Washington Contribution to the 2003 Meeting of the Technical Sub-Committee (TSC) of the Canada-US Groundfish Committee

Contributors:

Greg Bargmann
Thomas Jagielo
Wayne Palsson
Kurt Stick
Farron Wallace

Edited by:

Thomas Jagielo
Senior Research Scientist

Washington Department of Fish and Wildlife
Olympia, Washington

May 6-7, 2003

Sitka, Alaska

Review of Agency Groundfish Research, Assessment, and Management

A. Puget Sound Area Activities

1. Puget Sound Groundfish Management *(Contributed by Greg Bargmann (360) 902-2825)*

Pacific Cod Culture

In partnership with National Marine Fisheries Service, WDFW has undertaken a project to develop hatchery culture techniques for Pacific cod. Pacific cod populations in Puget Sound have greatly declined and harvest has been prohibited for several years. In an effort to speed rebuilding of the cod populations, adult cod were captured during the spawning season near Seattle and transferred to the NMFS lab at Manchester, WA. Several of the adults spawned, some on their own volition while others were "stripped" of their eggs and milt. We have had variable hatching success and the young cod (at about 1 month of age) are doing well. These fish will be used for experimental purposes, to test different foods, light intensities and water temperature on survival and growth. If successful rearing techniques can be developed, the intent is to raise the young cod in the hatchery for a short period (<1 yr) and then they will be released into the Sound. A companion genetic study is also being undertaken with samples being collected from Puget Sound, Alaska, and the western part of the Pacific Ocean.

Sixgill Shark

An interagency group has formed to conduct research on sixgill sharks in the northeast Pacific Ocean. This group consists of the Seattle Aquarium, Point Defiance Zoo and Aquarium, University of Washington, and WDFW. Staff of the Vancouver Aquarium participate as they are able. The purpose of the activity is to examine stock structure and local abundance of sixgill shark as well as collect basic biological information needed for management. Public education is also a component. Genetic samples have been collected, as well as neural arches for ageing purposes. Tagging studies are underway. The tags used are circular colored and numbered tags, which are placed on the dorsal fin. Information on any reported sightings of tagged fish would be appreciated. An informal scientific/public workshop on sixgill sharks is being planned for November 2003. The Seattle Aquarium will host the event.

Management of Dogfish Shark

At the request of WDFW staff, the Washington Fish and Wildlife Commission took action to restrict harvest of dogfish shark in Puget Sound. The action taken was to close commercial fishing during the summer months. Based on trawl surveys of abundance and the performance of the commercial fishery, WDFW staff believe that populations of dogfish are declining in Puget Sound. WDFW staff and interested tribal governments are now developing a process to establish annual harvest quotas for dogfish in Puget Sound. Because of the transboundary nature of the dogfish population (freely moving between British Columbia and Washington waters), WDFW is attempting to develop a joint management plan with officials of the Canadian Dept of Fish and

Oceans. To develop an assessment model, the department helped sponsor a graduate level class on Northeast Pacific sharks. We are also starting communications with Canadian managers and stock assessment specialists to develop a model of dogfish management. It appears that WDFW may get a small grant to fund travel to an informal session for DFO and WDFW staff involved with dogfish to meet and develop these ideas.

Derelict Fishing Gear *(Contributed by Mary Lou Mills (360) 902-2834)*
Derelict fishing gear can be found throughout Puget Sound as well as freshwater areas where salmon fishing has occurred. Gear encountered ranges from recreational fishing line and shellfish pots through various types of commercial gear (gillnet, purse seine, trawl gear, shellfish pots, etc.). Much of this gear has the potential to continue killing target and non-target organisms for periods of time that may be counted in years. Fish species affected include groundfish, salmonids. and crustacea.

The gear may present an environmental hazard as well as a potential problem for people who use the area. The total amount of gear and the cumulative impacts from this gear are unknown. Some areas have heavy accumulation of gear with multiple nets located at a single site. WDFW divers find some portions of gear at all rocky habitats surveyed in Puget Sound, with the least impacted sites having only a small piece of webbing or lead line visible.

WDFW in partnership with a variety of state, federal and local organizations developed guidelines for removal of derelict fishing gear. The department is also developing a database of derelict gear locations and will be posting a web-based reporting form. The database will be made available to organizations qualified to undertake removal of the gear. With the participation of WDFW and other organizations, Northwest Straits Commission conducted a removal project to test the guidelines that were under development. The Washington Department of Natural Resources dive staff also removed derelict gear at several sites. WDFW also estimated the total amount of gear south of Admiralty Inlet for the first time based on trawl, dive and video surveys.

2. Puget Sound Groundfish Monitoring, Research, and Assessment *(Contributed by Wayne Palsson, Marine Fish Science Unit (425) 379-2313, palsswap@dfw.wa.gov)*

Many of the groundfish staff have recently been organized into a newly created Marine Fish Science Unit (MFSU). The Puget Sound staff of this unit includes Wayne Palsson, Robert Pacunski, Tony Parra, Dick Mueller, and Jim Beam. Their tasks are supported by supplemental funds from the Washington State Legislature for the recovery of Puget Sound bottomfish populations. The staff is also associated with the Puget Sound Ambient Monitoring Program (PSAMP) and is tasked by the Puget Sound Action Team. Reductions in spending during 2002 resulted in the loss of one staff position and associated expenses.

The main activities of the unit include the assessment of bottomfish populations in Puget Sound and the evaluation of bottomfish in marine reserves. In addition, a new grant was received to examine the role of ecological succession and predation in new and old reserves.

Puget Sound Marine Habitat Studies

As reported in the 2001 TSC report, Robert Pacunski and Wayne Palsson analyzed quantitative video fish and habitat data and wrote and presented a paper entitled "Macro- and Micro-habitat Relationships of Adult and Sub-adult Rockfish, Lingcod, and Kelp Greenling in Puget Sound" at the 2001 Puget Sound Research Conference. This paper was published in 2002 in the conference proceedings (www.wa.gov/puget_sound) and is based upon video observations made during previous video surveys and provides a model of habitat usage based upon substrate, relief, and complexity habitat variables.

Wayne Palsson is collaborating with Professor Gary Greene and his students who are mapping the western San Juan Archipelago with a multi-beam echosounder. A grant has been funded by NOAA's Center for Coastal Services to further augment surveys collecting detailed bathymetric and backscatter data (Figure 1). As maps are developed and habitats are identified, trawl, video and ROV surveys will be correlated with fish abundance. Robert Pacunski and Jim Beam collaborated with Greene and Janet Tilden in an ROV survey funded by the National Undersea Research Program with the purpose of examining specific identified habitats and the associated fish fauna.

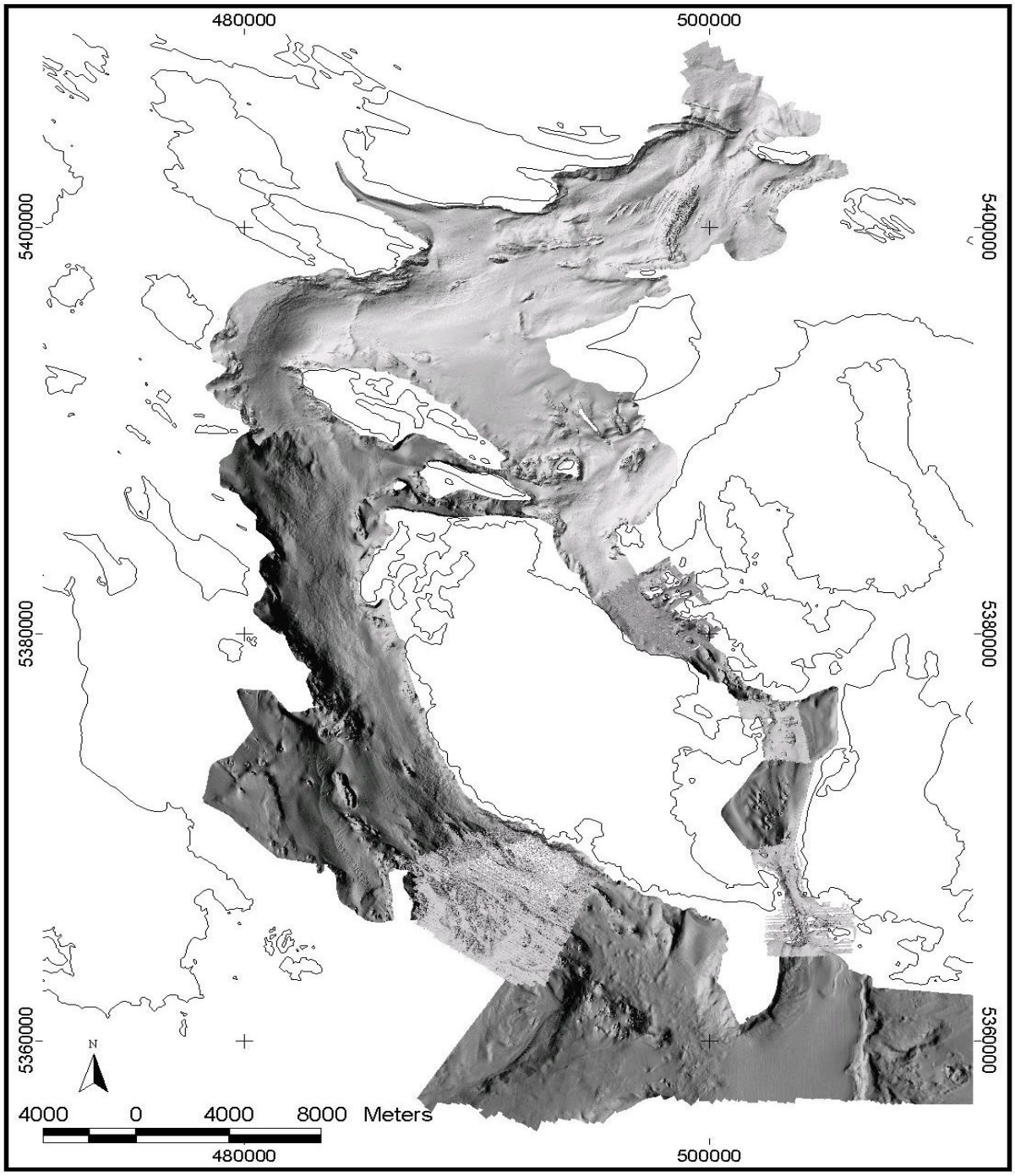

Figure 1. Preliminary map of the western San Juan Archipelago depicting backscatter data from multibeam surveys (Courtesy of Gary Greene, MLML).

