Washington Contribution to the 2002 Meeting of the Technical Sub-Committee (TSC) of the Canada-US Groundfish Committee

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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)*

Sixgill Shark Management

In March 2002, the Fish and Wildlife Commission voted to prohibit the retention of sixgill sharks taken in commercial fisheries in Puget Sound. This is a companion measure to the prohibition of retention of sixgills in recreational fisheries, which was passed last year. This prohibition was taken as a precautionary measure and was largely based on the results of sixgill shark research in British Columbia. The ban does not apply to sixgills taken in treaty fisheries; we are in discussions with the tribal staffs about their retention of sixgills.

Dogfish Shark Management

Agency staff continued to be concerned about the continued decline in abundance of dogfish shark in Puget Sound. This decline is reflected in both fishery data and trawl survey data. Many commercial fishers strongly disagree with the concept that dogfish are declining and state that the decline in landings is due to social and economic factors rather than the abundance of dogfish. Agency staff has been in contact with several members of DFO and the University of Washington regarding models of dogfish abundance and appropriate harvest levels. These contacts are likely to continue (even increase) during the upcoming years and we continue to decide a course of management action.

Pacific Cod Stock Stock Identification

In conjunction with the Makah tribe, the department attempted to identify stocks of Pacific cod using stable isotope analysis. In September 2001, otoliths were taken from 300 cod captured at three locations; the Washington coast, the western Strait of Juan de Fuca and the Gulf of Georgia just south of the U.S. – Canadian border. The otoliths will be examined to determine the oxygen and carbon isotope ratios to determine if there is a difference based on location of capture. Results are expected in June 2002.

Herring Workshop

The department is sponsoring a workshop on Pacific herring in Bellingham on June 11-13. Emphasis will be placed on identification of herring stocks and the effects of chemical contamination on herring. The chemical contamination session appears to be very interesting with a strong contingent of folks involved with the EVOS event -- some of whom have strongly opposing views. Registration to the workshop is free, but limited. Details on registration can be obtained from the agency webpage or by sending an email message to herring@dfw.wa.gov.

Marine Protected Areas
The department continued to develop a system of marine protected areas in Puget Sound. These areas are being developed as part of a groundfish conservation strategy to both rebuild depressed rockfish populations and to provide sustainable harvest opportunities.

Puget Sound Groundfish Conservation Plan
Department staff have been working on developing a comprehensive plan for the management of groundfish in Puget Sound. No development of this plan occurred during the past year. The department and interested tribal governments are reviewing the draft plan and intend to produce a document designed by both the state agency and tribal governments. Rather than develop a comprehensive plan, the emphasis in the past year has been on developing individual species plans. The two species chosen for initial emphasis were dogfish shark and Pacific cod.

In its March 2002 meeting, the Commission approved creation of a new marine conservation area at Keystone off Whidbey Island and new marine preserves at Zee's Reef off Fox Island near Gig Harbor and at Admiralty Head off Whidbey Island. The creation of the Zee's Reef marine preserve marks the first underwater rocky habitat south of the Tacoma Narrows to be designated for protection. The area will remain open for recreational salmon fly fishing only, but otherwise will be closed to fishing to protect rockfish and other marine fish species.

The marine preserve designation for Admiralty Head allows harvest of sea urchin and sea cucumber while protecting other species. The Commission also approved a change in the designation for an underwater area off Sund Rock in Hood Canal from a marine protected area to a marine conservation area. The change will prohibit all fishing activity in the conservation area.

Following the recommendation of WDFW staff, the Commission did not act on two other proposals to create marine sanctuaries at Scatchet Head off Whidbey Island and Rosario Beach in the San Juan Islands. In the case of Scatchet Head, a boundary could not be determined that would be enforceable to boaters without radar or global positioning system (GPS) devices onboard. The Rosario Beach proposal was withdrawn pending further discussion between WDFW, local government, State Parks and commercial divers.

2. Puget Sound Groundfish Monitoring, Research, and Assessment *(Contributed by Wayne Palsson (425) 379-2313)*

During the year 2001, most activities relating to monitoring, assessing, and studying Puget Sound groundfish experienced substantial changes. During the fall of 2000, Sportfish Restoration Act Funds that supported video-acoustic surveys, marine reserve studies, and other recreational studies were withdrawn by WDFW administration. The funding of most of these activities was replaced by Washington State general funds authorized under supplemental budget to recover bottomfish populations, especially those that were previously petitioned under the Endangered Species Act. Twice during the year, the staff which conducted these activities were reorganized creating substantial changes in supervision.

Video-Acoustic Technique 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) which consisted of a quantitative video camera to survey fishes within 2 m of the bottom and a scientific echosounder to survey fishes in the water column above rocky habitats. The use of the echosounder was discontinued during 2000 due both to lack of staff and to the need to further develop the scientific basis for the use of acoustic technology. The VAT has previously been used throughout Puget Sound to identify and characterize nearshore rocky reef habitats and to estimate the density of lingcod, rockfish, and other marine fishes that inhabit the rocky habitats. During the summer of 2001, the nearshore rocky habitats of the Whidbey Basin, and the main and southern basins of Puget Sound were surveyed. The video component of the survey consisted of establishing a grid that encompassed recognized or potential rocky habitats, randomly selecting individual cells, and occupying from 3 to 5 randomly selected video stations within each cell. During the survey, two lasers mounted in parallel and 10 cm apart were attached to the camera and used to provide measures of fish length and, in many cases, measure the visual range of the camera. In total, 1090 camera deployments in 265 cells were completed. During 2000, staff processed video tapes obtained from the 1999 and 2000 video surveys from the Strait of Georgia and San Juan Islands. Robert Pacunski and Wayne Palsson 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 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.

Evaluation of No-Take Refuges for Reef Fish Management

Ongoing field work was conducted during 2001 to further evaluate the potential of no-take refuges as a fisheries management and conservation tool for rockfish and lingcod in Puget Sound and to design new refuges. The field work, which began in 1992, has compared the size, density, and reproductive responses of rockfishes, lingcod, and other rocky reef fishes in no-fishing areas to comparable habitats in fished zones. Several years of intensive field work have shown that a small no-take refuge established at Edmonds, Washington in 1970 has large modal sizes of

rockfishes and lingcod that are virtually absent on any of the fished sites. This long-term refuge also has many times the densities of large rockfishes that are typically caught in recreational fisheries. Surveys in shorter-term reserves in the San Juan Islands revealed greater numbers of lingcod nests in the no-take refuges compared to the corresponding fished sites. These patterns were summarized in a web article (www.wa.gov/wdfw/science) that launched WDFW's on-line Science magazine in April 2001. The article is entitled "Marine Refuges Offer Haven for Puget Sound Fish" and was written by Wayne Palsson.

