Washington Contribution to the 2005 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 Management Activities *Contact: Greg Bargmann (360) 902-2825)*

Dogfish Sharks

An international conference on dogfish sharks is being held in Seattle in mid-June at the University of Washington. Sponsors are the Canadian Department of Fish and Oceans, the University of Washington, the Puget Sound Action Team and WDFW.

Details can be found on the WDFW web site at:

http://wdfw.wa.gov/fish/dogfish_conference/index.htm

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

Staff of the Puget Sound Marine Fish Science Unit includes Wayne Palsson, Robert Pacunski, Tony Parra, Jim Beam, Karl Mueller, and Jamie Selleck. Their tasks are primarily supported by supplemental funds from the Washington State Legislature for the recovery of Puget Sound bottomfish populations. Most of the work of the staff is associated with the Puget Sound Ambient Monitoring Program (PSAMP) and is tasked by the Puget Sound Action Team. The main activities of the unit include the assessment of bottomfish populations in Puget Sound and the evaluation of bottomfish in marine reserves. This year, additional grants and contracts were received for special studies regarding marine fish habitat modifications and marine reserves in Puget Sound.

A major effort was undertaken this year to assess the status and biology of rockfishes in Puget Sound. A draft document was nearing completion at the end of 2004 that included the results of most sampling programs reviewed below.

Puget Sound Marine Habitat Studies

Wayne Palsson and Robert Pacunski collaborated with Professors Don Gunderson of the University of Washington and Gary Green of Moss Landing Marine Labs in a Washington Sea Grant study to examine the distribution of marine fishes in relation to the distribution of different sea floor habitats in the San Juan Archipelago that were mapped Dr. Greene through the NOAA/CCS and other grants. San Juan Channel was mapped with a high-resolution multi-beam echosounder that collected detailed bathymetric and back-scatter information. These data were processed into geological formations based upon a hierarchical scheme of geomorphology that were condensed into four fish habitat types: Soft, Coarse, Complex Bedrock, and Smooth Bedrock. These subtidal habitats in San Juan Channel were stratified into North and South, Shallow and Deep, and Fished and Reserve treatments, and an ROV survey was developed to test the null hypothesis that rockfish, lingcod, and other marine fish are distributed independently

of habitat type, location, depth, and reserve status. The ROV was deployed at randomly selected starting points within each treatment and was piloted along the bottom in a direction to allow a consistent forward direction. An acoustic tracking system allowed us to navigate transects ranging from 0.1 nm to 0.2 nm in length. Transect widths were determined from a two parallel lasers mounted on a color video camera. All transects were video taped and analyzed in the laboratory for fish species, number, and sizes, invertebrates, and geomorphology.

Fifty-seven transects were conducted in San Juan Channel within 13 of the possible 16 treatment combinations. Rockfishes were almost exclusively distributed on the complex bedrock habitats in both northern and southern channel. Other complex habitat species included lingcod and kelp greenling. Smooth bedrock classification was not consistent with the observed habitat that ranged from cobble-pebble coarse sediments to fractured bedrock. Rockfishes were observed in fine-scale habitats that consisted of complex bedrock and boulder. Other marine fish species occupied the coarse and soft habitats including Pacific cod, walleye pollock, and red Irish lords.

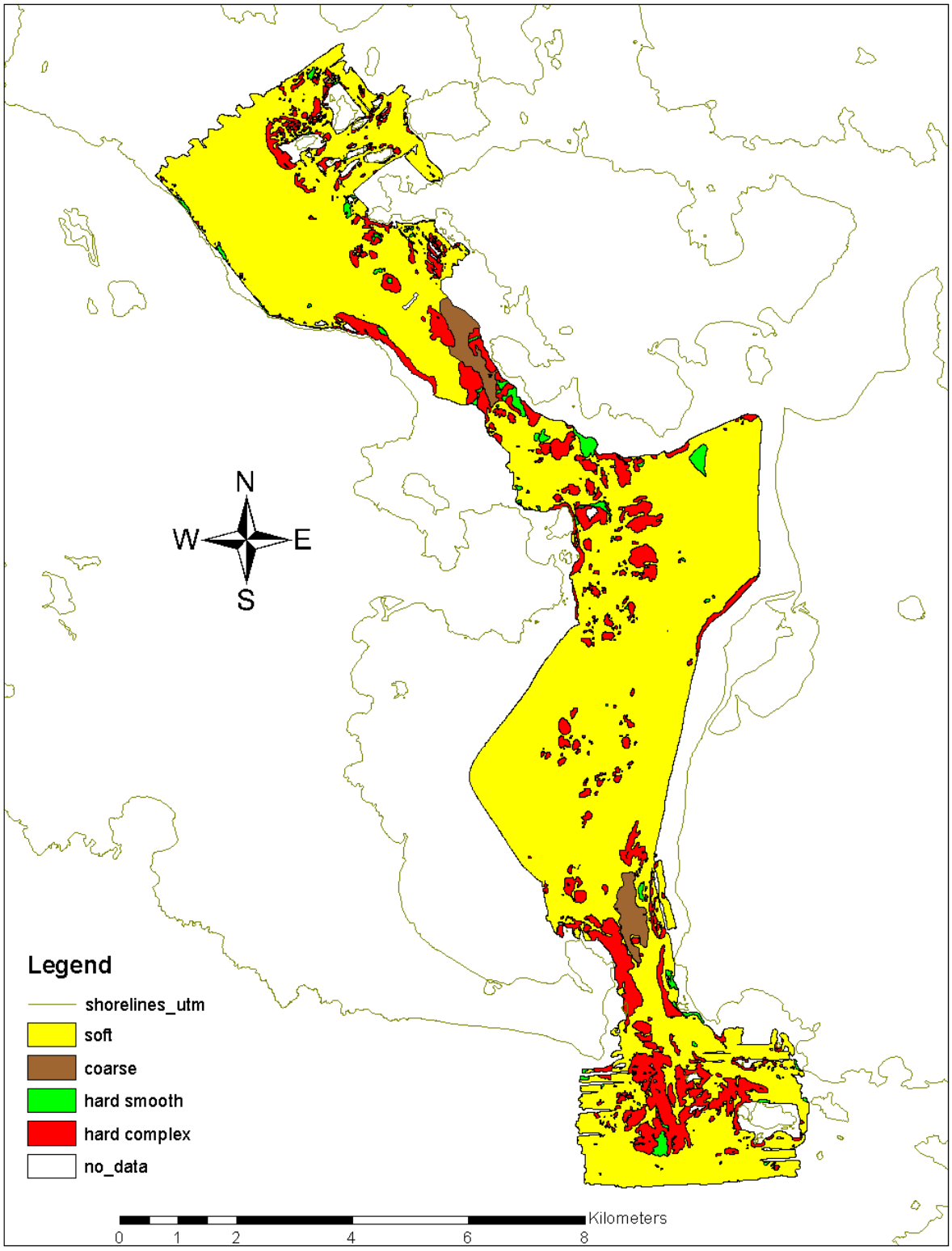

Figure 1. Initial stratification of geological habitats in San Juan Channel.