Evaluation of No-Take Refuges for Reef Fish Management

WDFW has developed a system of 18 fully and partially protected marine reserves in Puget Sound (Figure 2). As the system has expanded, MFSU staff has developed a plan to monitor a core series of the marine reserves on a frequent basis and visit other subtidal reserves on a

periodic basis. This plan builds upon field research at many of these sites that was begun as early as 1986. The field work primarily consists of scuba divers conducting visual censuses along strip transects. Along with estimating fish density, divers measure individual fish and in the case of lingcod, quantify nesting activity.

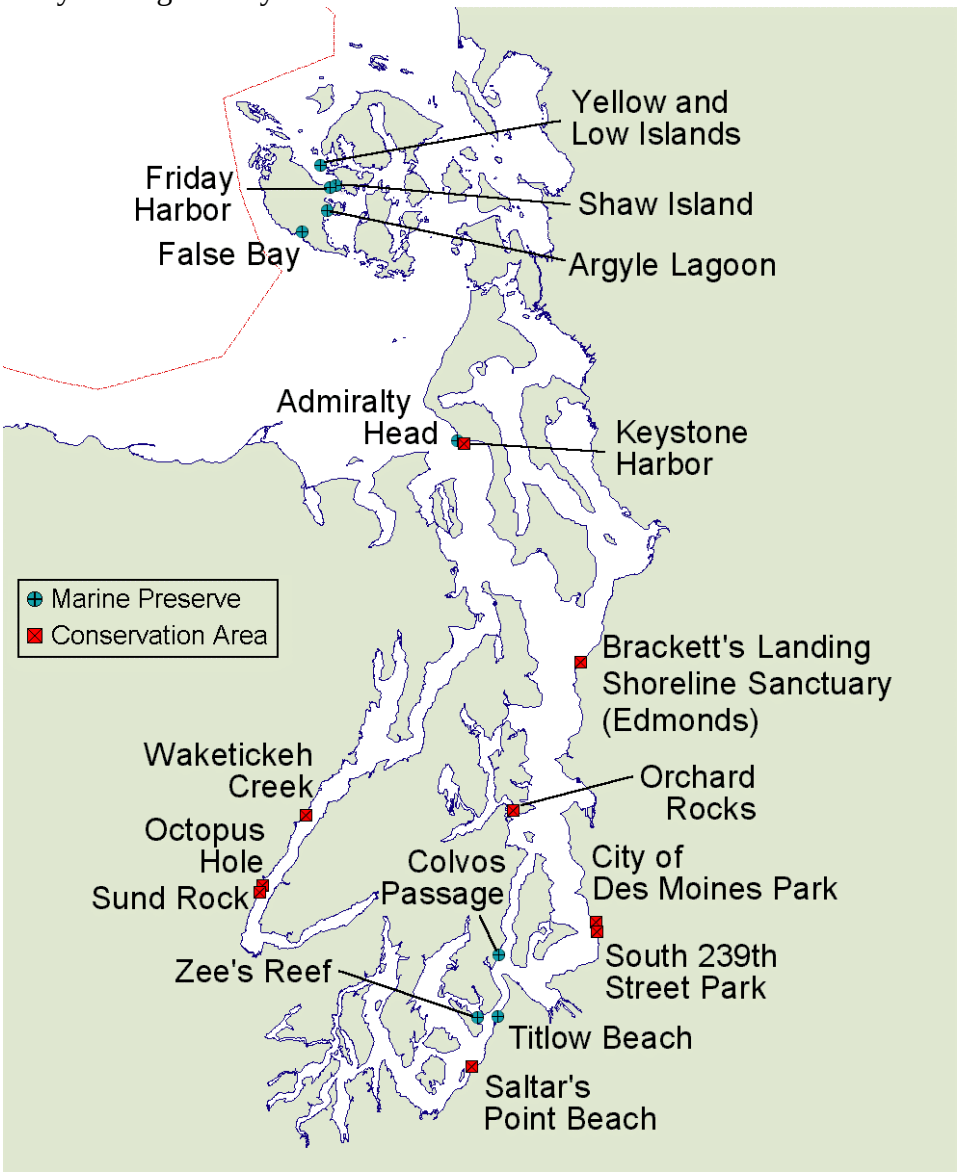

Figure 2. WDFW non-tribal marine reserves in Puget Sound. Conservation Areas are fully-protected, Marine Preserves are partially-protected.

Specific monitoring activities in 2002 included surveying many of the Puget Sound reserves and comparable fished sites. Several reserves in central Puget Sound were visited six times during 2002 as an extension of a study initiated in 1999 that takes advantage of the previous information collected at Orchard Rocks. This site was declared as a fully-protected reserve in 1998 but was a fished site monitored in 1986, 1987, and from 1995-1997. With the addition of a new fished site treatment at Point Glover, the newly created refuge in a formerly monitored fished area is an excellent opportunity to evaluate the before and after impacts of refuge creation with a comparable fished site treatment. WDFW also created several new reserves in 2002. These

included subtidal reserves at Admiralty Head and Keystone Jetty in Admiralty Inlet and Zee's Reef in Southern Puget Sound. Monitoring was initiated at Zee's Reef with six surveys conducted in 2002. The reserve at Colvos Passage was also monitored during the same survey series.

To date, results from reserve monitoring has shown greater densities of copper rockfish and lingcod at the long-term reserve at Edmonds (Brackett's Landing) compared to nearby fished sites. At other reserves, the results are mixed. At Orchard Rocks, the central Sound reserve created in 1998, there has not been any increase in copper rockfish abundance, but lingcod abundance has increased. In Hood Canal, where the existing reserves amount to almost 20% of the available nearshore rocky habitat, increasing sizes of copper rockfish have been observed since 1996 at a site set aside as a reserve in 1994. However, recent comparisons among fished and reserves sites has found similar size compositions between reserve and fished area treatments. The densities of copper rockfish are significantly greater in the Hood Canal reserves than the nearby fished area. In the San Juan Islands, rockfish and lingcod densities in the reserves are also greater than at nearby fished areas, but there have not been any discernable trends in size or density for copper rockfish over a span of ten years of monitoring and 12 years after reserve creation. For lingcod at these sites, the winter-time densities are substantially greater than in fished areas, but densities in both reserve and fished area treatments have been increasing.

Several major changes have occurred at the Edmonds reserve. The study site once harbored a large school of large copper rockfish that accounted for a high estimated reproductive advantage for the long-term reserve compared to fished areas. Since 1999, this school has disappeared with a resulting decrease in the density of copper rockfish at the site. During the same period, lingcod abundance has dramatically increased simultaneously with the decline in copper rockfish. While a number of competing hypotheses can not be ruled out to explain these patterns, the shift to a site dominated by large piscivores may reflect a shift in the trophic dynamics of the reserve. Co-incidentally, a new study on the ecological succession and trophic dynamics in Puget Sound reserves was initiated in 2002. With major funding from the Conservation and Re-investment Act Fund, administered by the U.S. Dept. of the Interior, the MFSU will take advantage of the new and old reserves within Puget Sound. In a comparison of these reserves, marine fish scientists will collect new information on forage and non-game marine species abundances to complement the abundance studies of lingcod, rockfish and larger species already in progress. Comprehensive information on fish communities and predator-prey relationships will be collected and modeled to test for any trophic cascade patterns that are suspected to occur as large predators re-populate older reserves. This project is anticipated to last for three years.

The results from the rocky reef refuge studies and quantitative video surveys in Puget Sound have been useful to begin planning a refuge network for Puget Sound. Wayne Palsson wrote and presented a paper entitled "The Development of Criteria for Establishing and Monitoring No-take Refuges for Rockfishes and Other Rocky Habitat Fishes in Puget Sound" at the 2001 Puget Sound Research Conference and this paper was published in the conference proceedings in 2002 (www.wa..gov/puget_sound).