Monitoring activities continued during 2000 at many of the Puget Sound reserves and comparable fished sites. Several reserves in central Puget Sound were visited six times during 2000 as an extension of a study initiated in 1999 which takes advantage of the previous information collected at Orchard Rocks which was one of the fished sites monitored during the first study. In 1998, this site was declared a complete no-take refuge for all organisms by the Washington Fish and Wildlife Commission. 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 and the implications of refuge management in Puget Sound. To date, the recovery of fishes at the Orchard Rocks Conservation Area has been slow, and follow up monitoring at the Edmonds Underwater Park, a long-term refuge, has shown local depletions of large rockfish. Continuing surveys were conducted at marine refuge sites in Hood Canal where more than 10% of the nearshore rocky habitat is conserved as marine refuges, and studies were conducted in the San Juan Islands marine refuges on lingcod recovery.

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 which will have its proceedings published in 2002. These criteria along with other information led to the nomination of several new marine reserves in Puget Sound that were considered by the Fish and Wildlife Commission during 2001 with a decision expected in 2002. Many other agencies and organizations are involved in planning marine refuges in Puget Sound and WDFW staff are integrally involved in most planning efforts. The results from stock assessments, fishery monitoring, refuge comparisons, and video assessments of rockfish and lingcod populations and their habitats are being integrated into a design of a system of no-take refuges to manage lingcod and rockfish populations in Puget Sound. A marine reserve system is the companion to reduced catch limits as the main action items for a rockfish conservation plan.

Wolf-eel Life History SCUBA Surveys

In January 1999, groundfish staff began 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. Although the recreational harvest of wolf-eel is not allowed in South Sound, wolf-eel harvest until recently has been open in the Strait of Juan de Fuca. 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 to be published in the conference proceedings in 2002. Differences in mate fidelity between sites were observed 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 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.

Wolf-eel appear to be a species that is sensitive to harvest and may be affected by competition with Pacific giant octopus and with fisheries. During 1999, one area in the harvest zone was surveyed that once contained a large wolf-eel colony. There were no wolf-eel present when surveyed. Fisheries that harvest octopuses, urchins, and crab may remove prey resources that wolf-eel depend upon. The results from this study led to a staff proposal to close the recreational harvest of wolf-eel in all inland marine waters. This proposal was adopted by the Fish and Wildlife Commission.

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) 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 week days.

The 2001 lingcod fishery at Tacoma Narrows showed several reversals in the trends in participation, catch and fishing success observed during the preceding several years (Table 1). Angler trips increased to 865 taken during the six week fishery compared to only 813 during the previous year. These anglers harvested 153 lingcod during the fishery with a fishing success rate of 0.18 lingcod per bottomfish trip. The trend in fishing success and inferred abundance from the Tacoma Narrows fishery has shown relative stability during the past ten years, and although the 1999 angler catch rate of 0.09 is the lowest since the 1983, the 2001 catch rate of 0.18 lingcod per bottomfish trip is slightly greater than the ten year average. Given the recent increasing trend estimated from the WDFW general survey and the recent stability of most of the recent years from the Tacoma Narrows fishery, the current regulatory regime will be continued.

Table 1. 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

Marine Recreational Fisheries Statistical Survey

In 1996, the Pacific States Marine Fisheries Commission selected WDFW as a contractor for the Marine Recreational Fisheries Statistical Survey (MRFSS). The MRFSS is a federal catch estimation system for marine anglers conducted in most coastal states. Although WDFW has had its own recreational catch estimation system, the implementation of the MRFSS came at a time when major fishery closures for salmon have prevented the WDFW system from estimating the catch of groundfish during key months in important fishery areas. Although MRFSS estimates do not provide precise sub-regional estimates, they provide a basis for comparing WDFW estimates, are more timely, result in biological and species composition information, and estimate catch and effort for all modes of fishing. Many of these statistics have not been available through the WDFW recreational catch estimation system. Staff have been involved in discussions with the RECFIN statistical committee and with PSMFC regarding improvements to the survey in Puget Sound and along the coast of Washington.

Puget Sound Groundfish Stock Assessments

Puget Sound Groundfish staff regularly assess 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) which 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. A new summary of the stock assessments was prepared for an upcoming Puget Sound Update, 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 that the majority of assessed groundfish populations are in poor condition in Puget Sound, but that some improvement was realized since the last update.

Acoustic-Trawl Surveys for Pacific Whiting (Hake)

Groundfish staff 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 which 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 1). This species and population was petitioned in 1999 for consideration under the Endangered Species Act, 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).

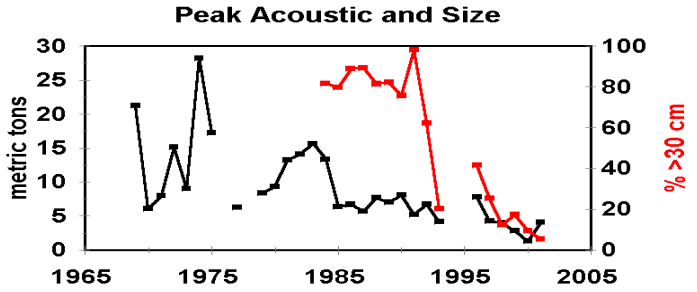

Figure 1. Peak acoustic estimate of Port Susan whiting and percent of estimate greater than 30 cm.

On March 12, 2001, groundfish staff conducted a mid-water trawl survey to assess Pacific whiting species composition and size in Port Susan and Possession Sound. An acoustic survey was conducted on March 14, 2001 to provide an estimate of pelagic biomass in the same areas. The 2001 survey estimate for total whiting for all surveyed areas has slightly improved to 4,100 mt, up from the nadir 2000 estimate of 2,857 mt. The 2001 total hake estimate has returned to the range of most total whiting estimates since 1993. The total whiting biomass in Port Susan was more than double the biomass of sampled during the record low survey of 2000 and fish sign

appeared to be more widely distributed along the west side of Port Susan in 2001 than during 2000.

The size composition of whiting was comparable between 2000 and 2001. Large fish 30 cm or greater comprised 7% and 6% of the on-deck samples in 2000 and 2001, respectively, and during both years, these large fish were almost exclusively observed in Possession Sound. Whiting in Port Susan once matured at 30 cm, but since the early 1990s, whiting mature at 21 cm (Gustavson et al. 2000). During 2000 and 2001, fish measuring between 21 cm and 29 cm comprised 80% of the research catch. The proportion of these intermediate-sized fish was always less than 30% prior to 1990 and greater than 60% since 1996.

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 2001 survey saw the lowest biomass of large whiting indicating that reproduction is completely dependent upon fish between 21 cm and 20 cm. The shift in length-at-maturity from 30 cm to 21 cm remains alarming and a hallmark of a stressed population. The complete fishery closure must continue and all steps to remove or minimize fishing and other stressors is required.