Evaluation of No-Take Refuges for Rocky Habitat Fishes

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.

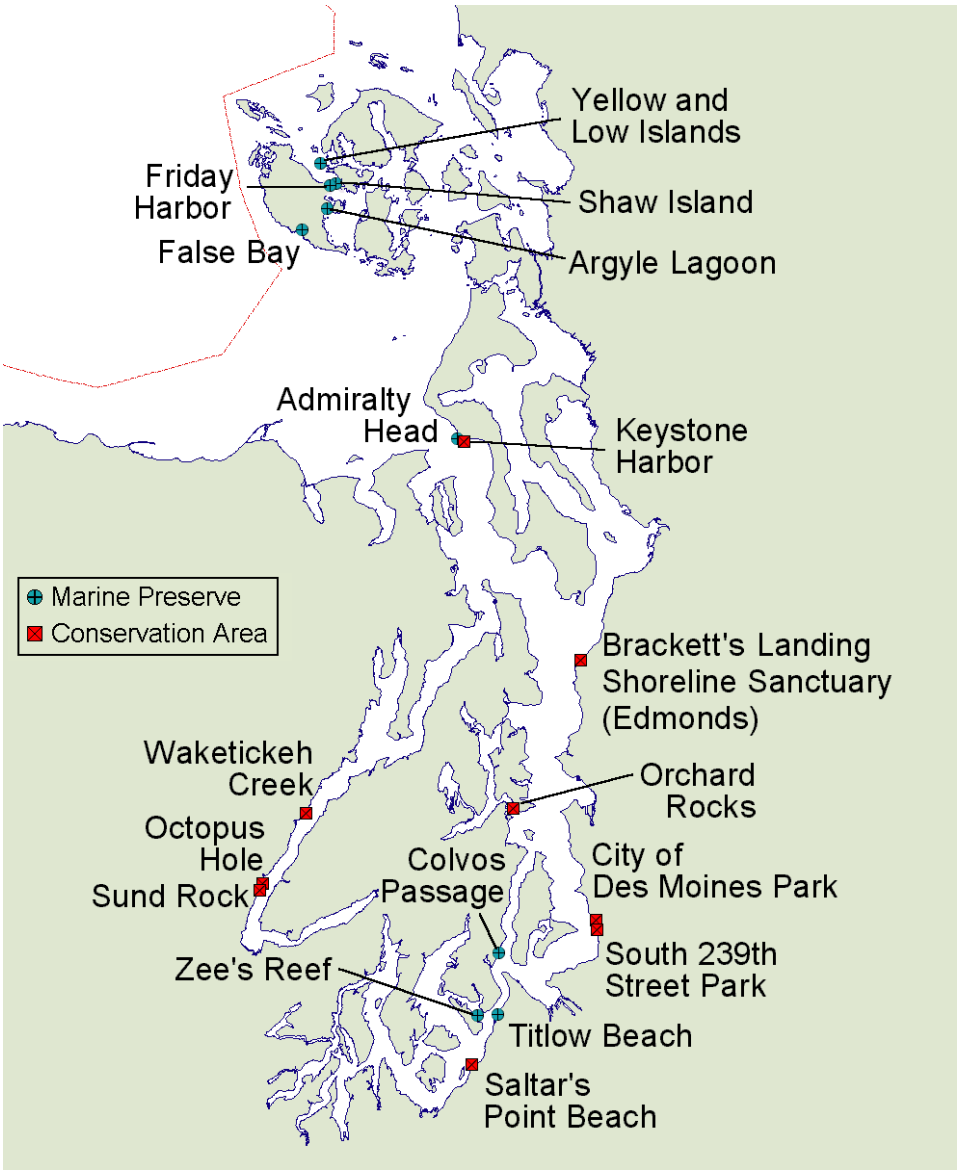

Figure 2. WDFW non-tribal marine reserves in Puget Sound. Conservation Areas are fully-protected, Marine Preserves are partially-protected.

Specific monitoring activities in 2004 included surveying many of the Puget Sound reserves and comparable fished sites. Several reserves in central Puget Sound were visited six times during 2004 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 in 2002 with six surveys conducted again in 2004. The reserve at Colvos Passage was also monitored during the same survey series.

The marine reserve monitoring studies conducted in the San Juan Islands, Hood Canal, and Central Puget Sound were analyzed and the results presented at the 2004 Western Groundfish Conference held in Victoria, B.C. The results confirmed those previously reported that most marine reserves had higher densities of copper rockfish and lingcod than comparable and nearby fished areas. These fishes were also larger in the long-term reserve at Edmonds (Brackett's Landing) than at the fished areas. 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 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. 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.

The analysis also found a major change at the long-term reserve at Edmonds. 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 (See Below). An expanded abstract of this analysis was published as the following citation and can be found under publications at www.psat.wa.gov.

Palsson, W.A., R.E. Pacunski, and T.R. Parra. 2004. Time will tell: Long-term observations of the response of rocky habitat fishes to marine reserves in Puget Sound. In: 2003 Georgia

Basin/Puget Sound Research Conference Proceedings, T.W. Droscher and D.A. Fraser, eds. Puget Sound Action Team, Olympia.

Ecological Succession and Trophic Cascades in Puget Sound Marine Reserves

With major funding from the Conservation and Re-investment Act Fund, administered by the U.S. Dept. of the Interior, the MFSU received a grant to examine the prey and predator relationships the array of long-term and newer reserves within Puget Sound as well as nearby fished areas. Karl Mueller was the lead biologist for this project. The grant was initially developed for a three-year study but was cut back to 1.25 years during the first year. The field work was completed during the contract period and an initial analysis was conducted. The amended work plan included the following objectives: 1.) Develop protocols for monitoring prey species in an array of old and new marine reserves, 2.) Implement biodiversity monitoring in a range of old to new reserves, 3.) Interface biodiversity monitoring with existing surveys for managed species, and 4.) Review predator-prey literature for northwest rocky habitat species, identify data gaps, and recommend further studies.

Protocols for monitoring small fishes, invertebrates and other potential prey species in marine reserves were developed during a pilot study completed in September 2003. Several transect and quadrat sampling techniques were tested using scuba visual census methods. We selected a 0.5 m^2 quadrat placed randomly within rocky habitats to estimate the density of small supra-benthic fishes and invertebrates that are known prey items of rockfish, lingcod, and other predaceous bottomfish.

A two-season study was implemented during Fall 2003 and spring 2004 at seven old and new marine reserves and four comparable fished areas in central and southern Puget Sound and Hood Canal. Thirty to 50 quadrat samples were collected from each study site during each season.

