		
92	0		
93	0		
94	0		

PRIMARY STOCK INDICATOR

SECONDARY STOCK INDICATOR

TRAWL SURVEY DATA

North Sound

PILE PERCH	1987	1989	1991
Abundance (N x 1000)			
Biomass (mt)			
Catch (mt)			
% Catch / Biomass			

STOCK SUMMARY

FISHERY IMPACT
Unknown
DATA QUALITY
Poor
RECENT TREND (5 Year)
Declining
STOCK STATUS (2 Year)
Critical

SOUTH SOUND—PILE PERCH

OVERVIEW

Pile perch is one of several species of surfperches that occur in South Sound. Pile perch is a schooling species that occurs in nearshore waters especially during the spring and summer months. Pile perch are seldom caught in the boat–based recreational fishery, but significant numbers are caught by anglers fishing from docks, piers, and jetties and by commercial fishers using drag (beach) seines. Because shore–based fishing is poorly sampled, the recreational component of the catch is underestimated. In South Sound, the recorded catch is almost exclusively by commercial fishers who once landed between 150,000 pounds and 235,000 pounds per year in the 1970s. Since then, the catch has progressively declined to about 75,000 pounds per year.

The primary stock indicator is the catch rate of pile perch from the drag seine fishery. The stock indicator has shown a long–term decline, but no population trend is evident during the last five years. Recent low catch rates indicate the stock status is below average. Trawl survey data for South Sound indicate the stock is fully exploited.

CATCH

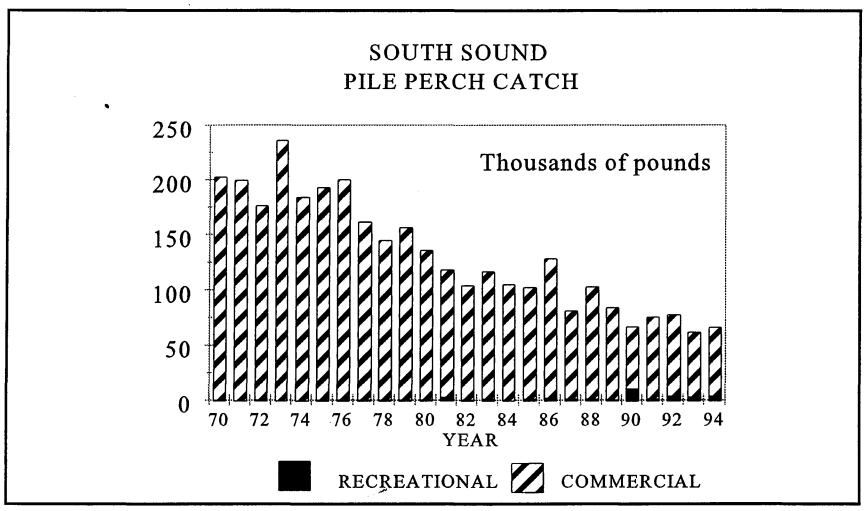


Figure 72. Recreational and commercial catch of pile perch in South Sound.

EFFORT

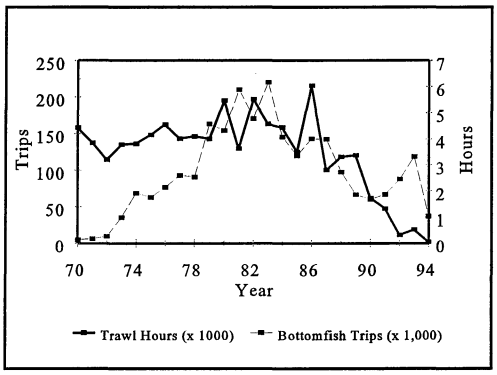


Figure 73. South Sound commercial effort in trawl hours and recreational effort in number of bottomfish trips.

STOCK STATUS PROFILE for SOUTH SOUND—PILE PERCH

YR	Drag Seine Catch Rate (lb/hr)	Recreational Catch Rate (fish/trip)	Other
70			
71			
72			
73			
74			
75			
76			
77	615.7		
78	669.7		
79	601.3		
80	473.3		
81	418.7		
82	435.3		
83	427.0		
84	522.3		
85	419.0		
86	445.7		
87	428.7		
88	542.7		
89	452.3		
90	455.0		
91	344.0		
92	393.0		
93	401.0		
94	404.3		

PRIMARY STOCK INDICATOR

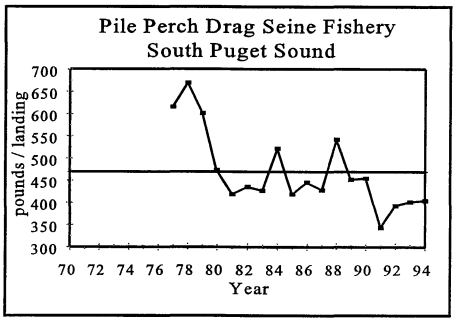


Figure 74. Commercial drag seine catch per unit effort and long–term mean.

SECONDARY STOCK INDICATOR

TRAWL SURVEY DATA

South Sound PILE PERCH	1987	1989	1991
Abundance (N x 1000)			
Biomass (mt)			
Catch (mt)			
% Catch / Biomass			

STOCK SUMMARY

FISHERY IMPACT
Fully utilized
DATA QUALITY
Poor
RECENT TREND (5 Year)
None
STOCK STATUS (2 Year)
Below average

NORTH SOUND—PACIFIC HALIBUT

OVERVIEW

Pacific halibut is a large predatory flatfish that primarily occurs in the western portions of North Sound. Commercial halibut fishing is limited in Puget Sound and recreational fishers harvest virtually all of the halibut. Annual catches were low, below 20,000 pounds, during most of the 1970s and early 1980s. Halibut catches began to increase in the mid 1980s apparently as a discovery and recovery of the southern components of the Pacific coast stock. Catches peaked in 1986 at over 300,000 pounds but have been declining since then. The decreased catches since 1986 have primarily resulted from increased restrictions including quota management for most of the 1990s.

Pacific halibut are migratory along the Pacific coast and only occur in the shallow waters of Puget Sound during the spring and summer. The Pacific coast stock of halibut is assessed by the International Pacific Halibut Commission. Their assessments indicate the population is on a long–term decline. With strict management, the stock's status is below average and the resource is fully utilized.

CATCH

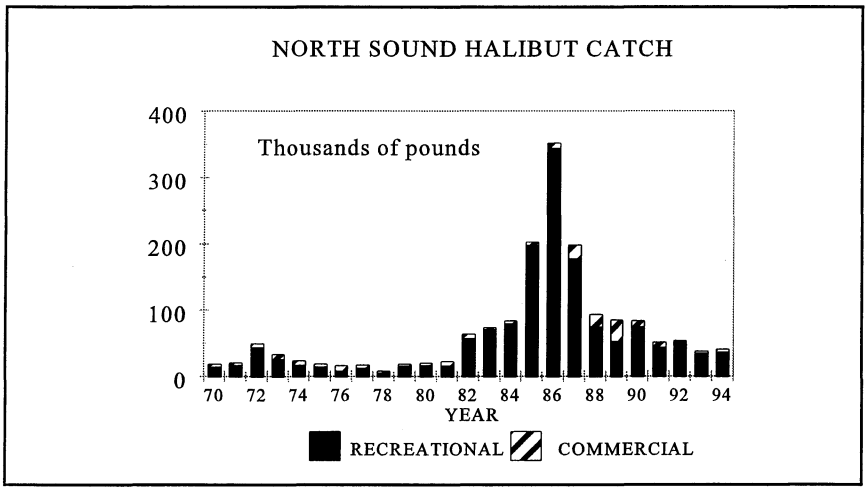


Figure 75. Recreational and commercial catch of Pacific halibut in North Sound.

EFFORT

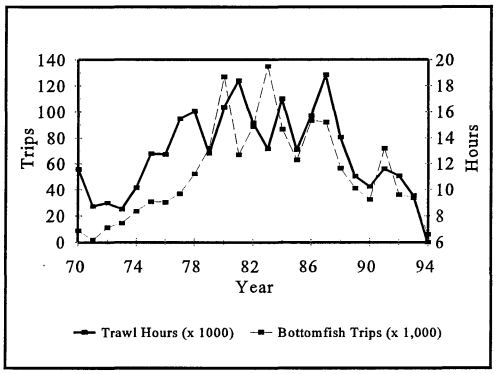


Figure 76. North Sound commercial effort in trawl hours and recreational effort in number of bottomfish trips.

STOCK STATUS PROFILE for NORTH SOUND—PACIFIC HALIBUT

YR	Trawl Catch Rate (lb/hr)	Recreational Catch Rate (fish/trip)	Other
70			
71			
72			
73			
74			
75			
76			
77			
78			
79			
80			
81			
82			
83			
84			
85			
86			
87			
88			
89			
90			
91			
92			
93			
94			

PRIMARY STOCK INDICATOR

SECONDARY STOCK INDICATOR

TRAWL SURVEY DATA

North Sound Pacific Halibut	1987	1989	1991
Abundance (N x 1000)			
Biomass (mt)			
Catch (mt)			
% Catch / Biomass			

STOCK SUMMARY

FISHERY IMPACT
Fully utilized
DATA QUALITY
Fair
RECENT TREND (5 Year)
Declining
STOCK STATUS (2 Year)
Below Average

SOUTH SOUND—PACIFIC HALIBUT

OVERVIEW

Pacific halibut is a large predatory flatfish that does not usually occur in South Sound. Harvests have been sporadic and below 200 pounds in any year. These occasional harvests have been made by commercial fishers. Harvest has been controlled by quota since 1990.

