Northwest Fisheries Science Center

Fish Matters

Center scientists take critical samples in wake of *New Carissa* oil crisis

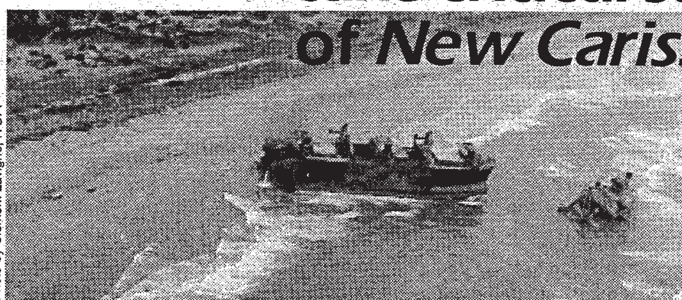

Photo by Clement Lavigne, ITOPF

When the beached freighter *New Carissa* threatened to dump up to 400,000 gallons of oil products on Oregon's beaches this February, a team of 10 Northwest Fisheries Science Center scientists responded quickly to gather samples that could be critical to cleanup considerations and research.

Salmon are extremely sensitive to petroleum hydrocarbons–the Alaska Fisheries Science Center's Auke Bay Laboratory has shown that petroleum contaminant levels of 1 part per billion affect the survival of pink salmon eggs and damage herring, a salmon food source—so sampling data on the levels of contaminants from the *New Carissa* incident will be critical. The data is also important to the Center's ongoing studies of juvenile salmon health at 6 of the 10 sites sampled *(see story on Newport salmon research)*. "It's definitely something we're interested in" because the Center has, or may have, research activities at all of these sites, said research fishery biologist Mark Myers.

Center crews worked quickly February 11 and 12 to gather samples before there was any major release of oil: they collected water and sediment samples from 10 sites, from Coos Bay to Grays Harbor; clam and oyster samples were also gathered from Willapa Bay and Grays Harbor. Sampling focused on sites where the Center has been studying juvenile salmon health (the Center is the only group monitoring juvenile salmon health in the coastal estuaries involved). Complete results were not immediately available, but Myers said there were no visible signs of oil except for a sheen on the water at a Coos Bay site.

The primary goal was to obtain pre-spill samples from estuarine areas with juvenile salmon that in a few months will head for the ocean. The sampling will provide invaluable baseline data if spilled oil later moves into any of the sampled estuaries.

The sampling team already has considerable baseline data on salmon exposure in many Oregon and Washington coastal estuaries, and can use reference sites and this historical data to assess increases in salmon exposure and changes in salmon health.

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Newport scientists look for clues to salmon's increasing troubles in the ocean, estuaries

Salmon face an ominous future: the ocean has become an unfriendly place.

Coho salmon are particularly threatened, so developments charted by scientists with the Northwest Fisheries Science Center are especially troubling for that species. But the news isn't good for any Pacific salmon.

Salmon research in years past has focused primarily on the freshwater portion of the salmon life cycle. But salmon can spend more than half of their lives in the ocean, so it is necessary to understand impacts occuring there, too.

Decreasing salmon populations appear linked to climate and ocean changes: a 1977 shift in the ocean climate regime, along with the increasing frequency of El Niño, for example, preceded recent declines in salmon populations off the Washington and Oregon coasts. Now researchers are taking a close look at physical and biological factors that influence ocean and estuarine productivity and at the impact of ocean and estuarine conditions on Pacific salmon growth, survival, and abundance to try to figure what constitutes natural variability and what is extraordinary.

That research is based at Center facilities at the Hatfield Marine Science Center in Newport, Oregon. The Newport Research Station is usually identified with groundfish research, but the same qualities that favor groundfish work make it an ideal location for ocean and estuarine salmon research: a good share of the Pacific Northwest's commercial fishing industry operates out of Newport; the pier facility was recently expanded; salmon-producing rivers and estuaries are nearby, and the Hatfield Center also houses offices for the U.S. Fish and Wildlife Service, Environmental Protection Agency, Oregon Department of Fish and Wildlife, and the Cooperative Institute for Marine Research Studies, a primary source of collaborative research with Oregon State University.

Probing links between ocean conditions and salmon abundance and size

Center scientists hypothesize that salmon growth and survival vary with year-to-year variations in ocean productivity. They are also thinking that ocean productivity rates in the Gulf of Alaska and the California Current are coupled, oscillate out of phase, and reverse with ocean climate regime shifts.

Supporting this idea are some dramatic changes since the 1977 regime shift: a doubling in zooplankton biomass in the Gulf and a sevenfold *decline* in the California Current; salmonid biomass in the gulf reaching the highest levels ever and coho biomass in the current dropping to the *lowest* levels ever. Researchers led by principal investigator Bill Peterson are collecting time series data for zooplankton and ocean conditions to identify changes in the northern California Current ecosystem. They've found that reduced upwelling since the early 1980s has warmed the physical environment and changed the biological environment.