These sampling activities were conducted while other WDFW scuba teams surveyed the same sites for lingcod, rockfish and other, larger rocky habitat fishes. Finally during the study period, we conducted a literature survey to identify existing knowledge on diet, abundance, trends, and succession of marine species.

Final analysis and reporting of the results are pending.

Low Dissolved Oxygen Conditions at Sund Rocks Marine Reserve

Hood Canal is a fjord connected to Puget Sound in the north and extending 100 km to the south (Figure 1). The steep sides of the canal extend to depths of 180 m in the north and range to depths of over 125 m for most of the water body. Hood Canal is one of the water bodies identified in the Pew Ocean Commission report as a hypoxic dead zone. Dissolved oxygen (DO) concentrations of less than 2 mg/l have been observed for decades in deep and shallow waters in the southern portion of the canal (Warner et al. 2002; Collias 1974), and these low concentrations have been attributed to naturally poor circulation resulting from low estuarine

flow and bottom water replacement. In recent years, low DO concentrations have become chronic, extending into nearshore waters and possibly becoming worse due to eutrophication (J. Newton, Wash. Dept. of Ecology, pers. comm). Mass mortality events of fishes and invertebrates (Fish Kills) in 1926 and 1963 likely have resulted from poor water quality.

Beginning in 2001, WDFW began surveying marine fishes with respect to depth at the Sund Rocks Reserve. Two discrete and prominent rocky habitats located north and south of each other were surveyed independently. A team of three divers conducted the visual surveys. One diver swam the 9 m isobath and oriented the two recording divers along the longitudinal axis of each survey area. The two divers swam along predetermined depth zones and identified, counted, and measured key fish species along the rocky outcropping. The divers swam close together to coordinate their observations and not double count fishes. Total length measurements to the nearest 10 cm meter were made with the aid of a graduated plastic rod.

DO concentrations were obtained from the Washington Department of Ecology's Marine Water Monitoring group, the University of Washington's PRISM program, and citizen monitors with the Hood Canal Salmon Enhancement Group. The data were collected by calibrated continuous oxygen sensors or with water samples and subsequent laboratory titration.

Dive surveys at both the North and South Sund Rocks sites in November 2001 found that copper rockfish were distributed evenly from a depth of 5 m to a depth of 20 m and were generally not present in depths of less than 5 m. Monthly monitoring by WDOE revealed that DO concentrations were at least 3 mg/l in waters shallower than 20 m. In October 2002, we found rockfish were almost exclusively concentrated in depths of less than 7 m during a period when DO concentrations were greater than 4 mg/l in shallow water and less than 2 mg/l at greater depths. Rockfish were distributed evenly to 20 m in depth again by November 2002 when rains restored circulation and DO concentrations were once again greater than 4 mg/l in the nearshore zone.

During the 2002 and 2004 low DO events, dead fish were not observed. On October 10, 2003, a fish kill was observed along the western edge of southern Hood Canal. WDFW divers observed dozens of dead copper rockfish, 24 other fish species, and many invertebrates along the shore and during census dives. Eighty dead copper rockfish were measured and they tended to be smaller than the live fish observed during the survey dives. The dive surveys also revealed that only half of the previous counts of copper rockfish were present . These numbers remained low during the subsequent November survey.

These field observations revealed that copper rockfish are hypoxia intolerant and cannot tolerate DO concentrations below 2 mg/l. The observed avoidance behavior is similar to the response of other marine fishes to low dissolved oxygen in Chesapeake Bay and other coastal waters where low dissolved oxygen limits the amount of available habitat (Breitburg 2002). The widespread occurrence of poor water quality in southern Hood Canal has many ramifications for sustainable fisheries pursued by tribal and recreational fishers and for the location and design of marine reserves in the area. Further work is planned for determining the causes of worsening water quality and the impact on marine resources.

Second Tacoma Narrows Bridge Mitigation Study

In March 2003, the Washington Department of Transportation (WSDOT) and the Washington Department of Fish and Wildlife (WDFW) established a contract to fulfill part of the terms of the mitigation agreement for the construction of a second bridge at Tacoma Narrows, connecting Tacoma with the Kitsap Peninsula across Puget Sound. The contract establishes that staff from WDFW will conduct sampling at the bridge site to determine the impacts of the disruptive activities associated with the construction of the bridge upon marine fish communities at the bridge site. Primary areas of interest include the two caisson and pier sites, the proposed anchor sites, and the rip-rap fields that will be placed at the footings of the existing and new tower piers. As part of the mitigation, a new artificial habitat will be created at Toliva Shoal. This habitat will be configured as a structure that will potentially attract juvenile rockfishes and improve the existing artificial rocky habitat that was intended to attract adult rockfishes and lingcod.

The first quarter of work was focused upon obtaining video and diving observations at the SNB site before construction activities began disrupting the existing habitats. A plan was submitted to WSDOT detailing the plan for the construction of a juvenile reef at Toliva Shoal as a mitigation measure for the bridge construction. Third quarter activities included indexing videotapes collected during the first quarter, developing protocols to analyze those tapes, and beginning to quantify the habitat, fishes, and invertebrates in those tapes. The fourth quarter of work was focused upon obtaining video and diving observations in the vicinity of the SNB construction site, and establishing line transects to evaluate the proposed juvenile rockfish habitat at Toliva Shoal.

Quantitative Video Surveys for Assessing Rocky Habitat Fishes

Since 1994, Marine Fish Science staff has been conducting quantitative video surveys of nearshore rocky habitats in order to estimate population abundances of rockfishes, lingcod, greenlings, and other rocky habitat species. 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. The remaining Video Assessment Techniques is based upon the area-swept method of quantitative surveys. The camera mounted on a platform is anchored at randomly-selected sites on identified rocky habitats. The camera is panned three times during the deployment and the video information is taped. The visual range of the camera is the radius of the area sampled by the camera and the fishes identified and enumerated during the last pan are used with the area to determine a density. The density observations are averaged and then multiplied by the amount of nearshore rocky habitat in the region.

Analysis of video data collected in the past and the estimation of population abundance has been limited by difficulties in estimating the visual range of video plots. Since 1998, two parallel lasers mounted on the camera aid in the determination of the visual range, but range estimates beyond three meters and during previous surveys is difficult and comparisons between observers and with previous determinations of the visual range have resulted in differences between 0.5 m and 1.5 m. Robert Pacunski led an effort in 2003 to develop criteria and tests of the observer's ability to determine visual range. A series of grids and plots were set up underwater around the

video platform to measure the visual acuity of the camera. In separate tests without the grid field, wooden fish models were placed around the camera at random but known locations within and outside of the expected range of the camera without the knowledge of the observers. Their observations were then compared to the known locations. Generally, observer agreement was good within 3 m of the camera but became progressively poor to 6 m. which was near the functional limit of the camera. These tests provided the basis to objectively determine the visibility from past surveys and aid the determination of the visual range during current surveys.