Pacific halibut is a migratory species along the Pacific coast and only occurs in the shallow waters close to the open ocean. The Pacific Coast stock is assessed by the International Pacific Halibut Commission whose assessments indicate the population in on a long–term decline. However, with strict management, the stock's status is below average, and the resource is fully utilized.

CATCH

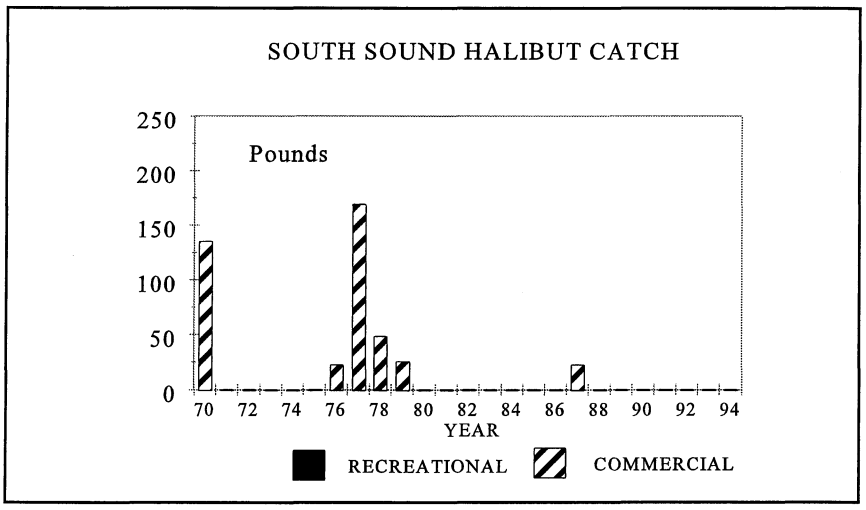


Figure 77. Recreational and commercial catch of Pacific halibut in South Sound.

EFFORT

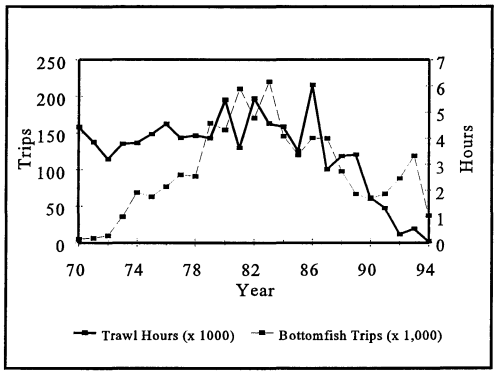


Figure 78. South Sound commercial effort in trawl hours and recreational effort in number of bottomfish trips.

STOCK STATUS PROFILE for SOUTH SOUND—PACIFIC HALIBUT

YR	Trawl Catch Rate (lb/hr)	Recreational Catch Rate (fish/trip)	Other	PRIMARY STOCK INDICATOR
70				
71				
72				
73				
74				
75				
76				
77				
78				
79				
80				
81				
82				
83				SECONDARY STOCK INDICATOR
84				
85				
86				
87				
88				
89				
90				
91				
92				
93				
94				

TRAWL SURVEY DATA

South Sound Pacific Halibut	1987	1989	1991
Abundance (N x 1000)			
Biomass (mt)			
Catch (mt)			
% Catch / Biomass			

STOCK SUMMARY

FISHERY IMPACT
Fully utilized
DATA QUALITY
Fair
RECENT TREND (5 Year)
Declining
STOCK STATUS (2 Year)
Below average

NORTH SOUND—ROCKFISH

OVERVIEW

Over 20 species of rockfish inhabit North Puget Sound, but only five are commonly caught in commercial or recreational fisheries. In recent years, recreational fishers have caught more than half of the 100,000 pounds to 250,000 pounds of the recorded annual catch. Rockfish harvests are likely higher than the estimated catch because rockfish speared by divers are not included in catch estimates, and divers can harvest significant numbers of rockfish (Bargmann, 1984).

The primary stock indicator is the recreational catch rate which has declined since 1977. Despite a reduction in the daily bag limit in 1994, from ten rockfish to five rockfish, the recent five years show no trend in the catch rate. The catch rates of the last two years are near the long–term average and the stock status is average. A 1994 video assessment of nearshore rockfish suggests the rockfish are fully utilized. Other biological data show the average size of rockfish in the recreational catch has declined by several inches since the 1970s and that several species have become rare in the catch.

CATCH

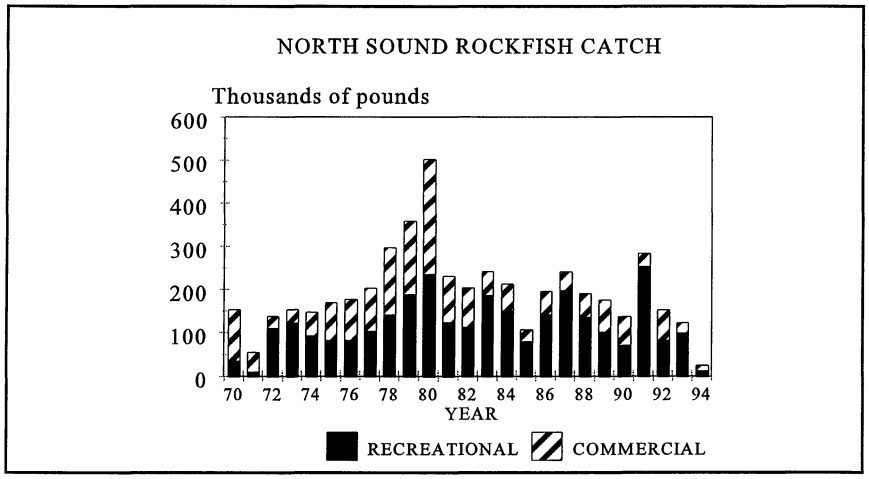


Figure 79. Recreational and commercial catch of rockfish in North Sound

EFFORT

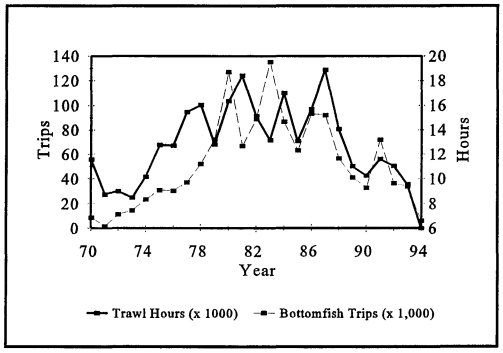


Figure 80. North Sound commercial effort in trawl hours and recreational effort in number of bottomfish trips.

STOCK STATUS PROFILE for NORTH SOUND—ROCKFISH

YR	Commercial Catch Rate (lb/hr)	Recreational Catch Rate (fish/trip)	Video–Acoustic Survey (mt)
70			
71			
72			
73			
74			
75			
76			
77		1.75	
78		1.21	
79		1.51	
80		1.15	
81		1.00	
82		0.93	
83		0.82	
84		0.75	
85		0.79	
86		0.56	
87		0.62	
88		0.61	
89		0.87	
90		0.77	
91		0.69	
92		0.90	
93		1.07	
94		0.71	7,300

PRIMARY STOCK INDICATOR

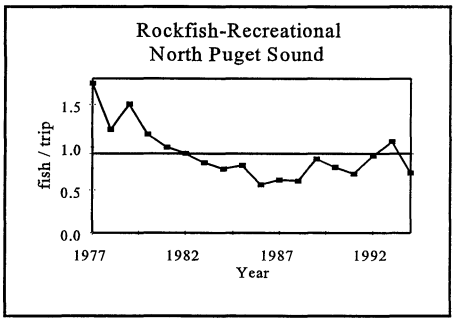


Figure 81. Recreational catch per unit effort and long–term mean.

SECONDARY STOCK INDICATOR

TRAWL SURVEY DATA

North Sound ROCKFISH	1987	1989	1991
Abundance (N x 1000)			
Biomass (mt)			
Catch (mt)			
% Catch / Biomass			

STOCK SUMMARY

FISHERY IMPACT
Fully utilized
DATA QUALITY
Fair
RECENT TREND (5 Year)
None
STOCK STATUS (2 Year)
Average

SOUTH SOUND—ROCKFISH

OVERVIEW

Recreational fishers have always harvested the majority of the 20 or more species of rockfish in South Sound. Annual catches have ranged from 100,000 pounds to almost 400,000 pounds between 1970 and 1993 with a peak catch in 1989 when commercial catches were above average. The 1994 catch is likely an underestimate due to the effects of salmon harvest restrictions on the catch estimation process.