Wolf-eel Life History SCUBA Surveys

Field work was concluded in 2002 on a study of wolf-eel *Anarrhichthys ocellatus* in Puget Sound. While this is an identified species managed under the Puget Sound Groundfish Management Plan (Palsson et al. 1998), little is known about their life history, population status, or vulnerability to fishing. As a result of this study, the Fish and Wildlife Commission closed the harvest of wolf-eel in all Puget Sound waters. The basic study was initiated at two sites in South Puget Sound known to have wolf-eel colonies. Scuba transects were established at each site and individual den locations mapped. These sites at Day Island and Sunrise Beach, lie at the southern and northern ends of the Tacoma Narrows, respectively, and are separated by a distance of approximately 7 nautical miles. A monthly dive schedule was developed to gain information on den occupancy, consistency of counts, and basic biological observations. Individual wolf-eels were anesthetized with clove oil and marked by implanting visible elastomer tags *in-situ* in the lip region of the animal. In addition, naturally occurring marks were used to identify non-tagged fish. During the survey dives, 35 mm still and digital video cameras were used to capture high quality images of both tagged and non-tagged wolf eels. These spotting patterns around the eyes of wolf eels along with scars and color are unique and were used as natural marks to identify individuals. By identifying individual animals it was possible to track den and mate fidelity during the year and among spawning seasons.

The methods and interim results were presented by Tony Parra in a paper titled "Abundance, Mate, and Den Fidelity of Wolf-eel (*Anarrichthys ocellatus*) in Puget Sound, Washington which was published in the conference proceedings in 2002 (www.wa.gov/puget_sound). Differences in mate fidelity between sites were observed for the over two years, with wolf-eels at Day Island exhibiting lower fidelity rates than those at Sunrise Beach. We observed a considerable decline in mate and den fidelity through subsequent spawning seasons at both survey sites. Only one of the original eight pairs that were observed at the beginning of the study remained together and five of twenty-one individuals remained in the same den throughout the duration of the study. Our results contrast with total mate and site fidelity resulting from captive observations and the generally accepted belief that wolf-eels mate for life. Factors that may contribute to a decline in mate and site fidelity of wolf-eels include the harvest management of competing and prey base species. Pacific giant octopuses have been observed displacing wolf-eels from their dens and we have observed evidence of such occurrences at our study sites.

There were no significant changes in the seasonal or inter-annual abundance of wolf-eels for twenty-five dens observed throughout the study period. Immigration rates have approximated emigration rates at both sites, but overall, they appear to be low. There were only four juvenile recruits to the study sites. All juveniles were found in small crevices and were the only inhabitants observed in these dens during the study.

Puget Sound Groundfish Stock Assessments

MFSU staff regularly assesses the status of the 20 groundfish species in Puget Sound. Stock assessments are based upon catch, effort, and biological information obtained from recreational and commercial fisheries or from surveys and special studies focusing upon key resources. In 1997, WDFW issued the 1995 Status of Puget Sound Bottomfish Stocks (revised) (Palsson et al.,

1997) that described the status and trends for 18 species or species groups of bottomfish. When sufficient and appropriate fishery or survey data were available, recent measures of stock abundance were compared to long-term means, and these comparisons were categorized into above average, average, below average, depressed, and critical measures of stock status. These stock status categories correspondingly range from populations that are healthy to populations that have poor productive capacity.

Table 1. 2002 Status of Groundfish Populations In Puget Sound.

Species	North Sound	South Sound
Spotted ratfish	Below avg.	Above avg.
Spiny dogfish	Depressed	Depressed
Skates	Above avg.	Depressed
Pacific cod	Below avg.	Critical
Walleye pollock	Above avg.	Critical
Pacific whiting (hake)	Unknown	Critical
Rockfishes	Depressed	Depressed
Lingcod	Below avg.	Above avg.
Sablefish	Below average	
Greenlings	Above avg.	Above avg.
Sculpins	Above avg.	Above avg.
Wolf-eel	Unknown	Average
Surfperches	Below avg.	Depressed
English sole	Above avg.	Below avg.
Rock sole	Average	Average
Starry flounder	Above avg.	Average
Dover sole	Depressed	Depressed
Sand sole	Average	Above avg.
Pacific halibut	Above average	
Other groundfish	Average	Below avg.
No. of Healthy Stocks	10	9
No. of Poor Stocks	8	11

A new summary of the stock assessments was published in the Puget Sound Update 2002 (www.wa.gov/puget_sound), a document summarizing the status of the marine resources of Puget Sound and published by Washington State's Puget Sound Action Team. The new assessment found a slight improvement in the status of Puget Sound groundfish stocks and that roughly half are in good condition and half are in poor condition (Table 1). This contrasts with previous findings that the majority of assessed groundfish populations were in poor condition. Several populations are still in depressed or critical condition including cod, pollock, whiting, rockfish, dogfish, skates, surfperches and Dover sole in South Sound and dogfish, rockfishes, and Dover sole in North Sound.

Quantitative Video Surveys for Assessing Rocky Habitat Fishes

With funds from the Washington State Legislature, the rocky habitats in the central and southern basins of Puget Sound were surveyed for lingcod and rockfish using a quantitative video camera. The survey was originally designed as the Video-Acoustic Technique (VAT) that consisted of a quantitative video camera to survey fishes within 2 m of the bottomfish and a scientific echosounder to survey fishes in the water column above rocky habitats. Beginning in 2002, the acoustic portion of the survey was dropped because of spending reductions. During 2002, staff processed video tapes obtained from the 2001 video surveys from the main and southern Puget Sound basins.

Analysis of video data collected in the past and the estimation of population abundance have been limited by difficulties in estimating the visual range of video plots. Comparisons between observers and with previous determinations of the visual range have resulted in differences between 0.5 m and 1.5 m. The addition of lasers to the video sampling has aided in the determination of near field visual ranges, but the lasers are not as useful in determining the far edge of the plots. MFSU staff is working on developing better criteria for the estimation of the radius of circular video plots in comparison to underwater measurements.

Hood Canal Video Survey of Rocky Habitats

During the summer of 2002, Robert Pacunski led a quantitative survey of the nearshore rocky habitats of Hood Canal. The survey personnel also included Jim Beam and Tony Parra. Two student interns, Matt Barnhardt and Andy Olson, from the Evergreen State College provided critical help to make the survey possible. The survey was conducted from 25 July to 5 September 2002 in the Hood Canal Management Region. The survey utilized a stratified-random design as the sampling framework, where habitat quality was the stratification variable. Based on the results and timely completion of the initial "High/Low" stratified survey, a second "high-quality habitat" survey was conducted to increase the sampling effort in a selected number of reef habitats in Hood Canal.

The initial survey planning relied heavily on GIS technology for the development of the sampling framework. GIS coverages of the shoreline and bathymetric contours were used to delineate the nearshore zone of Hood Canal, defined as all sub-tidal habitat less than 120' depth (mllw). These habitats were identified during the initial planning phase based on the results of the previous VAT and diving surveys conducted in the region, as well as through consultation with WDFW geoduck biologists who have conducted extensive diving surveys in the area. The area within the nearshore zone was separated into three strata, High, Low, and Absent, based on known or expected habitat quality. Areas within the High stratum included previously surveyed reef habitats, reef habitats known to exist but never surveyed, and areas where it was suspected that reef habitat would exist. The Low stratum included areas where small amounts of reef habitat where known to exist (e.g., scattered small boulders or other small isolated structures) but were spread over a large geographic area. The Absent stratum consisted of habitats that has no or little chance of containing rocky habitat and was the primary nearshore stratum. Discrete sampling polygons were constructed in ArcView for each stratum and overlaid with a 10 m x 10 m grid. The resultant High and Low stratum grids created in ArcView contained 24,544 cells and

138,400 cells, respectively. Because the Low stratum contained extensive area that project staff considered likely to be "non-reef" habitat, a pre-survey of the Low stratum was conducted using the VAT camera system and the echosounder on the survey vessel R/V *Molluscan* in order to remove as much unsuitable habitat as possible from the survey frame. The pre-survey resulted in the removal of over 90% of the original 138,400 cells (which were reassigned to the Absent stratum), leaving only 13,255 cells in the Low stratum. Based on the amount of time available for conducting the survey, staff concluded that it would be possible to sample a total of five hundred cells within the High and Low strata. In order to concentrate sampling in the highest quality habitats, four-hundred and fifty cells were randomly selected for sampling within the High stratum, while only fifty cells were randomly selected for sampling within the Low stratum.

The camera deployment location for each cell was designated as the cell centroid, as calculated in ArcView. Per standard VAT protocols, the R/V *Molluscan* was navigated to the deployment site and the camera platform was lowered to the bottom. Upon achieving a stable and upright position on the bottom, a minimum of three 360 degree camera sweeps were accomplished at each sampling station. The camera platform was then retrieved and the vessel transited to the next deployment location. All deployments were recorded on Digital Hi-8 videotape for later laboratory analysis.

Upon completion of the High/Low stratum survey, and based on the knowledge that much of the High stratum sampling occurred over non-reef habitat, project staff concluded that sufficient sampling time remained for conducting a secondary survey focusing on the "higher-quality" reef habitats in Hood Canal. Due to the substantial distances involved and coupled with the knowledge that almost no high-quality reef habitat exists east of the Toandos Peninsula or north of Port Gamble, the secondary "High-habitat" survey was designed to sample only those reef habitats south of Pulali Point in Dabob Bay. The utility of the High-habitat survey would be to provide staff with an additional data set that could be used for variance testing against the original survey data set, and for the development of more detailed habitat maps for future survey planning.