Newport scientists are collecting time series data on measures of ocean productivity (such as zooplankton, chlorophyll-a, and water clarity) and on juvenile salmon abundance and size during regular sampling cruises off the Oregon-Washington coast. The hope is to relate variations in ocean conditions (such as sea-surface temperature anomalies, sea-level anomalies, and upwelling indices) to year-to-year variability in growth of coho from several coastal Oregon basins. The team also plans to investigate whether wild coho survival patterns significantly differ from those of hatchery fish.

Plankton densities among samples collected nearshore (left), 15 miles (center), and 30 miles (right) offshore.

Who's eating who? Mapping out the salmon food chain

Changes in ocean conditions may also be influencing juvenile salmon by affecting both their predators (fish that eat juvenile salmon) and forage fish (fish that juvenile salmon eat, such as anchovies). A new study is exploring the idea that juvenile salmon are affected by the distribution and abundance of nearshore marine predators and forage fish.

The primary focus of the 5-year study will be assessing the strength of food-chain links between forage fish and predators (such as Pacific mackerel, jack mackerel, and dogfish shark), and to assess the influence of these relationships on the rates at which juvenile salmon are eaten. The study, led by principal investigator Bob Emmett, will try to find out if large marine fish (such as hake and mackerel) are a major source of salmon smolt mortality, and will gather data to describe the environmental factors that influence this predation.

Is the Columbia River plume a special place for salmon?

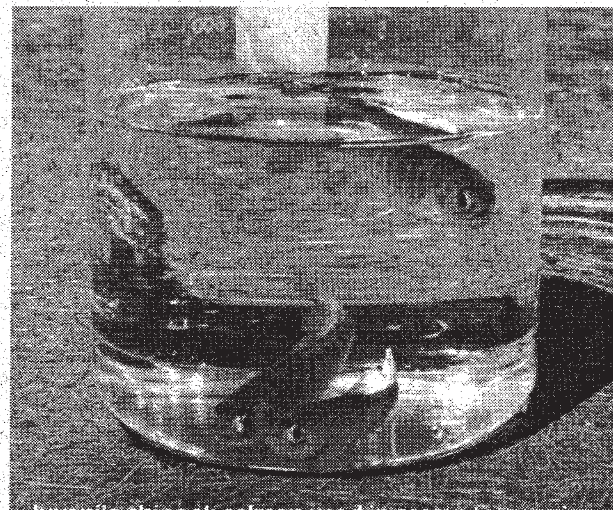
The plume is definitely unusual: a "river" that can extend for hundreds of miles into the Pacific, it is a blend of fresh- and saltwater that creates a large and unique habitat. If this habitat is especially good for young salmon, studies of the plume could be important to policies aimed at saving these fish.

A new study led by principal investigators Ed Casillas and Bill Peterson is trying to correlate salmon growth and survival with the plume's unique physical and biological characteristics, and is exploring a number of questions about the plume: Are juvenile salmon more abundant there than elsewhere along the Washington-Oregon coast? (Early sampling indicates they may be—more than half of the juveniles caught in June and September were netted in the plume.) Are growth rates and overall weight and length higher? Do higher nutrient concentrations enhance food availability? And might survival increase if river flows are regulated to counteract the calming effect upstream dams now have? (Dams still the water, which makes it clearer and easier for predators to see young salmon.)

Researchers will collect information on the distribution and abundance of salmon and other species in the upper water column, both in plume and coastal waters; that data will be related to ocean conditions and compared to 1980s data. Salmonid growth, condition, food habit, and prey fields are being measured and related to ocean conditions in and around the plume.

How do disease and man-made stresses affect salmon?

Estuarine studies led by scientists Mary Arkoosh and Kym Jacobson hope to assess the impact of natural microbial and parasitic disease and



Juvenile chinook salmon used in assays to examine various components of their immune system.

selected anthropogenic stresses on the survival of hatchery and natural juvenile fall chinook and coho in Washington, Oregon, and California.

In work thus far, the research team showed for the first time that juvenile salmon infected with the trematode *Nanophyteus salmincola,* and then subjected to additional stress, die at a higher rate than do uninfected fish. Added stressors include smoltification, exposure to nonlethal levels of polychlorinated biphenyls (PCBs, which come mainly from electric transformers), and the marine bacterium *Vibrio anguillarum.* Trematode-infected fish also developed immunosuppression when exposed to PCBs.

Preliminary results indicate that pathogens (including *N. salmincola)* are ubiquitous in both urban and nonurban estuaries, an important finding because previous studies of other species have demonstrated that pathogens can greatly influence fish survival by increasing their susceptibility to stressors and modifying their distribution. Sampling is being expanded to Washington and California estuaries and to out-migrating juvenile coho.