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 2001, 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.

2001 Trawl Survey

The Strait of Georgia and San Juan Archipelago encompass the northern reaches of Washington's inside marine waters and are confluent with the southern reaches of British Columbia's inside marine waters. Many of the resources harvested by commercial and recreational fisheries in the US portion of the region have undergone severe declines which have prompted a number of fishery closures and consideration of seven species under the U.S. Endangered Species Act. During Spring 2001, the Washington Department of Fish and Wildlife

conducted a bottom trawl survey in the U.S. Strait of Georgia and the San Juan Archipelago and in a limited portion of the B.C. Strait of Georgia, Boundary Pass, and Haro Strait. The goals and objectives of this survey were to: 1) estimate the abundance and describe the distribution of key recreational and commercial groundfish and macroinvertebrate species, 2) collect biological information from key species, 3) evaluate the relationship of abundance and distribution of key species to oceanographic features, and 4) evaluate the need for transboundary management.

The chartered *F.V. Chasina* was used as the sampling vessel which towed a 400 mesh Eastern net fitted with a 3 cm mesh codend liner. Stations were selected with a stratified random approach based upon four depth zones for each of the country survey areas. The area sampled at each station was measured with differential GPS and known net width openings. The catch from each trawl was identified, weighed, and enumerated, and the weights and numbers of each species were divided by the area sampled to estimate species densities. Abundances were estimated by averaging station densities within each stratum and multiplying these by the stratum area.

A total of 115 trawl stations were occupied and completed. Twenty five stations were occupied in British Columbia and 90 stations were sampled in the U.S. Fewer stations were occupied in the shallow waters of B.C. than planned due to unsuitable bottom habitats for bottom trawling. There were 218 living taxa identified including 86 species of fish and 132 species of invertebrates. There were over 3,000 records of species catch which comprised a catch weight of over 53 mt and represented 700,000 individuals. Almost 115,000 individual fish (48 mt) were collected. Large specimens of English sole, Pacific cod, walleye pollock, and Pacific whiting were frequently captured in the deep waters of the Strait of Georgia. There were a series of samples collected for later analysis or archives. These collections included almost one hundred fin clips for the genetic analysis of lingcod, quillback rockfish, copper rockfish, cabezon, and great sculpin. Ninety-three samples of up to 25 English sole and 24 samples of starry flounder were retained for laboratory analysis. Approximately 25 voucher specimens were collected for positive fish identification at a permanent museum collection. A series of fish samples were also collected for a food consumption study of marine pinnipeds.

The 2000 Trawl Survey of the Eastern Strait of Juan de Fucan and Discovery Bay

The data from the 2000 trawl survey of the eastern Strait of Juan de Fuca and Discovery Bay were processed and organized into a draft technical report. The approach to the survey was the same as those of the 2001 trawl survey described above. The survey encompassed both the U.S. and Canadian portions of the Strait (Figure 2). The survey revealed that there was an estimated population of 134.2 million fish (27,000 mt) living in the eastern Strait of Juan de Fuca. Washington contained 114 million bottomfish while B.C. had 20 million individuals. The B.C. bottomfish resource constituted an estimated 8,200 mt while the Washington resource weighed

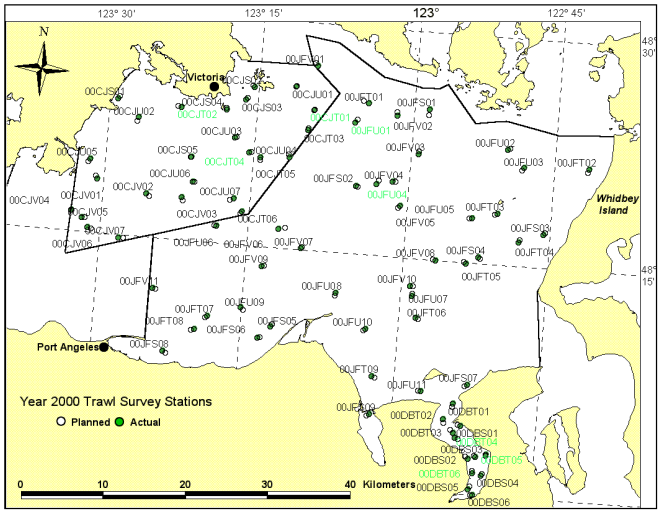

Figure 2. Planned and actual stations occupied during the 2000 Trawl Survey of the Eastern Strait of Juan de Fuca and Discovery Bay.

an estimated 19,000 mt. As expected, Discovery Bay had far fewer fish than either of the two larger survey areas. There was an estimated population of 2.8 million fish (90 mt) in Discovery Bay.

Spotted ratfish comprised more than 75% of the fish populations in Washington and B.C. Flatfish as a group was the second most dominant species group in Washington while other species contributed together to form the second greatest proportion of any species group in B.C.

Overall, most populations were less abundant than estimated during previous surveys of the Washington Strait of Juan de Fuca (Figure 3). Depressed species such Pacific cod and lingcod appear to be in continued low abundance despite fisheries that have been substantially reduced in recent years. Discovery Bay contains almost exclusively juvenile and small individuals of key species once harvested in commercial bottom trawl fisheries.

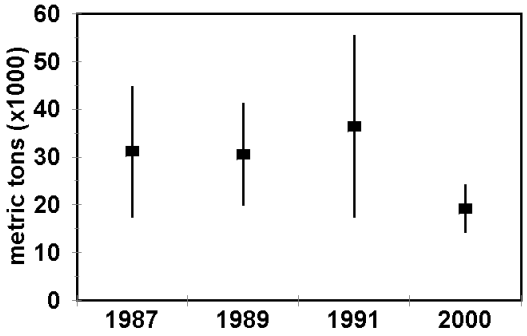

Figure 3. Estimated biomass (metric tons) and 95% confidence limits for all fish in the Washington Eastern Strait of Juan de Fuca.

The geographic distribution and depth preferences of key species and invertebrates resulted in a complex pattern for transboundary management. The shallow banks and deep basins in the central Strait provide habitat for both deep and some shallow water species resulting in a wide and continuous distribution spanning the international boundary (Figure 4). These continuous distributions require coordination between Washington and Canada if substantial fisheries re-develop in the area.

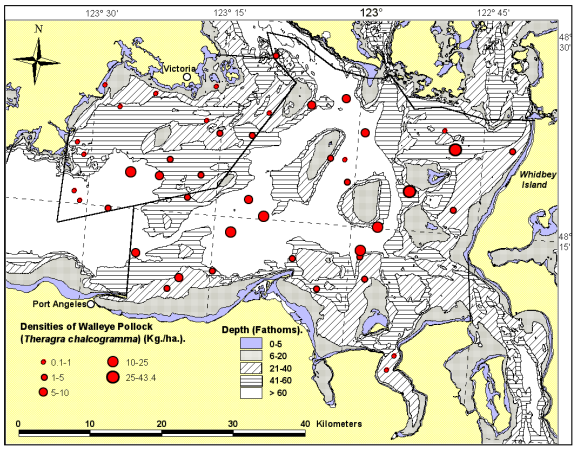

Figure 4. The transboundary distribution of walleye pollock in the eastern Strait of Juan de Fuca.