Prior to conducting the High-habitat survey, project staff spent several days mapping the known reef habitats in central Hood Canal, including the artificial reefs at Misery Point and Union, as well as several suspected reef sites not included in the original High/Low stratum survey. This process resulted in the exclusion of much of the originally suspected High stratum habitat and the inclusion of several more potential reef habitat areas. A new 10 m x 10 m grid was constructed for the identified High-habitat areas that contained 1,178 cells, from which 125 cells were randomly selected for sampling.

Sampling began on 25 July 2002 and concluded on 5 September 2002. Four-hundred and thirty-eight stations in the High stratum and fifty stations in the Low stratum were sampled during the originally planned High/Low survey. Of the 125 cells selected for sampling in the secondary High-habitat survey, 118 deployments were completed as planned, with 11 deployments conducted on Triton pinnacle at depths ranging from 100 to 160 feet. A total of 55 hours of videotape was collected during the High/Low stratified survey and the High-quality habitat

survey. While no videotapes have been reviewed thus far, some general comments can be made regarding the results of both surveys.

Several species of rockfish were encountered during the survey, including, copper, quillback, black, yellowtail, canary, and possibly vermillion rockfish. In nearly all of these observations, rockfish were closely associated with reef habitats. Lingcod were also seen during the survey, although the encounter rate for this species was much lower than for the rockfishes. Additional fish species observed included shiner perch, kelp perch, striped seaperch, pile perch, wolf eel, kelp greenling and white-spotted greenling. It is expected that the videotape review process will be completed in the fall of 2003.

Tacoma Narrows Lingcod Monitoring

Lingcod in south Puget Sound are assessed, in part, by using the results of a creel survey of bottomfish anglers fishing at the Tacoma Narrows for lingcod. This creel survey, developed under the auspices of previous Sportfish Aid projects, has provided consistent and precise estimates of catch per unit effort, total catch, and effort (Palsson 1991). The creel survey consists of boat counts at a designated fishing area (an artificial reef composed of anchors and debris from a previous bridge) as measures of total effort and a corresponding creel survey at major access points. The survey is stratified by periods of spring and neap tidal exchange and by weekends and weekdays. The fishery takes place on the historic remains of the first Tacoma Narrows which was torn apart during a storm.

The 2002 lingcod fishery at Tacoma Narrows showed the lowest participation and success ever estimated (Table 2). Angler trips dwindled to 437 taken during the six-week fishery compared to almost twice that estimate during the previous year. These anglers harvested only 24 lingcod during the fishery with the lowest rate of fishing success rate ever estimated of 0.05 lingcod per bottomfish trip. Although the trend in fishing success and inferred abundance from the Tacoma Narrows fishery has been relative stable during the past fifteen years, the recent fishing success is a sign of concern. The recent declining trend is in contrast to a recent increasing trend estimated from the WDFW general survey of Puget Sound anglers. One factor that may have influenced the fishery was restrictions for approaching the bridge piers implemented and enforced by the US Coast Guard for the purpose of national security. The lack of access to the bridge site may have precluded anglers from fishing on prime habitat in the proximity of the bridge piers.

Table 2. Catch, Effort and Catch Rate Estimates from the Tacoma Narrows Lingcod Fishery

	Bottomfish Anglers			Scuba Fishers		
Year	Trips	Catch	CPUE	Trips	Catch	CPUE
1983			0.27			0
1984			0.33			0.50
1985			0.43			0.63
1986	1927	928	0.42	259	178	0.69
1987	2948	1085	0.37	175	104	0.59
1988	1940	428	0.22	280	121	0.43

1989	1661	385	0.23	171	124	0.72
1990	1479	291	0.20	133	57	0.43
1991	1333	217	0.19	291	220	0.76
1992	500	105	0.21	29	19	0.65
1993	1483	288	0.19	86	25	0.29
1994	1673	297	0.18	175	107	0.66
1995	1498	395	0.26	177	75	0.43
1996	1296	139	0.12	138	97	0.70
1997	843	168	0.20	80	80	1.00
1998	691	118	0.17	156	106	0.68
1999	483	44	0.09	29	29	1.00
2000	813	131	0.16	0	0	0
2001	865	153	0.18	38	25	.67
2002	437	24	0.05	13	13	1

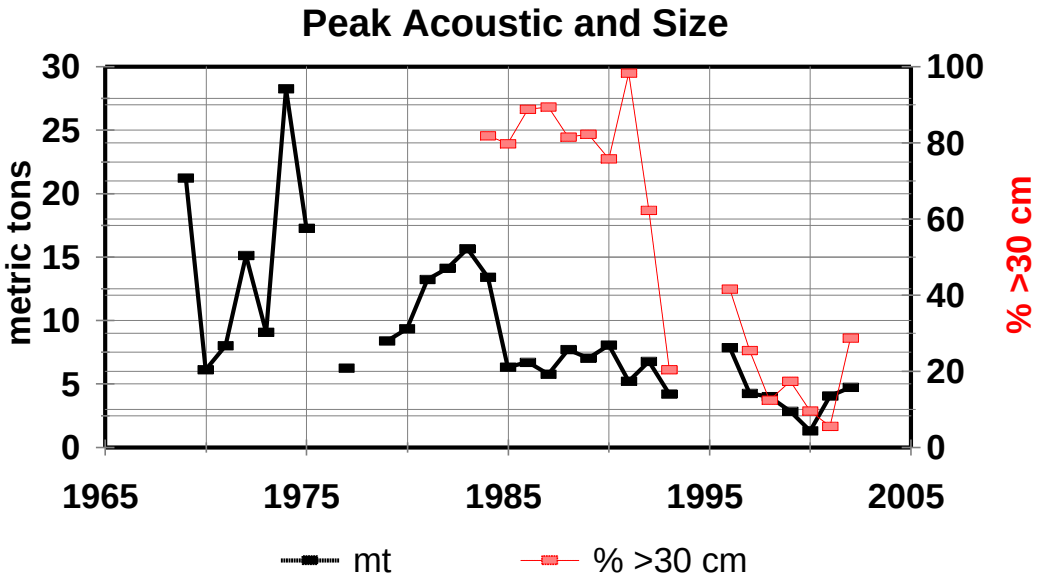

Figure 3. Acoustic estimate of Port Susan whiting and percent of estimate greater than 30 cm.

Acoustic-Trawl Surveys for Pacific Whiting (Hake)

Pacific whiting in Puget Sound remain as a candidate species under the terms of the Endangered Species Act and are in critically depressed condition in South Sound. Since the 1980s, WDFW has conducted a fishery-independent survey of the Pacific whiting (*Merluccius productus*) population that spawns in Port Susan near Everett, Washington. This population was once assessed at over 16,000 mt during the early 1980s and may have been in excess of 20,000 mt. During these early years, the whiting resource provided for an intense commercial trawl fishery in the 1970s and 1980s. Declining populations in the late-1980s resulted in a fishery closure, but

acoustic-trawl surveys found that the population continued to decline and that large fish were becoming rare (Figure 3). The dramatic decline and low population observed during the late 1990s prompted an ESA petition in 1999 and the resulting biological review left it as a candidate species pending further genetic studies to delineate the distinct population segment (Gustavson et al. 2000). In July 2002, funds supporting the assessment of whiting were eliminated.

On March 5, 2002, groundfish staff conducted the last acoustic and mid-water trawl surveys to assess Pacific whiting abundance in Port Susan and Possession Sound for the foreseeable future. The 2002 survey estimate was 4,700 mt for whiting for all surveyed areas, an estimate that was comparable to the 4,100 mt, estimated in 2001. These estimates are higher than the 2000 estimate of 1,200 mt that was the lowest estimate ever recorded. The most recent estimates have returned to the range of most total whiting estimates since 1993 but are substantially lower than the high population estimates prior the early 1980s.

The proportion of large fish in the population increased during 2002. Whiting greater than 30 cm accounted for less than 20% of the population during the recent years but then increased to almost 30% in 2002. As in recent years, most of the large whiting were in the Possession Sound area where this portion of the population has apparently increased. Whiting in Port Susan once matured at 30 cm, but since the early 1990s, whiting mature at 21 cm (Gustavson et al. 2001). Of interest was the observation of large and reproductively ripe fish in Saratoga Passage during the spring bottom trawl survey during 2002. This suggests the whiting population may have shifted spawning locations and timing from the winter time spawning aggregations typically observed in Port Susan during the early years when the population was at its peak.

While the total abundance of whiting has returned to the levels observed since 1993, the recent population levels are less than half of average abundance estimated between since 1982. Current spawning stock biomass is likely far less than 50% of unfished spawning biomass, since the abundances estimated during the 1980s are of heavily exploited populations. Acoustic estimates for years prior to 1982 were typically greater than 15,000 mt per year when large spawning fish dominated the population and unfished spawning biomass was likely higher before intensive fisheries were directed at whiting during the 1970s. The shift in length-at-maturity from 30 cm to 21 cm and potential shifts in spawning timing and location are alarming characteristics of stressed populations. The complete fishery closure must continue and all steps to remove or minimize fishing and other stressors are required especially since WDFW is not actively assessing the population.