The primary stock indicator is the recreational catch rate which shows the rockfish stocks have undergone long–term declines in abundance since 1977. However, there is no trend during the recent five years despite a reduction in the daily bag limit for recreational anglers in 1994. Fishery–independent scuba surveys also indicate a decline in rockfish densities between the late 1980s and early 1990s. The low catch rates of the last two years of data are less than the long–term mean indicating a below average rockfish population. The lowered catch rates appeared to be unaffected by the lowered bag limit in 1994 because low catch rates were observed in 1993 before the change from five fish per day to three fish per day occurred. The trawl survey data show unexpectedly high biomasses of rockfish in trawlable habitat. The trawl surveys also indicate rockfish are overutilized in South Sound.

CATCH

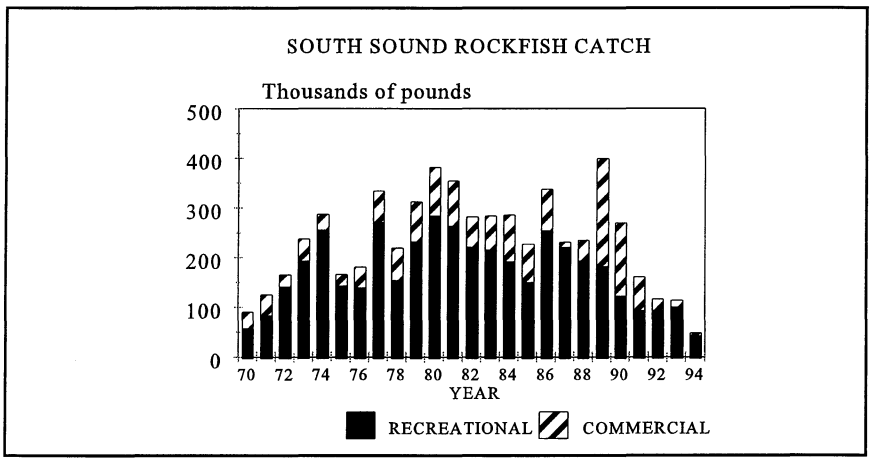


Figure 82. Recreational and commercial catch of rockfish in South Sound.

EFFORT

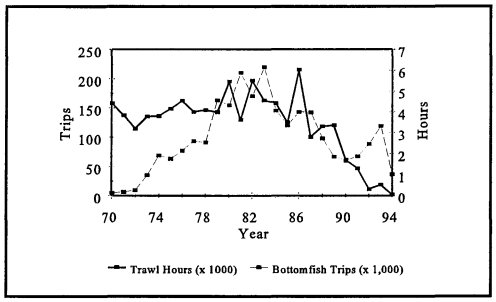


Figure 83. South Sound commercial effort in trawl hours and recreational effort in number of bottomfish trips.

STOCK STATUS PROFILE for SOUTH SOUND—ROCKFISH

YR	Trawl Catch Rate (lb/hr)	Recreational Catch Rate (fish/trip)	Scuba Densities (fish/ha)
70			
71			
72			
73			
74			
75			
76			
77		1.01	
78		0.78	
79		0.75	
80		0.79	
81		0.71	
82		0.76	
83		0.41	
84		0.63	
85		0.55	
86		0.50	
87		0.50	4,967
88		0.58	9,422
89		0.66	
90		0.57	
91		0.47	
92		0.62	2,555
93		0.45	1,978
94		0.50	1,867

PRIMARY STOCK INDICATOR

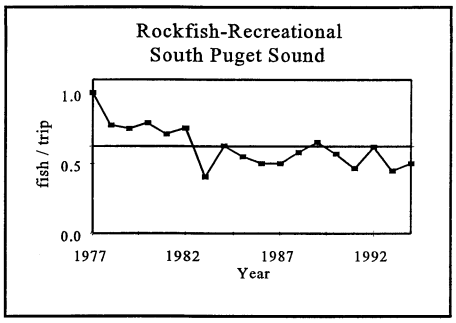


Figure 84. Recreational catch per unit effort and long–term mean.

SECONDARY STOCK INDICATOR

TRAWL SURVEY DATA

South Sound

ROCKFISH	1987	1989	1991
Abundance (N x 1000)	2,146	3,180	1,103
Biomass (mt)	1,368	1,853	550
Catch (mt)	104	181	73
% Catch / Biomass	7.6	9.8	13.2

STOCK SUMMARY

FISHERY IMPACT
Overutilized
DATA QUALITY
Fair
RECENT TREND (5 Year)
None
STOCK STATUS (2 Year)
Below average

NORTH SOUND—DOVER SOLE

OVERVIEW

Dover sole, especially juveniles, are common throughout North Sound, but adult Dover sole are harvested by bottom trawlers. They constitute less than 5 percent of the flatfish catch in this region, and their annual landings have ranged between 10,000 pounds and 50,000 pounds in the last 25 years. Recreational fishers rarely harvest Dover sole.

The primary stock indicator is the trawl catch rate. The long–term pattern in the trawl catch rate shows several episodic years of high abundance interspersed with long periods of low abundance. The recent trend of the stock indicator is declining, and the recent catch rates indicate the stock is depressed, far below the long–term average. The trawl surveys show Dover sole are underutilized.

CATCH

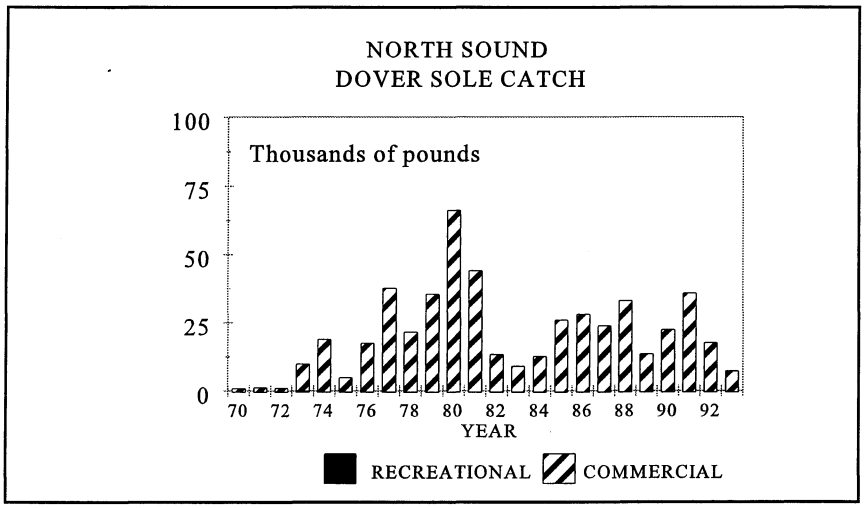


Figure 85. Recreational and commercial catch of Dover sole in North Sound.

EFFORT

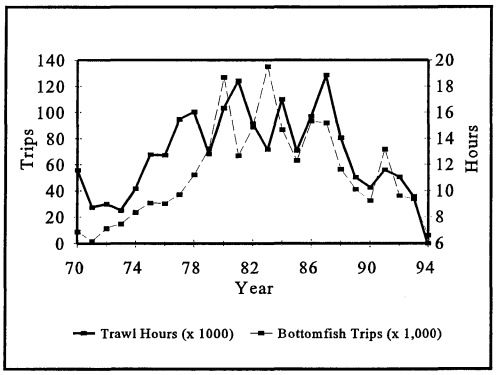


Figure 86. North Sound commercial effort in trawl hours and recreational effort in number of bottomfish trips.

STOCK STATUS PROFILE for NORTH SOUND—DOVER SOLE

YR	Trawl Catch Rate (lb/hr)	Recreational Catch Rate (fish/trip)	Other
70	0.0		
71	0.1		
72	0.1		
73	0.5		
74	1.0		
75	0.4		
76	1.6		
77	3.6		
78	1.0		
79	1.3		
80	1.7		
81	0.8		
82	0.3		
83	0.8		
84	0.5		
85	0.3		
86	0.5		
87	0.6		
88	0.3		
89	0.8		
90	2.1		
91	3.9		
92	1.5		
93	0.7		
94	0.8		

PRIMARY STOCK INDICATOR

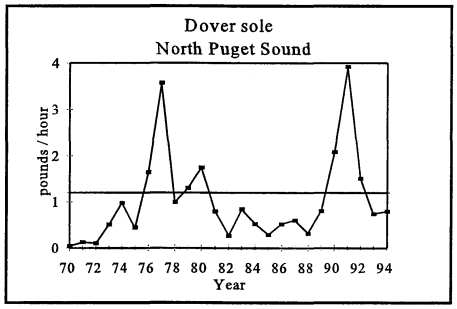


Figure 87. Commercial trawl catch per unit effort and long–term mean.

SECONDARY STOCK INDICATOR

TRAWL SURVEY DATA

North Sound DOVER SOLE	1987	1989	1991
Abundance (N x 1000)	4,579	1,367	910
Biomass (mt)	1,457	224	105
Catch (mt)	11	6	16
% Catch / Biomass	0.7	2.5	15.3

STOCK SUMMARY

FISHERY IMPACT
Underutilized
DATA QUALITY
Fair
RECENT TREND (5 Year)
Declining
STOCK STATUS (2 Year)
Depressed

SOUTH SOUND—DOVER SOLE

OVERVIEW

Dover sole, especially juveniles, are common throughout South Sound, but adult Dover sole were once targeted by bottom trawlers in areas around Seattle. Annual harvests of Dover sole have ranged from nearly 200,000 pounds in the 1970s to only about 10,000 pounds in the year prior to the Legislative closure of the trawl fishery. Recreational fishers rarely harvest Dover sole.