In 2004, a quantitative video survey was conducted in the Strait of Juan de Fuca.

Robert Pacunski present a poster and oral paper at the 2004 Western Groundfish Conference reviewing past survey activities and results and presenting the details of the visual range standardization study.

2004 Bottom Trawl Survey of Northern Puget Sound

In 2004, funding for the Bottom Trawl Survey was increased and allowed a synoptic survey of waters east of the Sediu River and north of Port Townsend (Figures 3 and 4). The goals and objectives of this survey were to estimate the abundance and describe the distribution of recreational and commercial groundfish and macroinvertebrate species, collect biological information from key species, and evaluate the relationship of abundance and distribution of key species to oceanographic features and the need for transboundary management. The subregions included the eastern WA Strait (JE), the western WA Strait (JW), the San Juan Archipelago (SJ) and the US Strait of Georgia (GB).

The chartered *F.V. Chasina* was used as the sampling vessel which towed a 400 mesh Eastern net fitted with a 3 cm codend liner. Stations were selected with a stratified random approach based upon four depth zones for each of the subregions. The area sampled at each station was measured a 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. Abundance will be estimated by averaging station densities within each stratum and multiplying these by the stratum area. A total of 168 of 170 planned trawl stations were occupied and completed.

Figure 3. Trawl stations for the 2004 bottom trawl survey, Northern Part.

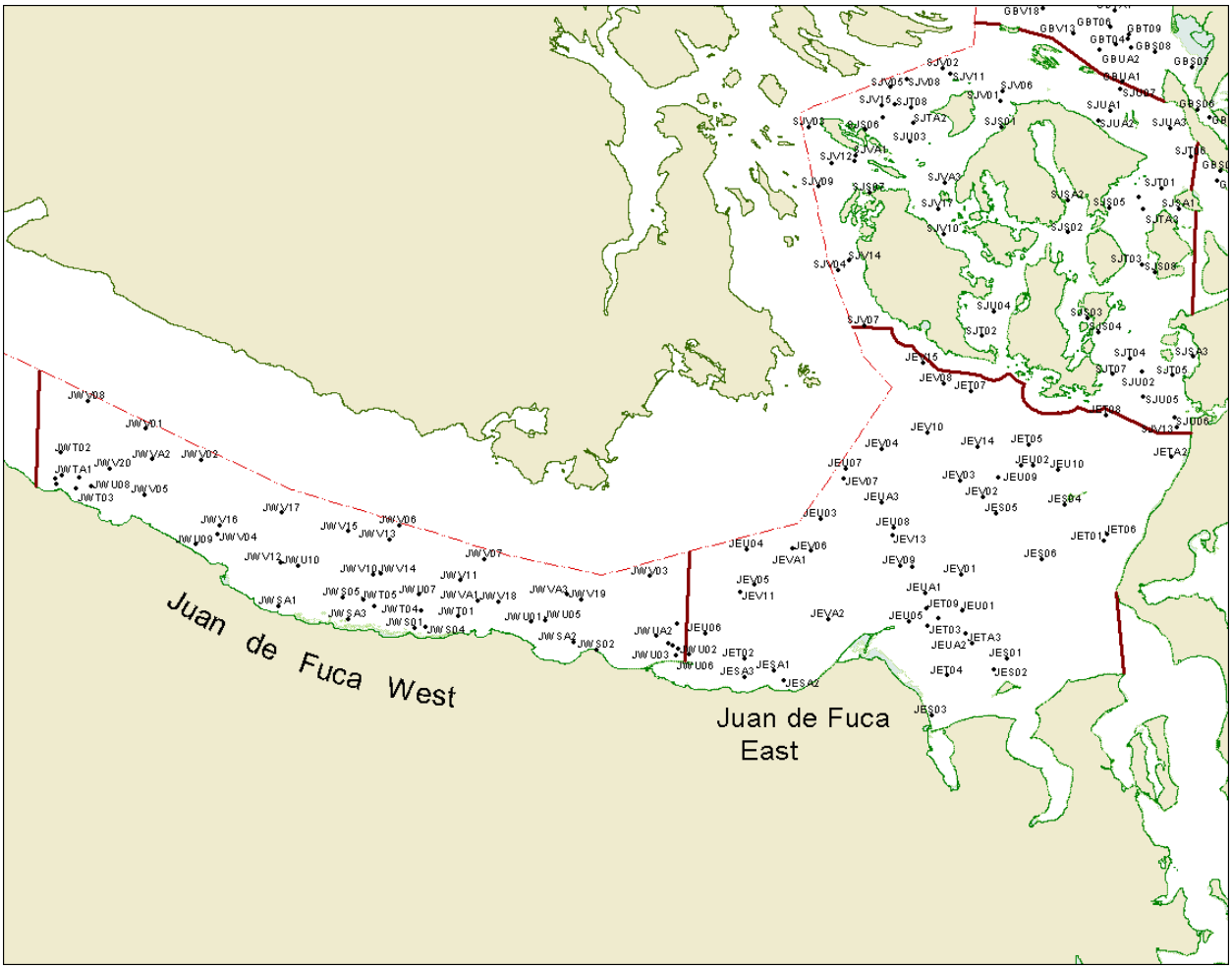

Figure 4. Trawl Survey Stations for 2004, Southern Part.

Two reports from past trawl survey reports were released and are available at www.wdfw.wa.gov:

Palsson, W.A., P. Clarke, S. Hoffmann, and J. Beam. 2002. Results from the 2000 transboundary trawl survey of the eastern Strait of Juan de Fuca and Discovery Bay. Wash. Dept. Fish Wildlife Report No. FPT 03-08, 76 p.

Palsson, W.A., S. Hoffmann, P. Clarke, and J. Beam. 2002. Results from the 2001 transboundary trawl survey of the southern Strait of Georgia San Juan Archipelago and adjacent waters. Wash. Dept. Fish Wildlife Report No. FPT 03-09, 109 p.

Literature Cited:

Breitburg, D. 2002. Effects of hypoxia, and the balance between hypoxia and enrichment, on coastal fishes and fisheries. Estuaries 25:767-781.

Collias, E.E., N. McGary, and C.A. Barnes. 1974. Atlas of Physical and Chemical Properties of Puget Sound and Its Approaches. Wash. Sea Grant..

Warner, M.J., M. Kawase, and J.A. Newton. 2002. Recent Studies of the overturning circulation in Hood Canal. 2001 Puget Sound Research Conference Proceedings. Puget Sound Action Team, Olympia.