Acoustic Surveys of Pacific Cod in Agate Passage

Pacific cod (*Gadus macrocephalus*) once aggregated in the waters between Bainbridge Island and the Kitsap Peninsula during the winter and were in spawning condition. An intense recreational fishery once targeted these fish resulting in high catches during the 1970s and early 1980s. However, the success of the fishery diminished during the late1980s, and WDFW undertook to assess the population in the late 1980s with scientific echosounding equipment. These acoustic surveys were successful in detecting concentrations of fish sign that were likely Pacific cod (Lemberg et al. 1990). In 1996, the acoustic survey was re-initiated with newer echosounding equipment. The potential spawning area is synoptically surveyed on one night during the period

that corresponded to the peak fishery period (Palsson 1990). In 2002, the acoustic survey was conducted on February 15th, but as in every year since 1996, there were no acoustic targets resembling the targets observed during the 1980s. There is little indication that cod are recovering in the main basin of Puget Sound. The financial support for this survey was ended in July 2002, and the survey will be discontinued for the foreseeable future.

Spiny Dogfish Assessment

The declines dogfish estimates observed in trawl survey and fishery indexes of abundance prompted a special review of spiny dogfish in the northern and southern areas of Puget Sound. A draft assessment is under review and concludes that given the long-lived demographic characteristics of dogfish, precautionary management for this species warrants conservative harvest guidelines. Canadian studies have found that female dogfish mature at 35 years and 85 cm. Dogfish can also live to 100 years. Since the commercial fishery targets larger dogfish, estimated yields are particularly low and harvests of 2% per year or less are required to keep the population stable. Further yield per recruit modeling is being conducted and special surveys are being considered to corroborate the results of the assessment.

2002 Bottom Trawl Survey of Puget Sound and Adjacent Basins

With support of the PSAMP, sufficient resources were pooled with Supplemental Recovery Funds to stage and execute an extensive survey of benthic fish populations in the central and southern basins of Puget Sound, Hood Canal, and the Whidbey Basin. These areas were previously surveyed between 1995 and 1996. The synoptic survey of 2002 provided the basis to estimate groundfish biomass with high sampling effort. There were 25 charter days of sampling during which 128 bottom trawl samples were conducted. Preliminary results show that English sole populations appear to have recovered from an earlier declining trend but that Pacific cod and spiny dogfish populations are still in poor condition.

2001 Bottom Trawl Survey of Puget Sound and Adjacent Basins

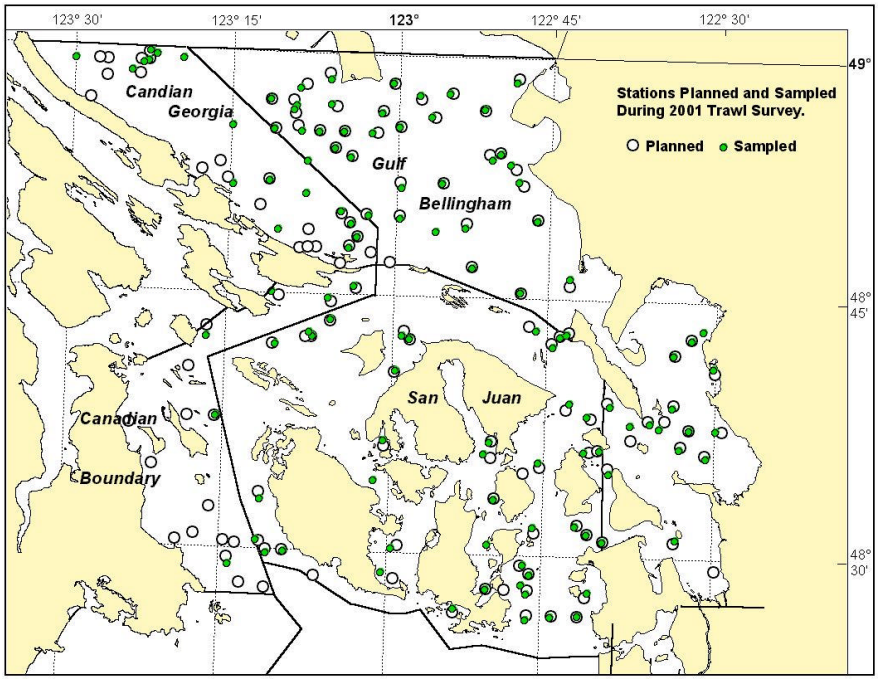

Figure 4. Actual and planned bottom trawl stations for the 2001 bottom trawl survey.

The results from the bottom trawl survey in the Strait of Georgia and San Juan Archipelago conducted in 2001 were analyzed and drafted into a report. These areas encompass the northern reaches of Washington's inside marine waters and are confluent with the southern reaches of British Columbia's inside marine waters. During May and June 2001, a synoptic survey of the southern Strait of Georgia, San Juan Archipelago and adjacent waters was conducted in the transboundary waters of Washington and British Columbia. The survey was designed to estimate the numerical and biomass abundances of key benthic species, identify population trends, and quantify the impact of fisheries. The 2001 survey was also designed to describe the distribution of key commercial fishes that inhabit the Strait of Georgia, San Juan Archipelago and adjacent waters. The survey was also designed to determine which species are likely to move between Washington and British Columbian waters and which species are vulnerable to fisheries on either side of the border.

Standard trawl survey methodology was used to design the stratified random survey. A 400 mesh Eastern Trawl was towed by a chartered fishing vessel. The bottom trawl was fitted with a codend net liner with a 3 cm mesh opening, and the trawl was towed at predetermined stations for approximately10 minutes. The survey was stratified by country and by five depth strata: 5-20 fathoms, 21-40 fm, 41-60 fm, 60-120 fm, and >120 fm. A total of 115 trawl samples were collected in the 2,313 km^2 survey area (Figure 4). Fifty stations were sampled the in the 876 km^2 Washingtonn Strait of Georgia, 19 samples were collected in the 361 km^2 of the B.C. Strait of Georgia, 40 samples in the 864 km^2 San Juan Archipelago, and 6 samples in the 274 km^2 Canadian Haro Strait. The two most shallow strata were not sampled in BC waters due to extensive rocky habitats or a lack of time.

Ninety identifiable species of fish were collected during the trawl survey of the four regions. Sixty-seven species of fish were collected in the Washington Strait of Georgia, and 43 fishes were collected in the BC Strait of Georgia, 65 species were collected in the San Juan Archipelago, and 30 species were collected in the B.C. Haro Strait and Boundary Pass. An estimated 112,108 individual fish were caught during the trawl survey, and they weighed 18 mt.

There was an estimated population of 251.3 million fish weighing 39,535 mt living in the southern Strait of Georgia and Archipelago. Washington contained 220 million bottomfish while B.C. had 31 million. The B.C. bottomfish resource constituted an estimated 8,811 mt while the Washington resource weighed an estimated 30,723 mt.

Spotted ratfish was the most abundant taxon of any region surveyed. They comprised almost 40% of the fish in the WA Strait of Georgia, and almost 60% of the deep waters surveyed in the BC Strait of Georgia. Ratfish made up almost half of the San Juan Archipelago fish populations and almost 70% of the BC Haro Strait and Boundary Pass. Flatfish as a group was the second most dominant species group in WA and BC Strait of Georgia while other species contributed together to form the third most common group in these waters. Dogfish was the third most abundant species in the San Juan Archipelago and the second most abundant fish in the BC Haro Strait and Boundary Pass.

Biomass and numerical abundance estimates and occurrence patterns were presented for key species including spiny dogfish, spotted ratfish, Pacific cod, walleye pollock, Pacific whiting (hake), lingcod, English sole, rock sole, starry flounder, Pacific sanddab, sand sole, Dover sole, Dungeness crab, and spotted prawn. Overall, biomass in the WA Strait of Georgia has been relatively stable (Figure 5) and the point estimate is comparable to that of the 1987 survey and greater than biomasses estimated in 1989 and 1991.

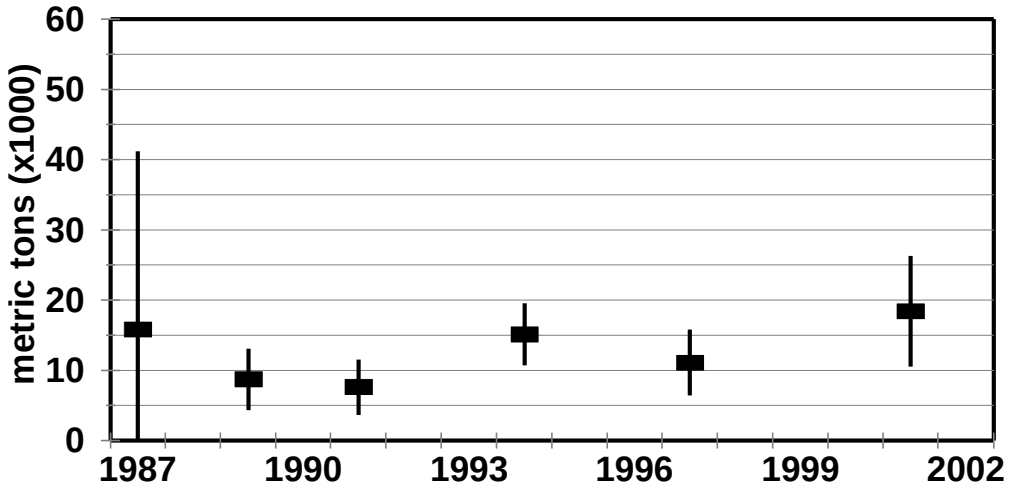

Figure 5. Total fish biomass (mt) and 95% confidence intervals estimated in the Washington Strait of Georgia bottom trawl surveys.