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Puget Sound Ambient Monitoring Program (PSAMP) *(Contributed by Sandie O'Neill (360) 902-2843 and Jim West (360) 902-2842)*

PSAMP is a multi-agency effort to monitor the health of Puget Sound. The Washington Department of Fish and Wildlife participates by monitoring toxic contaminants in Puget Sound fishes and assessing effects of contaminants on fish health. To date, we have measured contaminant levels in English sole, Pacific cod, three species of demersal rockfish, Pacific herring, chinook and coho salmon, and Dungeness crab from a wide range of environments (polluted to clean). Geographic patterns of contaminants in these species have previously been described. We have also now completed fine-scale distribution patterns of contaminants in English sole and rockfish in Elliott Bay, Sinclair Inlet and Commencement Bay, three of Puget Sound's most highly contaminated areas. Additional information about the PSAMP Fish Component is available through our website (www.wa.gov/wdfw/fish/psamp/).

Previously, we had shown that English sole from urban and near urban areas were 2 to 33 times more likely to develop liver disease than fish from clean reference areas. Liver disease in English sole is strongly correlated with the presence of polycyclic aromatic hydrocarbons (PAHs) in sediments, which originate from petroleum or from the combustion of fossil fuels. In addition, we had found from our six long-term Puget Sound sampling sites that the chances of English sole developing toxicant-related liver disease had increased roughly two-fold from 1989 to 1998 (relative to clean reference sites) but then declined in 1999, in English sole from Elliott Bay.

These results were presented as a poster the 2001 Research in Puget Sound Conference (PSR'01, February 2001). Our ongoing monitoring results indicate that the risk of developing liver disease remains low at Elliott Bay. These results will be published in the 2002 Puget Sound Update. The risk of English sole developing liver disease has remained unchanged during this period in the five other areas (Commencement Bay, Sinclair Inlet, Everett, Hood Canal, and the Strait of Georgia). Due to budget cuts, sampling frequency for English sole will be reduced to biannual surveys.

We have completed three samplings of contaminants in Pacific herring from three to five locations in Puget Sound and Canada (1999, 2000 and 2001). Herring from central and southern Puget Sound had significantly higher PCB concentrations in whole bodies than fish from northern Puget Sound and the Strait of Georgia. Exposure to PAHs (measured as PAH metabolites in bile) was also elevated in herring from central and southern Puget Sound but not in fish from northern Puget Sound. These results were published in the proceedings of PSR'01 and the 2002 Puget Sound Update.

We are collaborating with WDFW's Oil Spill Team (OST) on a survey of toxic contaminants in spawned herring eggs from 5 locations in Puget Sound. Early results indicate high concentrations of PAHs in one sub-site sampled from the Port Orchard/Madison spawning stock. We are conducting further sampling at this site, Hidden Cove, on the north end of Bainbridge Island, to evaluate the significance of these findings. A summary and progress report of results from this study will be presented at the 2002 Herring Summit in Bellingham, WA, in June.

PSAMP and OST staff also conducted a pilot study in 2001 to evaluate background levels of PAHs and other toxics in Dungeness crab (*Cancer magister*). The PSAMP goals of this pilot project were to determine whether crabs are sufficiently exposed to toxics (as measured by tissue burdens) to warrant their use as a monitoring species. OST staff are working with scientists from other trustee agencies and programs (such as PSAMP) to evaluate and refine methods that may be used for natural resource damage assessments in the event of an oil spill and to collect baseline information on key resources and habitats. PAHs were measured in all hepatopancreas composites in crab from four locations in Puget Sound, and concentrations were correlated with PAH sediment contamination. Preliminary analysis of these results shows that Dungeness crab from Commencement Bay (Thea Foss Waterway), one of Puget Sound's more PAH contaminated habitats, had significantly greater total PAH concentration than those from Port Gardner (situated near Everett in Central Puget Sound), Vendovi Island (outside of Bellingham Bay), and Cherry Point (northern Puget Sound).

In an ongoing collaborative study with National Marine Fisheries Service, we have documented that English sole and quillback and brown rockfish from several locations in central Puget Sound are displaying evidence of endocrine disruption. Up to 56% of male English sole collected near sites receiving untreated sewage had vitellogenin in their blood serum, at concentrations documented to indicate adverse affects in other fish species. Vitellogenin, a lipo-protein involved in egg development, is not normally present in male fish but can be induced by exposure to xenoestrogenic compounds that are present in sewage and other sources.

We have developed an ACCESS database for the exposure and effects data collected by the Fish Component Database. The PSAMP ACCESS Database Manual and User's Guide has been completed, and we have published an 11-year summary report of the toxics data (West et al. 2001).

In collaboration with other WDFW staff, we have finished a field manual for evaluating Dungeness crab shell condition (Lippert et al., in press). This manual describes indices of condition based on easily quantifiable criteria, and will be used by field samplers to determine shell condition during the fishing season, as an aid to WDFW shellfish management.

PSAMP staff are working with Art Johnson of Washington's Department of Ecology Environmental Assessment Program to investigate arsenic levels in Puget Sound seafood. PSAMP's long-term monitoring data suggest that most Puget Sound fish from most areas will exceed the Clean Water Act 303-d limit for arsenic (suggesting a natural condition). Johnson is collaborating with PSAMP staff to bring the issue into perspective with a study analyzing up to 60 PSAMP English sole samples from 2000 or 2001. Samples of English sole, Dungeness crab, coho salmon, Pacific herring and quillback rockfish will be analyzed for total and inorganic arsenic concentrations. Analysis should be completed by March 2002.

Recent PSAMP Publications:

Lippert, G., S. Hoffmann, and P. Clarke. in press. Dungeness Crab Shell Condition Field Manual. WDFW Technical Report.

O'Neill, S.M. and J. E. West. 2001. Exposure of Pacific Herring (*Clupea pallasi*) to Persistent Organic Pollutants in Puget Sound and the Georgia Basin. Puget Sound Research '01 Proceedings. Puget Sound Water Quality Action Team, Seattle, WA.

O'Neill, S.M., et al. 1998. Geographic and Temporal Patterns in Toxicopathic Liver Lesions in English sole (*Pleuronectes vetulus*) from Puget Sound and Relationships with Contaminant Concentrations in Sediments and Fish Tissues (Abstract). Page 730 in E. R. Strickland, editor. Puget Sound Research '98 Proceedings. Puget Sound Water Quality Action Team, Seattle, WA.