3. Herring Stock Assessment *Contact: Kurt Stick (360) 466-4345 ext 243)*

Herring spawning biomass estimates were conducted on nineteen spawning grounds in Puget Sound and two coastal grounds in 2004. Stock assessment field work for the 2005 spawning season is in progress. Spawning biomass is estimated for each area by spawn deposition surveys and/or acoustic-trawl surveys.

The herring spawning biomass estimate for all Puget Sound stocks combined in 2004 is 12,007 tons, the lowest cumulative total since 1998. Central and south Puget Sound stocks are generally considered to be at average or above average levels compared to the previous 25 year mean.

The Cherry Point and Discovery Bay stocks are the primary significant Puget Sound stocks that continue to be at critically low levels of abundance. However, the Cherry Point stock spawning biomass estimate for 2004 (1,734 tons) was slightly higher than the 2003 estimate of 1,611 tons and is the highest observed estimate since 1996. The Cherry Point stock is currently under review for potential listing as endangered or threatened under the Endangered Species Act.

Estimated herring spawning biomass for 2004 for coastal stocks (Willapa Bay and Grays Harbor) was much lower than recent years. However, sampling there was limited primarily due to inclement weather conditions.

HERRING SPAWNING BIOMASS ESTIMATES (SHORT TONS) BY STOCK AND REGION, 1995-2004.
(blanks indicate no surveys done that year)

	YEAR									
	2004	**2003**	**2002**	**2001**	**2000**	**1999**	**1998**	**1997**	**1996**	**1995**
Squaxin Pass	828	2201	3150	1597	371	474	68	149	374	157
Wollochet Bay	52	152	106	133	142					
Quartermaster Harbor	727	930	416	1320	743	1257	947	1402	805	2001
Port Orchard-Port Madison	700	1085	878	2007	1756	2006	489	360	806	863
South Hood Canal	176	207	166	187	140	516	101	226	239	
Quilcene Bay	2342	916	2585	2091	2426	2464	1152	465	328	817
Port Gamble	1257	1064	1812	1779	2459	1664	971	1419	2058	3158
Kilisut Harbor	184	448	784	612	107	802	311	307	380	
Port Susan	429	450	1356	587	785	545	2084	828	110	363
Holmes Harbor	673	678	573	275	281	175	464	530	336	
Skagit Bay	1245	2983	2215	2170	646	905	209	893	736	891
South-Central Puget Sound Total	8613	11114	14041	12758	9856	10808	6796	6579	6172	8250
Fidalgo Bay	339	569	865	944	737	1005	844	929	590	1173
Samish/Portage Bay	351	299	496	470	196	555	643	509	636	194
Int. San Juan Is.	67	72	158	219	128	197		30	277	
N.W. San Juan Is.	0	13	131	62	90		107	79	53	
Semiahmoo Bay	629	1087	1012	1098	926	868	919	621	1219	1245
Cherry Point	1734	1611	1330	1241	808	1266	1322	1574	3095	4105
North Puget Sound Total	3120	3651	3992	4034	2885	3891	3835	3742	5870	6717
Discovery Bay	252	207	148	137	159	307	0	199	747	261
Dungeness/Sequim Bay	22	44	131	93	138	352	112	158	180	287
Strait of Juan de Fuca Total	274	251	279	230	297	659	112	357	927	548
Puget Sound Total	12007	15016	18312	17022	13038	15358	10743	10678	12969	15515
Grays Harbor	33	129	87	77	166	297	77			
Willapa Bay	0*	398	389	150	345	397	57	144		
*partial survey coverage										
Coast Total	33	527	476	227	511	694	134	144		

4. **Puget Sound Ambient Monitoring Program (PSAMP)** *Contact: Sandie O'Neill (360) 902-2843*

The Washington Department of Fish and Wildlife continues to be a key component of the Puget Sound Ambient Monitoring Program Project (PSAMP), a multi-agency effort to assess the health of Puget Sound. To assess how the health of the Sound is affected by chemical contamination of it's fish, the PSAMP Fish Component monitors "legacy" pollutants like PCBs and DDTs that persist in the ecosystem despite restrictions in their use, PAHs, which are compounds associated with petroleum and with combustion, heavy metals, and emerging toxics like PBDEs that are used as flame retardants. The following are summaries of projects we have been working on this past year.

Contaminant Levels in Pacific Herring

Since 1999, WDFW has annually monitored contaminant levels is whole bodies of Pacific herring at several sites in Puget Sound. The results of this ongoing monitoring were reported at the 2005 Research in Puget Sound Georgia Basin Conference and are summarized in the following abstract:

Persistent organic contamination in whole bodies of Pacific herring (Clupea pallasi) in Puget Sound, Washington: evidence of environmental segregation of stocks based on contaminant levels and patterns of contamination.

Presented by James E. West[1], Sandra M. O'Neill[1], and Gina Ylitalo[2]

[1]Washington State Department of Fish and Wildlife
[2]National Marine Fisheries Service

We assessed spatial variation in body burdens of toxics in spawning stocks of Pacific herring (Clupea pallasi) from Puget Sound, Washington to determine if stocks differ in the degree of contaminant exposure concentrations in this pelagic planktivore. We estimated exposure to persistent organic pollutants in adult fish by measuring whole body concentrations of PCBs, chlorinated pesticides (DDT and its metabolites) and hexachlorobenzene (HCB). Recent exposure to polycyclic aromatic hydrocarbons (PAHs), was estimating from biliary concentrations of PAH-metabolites, measured as fluorescing aromatic compounds (FACs). We observed higher exposures of PCB and biliary FACs (PAH metabolites expressed as equivalents of benzo-a-pyrene, and phenanthrene) in adult herring from the central Puget Sound basin where most of the urban bays are located. The higher toxics levels in herring from the central and southern Puget Sound basin suggest that zooplankton in the central and southern Puget Sound basins are contaminated. Unique contaminant exposure patterns indicate that winter- spawning stocks in northern Puget Sound and the Strait of Georgia feed in different area those in central and southern Puget Sound. The spring-spawning Cherry Point stock appears to have feed in a different location than any of the winter-spawning stocks.

Contaminants in Prey of Killer whales

The Washington Department of Fish and Wildlife (WDFW), in conjunction with NOAA Fisheries, is conducting a study to assess contaminant concentrations in prey of northern and southern resident killer whales. In 2003 AND 2004 we concentrated our efforts on known prey, especially Pacific salmon species, that are consumed by these whales during the summer and early fall as the salmon migrate back to their natal streams. In 2005 we plan to sample epi-benthic and demersal species that have been infrequently documented as prey items, mostly from gut contents of carcasses from stranded whales as well as potential prey items. Lingcod will be sampled for chemical analyses. The following is an abstract for a poster presented at the 2005 Research in Puget Sound Georgia Basin Conference held in Seattle, March 2005:

Elevated levels of persistent organic pollutants in Puget Sound vs. other free-ranging populations of Pacific salmon: the importance of residency in Puget Sound.