The primary stock indicator is the trawl catch rate which has shown an erratic pattern over most of the years of the active fishery. In the few years prior to closure, the stock indicator was declining. The recent trend and status of the population are unknown. The results of the trawl survey indicate Dover sole were underutilized in South Sound.

CATCH

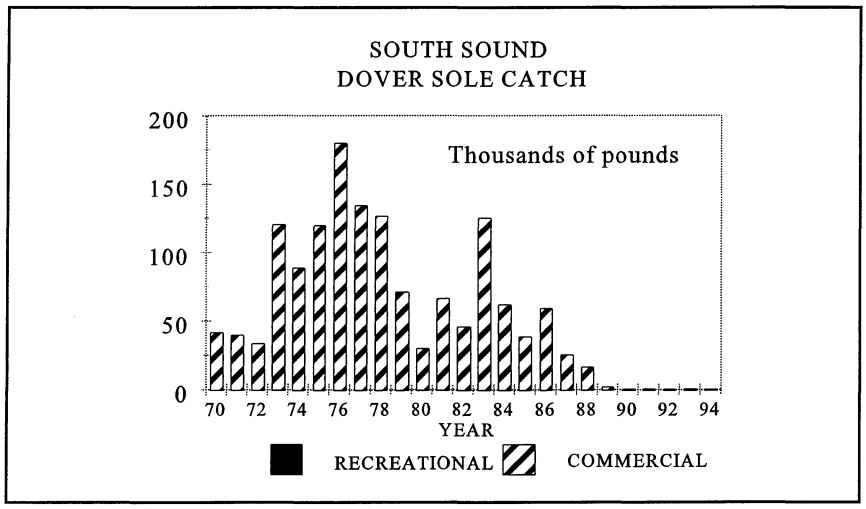


Figure 88. Recreational and commercial catch of Dover sole in South Sound.

EFFORT

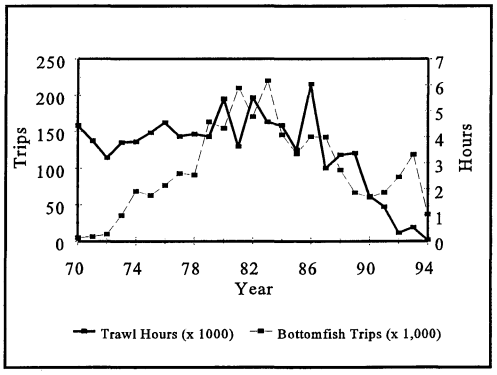


Figure 89. South Sound commercial effort in trawl hours and recreational effort in numbers of bottomfish trips.

STOCK STATUS PROFILE for SOUTH SOUND—DOVER SOLE

YR	Trawl Catch Rate (lbs/hr)	Recreational Catch Rate (fish/trip)	Other
70	8.1		
71	7.6		
72	11.0		
73	24.1		
74	14.3		
75	30.1		
76	38.7		
77	40.2		
78	31.7		
79	2.3		
80	8.5		
81	20.4		
82	11.9		
83	29.2		
84	10.3		
85	11.8		
86	12.6		
87	9.1		
88	3.5		
89	0.3		
90	0.0		
91	0.0		
92	0.0		
93	0.0		
94	0.0		

PRIMARY STOCK INDICATOR

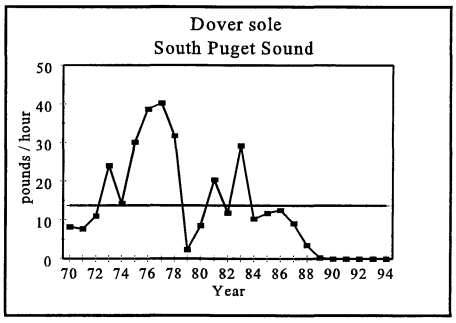


Figure 90. Commercial trawl catch per unit effort and long–term mean.

SECONDARY STOCK INDICATOR

TRAWL SURVEY DATA

South Sound

DOVER SOLE	1987	1989	1991
Abundance (N x 1000)	5,655	1,688	958
Biomass (mt)	1,860	489	139
Catch (mt)	11	1	0
% Catch / Biomass	0.6	0.1	0.1

STOCK SUMMARY

FISHERY IMPACT
Underutilized
DATA QUALITY
Poor
RECENT TREND (5 Year)
Unknown
STOCK STATUS (2 Year)
Unknown

NORTH SOUND—ENGLISH SOLE

OVERVIEW

English sole are dominant members of the flatfish community and are one of the primary species targeted in bottom trawl fisheries. North Sound English sole are exclusively harvested in the commercial fishery which has landed between 350,000 pounds and 1.4 million pounds in any year. Catches peaked in the 1970s but in recent years have been stable ranging between 400,000 pounds and 500,000 pounds. Commercial fishers are only allowed to land English sole that measure at least 12 inches.

The primary stock indicator is the catch rate from the trawl fishery. Peak catch rates were achieved in the early 1970s followed by a decline in the 1980s when trawl effort was building. The recent trend of the stock has been increasing and the status in the last two years is above average. Trawl survey abundance observed in 1989 and 1991 indicates the fishery impact is over utilizing the adult resource of English sole.

CATCH

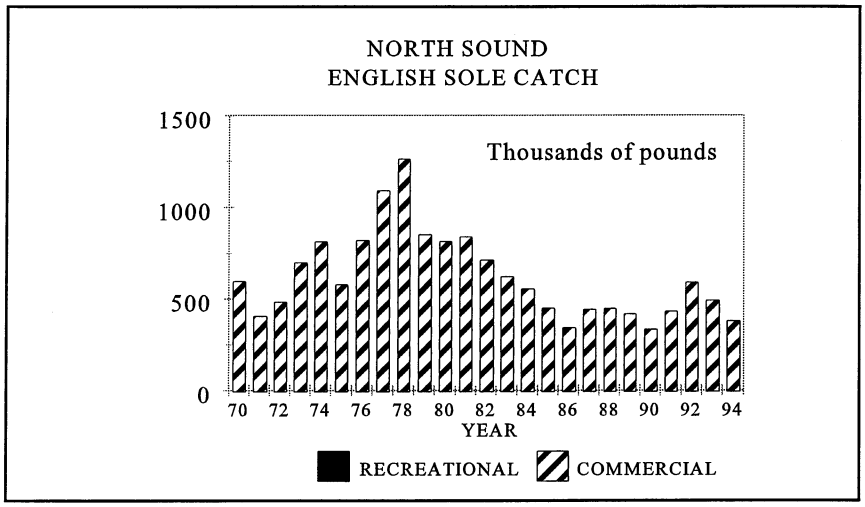


Figure 91. Recreational and commercial catch of English sole in North Sound.

EFFORT

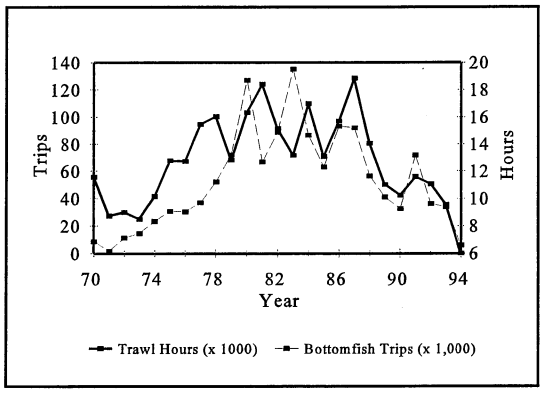


Figure 92. North Sound commercial effort in trawl hours and recreational effort in number of bottomfish trips.

STOCK STATUS PROFILE for NORTH SOUND—ENGLISH SOLE

YR	Trawl Catch Rate (lb/hr)	Recreational Catch Rate (fish/trip)	OTHER
70	43.8		
71	38.5		
72	50.5		
73	78.9		
74	68.7		
75	43.1		
76	56.5		
77	62.0		
78	55.7		
79	40.0		
80	33.9		
81	41.5		
82	37.5		
83	27.0		
84	18.9		
85	36.0		
86	22.0		
87	24.5		
88	33.8		
89	40.7		
90	38.2		
91	41.0		
92	51.7		
93	52.9		
94	61.5		

PRIMARY STOCK INDICATOR

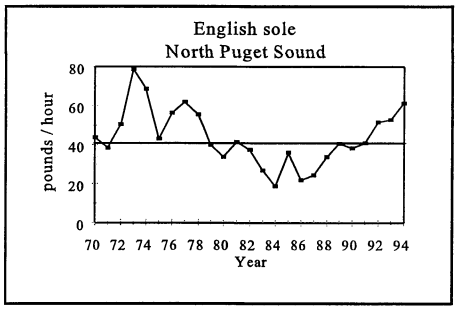


Figure 93. Commercial trawl catch per unit effort and long–term mean.