O'Neill, S.M., J.E. West, and J.C. Hoeman 1998. Spatial Trends in the Concentration of Polychlorinated Biphenyls (PCBs) in Chinook (*Oncorhynchus tshawytscha*) and Coho Salmon (*O. kisutch*) in Puget Sound and Factors Affecting PCB Accumulation: Results from the Puget Sound Ambient Monitoring Program. Pages 312-328 in E. R. Strickland, editor. Puget Sound Research '98 Proceedings. Puget Sound Water Quality Action Team, Seattle, WA.

Puget Sound Water Quality Action Team. 1998. Toxic Contaminants: Fish. Pages 40-51 in 1998 Puget Sound Update: Sixth Report of the Puget Sound Ambient Monitoring Program. Puget Sound Water Quality Action Team. Olympia, Washington.

Puget Sound Water Quality Action Team. 2000. Toxic Contaminants in Fish. Pages 56-64 in 2000 Puget Sound Update: Seventh Report of the Puget Sound Ambient Monitoring Program. Puget Sound Water Quality Action Team. Olympia, Washington.

West, J.E. and S.M. O'Neill. 1998. Persistent Pollutants and Factors Affecting their Accumulation in Rockfishes (*Sebastes* spp.) from Puget Sound, Washington. Pages 336- 345 in E. R. Strickland, editor. Puget Sound Research '98 Proceedings. Puget Sound Water Quality Action Team, Seattle, WA.

West, J.E. S.M. O'Neill, D. Lomax , and L. Johnson. 2001. Implications for reproductive health in rockfish (*Sebastes* spp) from Puget Sound exposed to polychlorinated biphenyls. Puget Sound Research '01 Proceedings. Puget Sound Water Quality Action Team, Seattle, WA.

West, J.E., S.M. O'Neill, G. Lippert, and S. Quinnell. 2001. Toxic contaminants in marine and anadromous fish from Puget Sound, Washington: Results from the Puget Sound Ambient Monitoring Program Fish Component, 1989-1999. Technical Report FTP01-14, Washington Department of Fish and Wildlife, Olympia, WA.

3. Puget Sound Forage Fish Monitoring and Assessment

Pacific Herring Fisheries *(Contributed by Greg Bargmann (360) 902-2825)*

Fisheries for adult herring remain closed throughout Washington waters. A small fishery for juvenile herring for use as bait continues to operate. Spawning abundance of herring continues to be generally increasing over the low levels seen throughout most of the 1990's. Spawning populations remain low at Cherry Point near Bellingham and at Discovery Bay in the eastern Strait of Juan de Fuca.

Herring Stock Assessment *(Contributed by Mark O'Toole (360) 466-4345 ext 241)*

Herring spawning biomass estimates were completed for nineteen spawning grounds in Puget Sound and two coastal grounds in 2001. Stock assessments for the 2002 season are not yet completed. Spawning biomass is estimated for each area by spawn deposition surveys and/or acoustic/trawl surveys.

Herring spawner abundance in 2001 continued the general trends observed in recent years, with: 1) relatively high abundance for central and south Puget Sound stocks, 2) average abundance for north Puget Sound stocks (with the exception of the Cherry Point stock, which has been very low since 1997), and 3) very low abundance for the Strait of Juan de Fuca stocks (which traditionally is dominated by the Discovery Bay stock).

Documented herring spawning grounds in Grays Harbor continue to be expanded since a limited survey effort was started there in 1998.

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									
STOCK	**2001**	**2000**	**1999**	**1998**	**1997**	**1996**	**1995**	**1994**	**1993**	**1992**
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 *(Contributed by 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.

Exempted Fishing Permits

The Council approved an exempted fishing permit (EFP) for an arrowtooth flounder fishery conducted in August and September 2001, and to be continued in 2002. The arrowtooth EFP fishery is part of the Department's At-Sea Data Collection Program funded by federal Disaster Relief monies, and the primary purpose is to use at-sea observers to measure bycatch rates for canary and other rockfish associated with the arrowtooth flounder trawl fishery. This will allow future management of the fishery to be based on correct estimates of bycatch and may permit higher trip limits of arrowtooth as a result. To measure bycatch rates for canary and other rockfish associated with the arrowtooth fishery, fishers were required to carry Department-provided observers onboard their vessels for all fishing activities during the two months of the experiment.

Preliminary results of the experimental fishery indicate that it was a success. The canary bycatch in directed arrowtooth tows was 0.09% and 2.10% in non-directed tows. The average canary bycatch rate across all tows was 0.28%. In looking at the canary bycatch by month, the August rate was 0.55% and the September rate was 0.13% which could indicate that, in general, arrowtooth catch went up while canary catch went down. While this could reflect the availability of the two species, it also suggests that the vessels became more effective in minimizing their canary bycatch in the arrowtooth fishery as time went on. These preliminary results were presented to the Pacific Fishery Management Council in November 2001. A more thorough analysis of the bycatch in the experimental fishery will be completed in 2002. The second phase of the experiment will be conducted in May-August 2002, which will be followed by a more detailed analysis of the two-year program.

Overfished Species

Yelloweye rockfish was added to the PFMC list of overfished species, based on a stock assessment conducted in the summer of 2001. Data indicates that the yelloweye rockfish stock north of Cape Mendocino are at 13% of the unfished spawning biomass. Under the Pacific

Fishery Management Council's groundfish fishery management plan, stocks which are below 25% of the unfished spawning biomass are considered overfished and legally require a rebuilding plan. At its November 2001 meeting, the PFMC adopted a coastwide harvest guideline of 11 mt (commercial and recreational) for yelloweye rockfish in 2002 and recreational rockfish seasons. To put things in perspective, the 2001 Washington recreational fishery alone took 15 mt; therefore, harvest yelloweye rockfish must be significantly curtailed this year.

West Coast Groundfish Observer Program

The National Marine Fisheries Service (NMFS) began the West Coast Fishery Observer Program in August 2001. Current funding is providing for 20 experienced observers who are stationed among 13 port groups coastwide. The sampling plan is designed to provide in the first year at least 10% coverage coastwide for the limited entry trawl fleet and pilot observer coverage in the limited entry fixed gear sablefish and rockfish fisheries. In addition, one or two observers will be allocated to a pilot program on overages.

The primary goal of the observer program is to improve management of groundfish by improving the estimate of total catch, mainly through ongoing collection of information on discarded catch which will complement current shoreside information on landed catch. Also, fishery and resource management can be improved through the collection of groundfish biological information and the catch of prohibited species. NMFS, Pacific States Marine Fisheries Commission (PSMFC) and the states will cooperate to manage the observer program. NMFS will be responsible for training, debriefing, and coordinating observers; designating which vessels are to carry observers; determining observer assignments; data entry; and database development and maintenance. Through a contract with an experienced provider of observer services, PSMFC will hire, equip, insure, and transport observers. In addition, PSMFC will work with the states who are providing coordination with current shoreside fishery sampling and other support for the observers.