Presented by Sandra O'Neill[1], Gina Ylitalo[2] Margaret Krahn[2], Jim West[1], Jennie Bolton[2] and Donald Brown[2].

[1]WA Dept Fish and Wildlife
[2]NOAA Fisheries, Northwest Fisheries Science Center

Free ranging populations of anadromous Pacific salmon generally have low levels of persistent organic pollutants (POPs), as most of their growth occurs in open water of the Pacific ocean, distant from contaminant sources in populated coastal locations. However, the five species of Pacific salmon differ in their oceanic distribution with some species having a more coastal distribution. Furthermore, populations within species can also differ in their use of estuaries and in oceanic distribution. We analyzed whole body samples of 5 species of Pacific salmon from populated and unpopulated locations to assess species-specific body burdens in POPs and to determine whether Puget Sound salmon were more contaminated than other free-ranging populations. More Chinook populations were sampled than for the other salmon species, including a population resident in Puget Sound. Our results indicate that in remote, unpopulated

areas, POP concentrations were highest in Chinook and sockeye salmon, likely because of their higher trophic position and higher fat content. For Chinook salmon, Puget Sound residents had the highest POPs concentrations, followed by Puget Sound populations believed to be ocean-reared and both were significantly higher than other free-ranging populations from other locations. A separate study on POPs in fillets of Puget Sound Chinook indicated that fish returning to spawn at a younger age (which were also less likely to have migrated far beyond Puget Sound) had higher POP concentrations than older fish that probably migrated further from Puget Sound. Collectively, these results suggest that residence in Puget Sound exposes Chinook salmon to higher POP concentrations and the longer a Chinook resides in Puget Sound, the greater its exposure to POPs will be.

Evaluation of PBDE levels in Puget Sound Fishes

WDFW completed a project to assess the degree to which chemicals associated with flame-retardants are accumulating in Puget Sound fishes. The results, summarized in an presentation at the 2005 Research in Puget Sound Georgia Basin Conference (see abstract below), clearly showed that polybrominated diphenyl ethers (PBDEs) are present in both benthic and pelagic fishes, often at concentrations higher than other west coast populations. This work was funded by an grant from US EPA, Region 10 and the Puget Sound Action Team. Abstract follows:

A multi-species evaluation of the presence of polybrominated diphenyl ethers in the Puget Sound food web.

Presented by Sandra M. O'Neill[1], James E. West[1], , and Gina Ylitalo[2]

[1]Washington State Department of Fish and Wildlife
[2]NOAA Fisheries, Northwest Fisheries Science Center

Concentrations of polybrominated diphenyl ethers (PBDEs) were measured in fish species representing a variety of life history traits to give a broad overview of contamination in Puget Sound. Our objectives were to determine to what extent PBDEs have infiltrated the benthic and pelagic food webs, and to assess potential exposure routes. A coarse assessment of PBDEs in the benthic food web indicated that PBDE concentrations in muscle tissue of English sole (Parophrys vetulus) were higher at urban sites compared to near-urban and non-urban sites. At one of these urban bays we also measured PBDEs in individual male quillback rockfish (Sebastes maliger) and individual female lingcod (Ophiodon elongatus) to assess biomagnification of PBDEs in species with different trophic status. PBDE concentrations were similar similar between English sole and rockfish from the same urban bay, despite rockfish's higher trophic status and greater age, but were considerably higher in lingcod, a high-level carnivore. Although PBDEs were not higher in rockfish than English sole, they did accumulate with age in male rockfish. Overall, PBDE concentrations in benthic species were lower than concentrations measured in whole body samples of Pacific herring (Clupea pallasii) from Puget Sound, and in sub-adult resident Chinook salmon (Oncorhynchus tshawytscha), indicating broad PBDE contamination of the pelagic food web. A comparison of concentrations of PBDE and PCBs in benthic and pelagic fish suggests that PBDEs accumulate faster in lipid rich pelagic species. Finally, we determined that PBDEs in mature Chinook salmon from Puget Sound were

considerably higher than other Pacific Northwest free-ranging populations, suggesting a Puget Sound source of PBDEs.

English sole Home Range Study

WDFW and NMFS have a collaborative study designed to examine the home range and site fidelity of adult English sole in Eagle Harbor, an embayment with contaminated sediments. We tagged surgically implanted R256 (channel D) V8 transmitters in 20 English sole in 2003 and 19 in 2004. During both years we maintained an array of 6 receivers in Eagle Harbor to detect entrance and exit of the English sole. The receivers were attached to aids to navigation, derelict piles, and moored to the bottom in some cases. We also conducted periodic mobile tracking with a VR60 to find fish in the bay. Our plan is to operate the receiver array through this summer, as many of our transmitters will still be ticking through December 2005. We are looking forward to possibly releasing yet another group of English sole in the Harbor in 2006 after a more extensive VR2 array is operational in Puget Sound. The following is an abstract for a poster presented at the 2005 Research in Puget Sound Georgia Basin Conference held in Seattle, March 2005:

USE OF ACOUSTIC TAGGING TO STUDY HOME RANGE AND MIGRATION OF ENGLISH SOLE (PAROPHRYS VETULUS) IN PUGET SOUND: APPLICATION TO MANAGEMENT OF CONTAMINATED SEDIMENTS.

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English sole are a suitable species for studies on effects of contaminants because they are broadly distributed in benthic habitats along the Pacific Coast where they can contact contaminated sediment. Historic tagging studies of Puget Sound stocks have shown that, with the exception of a winter spawning migration, adult English sole demonstrate site fidelity within sub-basins of Puget Sound, tending to remain on discrete feeding grounds most of the year. A significant correlation between liver disease in English sole and chemical contaminants in the sediments at their capture sites further support the hypothesis of high site fidelity. However, more complete information is needed on home range and habitat utilization to adequately characterize relationships between sediment contamination and fish health. A two-year study was initiated in 2003 to document movements by adult English sole tagged with acoustic transmitters. Twenty fish from Eagle Harbor, a small, contaminated bay, were implanted with transmitters and released at the site of capture. Stationary hydrophones were deployed to monitor fish moving in and out of the harbor. Individual fish movements within the harbor were actively tracked using portable hydrophones. Ten fish (50%) left the bay and did not return (9 of the 10 left within two weeks of release). Fish that stayed in the bay were generally found near the area of capture. Preliminary data analyses from tagged fish released in 2004 indicated similar movements patterns for the fish. These data will help refine estimates of home range, habitat use, and migration timing of English sole so we can better understand their exposure to contaminated sediments.