SECONDARY STOCK INDICATOR

TRAWL SURVEY DATA

North Sound ENGLISH SOLE	1987	1989	1991
Abundance (N x 1000)	23,346	17,850	11,842
Biomass (mt)	2,747	1,271	1,623
Catch (mt)	200	189	195
% Catch / Biomass	7.3	14.9	12.0
% Catch /Adult Biomass	26.9	40.8	27.1

STOCK SUMMARY

FISHERY IMPACT
Overutilized
DATA QUALITY
Fair
RECENT TREND (5 Year)
Increasing
STOCK STATUS (2 Year)
Above average

SOUTH SOUND—ENGLISH SOLE

OVERVIEW

English sole are dominant members of the flatfish community of South Sound and once was the primary target of a bottom trawl fishery. Annual landings peaked at 1.5 million pounds in 1970 but typically ranged between 400,000 pounds and 800,000 pounds. In 1989, the trawl fishery was closed by the Legislature, and although a small portion of the region remained open until 1994, harvests were minimal. Commercial fishers were only allowed to harvest English sole that measured at least 12 inches.

At present, the trend and status of English sole in South Sound is unknown because the primary stock indicator, the catch rate of the trawl fishery, ended in 1989 when the fishery was closed. Prior to closure, the trawl catch rate was following a declining pattern. A secondary indicator, the recreational catch rate of flatfish, shows an increasing trend during the recent five years. Trawl survey data indicate the adult population is underutilized.

CATCH

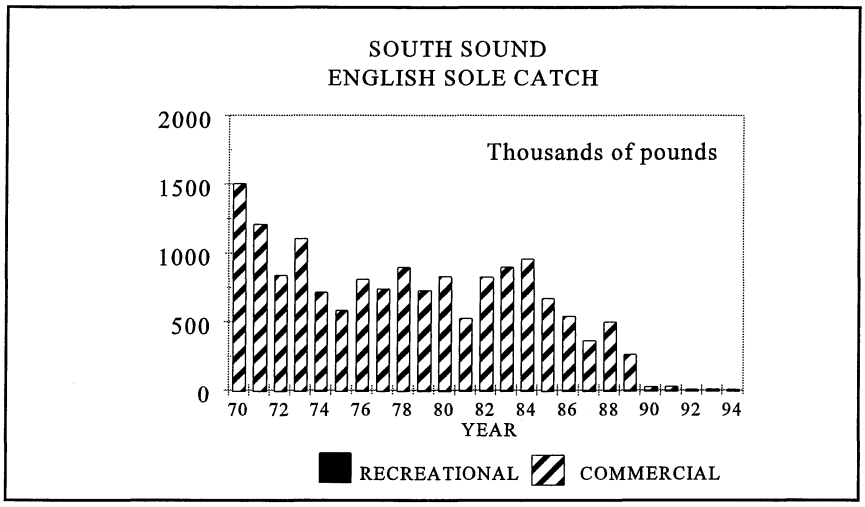


Figure 94. Recreational and commercial catch of English Sole in South Sound.

EFFORT

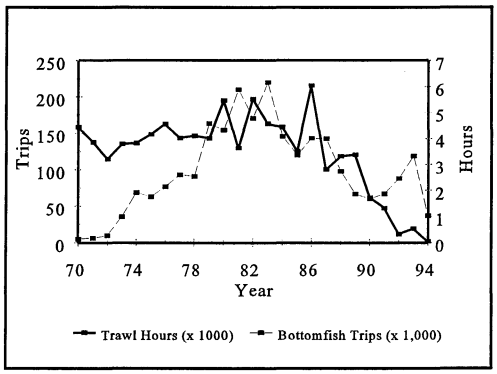


Figure 95. South sound commercial effort in trawl hours and recreational effort in number of bottomfish trips.

STOCK STATUS PROFILE for SOUTH SOUND—ENGLISH SOLE

YR	Trawl Catch Rate (lb/hr)	Recreational Catch Rate (fish/trip)	Other
70	395.5		
71	340.7		
72	272.1		
73	299.0		
74	225.3		
75	189.0		
76	226.0		
77	227.4	0.38	
78	250.3	0.37	
79	151.8	0.33	
80	185.7	0.51	
81	132.8	0.56	
82	236.7	0.59	
83	274.2	0.26	
84	343.3	0.33	
85	311.4	0.17	
86	102.5	0.38	
87	146.4	0.26	
88	178.0	0.27	
89	59.4	0.41	
90	17.4	0.33	
91	21.9	0.45	
92	2.8	0.30	
93	18.1	0.51	
94	0.0	0.51	

PRIMARY STOCK INDICATOR

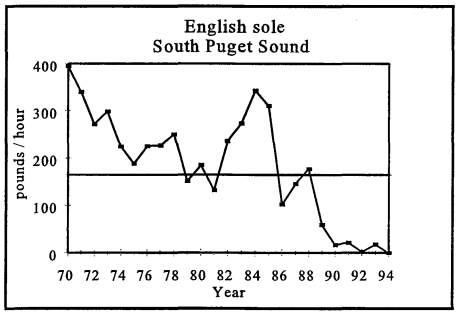


Figure 96. Commercial trawl catch per unit effort and long–term mean.

SECONDARY STOCK INDICATOR

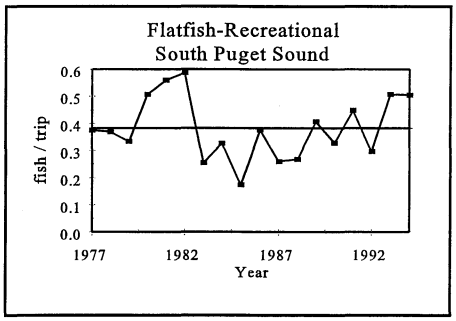


Figure 97. Recreational catch per unit effort and long–term mean.

TRAWL SURVEY DATA

South Sound

ENGLISH SOLE	1987	1989	1991
Abundance (N x 1000)	69,739	56,275	33,113
Biomass (mt)	10,658	6,982	3,295
Catch (mt)	163	117	11
% Catch/Biomass	1.5	1.7	0.3
% Catch/Adult Biomass	3.3	3.5	0.9

STOCK SUMMARY

FISHERY IMPACT
Underutilized
DATA QUALITY
Poor
RECENT TREND (5 Year)
Unknown
STOCK STATUS (2 Year)
Unknown

NORTH SOUND—STARRY FLOUNDER

OVERVIEW

Starry flounder is an important member of the flatfish community in North Sound and is often targeted by the bottom trawl fishery. Only commercial fishers have harvested starry flounder and their landings typically have ranged from 200,000 pounds to 600,000 pounds per year. Commercial fishers are only allowed to harvest starry flounder that measure at least 14 inches.

The primary stock indicator is the catch rate of the bottom trawl fishery. The stock indicator has been cyclical over the last 25 years with high catch rates in the 1970s and 1990s separated by a period of low catch rates in the 1980s. During the recent five years, there has been no stock trend and the stock status is above average. During this period of high abundance, the trawl surveys show that the catch is extremely high in relation to the biomass of fish greater than 14 inches. The fishery is over utilizing the adult population.

CATCH

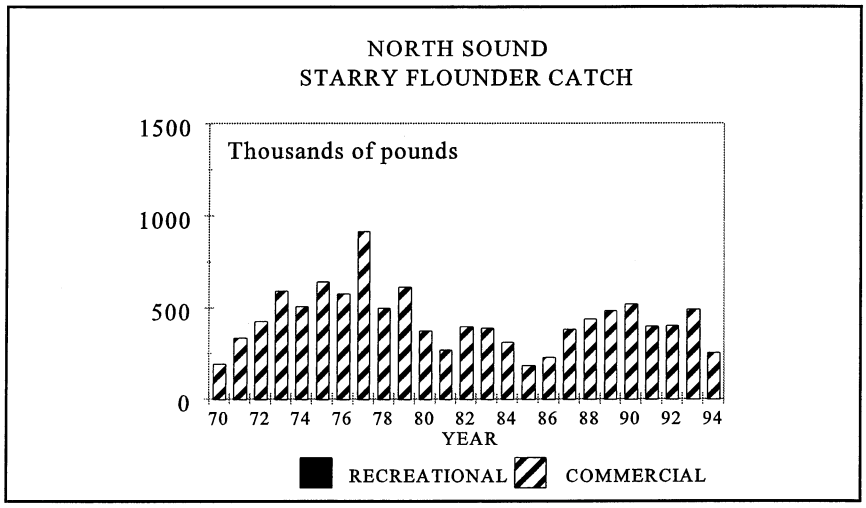


Figure 98. Recreational and commercial catch of starry flounder in North Sound.

EFFORT

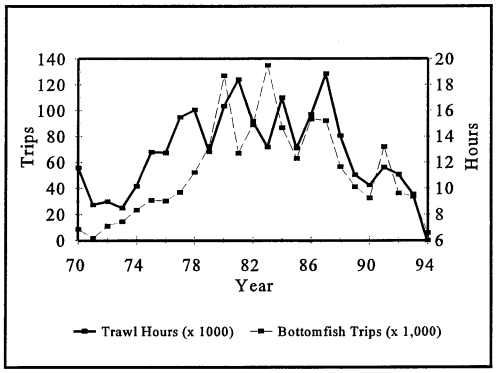


Figure 99. North Sound commercial effort in trawl hours and recreational effort in number of bottomfish trips.