Groundfish Multi-Year Management Committee

At the November 2001 PFMC meeting, the Council appointed an ad hoc committee to scope multi-year management approaches for the West Coast groundfish fishery. Multi-year management of the groundfish fishery would be synchronized with a multi-year groundfish stock assessment schedule. Full accommodation of federal notice and comment requirements would also be incorporated into the multi-year cycle.

2. Coastal Groundfish Monitoring, Research, and Assessment

Pacific Whiting Stock Assessment Review (STAR/PSARC) Panel *(Contributed by Tom Jagielo (360) 902-2837)*

In February 20-22, 2002, Tom Jagielo (WDFW) co-chaired a bi-national US-Canada Stock assessment review panel for Pacific Whiting (hake). The Canadian co-chair was Alan Sinclair, of the Department of Fishes and Oceans (DFO). The purpose of the Panel was to evaluate the technical merits of the hake stock assessment for use by managers for the 2002 fishing season.

Dr. Tom Helser (NMFS-NWFSC) provided an overview of the assessment, and NMFS 2001 acoustic and shelf trawl survey results were summarized by Mark Wilkins (NMFS) and Michael Guttormsen (NMFS), respectively. Mark Saunders (DFO) summarized the results of the 2001 Canadian acoustic survey. During their presentations and over the course of the 3-day review, the Stock Assessment Team (STAT) provided additional information and data at the request of the Panel that greatly assisted the Panel in carrying out its work.

The Panel agreed with the Helser et al. (2002) assessment that the best estimate of 2001 stock abundance is 0.7 million mt, and concurred with the assessment methods used in the analysis. The Panel noted that:

- Stock size has declined continuously over the past four years to its lowest point of 711 thousand mt in 2001.
- The exploitation rate increased from below 10% prior to 1993, to 31% in 2001.
- The mature female biomass in 2001 is estimated to be 20% of an unfished stock.
- Mature female biomass is projected to rise over the next three years as the above average 1999 year class enters the mature biomass of the stock.
- The percentage of unfished stock size, and the future yield trajectory, depend heavily on the estimated strength of the 1999 year class, persistance in the recent increases in weight-at-age, and harvest policy chosen.

The Panel offered the following recommendations for future work (not prioritized):

- The next assessment should include a detailed description of the catch monitoring and sampling regime for each fishery.
- Possible explanatory factors for the dome-shaped selectivity curve should be further explored prior to the next assessment.
- The assumption of a constant maturity ogive should be examined in the next assessment.
- Reasons for the poor model fit to the acoustic survey biomass estimates of abundance should be further explored and model runs employing the two time-stanza approach should be investigated further in the next assessment.
- Given concerns with the current formulation of the stock reconstruction model and the dependence of yield options beyond 2002 on continued recruitment of the 1999 year-class and recruitment from year-classes not actually observed, the Panel recommends against adopting 2003 projections until another assessment is conducted.

Literature Cited:

Helser, T.E., M. W. Dorn, M.W. Saunders, C.D. Wilson, M.A. Guttormsen, K. Cooke, and M.E. Wilkins. 2002. Status of Pacific hake/whiting stock in U.S. and Canadian waters in 2001.

Demersal Groundfish Submersible Survey Methodology Development *(Contributed by Tom Jagielo (360) 902-2837)*

Tom Jagielo, Annette Hoffmann, and Jack Tagart (WDFW) and Mark Zimmermann (NMFS-AFSC) completed a manuscript entitled: "*Demersal Groundfish Densities in Trawlable and Untrawlable Habitats off Washington: Implications for Estimation of the Trawl Survey Habitat Bias*". The manuscript has been submitted to Fishery Bulletin for pre-publication review. This work resulted from a National Undersea Research Program (NURP) grant, which funded field work conducted in 1998 using the submersible *Delta*. An abstract of this manuscript follows:

Demersal groundfish densities were estimated by conducting a visual strip-transect survey via manned submersible within a 13,800 hectare study area on the continental shelf off Cape Flattery, Washington. The purpose of this study was to evaluate the statistical sampling power of the submersible survey as a tool to discriminate density differences between trawlable and untrawlable habitats.

A detailed geophysical map of the study area was prepared with side-scan sonar imagery, multibeam bathymetry data, and the locations of historical NMFS trawl survey events. Forty seven submersible transects were completed at sixteen randomly selected dive sites, with eight dive sites located in each habitat type. Significant differences in density between habitats were observed for lingcod (*Ophiodon elongatus*), yelloweye rockfish (*Sebastes flavidus*), and tiger rockfish (*S. nigrocinctus*) individually, and for “all rockfish” and “all flatfish” in the aggregate. The mean density of rockfish and lingcod was higher in the untrawlable habitat, while the mean density of flatfish was higher in the trawlable habitat.

Sample size guidelines and implications for estimation of the continental shelf trawl survey habitat bias are considered. The results suggest that when the relative proportions of untrawlable and trawlable habitat, as well as the variability in the trawl survey estimates of abundance are taken into consideration, the problem of estimating the trawl survey habitat bias can require substantially more samples than would be required to simply compare the density differences between two habitat types. We demonstrate an approach that can be used to establish sample size guidelines for future work, by illustrating the interplay between statistical sampling power and 1) habitat specific density differences, 2) variance of density differences, and 3) the proportion of untrawlable area in a habitat.

Coastal Lingcod Rebuilding Analysis for PFMC *(Contributed by Tom Jagielo (360) 902-2837)*

In 1997, an assessment of lingcod prepared for the PFMC found that female spawning biomass estimates were below 25% of the unfished biomass level for the northern portion of the stock (Jagielo et al 1997). An analysis was subsequently prepared which indicated that rebuilding to the $B_{40\%}$ level was possible within 10 years at F=0 (Jagielo 1999). Based on the analysis for the northern area, a 10 year rebuilding plan was implemented by PFMC for the entire West Coast (Washington-Oregon-California). The rebuilding plan began in 1999 and set the target date of the start of 2009 for achieving the $B_{40\%}$ spawning stock size.

More recently, a new coastwide assessment for lingcod was conducted in 2000 (Jagielo et al 2000). The new assessment provides separate estimates of spawning stock biomass for the northern (LCN: US-Vancouver and Columbia) and southern (LCS: Monterey, Eureka, Conception) areas. Spawning stock size estimates have increased since 1997 in both areas, indicating progress toward the rebuilding target since the implementation of coastwide catch reductions.