5. **Puget Sound Marine Fish Research** *Contact: Ray Buckley (360) 902-2828*

Trans-generational Marking of Viviparous Marine Fish in Puget Sound, Washington
(Contact: Ray Buckley, Marine Fish Science, 360 902-2828, bucklrmb@dfw.wa.gov)

Investigators at the Washington Department of Fish and Wildlife have been experimenting with the use of elemental strontium as a means to mark the otoliths of viviparous marine fish larvae prior to birth. Laboratory trials with captive perch and rockfish have shown that a single intermuscular injection of strontium into gestating adults is sufficient to produce a lifelong strontium mark in the otoliths of larvae prior to birth, thus providing a potential method for directly estimating retention and dispersion rates from local populations.

Co-investigators at U.C. Santa Cruz developed FDA approved protocols for evaluating withdrawal rates of strontium chloride from injected fish. Depuration curves based on 30,000 ppm injections delivered at 5 cc's per kilogram of body weight (maximum anticipated dosage) produced strontium concentrations well below the FDA maximum allowable for human consumption. Based largely on these findings, the FDA granted regulatory discretion in June of 2004 for a period of four years to capture and release strontium injected rockfish and perch into two study sites: Point Heyer Artificial Reef, Washington and Point Lobos Ecological Reserve, California. The first field application is now underway.

Methods for capturing and injecting fish in situ using SCUBA and a self-filling syringe designed for use underwater were tested and refined in spring of 2004. Thirty-one late stage gravid brown rockfish were captured, injected, and released at Point Heyer during May through August, 2004. In conjunction with a companion project that is using genetics to search for evidence of self-recruitment (see below), sampling of juvenile rockfish commenced in May of 2004. Based on time of capture and length, a subsample of approximately 225 juveniles captured to date were judged to be potential recruits from progeny of injected females. Otoliths from these fish were dissected and 12 of them have been examined using wavelength dispersive elemental analysis to test for the presence of above ambient levels of strontium chloride. Strontium marks have not, thus far, been unequivocally detected. Juvenile fish collecting is ongoing and analytical techniques are being refined. More fish will be analyzed in coming months.

Transects will be established at Point Heyer in 2005 and surveyed periodically in order to produce estimates of rockfish and perch size distribution and abundance. This baseline data will be used to evaluate the extent of self-recruitment in the event that strontium marked offspring are recovered.

Use of Microsatellite DNA and Pedigree Analysis to Test For Self-recruitment in an Isolated Population of Brown Rockfish in Puget Sound, Washington
(Contact: Larry LeClair, Marine Fish Science, 360 902-2767, leclalll@dfw.wa.gov)

This collaborative study between the Washington Department of Fish and Wildlife and the University of Washington is aimed at using genetic markers to identify progeny of resident adult brown rockfish among juveniles sampled at an isolated reef near Point Heyer, Washington. Non-lethal in situ sampling using tissue clipped from the dorsal lobe of the caudal fin are being

used to genotype individuals at 12 microsatellite loci. To date, 137 adults, estimated to be about one third of the total adult population, have been sampled and genotyped. Genotypes from 118 juveniles have been obtained. Preliminary results using a maximum likelihood estimation approach indicate self-recruitment to be about 15%; however, low genetic variability and higher than expected genotyping error has lead to some ambiguity in assigning parent-offspring-sib relationships. Further work in coming months will focus on the development of additional marker loci with greater allelic richness and ways to reduce genotyping error. Genotypes will also be used to pedigree strontium marked juveniles if encountered (see above). Results are expected to be directly applicable to the design and placement of MPA's in Puget Sound and elsewhere.

B. Coastal Area Activities

1. Coastal Groundfish Management *(Contact Michele Culver, (360) 249-1211 or Brian Culver, (360) 249-1205)*

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 Teams of the North Pacific Fishery Management Council. Landings and fishery management descriptions for PFMC-managed groundfish are summarized annually by the GMT in the Stock Assessment and Fishery Evaluation (SAFE) document.

Essential Fish Habitat Draft Environmental Impact Statement

The Pacific Fishery Management Council is considering proposals to protect Essential Fish Habitat (EFH) for West Coast groundfish stocks. Under the Magnuson-Stevens Fishery Conservation and Management Act, regional fishery management councils are required to "describe and identify essential fish habitat…minimize to the extent practicable adverse effects on such habitat caused by fishing, and identify other actions to encourage the conservation and enhancement of such habitat…."

The Council will be considering alternatives that describe and identify EFH for groundfish and, as part of this process, will also consider establishing Habitat Areas of Particular Concern (HAPCs). Although the Magnuson-Stevens Act does not require regional councils to designate HAPCs, the National Marine Fisheries Service has encouraged them to do so, based on one or more of the following considerations: 1) the importance of the ecological function provided by the habitat; 2) the extent to which the habitat is sensitive to human-induced environmental degradation; 3) whether, and to what extent, development activities are, or will be, stressing the habitat type; and 4) the rarity of the habitat type.

The National Marine Fisheries Service has produced a Draft Environmental Impact Statement (DEIS), which includes descriptions and analyses of the proposed EFH and HAPC alternatives.

The EFH DEIS is available online at:
http://www.pcouncil.org/groundfish/gfefheis/gfefheis_doc.html

Designation of areas as HAPCs does not automatically mean that management measures (e.g., prohibiting fishing activities) would apply to those areas. However, a conservation group, Oceana, has proposed a HAPC alternative whereby identified areas would be closed to bottom trawl fishing. The areas, which would be closed to bottom trawl fishing under this alternative, are described in a list of coordinates, which are included in the EFH DEIS.

The Washington Department of Fish and Wildlife is reviewing and analyzing the potential impacts to fishers by closing these areas to bottom trawling, based on trawl logbook data. The Department is not necessarily endorsing the Oceana alternative; rather, we are trying to gain a better understanding of the potential impacts to fishing activities that could result from these closures. We are also trying to facilitate communication between Oceana and the affected industry members in an effort to mitigate these potential impacts.

Bycatch Plan Amendment
In September 2004, the Pacific Fishery Management Council adopted a preferred alternative to address bycatch in the West Coast groundfish fishery. The Council is in the process of finalizing a Groundfish Fishery Management Plan (FMP) Amendment and a work plan to implement the preferred alternative.

The preferred alternative contains the following elements: 1) amend the FMP to require the use of current bycatch minimization measures; 2) amend the FMP to fully describe the current standardized bycatch reporting methodology; 3) amend the FMP to incorporate the Pacific Council's Groundfish Strategic Plan goal of reducing overcapacity in all commercial fisheries; 4) implement a sector-specific bycatch accounting methodology; 5) support the future use of individual fishing quota (IFQ) programs as bycatch reduction tools for appropriate fishery sectors (e.g., bottom trawl); 6) authorize the use of sector-specific total catch limit programs (total catch = landed catch + discard mortality) to reduce bycatch of overfished (depleted) species in appropriate sectors of the fishery. These programs could include monitoring standards, full retention programs, and individual vessel incentives for exemption from total catch limits.