STOCK STATUS PROFILE for NORTH SOUND—STARRY FLOUNDER

YR	Trawl Catch Rate (lb/hr)	Recreational Catch Rate (fish/trip)	Other
70	13.3		
71	21.0		
72	36.7		
73	52.4		
74	31.9		
75	49.0		
76	49.7		
77	51.7	0.14	
78	29.5	0.08	
79	28.6	0.09	
80	14.2	0.06	
81	9.9	0.10	
82	22.7	0.04	
83	25.7	0.03	
84	12.5	0.03	
85	11.5	0.01	
86	15.4	0.04	
87	21.5	0.01	
88	29.7	0.01	
89	39.2	0.02	
90	52.1	0.07	
91	40.5	0.01	
92	34.3	0.02	
93	48.1	0.03	
94	40.0	0.03	

PRIMARY STOCK INDICATOR

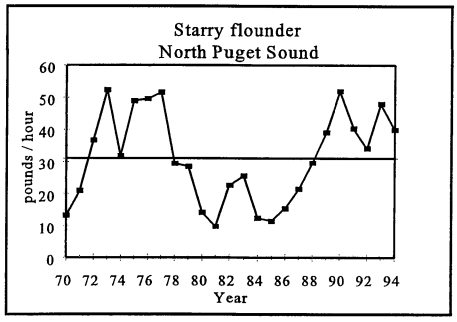


Figure 100. Commercial trawl catch per unit effort and long–term mean.

SECONDARY STOCK INDICATOR

TRAWL SURVEY DATA

North Sound

STARRY FLOUNDER	1987	1989	1991
Abundance (N x 1000)	110	380	286
Biomass (mt)	94	462	146
Catch (mt)	173	219	180
% Catch / Biomass	184.5	47.4	123.0
% Catch / Adult Biomass		50.2	616.7

STOCK SUMMARY

FISHERY IMPACT
Overutilized
DATA QUALITY
Fair
RECENT TREND (5 Year)
None
STOCK STATUS (2 Year)
Above

SOUTH SOUND—STARRY FLOUNDER

OVERVIEW

Starry flounder is an important member of the flatfish community in South Sound and once comprised one–fifth to one–quarter of the flatfish catch in the bottom trawl fishery. Starry flounder were harvested primarily by commercial fishers in the bottom trawl fishery until 1989 when most of the area was closed to trawling. Approximately 150,000 pounds of starry flounder were caught during most years, but higher catches were achieved during the early 1980s.

The recent trend and status of the stock is unknown because the primary stock indicator, the trawl catch rate, has not been available since 1989 when the trawl fishery was curtailed. Prior to 1989, the trawl catch rate was relatively stable and generally mirrored the catch pattern. The secondary stock indicator is the recreational catch of flatfish which has increased in recent years. The trawl survey data indicate the stock was fully harvested in 1989 but is underutilized at present.

CATCH

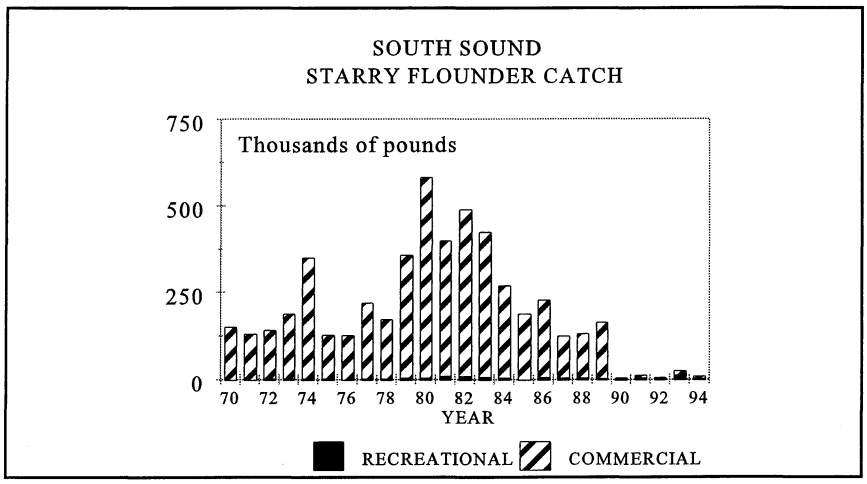


Figure 101. Recreational and commercial catch of starry flounder in South Sound.

EFFORT

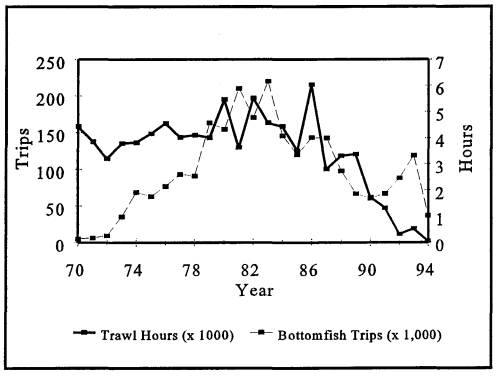


Figure 102. South Sound commercial effort in trawl hours and recreational effort in number of bottomfish trips.

STOCK STATUS PROFILE for SOUTH SOUND—STARRY FLOUNDER

YR	Trawl Catch Rate (lb/hr)	Recreational Catch Rate (fish/trip)	Other
70	34.1		
71	29.6		
72	41.5		
73	48.7		
74	93.6		
75	25.2		
76	25.2		
77	53.3	0.38	
78	40.0	0.37	
79	80.6	0.33	
80	87.3	0.51	
81	78.2	0.56	
82	90.7	0.59	
83	69.8	0.26	
84	49.9	0.33	
85	26.7	0.17	
86	36.3	0.38	
87	40.2	0.26	
88	45.7	0.27	
89	69.2	0.41	
90	0.3	0.33	
91	1.2	0.45	
92	0.2	0.30	
93	24.0	0.51	
94	122.8	0.51	

PRIMARY STOCK INDICATOR

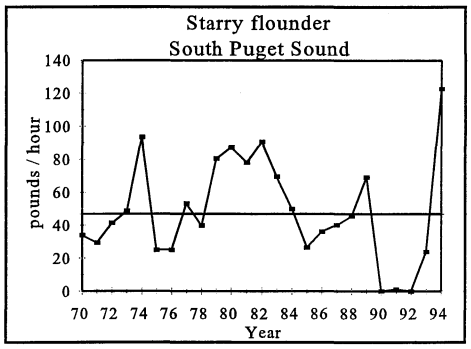


Figure 103. Commercial trawl catch per unit effort and long–term mean..

SECONDARY STOCK INDICATOR

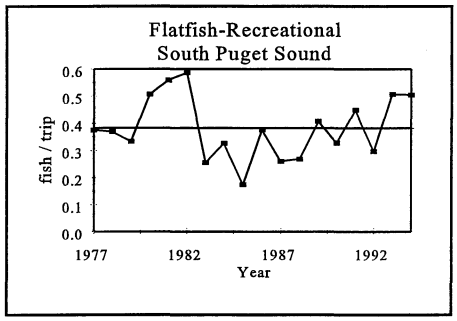


Figure 104. Recreational catch per unit effort and long–term mean.

TRAWL SURVEY DATA

South Sound

STARRY FLOUNDER	1987	1989	1991
Abundance (N x 1000)	2,922	2,901	2,083
Biomass (mt)	2,337	1,293	1,053
Catch (mt)	56	73	5
% Catch / Biomass	2.4	5.7	0.5
% Catch / Adult Biomass	3.3	9.5	0.7

STOCK SUMMARY

FISHERY IMPACT
Underutilized
DATA QUALITY
Poor
RECENT TREND (5 Year)
Unknown
STOCK STATUS (2 Year)
Unknown

NORTH SOUND—SAND SOLE

OVERVIEW

Sand sole can be important members of flatfish communities in North Sound. They are harvested by the bottom trawl fishery and occur in less than 5 percent of the flatfish catch. Catches were high during the 1970s and early 1980s when they reached over 125,000 pounds in 1977 and 1978. In recent years, slightly less than 50,000 pounds have been harvested per year. Recreational fishers seldom harvest sand sole in North Sound.

The primary stock indicator for sand sole is their catch rate in the bottom trawl fishery. The catch rate trend indicates the population was higher than average during the late 1970s, but then has been below average during most of the 1980s. During the recent five years, the stock has been increasing, and at present, the stock status is above average. The trawl survey information indicates that sand sole are overutilized.