The present rebuilding analysis utilizes information from the most recent stock assessment and conforms to the SSC Terms of Reference for Groundfish Rebuilding Plans. The analysis provides new rebuilding trajectories for both the northern and southern areas that provide for lingcod rebuilding within the time frame originally established by PFMC in 1999. The analysis uses the SSC Default Rebuilding Analysis software developed by Punt (2001). For each area, data inputs included: 1) spawning output by age (the product of the weight-at-age and % maturity-at-age vectors); 2) sex-specific natural mortality; 3) age specific weight (kg), selectivity, and numbers of fish for the year 2000; and 4) vectors of annual recruitment (age 2 fish) and spawning biomass estimates (1973-2000). Age specific data were input for ages 2-20+, with 20+ serving as an accumulator age. The population projection was configured to begin in 2001 with rebuilding occurring by the start of 2009 (year 10 from the original rebuilding start year of 1999). Catches were pre-specified for 2001, and were derived from the projections for the years 2002-2008.

Separate estimates of B_0 were computed using random draws from 1) the full time series of recruitment estimates (1973-1995), and 2) the time series of early recruitments (1973-1982). Distributions of the simulated B_0 estimates under these alternative recruitment scenarios indicated a marked difference for the northern area, but little difference for the southern area. For both areas, the full recruitment time series B_0 scenario was selected for the rebuilding projection analysis. Comparison of the spawning stock estimates for 2000 with the full recruitment time series estimates of B_0 indicate that the recent coastwide spawning population size is approximately 15% of the unfished population size.

The median time to rebuild at F=0 was determined by the previous lingcod rebuilding analysis to be 5 years, and the maximum time allowed to rebuild (T_{max}) was established by PFMC to be 10 years (by the start of 2009) (Jagielo 1999). The present analysis confirmed that rebuilding could

occur within 10 years with no fishing; the median time to rebuild at F=0 was estimated to be 3.6 years for the northern area, and 4.8 years for the southern area.

Population projections were conducted using the "recruits" in lieu of the "recruits-per-spawner" option provided by Punt (2001). The basis for this choice was the lack of a credible spawner-recruit relationship for lingcod. This is evidenced particularly for the northern area, where the ratio of recruit/spawning output increased substantially from 1987-1993 -- a period where the trend in spawning stock size was decreasing. Recruitments for the LCN and LCS projections were randomly drawn from the values estimated from the most recent years (1986-1995) in the assessment (Jagielo et al 2000).

Estimates of fishing mortality, median years to rebuild, and OY (mt) for 2002-2009 were computed for alternative probabilities of achieving the rebuilding target by start of 2009--50%, 60%, 70% and 80%--as well as the 40-10 and F=0 policies. For the alternative with 60% likelihood of rebuilding, coastwide yields ranged from 577 mt in 2002, to 1022 mt in 2008.

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Jagielo, T., P. Adams, M. Peoples, S. Rosenfield, K. Silberberg, and T. Laidig. 1997. Assessment of lingcod (*Ophiodon elongatus*) for the Pacific Fishery Management Council in 1997. In: Status of the Pacific Coast groundfish fishery through 1997 and recommended biological catches for 1998. Stock assessment and fishery evaluation. Pacific Fishery Management Council, Portland, Oregon.

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Punt, A.E. 2001. SSC Default Rebuilding Analysis. Technical specifications and user manual. Ver. 1.000003 (July 2001).

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 15th year in 2001. 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.

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.

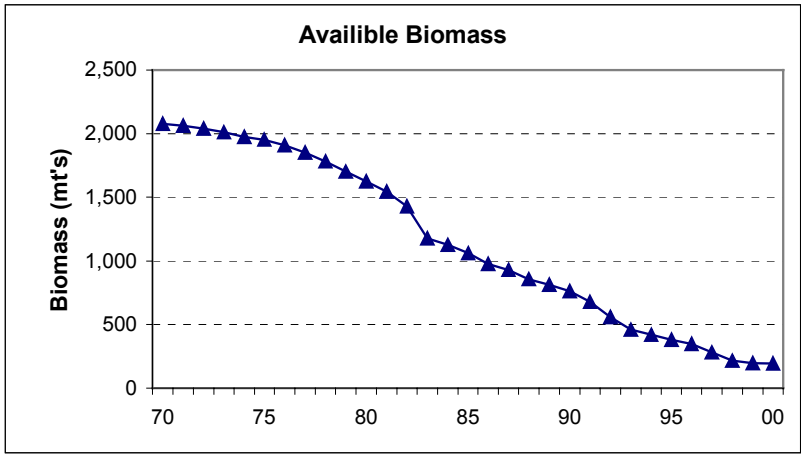
Coastal Yelloweye Stock Assessment for PFMC *(Contributed by Farron Wallace (360) 249-4628)*

This assessment incorporated two separate assessments corresponding to yelloweye rockfish (*Sebastes ruberrimus*) found in waters off the northern California coast (PMFC areas 1B and 1C) and from waters off the Oregon coast (Wallace 2001). An assessment model was not developed for Washington due to limited length and age composition time series. Because of differing sport CPUE trends, aggregating Washington and Oregon data into a single model was not justified.

Two length-based Stock Synthesis models were used to derive population trends for northern California and Oregon. Auxiliary indices of abundance from the NMFS triennial trawl survey and halibut longline survey (Halibut Commission) were examined but rejected. The northern California assessment includes two sport CPUE indices constructed from Marine Recreational Fishery Statistical Survey (MRFSS) sample data and CDFG data collected on-board Commercial Passenger Fishing Vessels (CPFV). The Oregon assessment model includes a sport CPUE index derived from ODFW estimated bottomfish effort and yelloweye catch. Both assessment models are for combined sexes, include two fisheries, sport and commercial spanning 1970-2000. Length composition data are available beginning 1978 and 1980 for the northern California and Oregon assessment, respectively.

Northern California

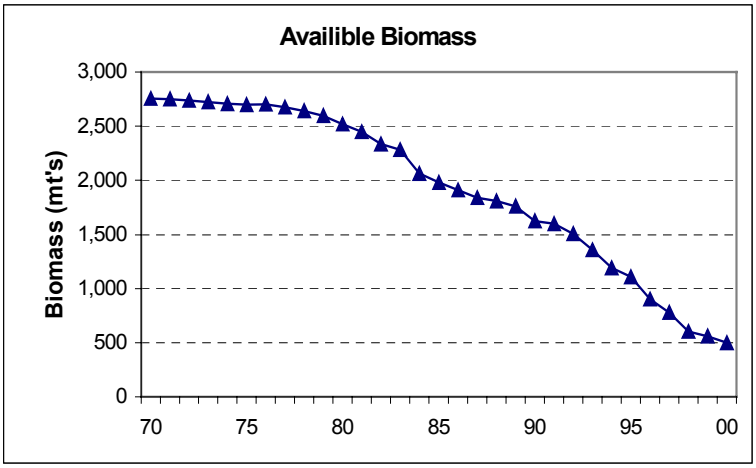
Results from the Stock Synthesis model indicate that stock biomass has significantly declined throughout the time series. Current spawning biomass is estimated to be approximately 7% of the unfished spawning biomass.