A controversial question is being examined by the team: are pathogens transferred between wild and hatchery juvenile chinook? Researchers are watching wild and hatchery fish in the Elk River system, using a sensitive molecular technique of DNA amplification to assess the transmissibility of *R. salmoninarum.* This work may also help determine whether infected and uninfected wild fish have different mortality rates (a different rate would suggest that pathogens influence survival by altering factors such as growth, immune function, or behavior).

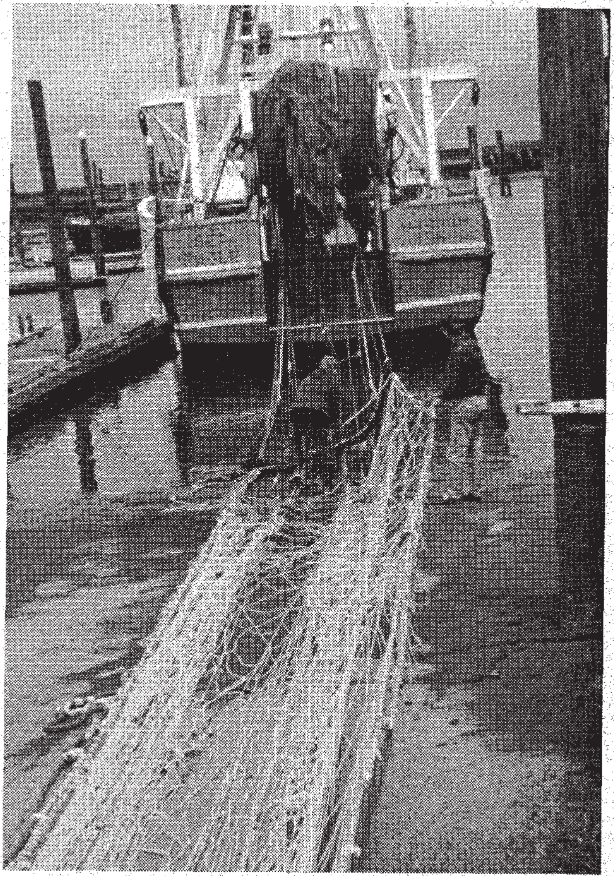
Scientists and commercial fishers work together on sampling cruises

Innovative partnerships with commercial fishers have greatly enhanced research efforts for salmon and groundfish teams alike at the Newport Research Station.

The RV *Miller Freeman* isn't always readily available for sampling missions, so chartered commercial vessels have helped carry out sampling for the salmon team's research in ocean ecology and the Columbia River plume *(see story on Newport salmon research)*.

Bill Peterson's plume researchers went to sea with commercial trawl net fishers last year and found the experience refreshing, enlightening, and productive. "It was amazing," Peterson said of the two 10-day charter trips last June and September for juvenile salmon sampling in the Columbia River plume. The sampling used surface trawling—a technique in which the net is pulled right along the surface, rather than along the ocean floor as groundfish crews do. Researchers were amazed by the way commercial fishers whipped around trawl nets roughly 60 feet high and 500 feet long—about three-quarters of the length of the Northwest Fisheries Science Center's Montlake facility. The trawl nets are designed to float on the surface, with vertical doors crews use to open the net up. Center scientists were in awe of the huge net, but the charter crews "took one look at it and knew exactly what to do," Peterson said. Compared to nets the charter fishers use for groundfish, this was a "baby net," Peterson said.

Commercial charters have also been very helpful in carrying out groundfish research. With the RV *Miller Freeman* in dry dock last fall, scientists from Newport and Seattle used commercial trawl vessels to complete an at-sea survey of several West Coast groundfish species. The team spent 80 days at sea on board four chartered commercial fishing boats, examining depths of 600 to 4,200 feet from Washington's Cape Flattery to Morro Bay, in California. The effort showed that small survey parties on boats of this class can sample efficiently following strict sampling protocol. The way boat owners were paid was also innovative—new legislation allows half of their compensation to come from selling fish caught during the survey and subsequent trips.



Preparing a trawl net for juvenile salmon sampling in the Columbia River plume.

***New Carissa* continued from front page**

The sampling team worked closely on this natural resource damage assessment with several agencies, including the National Ocean Service and Washington Departments of Ecology and Fish and Wildlife. The team is also watching for incompletely burned oil that might result from the explosion that was set on the boat to burn the oil and thus prevent a spill.

The Center's team draws on years of experience in sampling petroleum levels and examining those levels to gauge effects on fish health. The Center's work in this area goes back more than 20 years, including the *Exxon Valdez* spill, the *North Cape* spill off Rhode Island, and the Gulf War. The *Exxon Valdez* experience was especially important, Myers said, in demonstrating that good sediment and biota samples are critical in trying to identify links between contamination and the levels of aromatic hydrocarbons (petroleum products) that can cause disease and reproductive problems in fish.