Literature Cited:

Gustafson, R.G., W.H. Lenarz, B.B. McCain, C.C. Schmitt, W.S. Grant, T.L. Builder, and R.D. Methot. 2000. Status review of Pacific hake, Pacific cod, and walleye pollock from Puget Sound, Washington. NOAA Technical Memorandum NMFS-NWFSC-44, 275 p.

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

Palsson, W.A. 1991. Using creel surveys to evaluate angler success in discrete fisheries. American Fisheries Society Symposium 12: 139-154.

Palsson, W.A., J.C. Hoeman, G.G. Bargmann, and D.E. Day. 1997. 1995 status of Puget Sound bottomfish stocks (revised). Washington Department of Fish and Wildlife Report No. MRD97-03, 98 p.

Palsson, W.A., T.J. Northup, and M.W. Barker. 1998. Puget Sound groundfish management plan. Washington Department of Fish and Wildlife, 43 p.

3. Puget Sound Forage Fish Monitoring and Assessment

Herring Stock Assessment *(Contributed by Kurt Stick (360) 466-4345 ext 243)*
Herring spawning biomass estimates were completed for nineteen spawning grounds in Puget Sound and two coastal grounds in 2002. Field work for the 2003 spawning season is in progress. Spawning biomass is estimated for each area by spawn deposition surveys and/or acoustic-trawl surveys.

The estimate of herring spawning biomass in 2002 for all Puget Sound areas combined (over 17,000 tons) was the largest observed in the last ten years. Estimated spawning biomass in 2002

for most populations that spawn in south or central Puget Sound (including Hood Canal) met or exceeded the previous 25 year mean. North Puget Sound spawning populations exhibited mostly average abundance; the notable exception continues to be the Cherry Point stock, which remained critically low in 2002. The Discovery Bay herring stock is the only other traditionally significant herring population in Puget Sound that is considered to be currently at a depressed or critical level of abundance.

Limited spawn deposition survey effort in Grays Harbor and Willapa Bay in 2002 provided spawning biomass estimates that were similar to recent years' results. The herring spawning biomass observed in the last several years in these coastal areas appears to be relatively high.

Washington State herring spawning biomass estimates, 1993 - 2002:

HERRING SPAWNING BIOMASS ESTIMATES (SHORT TONS) BY STOCK AND REGION, 1993-2002.
(blanks indicate no surveys done that year)

	YEAR									
	2002	**2001**	**2000**	**1999**	**1998**	**1997**	**1996**	**1995**	**1994**	**1993**
Squaxin Pass	3150	1597	371	474	68	149	374	157	225	596
Wollochet Bay	106	133	142							
Quartermaster Harbor	416	1320	743	1257	947	1402	805	2001	1412	1075
Port Orchard-Port Madison	878	2007	1756	2006	489	360	806	863	424	304
South Hood Canal	166	187	140	516	101	226	239			
Quilcene Bay	2585	2091	2426	2464	1152	465	328	817		
Port Gamble	1812	1779	2459	1664	971	1419	2058	3158	2857	1522
Kilisut Harbor	784	612	107	802	311	307	380		292	538
Port Susan	1356	587	785	545	2084	828	110	363	365	1693
Holmes Harbor	573	275	281	175	464	530	336			
Skagit Bay	2215	2170	646	905	209	893	736	891		
South-Central Puget Sound Total	14041	12758	9856	10808	6796	6579	6172	8250	5575	5728
Fidalgo Bay	865	944	737	1005	844	929	590	1173	1207	1417
Samish/Portage Bay	496	470	196	555	643	509	636	194	459	198
Int. San Juan Is.	158	219	128	197		30	277			472
N.W. San Juan Is.	131	62	90		107	79	53			
Semiahmoo Bay	1012	1098	926	868	919	621	1219	1245	1389	1902
Cherry Point	1330	1241	808	1266	1322	1574	3095	4105	6324	4894
North Puget Sound Total	3992	4034	2885	3891	3835	3742	5870	6717	9379	8883
Discovery Bay	148	137	159	307	0	199	747	261	375	737
Dungeness/Sequim Bay	131	93	138	352	112	158	180	287		
Strait of Juan de Fuca Total	279	230	297	659	112	357	927	548	375	737
Puget Sound Total	18312	17022	13038	15358	10743	10678	12969	15515	15329	15348
Grays Harbor	87	77	166	297	77					
Willapa Bay	389	150	345	397	57	144				
Coast Total	476	227	511	694	134	144				

Table 2. Washington State herring spawning biomass estimates, 1994 – 2001:

HERRING SPAWNER BIOMASS ESTIMATES (SHORT TONS) BY STOCK AND REGION, 1992-2001.
(blanks indicate no surveys conducted that year)

	YEAR									
	2001	**2000**	**1999**	**1998**	**1997**	**1996**	**1995**	**1994**	**1993**	**1992**
STOCK										
Squaxin Pass	1597	371	474	68	149	374	157	225	596	771
Wollochet Bay (Hale Pass)	133	142								
Quartermaster Harbor	1320	743	1257	947	1402	805	2001	1412	1075	518
Port Orchard-Port Madison	2007	1756	2006	489	360	806	863	424	304	314
South Hood Canal	187	140	516	101	226	239				144
Quilcene Bay	2091	2426	2464	1152	465	328	817			97
Port Gamble	1779	2459	1664	971	1419	2058	3158	2857	1522	2270
Kilisut Harbor	612	107	802	311	307	380		292	538	
Port Susan	587	785	545	2084	828	110	363	365	1693	545
Holmes Harbor	275	281	175	464	530	336				
Skagit/Similk Bay	2170	646	905	209	893	736	891			
South-Central Puget Sound Total	12758	9856	10808	6796	6579	6172	8250	5575	5728	4659
Fidalgo Bay	944	737	1005	844	929	590	1173	1207	1417	1399
Samish/Portage Bay	470	196	555	643	509	636	194	459	198	262
Interior San Juan Is.	219	128	197		30	277			472	17
N.W. San Juan Is.	62	90		107	79	53				
Semiahmoo Bay	1098	926	868	919	621	1219	1245	1389	1902	1501
Cherry Point	1241	808	1266	1322	1574	3095	4105	6324	4894	4009
North Puget Sound Total	4034	2885	3891	3835	3742	5870	6717	9379	8883	7188
Discovery Bay	137	159	307	0	199	747	261	375	737	727
Dungeness/Sequim Bay	93	138	352	112	158	180	287			
Strait of Juan de Fuca Total	230	297	659	112	357	927	548	375	737	727
Puget Sound Total	17022	13038	15358	10743	10678	12969	15515	15329	15348	12574
Grays Harbor	77	166	297	77						
Willapa Bay	150	345	397	57	144					
Coast Total	227	511	694	134	144					

B. Coastal Area Activities

1. Coastal Groundfish Management *(Michele Robinson (360) 249-1211 and Brian Culver (360) 249-4628)*

Council Activities
The Department contributes technical support for coastal groundfish management issues via participation on the Groundfish Management Team (GMT), the Scientific and Statistical Committee (SSC), and the Habitat Steering Group (HSG) of the Pacific Fishery Management Council (PFMC). The Department is also represented on the Scientific and Statistical Committee and Groundfish Plan Team of the North Pacific Fishery Management Council (NPFMC). Landings and fishery management descriptions for PFMC-managed groundfish are summarized annually by the GMT in the Stock Assessment and Fishery Evaluation (SAFE) document.

2. Coastal Groundfish Monitoring, Research, and Assessment

Cape Flattery Lingcod Tagging Study *(Contributed by Tom Jagielo (360) 902-2837)*
The annual February-March lingcod survey with bottom troll gear at Cape Flattery was conducted for the 17th year in 2003. This survey produces estimates of lingcod survival and abundance at Cape Flattery, which have proven useful for the PFMC stock assessment, particularly as an aid to estimate recruitment. Since 1998 we have employed coded wire tags in the mark-recapture survey as internal marks, and WDFW samplers have examined as many fish as possible from the sport catch at Neah Bay with an R8-tube CWT detection system. The new survey design involves a much more labor-intensive recapture sampling effort, but eliminates the need for estimates or assumptions about tag reporting rates. The direct catch sub-sampling approach also has the potential to yield estimates of abundance with greater precision than the voluntary tag return sampling design, as estimates of the total sport catch and its variance are not required.