CATCH

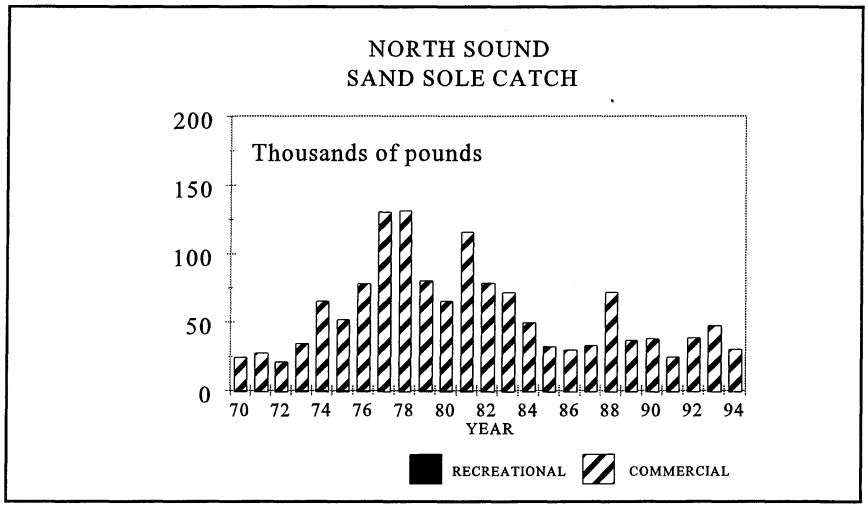


Figure 105. Recreational and commercial catch of sand sole in North Sound.

EFFORT

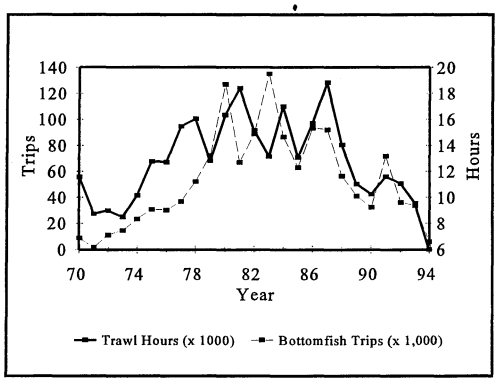


Figure 106. North Sound commercial effort in trawl hours and recreational effort in number of bottomfish trips.

STOCK STATUS PROFILE for NORTH SOUND—SAND SOLE

YR	Trawl Catch Rate (lbs/hr)	Recreational Catch Rate (fish/trip)	Other
70	2.2		
71	3.1		
72	2.2		
73	3.8		
74	6.1		
75	3.5		
76	6.7		
77	7.6		
78	7.4		
79	3.8		
80	3.5		
81	5.0		
82	4.1		
83	3.6		
84	1.9		
85	1.0		
86	1.9		
87	1.6		
88	4.8		
89	2.6		
90	3.4		
91	2.5		
92	2.9		
93	4.6		
94	4.8		

PRIMARY STOCK INDICATOR

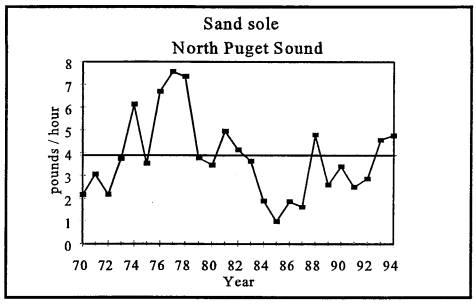


Figure 107. Commercial trawl catch per unit effort and long–term mean.

SECONDARY STOCK INDICATOR

TRAWL SURVEY DATA

North Sound SAND SOLE	1987	1989	1991
Abundance (N x 1000)	33	277	929
Biomass (mt)	6	47	133
Catch (mt)	15	17	11
% Catch / Biomass	260.3	35.0	8.2

STOCK SUMMARY

FISHERY IMPACT
Overutilized
DATA QUALITY
Fair
RECENT TREND (5 Year)
Increasing
STOCK STATUS (2 Year)
Above average

SOUTH SOUND—SAND SOLE

OVERVIEW

Sand sole are important members of the flatfish community in South Sound. They have been harvested by the bottom trawl fishery, and before that fishery was curtailed, constituted about 5 percent of the flatfish catch. Catches of sand sole were relatively constant during much of the fishery period with 30,000 pounds to 40,000 pounds being harvested during an average year. Sand sole are seldom harvested by recreational fishers.

There is little current information on the stock trend or status for sand sole in South Sound. Before the trawl fishery ended, the trawl catch rate was relatively constant, but displayed minor episodic peaks and nadirs of abundance. The population appeared to be at above average levels before the trawl fishery was ended. The trawl survey shows that sand sole are underutilized in South Sound.

CATCH

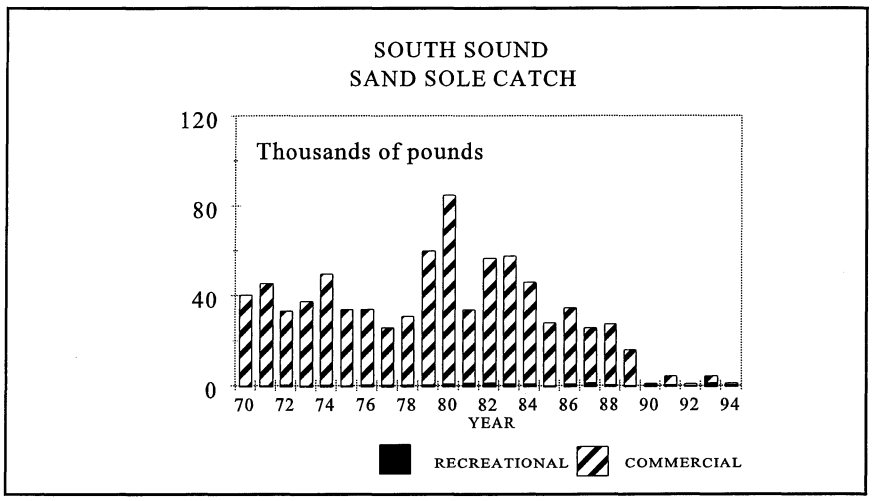


Figure 108. Recreational and commercial catch of sand sole in South Sound.

EFFORT

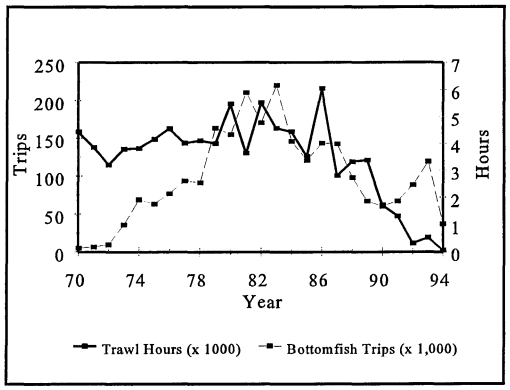


Figure 109. South Sound commercial effort in trawl hours and recreational effort in number of bottomfish trips.

STOCK STATUS PROFILE for SOUTH SOUND—SAND SOLE

YR	Trawl Catch Rate (lb/hr)	Recreational Catch Rate (fish/trip)	Other
70	5.9		
71	7.2		
72	8.1		
73	8.0		
74	11.0		
75	4.3		
76	6.1		
77	5.4		
78	6.4		
79	8.0		
80	8.6		
81	3.0		
82	11.4		
83	9.8		
84	7.6		
85	5.2		
86	5.3		
87	8.8		
88	7.6		
89	4.6		
90	0.0		
91	3.6		
92	0.4		
93	5.8		
94	0.0		
95	0.0		

PRIMARY STOCK INDICATOR

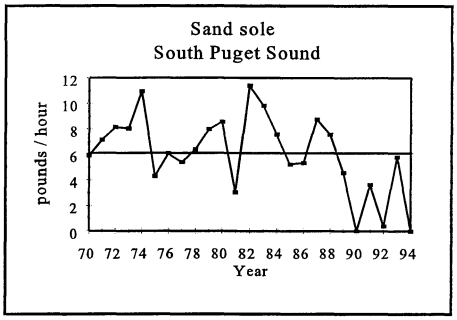


Figure 110. Commercial trawl catch per unit effort and long–term mean.

SECONDARY STOCK INDICATOR

TRAWL SURVEY DATA

South Sound

SAND SOLE	1987	1989	1991
Abundance (N x 1000)	951	1,273	837
Biomass (mt)	193	266	145
Catch (mt)	12	7	2
% Catch / Biomass	6.0	2.7	1.2

STOCK SUMMARY

FISHERY IMPACT
Underutilized
DATA QUALITY
Poor
RECENT TREND (5 Year)
Unknown
STOCK STATUS (2 Year)
Unknown

ACKNOWLEDGMENTS

We thank the numerous reviewers of this document and its earlier drafts. We especially thank James West, Dr. William Clark, Tom Jagielo, Dr. Morris Barker, and Bruce Crawford for their helpful comments. Dale Gombert is thanked for the chart showing the Puget Sound regions. Mel Stanley is gratefully acknowledged for his help in preparing commercial catch information.

This work was supported in part by federal aid to the Sport Fish Restoration Act, administered by the U.S. Fish and Wildlife Service (Project F-110-R, Segments 3 and 4).

LITERATURE CITED

Alverson, D.L., A.T. Pruter, and L.L. Ronholt. 1964. A study of demersal fishes and fisheries of the northeastern Pacific Ocean. Univ. of British Columbia, Inst. of Fisheries (H.R. MacMillan Lectures in Fisheries Series), 190 p.

Bargmann, G.G. 1982a. The biology and fisheries for lingcod (*Ophiodon elongatus*) in Puget Sound. Wash. Dept. Fish. Tech. Rep. No. 66. 68 p.