Spiny Dogfish Control Date
The spiny dogfish fishery is currently prosecuted by a limited number of vessels specializing in the fishery during the winter and early spring months when dogfish occur in fishable concentrations off the northern Washington coast. The dogfish market is also relatively limited. A formal stock assessment for west coast dogfish has not yet been conducted, but one is planned for the next assessment cycle (2007). Even in the absence of a formal assessment, life history information indicates that characteristics of the spiny dogfish (slow growing, late maturing, low fecundity) make it susceptible to overfishing. Dogfish populations have been depressed as a result of fishing in areas of Puget Sound and have been declared overfished on the East Coast.

Dogfish are currently included in the optimum yield for "Other Fish" in the management specifications for the West Coast groundfish fishery. Given the life history characteristics of

dogfish and their status in other areas, the Pacific Council may consider adopting a separate ABC and OY for dogfish along with harvest control regulations (trip limits, etc.) as part of the 2007-08 management cycle. Therefore, it might be prudent to consider a mechanism to maintain the viability of the historical fishery while remaining within the allowable catch. Requiring an endorsement or permit based upon catch history is one mechanism that could be used to preserve the stability and economic viability of the current fishery should overall reduction of total catch become necessary.

Implementation of a dogfish endorsement or other mechanism to control dogfish catch for would require an amendment to the FMP. The results of stock assessments conducted and reviewed in 2007 could affect management measures considered as part of the 2009-10 management cycle. Therefore, endorsements or other mechanisms to control dogfish catch, if approved, would be effective in 2009, at the earliest. While the potential effective date is a few years away, it will likely take over a year to draft the proposed and final rule and implement the resulting endorsement or permit application review, response, and appeal processes. As fishers are already aware that the Council may be considering limiting participation in the dogfish fishery in the future, the Pacific Council adopted a control date of April 8, 2005, to address the potential of speculation-based fishing activities.

2. Coastal Sardine Management *(Contact Michele Culver, (360) 249-1211 or Brian Culver, (360) 249-1205)*

Experimental Purse Seine Fishery for Sardines

In Washington, sardines are managed under the Emerging Commercial Fishery provisions, which provide for the harvest of a newly classified species, or harvest of a previously classified species in a new area or by new means. From 2000 through 2002, the Washington Department of Fish and Wildlife had trial purse seine fisheries for Pacific sardines, under which the number of participants cannot be limited. Following an extensive public process which included establishing and meeting with a formal Sardine Advisory Board, the Director decided to advance the sardine fishery to an experimental fishery in 2003, under the Emerging Commercial Fisheries legislation, which mandates that permits be limited.

Pacific sardines are managed under the Pacific Fishery Management Council's Coastal Pelagic Species (CPS) fishery management plan. The Pacific Council develops and adopts a coastwide annual harvest guideline, which is then allocated between the two areas which take into account the biological and ecological impacts of harvesting forage fish. Earlier this year, the Pacific Council adopted an interim allocation regime with plans to develop a long-term allocation strategy over the next year.

The Northwest sardine fishery has rapidly expanded over the past few years, which was the primary reason the Department decided to convert from a trial to an experimental fishery. Oregon began its limited developmental fishery in 1999, which yielded 771 mt in sardine landings. Since then, the Northwest landings have increased for a total of 37,923 mt in 2002, and 36,862 mt in 2003. In 2004, the overall coastwide harvest guideline increased from 110,908 mt in 2003 to 122,707 mt, producing an initial northern allocation of 40,493 mt.

The fishery opened on May 15, 2004, however, the first landing into Washington occurred on June 24. The Department issued a total of 21 permits and 14 permit holders participated in the fishery. There were two primary vessels who accounted for 58% of the total landings–both vessels fished out of Ilwaco.

A total of 8,799.5 mt of sardines were landed into Washington. A total of 238 landings were made and 100 occurred within the month of August. A total of 375 sets were made with 89% (333) of them successful. Average catch per successful set was about 38 mt.

The Department provided observer coverage for the fishery and averaged about 27% coverage overall. Observers collected total catch data including species, amount, and condition, and noted whether the fish were released or landed. Bycatch included small amounts of salmon, spiny dogfish, blue shark, herring, mackerel, and other species of fish.

Department staff also collected and processed biological samples. Otoliths were extracted and sent to the Department's lab in Olympia for age-reading. Data collected on the samples include standard lengths, individual weights, sex, and maturity.

3. Coastal Groundfish Monitoring, Research, and Assessment

Black Rockfish Tagging Study *Contact: Eric Eisenhardt (360) 249-1208*
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 annual releases of coded wire tagged (**CWT**) fish and recovery of tagged carcasses from the recreational fishery, both of which are currently on going. From 1998 to 2001, WDFW's R/V Corliss was used to capture, tag and release 2,622, 3,478, 2,779 and 3,200 black rockfish annually. Since 2002, commercial charter vessels have been used, including F/V Hula Girl, F/V Slammer and F/V Tequila Too. A total of 4,089 black rockfish were caught, tagged and released in 2002, 6,744 in 2003, 5,981 in 2004, and 3,716 in 2005. In 2004, passive integrated transponder (**PIT**) tags were used to reduce the labor need to read and match recovered tags. In 2005, all tagged fish released were tagged with both CWTs and PIT tags, which will allow estimation of PIT tag loss rates (since CWT loss rates are already known).

Fish are released on pinnacles distributed throughout the area fished by the Westport charter fishing fleet. Each CWT tagged fish had two tags placed in the opercular musculature: one on each side of each fish's 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, 1999 and 2003. PIT tags are injected into the throat patch musculature, and appear to have excellent retention and very low to non-existent shedding rates.

On an annual basis, roughly 40% of the total Westport recreational black rockfish catch is sampled for tags by passing fish carcasses through a metal detector tube (Northwest Marine Technologies R8000). A total of 14, 79, 365, 260, 423, 612 and 293 tags were recovered in 1998, 1999, 2000, 2001, 2002, 2003 and 2004 respectively. The cooperation of the charter boat fleet

has been 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 is used to estimate fishing mortality (which is the primary driver for assessing trends in the fishery), as well as to measure growth and movement of black rockfish in the Westport coastal area. Population parameter estimates will be incorporated into the 2005 black rockfish age structured model.

We are also in developing stages for two additional projects. First, we are deploying juvenile traps in a habitat stratified design this spring through late fall to monitor recruitment. This work is in collaboration with Susan McBride (UC Sea Grant) and Jennifer Bloeser (Pacific Marine Conservation Council) who have been conducting this research in California and Oregon since at least 2002. Second, we will place sonic tags in nine black rockfish this summer and monitor their movements using acoustic telemetry through the winter of 2005-2006.