Evaluation of Survey Methods for Nearshore Rockfish *(Contributed by Tom Jagielo (360) 902-2837).*
During the 2001-2002 project segment, WDFW took delivery of a 3-beam laser quantitative measurement system, developed by Harbor Branch Oceanographic Institute (HBOI), Fort Pierce, Florida. This integrated system employs an undersea camera, three green lasers, a vertical reference unit (VRU), and associated computer software and hardware to quantify the area swept during underwater benthic videography surveys. In February, 2002, WDFW coordinated installation of the 3-beam system on the Delta submersible with the assistance of personnel from HBOI and Delta Oceanographics. The installation process resulted in the manufacture of a custom mounting bracket for deploying the 3-beam system on the bow of the *Delta*.

The original field plan with PSMFC-IJFA funds for the summer of 2002 was for 5 dive days. WDFW was successful in obtaining funds for an additional 10 dive days from the National Marine Fisheries Service, Northwest Fisheries Science Center to conduct a survey of yelloweye rockfish (*Sebastes ruberrimus*) in the untrawlable portions of the US-Vancouver INPFC

statistical area. Based on a recent stock assessment (Wallace, 2001), yelloweye rockfish are recognized as an overfished species by the Pacific Fishery Management Council. The 15 day survey was carried out successfully and a report is now in preparation (see below).

The objective for 2002-2003 is to continue developmental work to enhance the utility of the 3-Beam system for conducting demersal groundfish surveys. WDFW will work with engineers to accomplish implementation and testing of new 3-beam enhancements designed to enable distance-based quadrat sampling. Field implementation and testing of the new equipment is scheduled for September, 2003. Six WDFW dive days are proposed to occur in the Channel Islands National Marine Sanctuary, which will afford us the opportunity to demonstrate the utility of the system to scientists from other Federal and State agencies.

Density of Demersal Groundfish in Untrawlable Habitat of the US-Vancouver INPFC Area
(Contributed by Tom Jagielo (360) 902-2837)
In August of 2002, WDFW conducted field trials of the new 3-Beam system and executed a test survey using the submersible *Delta* onboard the support vessel R/V *Velero*. The *Delta* is 4.7 m long, accommodates 1 observer and 1 pilot, and has a maximum operating depth of 365 m. An acoustic Trak-Point system was used with differential GPS and WinFrog navigational software to track and log the position of the submersible from the support vessel. The purpose of the test survey was to judge the feasibility of using the 3-Beam system to obtain submersible survey estimates of demersal groundfish densities in untrawlable habitats on a spatial scale large enough to be useful for west coast fisheries management. Nominally untrawlable habitat of the 55-183m stratum of the US-Vancouver INPFC area was used as the primary spatial sampling frame.

Submersible transects were completed at 50 randomly selected dive sites selected *a priori* from a sampling grid prepared as an overlay to the spatial sampling frame (Figure 1). Strip transects were conducted 1- 2 m off bottom at a cruising speed of approximately 2.5 km/hr. All dives were made during daylight hours. To quantify fish density, each strip transect was documented with the 3-beam system mounted externally on the bow of the *Delta,* and pointed forward. The scientific observer onboard the *Delta* verbally annotated the videotape record with observations taken through the submersible viewing ports, to help identify fish and interpret the videotapes during subsequent analysis.

Transect area swept (m^2) was estimated as the product of average width swept (m), and the total transect length (m) (Table 1). The average width swept was estimated from systematic frame grabs (approximately 250 per transect, taken approximately 14 seconds apart) using the 3-Beam system topside software. Transect length was estimated as the product of the submersibles average speed (m/second) and transect duration (seconds). Transects were nominally of one hour in duration. The submersibles average speed was obtained from analysis of Winfrog and Trackpoint data, used to plot the location of the Delta during the submersible transects. Fish count data will be integrated with the area swept estimates to produce estimates of demersal groundfish densities for selected species.

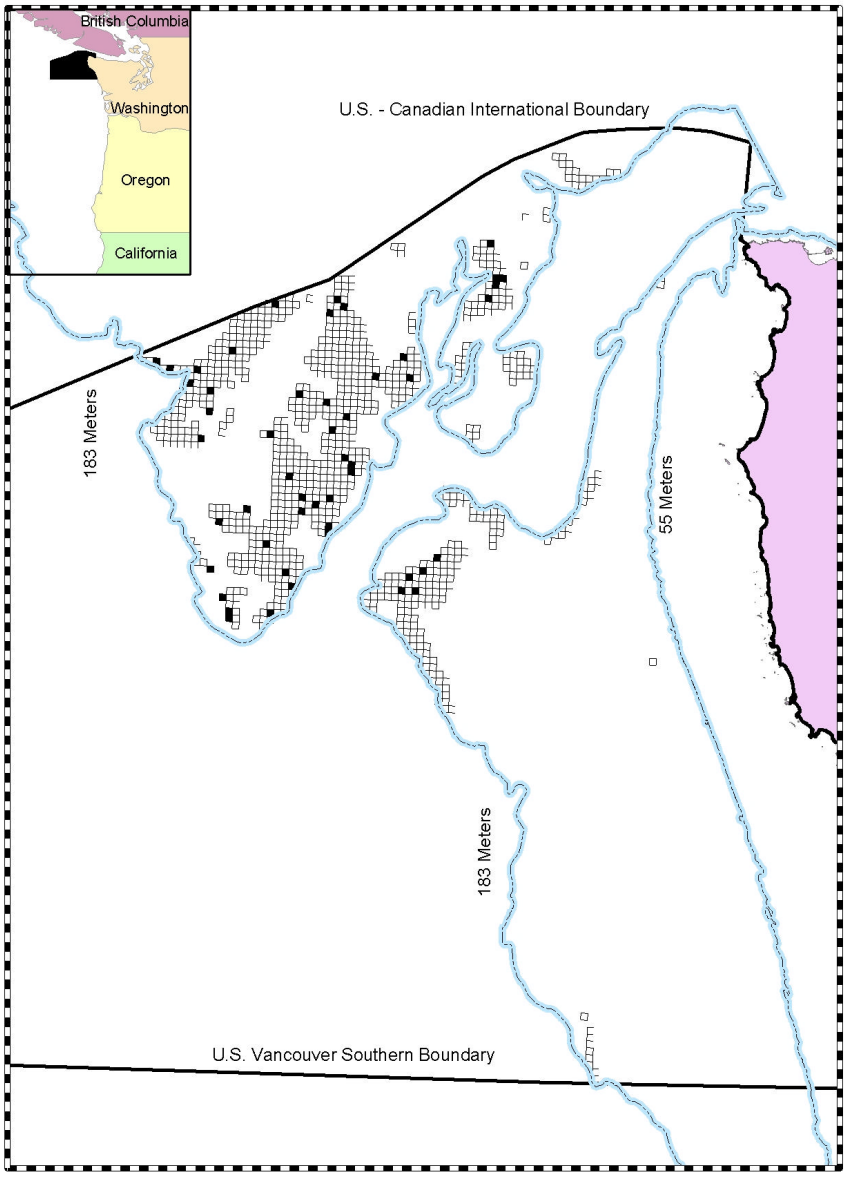

Figure 1. Locations of sampled stations (darkened squares) within the untrawlable habitat stratum (gridded area) of the US-Vancouver 55-183m INPFC area.

Table 1. Summary of transect start depth in meters (m) and the parameters used to calculate transect area-swept (m^2).

Dive No.	Site ID No.	Depth (m)	Ave Width (m)	Ave Speed (m/sec)	Duration (sec)	Length (m)	Area (m^2)	CV Area
5642	3889	116	1.70	0.47	3649	1698	2880	0.44
5643	4771	115	2.70	0.56	3695	2053	5539	0.47
5644	4778	110	2.44	0.57	3705	2117	5171	0.38
5645	4946	110	2.31	0.54	3657	1976	4557	0.33
5646	5289	112	2.67	0.48	3530	1710	4572	0.41
5647	6888	225	2.32	0.62	3661	2271	5274	0.37
5648	7077	168	2.33	0.65	3697	2392	5583	0.53
5649	7105	145	2.58	0.41	3635	1507	3894	0.35
5650	5429	125	2.34	0.70	3705	2591	6076	0.31
5651	6615	134	2.54	0.54	3697	2013	5111	0.39
5652	8862	152	2.30	0.58	3655	2125	4884	0.40
5653	10661	135	2.32	0.68	3695	2530	5869	0.27
5654	10983	160	2.20	0.56	3699	2075	4565	0.37
5655	11554	133	2.62	0.39	3698	1431	3749	0.41
5656	12273	140	2.67	0.66	3638	2406	6433	0.30
5657	12630	155	2.21	0.58	3660	2127	4709	0.42
5658	11265	140	2.48	0.64	3694	2362	5865	0.42
5659	11090	136	2.72	0.67	3683	2484	6764	0.42
5660	9711	120	2.17	0.53	3697	1955	4235	0.38
5661	9536	117	2.28	0.61	3707	2267	5165	0.41
5662	9354	120	3.20	0.66	3677	2414	7719	0.29
5663	7317	115	2.10	0.45	3708	1675	3524	0.39
5664	6785	125	2.50	0.68	3683	2491	6235	0.37
5665	7448	157	2.92	0.68	3683	2510	7339	0.36
5666	7644	156	2.46	0.55	3695	2017	4956	0.35
5667	8169	150	2.26	0.64	3696	2382	5372	0.30
5668	8754	131	2.65	0.65	3695	2405	6384	0.36
5669	11900	145	2.64	0.52	3520	1820	4807	0.41
5670	12238	145	2.75	0.60	3695	2205	6057	0.36
5671	12399	153	2.78	0.70	3665	2560	7120	0.31
5672	12756	164	2.28	0.50	3697	1844	4211	0.37
5673	12742	159	2.67	0.58	3696	2135	5711	0.37
5674	12201	171	2.57	0.72	3698	2679	6893	0.50
5675	12915	165	2.71	0.80	3696	2972	8061	0.72
5676	13272	164	2.60	0.78	3685	2880	7474	0.48
5677	13447	169	2.76	0.64	3695	2369	6531	0.33
5678	13310	164	2.46	0.62	1842	1142	2813	0.37
5679	9823	117	2.72	0.56	3717	2099	5711	0.31
5680	10362	110	2.74	0.63	3694	2316	6344	0.33
5681	10712	116	2.45	0.67	3661	2449	5993	0.32
5682	10551	117	2.33	0.61	3693	2263	5271	0.28
5684	10390	112	2.97	0.52	3698	1925	5726	0.31
5685	7730	117	2.33	0.71	3699	2637	6136	0.35
5686	7933	102	2.53	0.67	3696	2473	6261	0.20
5687	8640	110	2.64	0.59	3692	2193	5781	0.31
5688	8304	107	2.61	0.58	3696	2145	5590	0.36
5689	7282	126	2.44	0.58	3701	2144	5226	0.34
5690	5497	104	2.91	0.61	3698	2242	6515	0.26
5691	5315	105	2.70	0.48	3696	1769	4771	0.41
5692	5658	111	2.56	0.52	3670	1891	4833	0.32