	Biomass (mt)	
Year	Begin Year	Spawning
90	760	280
91	678	245
92	558	199
93	458	164
94	420	151
95	380	137
96	346	123
97	280	99
98	214	79
99	198	74
00	194	73

Oregon

Results from the Stock Synthesis model indicate that stock biomass has significantly declined throughout the time series. Current spawning biomass is estimated to be approximately 13% of the unfished spawning biomass.



	Biomass (mt)	
Year	Begin Year	Spawning
90	1626	593
91	1600	569
92	1508	520
93	1357	454
94	1193	397
95	1110	362
96	903	296
97	778	255
98	603	207
99	562	198
00	500	182

Recruitment

Northern California

Recruitment is variable across the time series and parallels a decreasing trend in population biomass. The last above average recruitment was 1987 (age 3 recruits) and recruitment failure is apparent during the last decade.

Oregon

Recruitment estimates are quite variable and imprecise across the time series. Above average recruitment (age 3 recruits) occurred during 1986 and 1987, but recruitment failure is evident during the last decade.

Exploitation status

Northern California

Commercial exploitation rate peaked at over 25% in 1997 decreasing to less that 1% in 2000. Exploitation rate in the sport fishery peaked at over 10% in 1985 decreasing to less than 5% in recent years.

Oregon

Commercial exploitation rate peaked at over 30% in 1997 decreasing to less that 2% in 2000. Exploitation rate in the sport fishery has been at or below 3% across the time series.

Recommendations: research and data needs

Additional effort to collect age and maturity data is essential for improved population assessment. Collection of these data may be necessary by onboard observers if this species becomes prohibited. Increased effort toward habitat mapping will provide information on essential habitat and distribution for this species. Development of fishery independent indices will be necessary as allowable catch becomes restricted. A study of the role of MPAs in harvest management will be beneficial for yelloweye rockfish and other sedentary species. Genetic study is required as a first step in delimiting stock boundaries for this species.

Literature Cited:

Wallace, F. 2001. Assessment of yelloweye rockfish In: Status of the Pacific Coast groundfish fishery through 2001 and recommended biological catches for 2002. Stock assessment and fishery evaluation. Pacific Fishery Management Council, Portland, Oregon.

Evaluation of Survey Methods for Nearshore Rockfish *(Contributed by Tom Jagielo (360) 902-2837).*

In 2001, 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. Tom Jagielo (WDFW) met with project engineer John Kloske (HBOI) and Delta Oceanographics personnel Doug Privitt and Chris Ijames at the Delta Oceanographics shop in Los Angeles in late February to install the 3-beam system on the *Delta* submersible. 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 basic performance of the 3-beam system was tested during the installation process, and the system was found to be operational under shop conditions. During our work with the system, a number of items requiring follow-up attention were identified and conveyed to Donna Kocak, software engineer (HBOI). John is working with Donna to resolve the remaining work items, and we expect to have the system ready for field use in time for our summer 2002 dive schedule.

Our original field plan with PSMFC-IJFA funds for the summer of 2002 was for 5 submersible dive days. We have been successful in obtaining additional funds to bring the 2002 field plan up to a 15 day dive plan. Funding for the additional 10 dive days will be provided by the National Marine Fisheries Service, Northwest Fisheries Science Center (NMFS-NWFSC).

The objectives of the 2002 field work are: 1) to evaluate the performance of the new 3-beam quantitative measurement system under field survey conditions, and 2) to conduct a survey to estimate the density 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). Our plan is to stratify the US-Vancouver area into trawlable and un-trawlable habitat classifications using ArcView coverages of untrawlable habitat provided by NMFS Alaska Fisheries Science Center. We plan to execute a random sampling survey design within the untrawlable habitat utilizing the 3-beam system on board the *Delta* from August 12th-through August 29th.

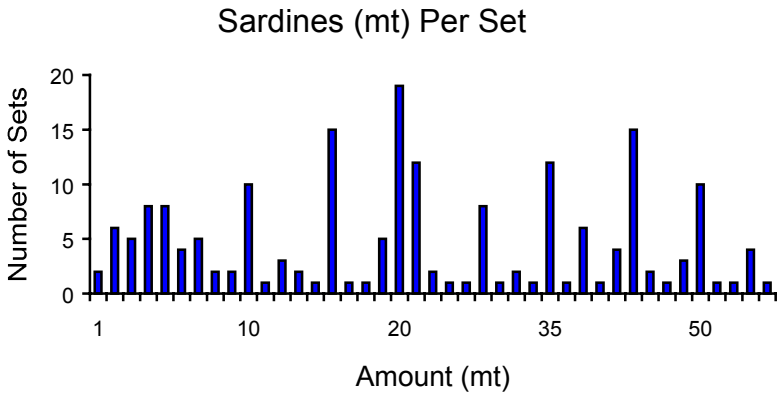
3. Coastal Sardine Management *(Contributed by Michele Robinson, (360) 249-1211 and Brian Culver, (360) 249-1205)*

Trial Purse Seine Fishery for Sardines

In Washington, sardines are managed under the Emerging Commercial Fishery provisions as a trial commercial fishery. In response to a request from Washington-based fishers and processors, the Washington Fish and Wildlife Commission approved trial ocean purse seine sardine fisheries for 2000, 2001, and 2002. The target of the trial fishery was sardines; however, anchovy, mackerel, and squid could also be landed.

The 2001 trial purse seine fishery for sardines fishery opened on May 15, 2001; however, the first landing into Washington occurred on June 19. The Department issued a total of 40 permits and 13 permit holders participated in the fishery. The Fish and Wildlife Commission set an annual harvest guideline for the 2001 fishery of 15,000 mt. A total of 10,837 mt of sardines were landed

into Washington, which is more than twice the amount landed in 2000 (4,791 mt). A total of 299 landings were made (compared to 153 landings in 2000) and 128 occurred within the



month of July. The majority of the landings (79%) were made into Ilwaco, and 43% of the catch occurred in waters adjacent to Washington.

The Department provided observer coverage for the fishery and averaged about 24% coverage overall. Observers collected total catch data including species, amount, and condition, and noted whether the fish were released or landed. Bycatch included Chinook and coho salmon, spiny dogfish, blue shark, and other species of fish.

Department staff also collected and processed biological samples (n=1,450 samples). Otoliths were extracted and sent to the California Department of Fish and Game laboratory in La Jolla for age-reading. Data collected on the samples include standard lengths, individual weights, sex, and maturity.