Bargmann, G.G. 1982b. Recreational angling from piers, docks, and jetties in Puget Sound, Washington, during 1981. Wash. Dept. Fish. Tech. Rep. No. 73. 66 p.

Bargmann, G.G. 1984. Recreational diving in the state of Washington and the associated harvest of food fish and shellfish. Wash. Dept. Fish. Tech. Rep. No. 82. 66 p.

Barker, M.W. 1979. Population and fishery dynamics of recreationally exploited marine bottomfish in northern Puget Sound. PhD. Thesis, Univ. of Washington, Seattle. 134 p.

Clark, W.G. 1986a. Washington's trawl logbook data, past and present. Wash. Dept. Fisheries Prog. Rep No. 228, 62 p.

Clark, W.G. 1986b. Standardization of Washington's historical trawl logbook data. Wash. Dept. Fish Prog. Rep. No. 229.

Day, D.E. 1976. Homing behavior and population stratification in central Puget Sound English sole (*Parophrys vetulus*). J. Fish. Res. Bd. Can 33: 278-282.

Deriso, R.B., T.J. Quinn II, and P.R. Neal. 1985. Catch at age analysis with auxilliary information. Can. J. Fish. Aquat. Sci. 42:815-824.

El Sayed, S.Z. 1959. Population dynamics of English sole (*Parophrys vetulus*, Girard) in Puget Sound, Washington with special reference to problems of sampling. PhD. Thesis, Univ. of Washington, Seattle.

Goni, R. 1988. Comparison of Pacific hake (*Merluccius productus* Ayres, 1855) stocks in inshore waters of the Pacific Ocean: Puget Sound and Strait of Georgia. M.S. Thesis, Univ. Of Washington, Seattle, 104 p.

Gowan, R.E. 1983. Population dynamics and exploitation rates of rockfish (*Sebastes* spp.) in central Puget Sound, Washington. PhD. Thesis, Univ. of Washington, Seattle, 90 p.

Grant, W.S., R. Bakkala, F.M. Utter, D.J. Teel, and T. Kobayashi. 1983. Biochemical genetic population structure of yellowfin sole, *Limanda aspera*, of the North Pacific Ocean and Bering Sea. Fish. Bull. 81:667-677.

Grant, W.S., C.I. Zhang, T. Kobayashi, and G. Ståhl. 1987. Lack of genetic stock discretion in Pacific cod (*Gadus macrocephalus*). Can. J. Fish. Aquat. Sci. 44:490-498.

Gulland, J.A. 1983. Fish stock assessment. A manual of basic methods. J. Wiley and Sons. 223 p.

Gunderson, D.R. 1993. Surveys of fisheries resources. J. Wiley and Sons. 248 p.

Hilborn, R., and C.J Walters. 1992. Quantitative fisheries stock assessment. Chapman and Hall, New York. 570 p.

Hoines, L.J., W.D. Ward, and C. Smitch. 1983. Washington State sport catch report, 1983. Wash. State Dept. Fish. 55 p.

Hollowed, A.B., and W.S. Wooster. 1995. Decadal-scale variations in the eastern subarctic: II. Response of Northeast Pacific fish stocks, p. 373-385. *In* R.J. Beamish [ed.] Climate change and northern fish populations. Can. J. Fish. Aquat. Sci. 121.

Jagielo, T.H., L.L. LeClair, and B.A. Vorderstrasse. 1996. Genetic variation and population structure of lingcod. Trans. Am. Fish. Soc. 125: 372-386.

LaRiviere, M.G. 1981. Lingcod (*Ophiodon elongatus*) populations studies in northern Puget Sound, Washington. M.S. Thesis, Univ. of Washington, Seattle.

Lemberg, N., S. Burton, and W. Palsson. 1990. Hydroacoustic results for Puget Sound herring, whiting, and Pacific cod surveys, 1988 and 1989. Wash. Dept. Fish. Prog. Rep. No. 281. 76 p.

Matthews, K.R. 1990. A comparative study of habitat use by young-of-the-year, subadult, and adult rockfishes on four habitat types in central Puget Sound. Fish. Bull. 88:223-239.

Olesiuk, P.F., M.A. Bigg, G.M. Ellis, S.J. Crockford, and R.J. Wigen. 1990. An assessment of the feeding habits of harbour seals (*Phoca vitulina*) in the Strait of Georgia, British Columbia, based on scat analysis. Can. Tech. Rept. Fish. Aquat. Sci. No. 1730. 135 p.

Palsson, W.A. 1988. Bottomfish catch and effort statistics from boat-based recreational fisheries in Puget Sound, 1970-1985. Wash. Dept. Fish. Prog. Rep. No. 261 (Revised). 104 p.

Palsson, W.A. 1990. Pacific cod (*Gadus macrocephalus*) in Puget Sound and adjacent waters: Biology and stock assessment. Wash. Dept. Fish. Tech. Rep. No. 112. 137 p.

Palsson, W.A. 1991. Using creel surveys to evaluate angler success in discrete fisheries. Am. Fish. Soc. Symp. 12: 139-154.

Palsson, W.A. and R.E. Pacunski. 1995. The response of rocky reef fishes to harvest refugia in Puget Sound. In: Puget Sound Research '95, Vol. 1, pp. 224-234. Puget Sound Water Quality Authority, Olympia.

Palsson, W.A. 1996. Lingcod and rockfish management. 1995 annual Job Performance Report to the U.S. Fish and Wildlife Service. Wash. Dept. of Fish and Wildlife. 40 p.

Parker, K.S., T.C. Royer, and R.B. Deriso. 1995. High-latitude climate forcing and tidal mixing by the 18.6-yr lunar nodal cycle and low-frequency recruitment trends in Pacific halibut (*Hippoglossus stenolepis*), p. 447-459. *In* R.J. Beamish [ed.] Climate change and northern fish populations. Can. J. Fish. Aquat. Sci. 121.

Pedersen, M., and G. DiDonato. 1982. Groundfish management plan for Washington's inside waters. Wash. Dept. Fish. Prog. Rep. No. 170. 123 p.

Pedersen, M., and G. Bargmann. 1986. 1984 supplement for the groundfish management plan for Washington's inside waters. Wash. Dept. Fish. Prog. Rep. No. 247. 60 p.

Quinnell, S., and C. Schmitt. 1991. Abundance of Puget Sound demersal fishes: 1987 research trawl survey results. Wash. Dept. Fish. Prog. Rep. No. 286. 267 p.

Schmitt, C. 1990. Marine fish resources, users, and managers: How are we doing? In: Status and management of Puget Sound's Biological Resources. pp. 118-141, Puget Sound Estuary Program EPA 910/9-90-001. 190 p.

Schmitt, C, S. Quinnell, M. Rickey, and M. Stanley. 1991. Groundfish statistics from commercial fisheries in Puget Sound, 1970-1988. Wash. Dept. Fish. Prog. Rep. No. 285. 315 p.

Schmitt, C., J. Schweigert, and T.P. Quinn. 1994. Anthropogenic influences on fish populations of the Georgia Basin. In: Review of the Marine Environment and Biota of Strait of Georgia, Puget Sound, and Juan de Fuca Strait, pp. 218-252. Canadian Technical Report of Fisheries and Aquatic Sciences No. 1948. 390 p.

Schmitt, C., S. J. Jeffries, and P. J. Gearin. 1995. Pinniped predation on marine fish in Puget Sound. In: Puget Sound Research '95, Vol. 1, pp. 630-637. Puget Sound Water Quality Authority, Olympia.

Smith, R.T. 1936. Report on the Puget Sound otter trawl investigations. Wash. Dept. Fisheries Biological Rep. No. 36B. 61 p.

Smith, P.J., and A. Jamieson. 1986. Stock discreteness in herrings: A conceptual revolution. Fish. Res. 4:223-234.

Tagart, J.V., A. Hoffmann, and T.H. Jagielo. 1996. Biometric review of the Marine Resources Division. Wash. Dept. Fish and Wildlife. 58 p.

Utter, F.M., and H.O. Hodgins. 1971. Biochemical polymorphisms in Pacific hake (*Merluccius productus*). Cons. Int. Explor. Mer., Rapp. Proc. Verb. 161:87-89.

Utter, F.M., and N. Ryman. 1993. Genetic markers and mixed stock fisheries. Fisheries 18:11-21.

Ward, R.D., M. Woodwark, D.O.F. Skibinski. 1994. A comparison of genetic diversity levels in marine, freshwater, and anadromous fishes. J. Fish Biology 44: 213-232.

Ware, D.M., and G.A. McFarlane. 1995. Climate-induced changes in Pacific hake (*Merluccius productus*) abundance and pelagic community interactions in the Vancouver Island upwelling system, p. 509-521. *In* R.J. Beamish [ed.] Climate change and northern fish populations. Can. J. Fish. Aquat. Sci. 121.

Washington Department of Fish and Wildlife and North Sound Treaty Tribes. 1995. 1994 Washigton State baitfish stock status report. Wash. Dept. of Fish and Wildlife. Olympia, Washington. 77 p.

Wildermuth, D.A. 1983. Length-weight regression analysis for thirty-eight species of sport caught marine fishes. Wash. Dept. Fisheries Prog. Rep. No. 189, 7 p.