Black Rockfish Tagging study (*Contributed by Farron Wallace (360) 249-4628)*
In 1998, WDFW began a multi-year mark-recapture survey near Westport Washington, the principal location of recreational landings of black rockfish along the Washington coast. The survey design involves five annual releases, and seven years of tag-recovery monitoring in the sport fishery. Aboard the WDFW research vessel Corliss, 2,622, 3,478, 2,779 and 3,200 black rockfish were captured, tagged and released during 1998, 1999, 2000 and 2001 respectively. Fish were released on pinnacles distributed throughout the area fished by the Westport charter fishing fleet. Each fish was tagged with two coded wire tags (CWT) placed in the opercular musculature: one on each side of the fishes head. The tags were marked to allow for identification of specific individuals upon subsequent recapture. No tag shedding or tag related mortality was observed during holding experiments during 1998 and 1999.

On an annual basis, roughly 40% of the total Westport recreational black rockfish catch is sampled for tags by passing fish carcasses through a CWT tube detector. A total of 14, 79, 300 and 250 tags were recovered in 1998, 1999, 2000 and 2001 respectively. Cooperation of the charter boat industry was very good and enabled us to achieve the high sample proportion of the total number of fish landed (including those filleted at sea). Mark-recapture data will be used to produce estimates of abundance, survival, and mortality for black rockfish in the Westport coastal area. Population parameter estimates will be incorporated into the 2003 black rockfish age structured model.

Data analyses show the importance of tagging as many fish as possible each year, and conducting an accurate and thorough sampling of as large a proportion of the catch as possible for tags. We hope to increase our releases and sampling rate during 2001. Study results so far are quite promising and efforts may be expanded to include the entire Washington coast in subsequent segments.

2002 Coastal Yelloweye Stock Assessment for PFMC *(Contributed by Farron Wallace (360) 249-4628)*
The estimate of virgin biomass is estimated at 3,875 mt of spawners in an unfished state. The female spawner abundance projected to the beginning of 2002 is 934 mt. This is 24.1% of the unfished level. The target abundance (40% of the unfished level) is 1,550 mt of spawners. From the spawner-recruitment parameters fitted within the assessment model, the steepness of the S-R relationship is 0.437. This is lower than the 0.7 level found as typical for several rockfish species (Dorn, 2002), but above the level near 0.3 found for canary rockfish (Methot and Piner, 2002). However, profiling the assessment model on the steepness parameter found that the overall model fit was insensitive to steepness over the steepness range of 0.3 to 0.7, so the 0.437 estimate has substantial uncertainty. With a steepness of 0.437, the Fmsy corresponds to F57% SPR and is an annual exploitation rate of approximately 0.018. Fishing at this rate in the long-term would be expected to produce an average spawning biomass level that is 36% of the unfished level, and the equilibrium MSY would be 59 mt. Fishing at F50% SPR, the current default harvest rate, would produce an exploitation rate of about 0.023 and would result in an equilibrium spawning biomass level that is at 26% of the unfished level (not taking into account the effect of the 40:10 reduction in harvest as the stock would fall below the 40% level). These

point estimates of productivity have substantial uncertainty that cannot be reduced significantly until several more years of information of recent recruitment levels is collected.

The mean generation time is 44 years. The selectivity, weight, fecundity,, natural mortality, and numbers-atage used in the rebuilding analysis are reported in Table 23. Although we do not believe the point estimate of Bmsy (36% of unfished) is sufficiently precise to warrant replacing the current Bmsy proxy and rebuilding target (40% of unfished), we do believe that the point estimate of steepness provides a useful prediction for the range of future recruitments in a forecast. Forecasts that use deviations around a reasonable spawner-recruitment curve will be intermediate between forecasts based upon re-sampling of recruitments and forecasts based upon re-sampling of recruits per spawner. A range of steepness values should be considered to present the best case (steepness = 0.437) and high and low confidence intervals.

With no fishing (F=0) beginning in 2003, the stock would rebuild to the 40% level by the year 2024 (NOTE: this calculation will be superceded by the stochastic forecasts conducted in the rebuilding analysis). With F = F50%, the ABC would be 52 mt in 2003 and the 40:10 adjustment would put the OY at 42 mt. However, the degree of S/R steepness indicates that this level of harvest would not rebuild the stock to the 40% level. A long-term harvest level of F57% is close to Fmsy and, with the 40:10 adjustment, would result in an initial OY of 33 mt. Under this strategy, harvest would be expected to increase to 41 mt within 10 years if recruitments and harvests were as used in this projection. The long-term MSY would be 59 mt. There is, however, substantial uncertainty in these forecasts. For example if the actual future recruitments are at a level that is closer to a S/R steepness of 0.429, then the Fmsy proxy would be closer to F62% and the annual OY calculations would be reduced by about 10 mt per year. There are no data with which to reduce this uncertainty at this time. Future assessment with more and different data should be more precise, but may provide point estimates that differ from those that can be calculated today.

Estimated Discard and Discard Rates in the Coastal Washington Arrowtooth Flounder Fishery In 2001 *(Contributed by Farron Wallace (360) 249-4628)*
In 2001, WDFW began a two-year cooperative industry at-sea data collection program in an effort to facilitate directed arrowtooth flounder fishing and to establish an objective basis for estimation of canary rockfish discard in that fishery. The program was approved by the PFMC and NMFS and administered under an Exempted Fishing Permit. This report provides a review of the 2001 (year 1) observer data and an estimate of discarded catch for the participating vessels. A final report will be produced in 2003 summarizing results of the entire program.

All participating vessels were required to carried observers throughout the study period and retain all rockfish species (*Sebastes* and *Sebastelobus*) caught. Shoreside, rockfish catch was sorted into marketable, unmarketable and forfeited cateories. Unmarketable catch was typically made up of small fish of no value and rockfish landings exceeding monthly cumulative trip limits were forfeited. Rockfish discard estimates in this study are assumed equal to the sum of forfeited and unmarketable, because this catch would have ordinarily been discarded at-sea under normal

fishing operations. Observers also monitored fishing strategies and collected data to estimate total catch, discard and bycatch rates of incidental catch of non-rockfish species.

Participating vessels landed approximately 810 mt of arrowtooth flounder that would not have been possible without the EFP fishery. The estimated bycatch rate for canary rockfish in the north coastal Washington arrowtooth fishery is significantly lower than that used to set current regulations for the arrowtooth fishery in 2002. In arrowtooth directed tows, the ratio of canary to arrowtooth was 0.07% compared to an assumed rate of 2.0% to 3.0%. Among the 7 vessels participating in the study, the highest canary discard rate for a single vessel was 1.9%. Two vessels caught no canary. This questions the ability for at least some vessels to avoid canary rockfish in directed arrowtooth tows. This also suggests that predicting bycatch may be highly prone to error. Although the relative volume of catch was low, the percent discard within rockfish market category was much higher.

Analysis in this study is based on data collected from 7 volunteer vessels and does not represent a random sampling of the fleet. Because this study is limited in scope, results should not be widely applied to other fisheries. Furthermore, vessels participating in this study actively attempted to minimize canary bycatch and discard rates may not be representative of other vessels targeting arrowtooth.

Total estimated rockfish catch and discard

Species/Market Category	Total Estimated Catch(lbs)	Discard(lbs)	Discard Rate
Canary	5,226	2,574	49.3%
Darkblotched	4,359	22	0.5%
POP	28,099	4,528	16.1%
Shortspine Thornyhead	14,893	3,838	25.8%
Shelf	21,656	12,193	56.3%
Slope	15,851	5,922	37.4%
Widow	632	-	0.0%
Yellowtail	41,975	10,014	23.9%
Sub-Total	132,691	39,091	29.5%