



## POSTER PRESENTATION ABSTRACTS

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Conservation Division, Northwest Fisheries Science Center, Seattle, WA 98112; <sup>3</sup>University of Washington, School of Oceanography, Seattle, WA 98195. **The nearshore development of a**

**toxigenic *Pseudo-nitzschia* bloom and subsequent domoic acid contamination of intertidal**

**bivalves.** Along the coast of Washington State, USA, periods of storm winds intensify in late

summer and may advect domoic acid-producing *Pseudo-nitzschia* to the coast where they impact

the coastal razor clam fishery, rendering the clams toxic to humans. To test this hypothesis,

during the late summer and early fall of 2002 repeated measurements of *Pseudo-nitzschia*

species, particulate domoic acid, temperature, and salinity were made in nearshore waters and at

Kalaloch beach on the central Washington coast. A shift in the composition of the *Pseudo-*

*nitzschia* population to *P. australis* cells was observed following a storm event during 8-10

September. Following a second storm event that occurred 16-18 September, *Pseudo-nitzschia*

cell numbers multiplied and a concurrent increase in levels of particulate domoic acid occurred

in nearshore waters. Data from moored instruments show the presence of Columbia River plume

water on the inner shelf for several weeks beginning on 8 September, persisting for

approximately 8 days after the second storm and effectively inhibiting upwelling near the

Washington coast. Domoic acid in intertidal razor clams accumulated to levels that exceeded the

regulatory safety limit 18 days following the shift to *P. australis* cells. These data indicate that

the strategic placement of a mooring in nearshore waters with appropriate sensors for the

detection of cells, toxins and environmental data may provide coastal managers with an early

warning of impending toxification of coastal shellfish.

Andrew M. Albaugh<sup>1</sup> and Jeffrey Cowen<sup>2</sup>. <sup>1</sup>NOAA Fisheries, Conservation Biology Division,

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98112. **Where's the point -- details of a large-scale inter-agency salmon hatchery release**

**mapping project in the Pacific Northwest.** To aid in the recovery of Threatened and

Endangered Pacific Northwest salmon populations, we at NMFS Northwest Fisheries Science

Center have developed a geo-spatial database to house a wide array of salmon related data. One

key component of the database, developed in cooperation with several state, federal, and tribal

agencies, is a module to capture and display agency data on artificial propagation operations

(hatcheries). One challenge of this endeavor was standardizing the agencies' diverse methods of

documenting hatchery release locations. There were roughly 40,000 records submitted spanning

years 1990 to 2002, with about 8,500 unique locations provided as narrative text or a stream

name. Mapping these locations from this limited information required the development of tools

for the ArcGIS software environment. The result is a comparatively accurate and highly useful

display of hatchery release points and spawning events presented in a spatially rigorous form. A major benefit from our approach is that it will grant all agencies access to a central location, through a web-based interface, where they can download salmon related data. We foresee this mapping effort, coordinated with our database development as a whole, becoming a vital tool for policy and decision makers with regards to Endangered Species Act status updates for these salmon populations.

David Baldwin<sup>1</sup>, Jason Sandahl<sup>2</sup>, Jeffrey Jenkins<sup>2</sup>, and Nathaniel Scholz<sup>1</sup>. <sup>1</sup>*NOAA Fisheries, Environmental Conservation Division, Northwest Fisheries Science Center, Seattle, WA 98112 ([david.baldwin@noaa.gov](mailto:david.baldwin@noaa.gov));* <sup>2</sup>*Department of Environmental and Molecular Toxicology, Oregon State University, Corvallis, OR 97331.* **Comparative thresholds for acetylcholinesterase inhibition and behavioral impairment in coho salmon exposed to chlorpyrifos.** Chlorpyrifos is a common organophosphate insecticide that has been widely detected in surface waters that provide habitat for Pacific salmon in the western United States. Although chlorpyrifos is known to inhibit acetylcholinesterase (AChE) in the brain and muscle of salmonids, the relationship between sublethal AChE inhibition and more integrative indicators of neurobehavioral impairment is poorly understood. This is particularly true for exposures that reflect the typical range of pesticide concentrations in the aquatic environment. To directly compare the effects of chlorpyrifos on AChE activity and salmon behavior, we exposed juvenile coho salmon (*Oncorhynchus kisutch*) to chlorpyrifos (0 – 2.5 ppb) for 96 h. A computer-assisted, three-dimensional video imaging system was used to measure spontaneous swimming and feeding behaviors in control and chlorpyrifos-exposed fish. Following the behavioral trials, brain and muscle tissues were collected and analyzed for AChE activity. Chlorpyrifos inhibited tissue AChE activity and all behaviors in a dose-dependent manner. Benchmark concentrations for sublethal neurotoxicity (statistical departure values) were < 0.5 ppb and were similar for both neurochemical and behavioral endpoints. Moreover, brain AChE inhibition and reductions in spontaneous swimming and feeding activity were significantly correlated. Collectively, these results indicate a close relationship between brain AChE inhibition and behavioral impairment in juvenile coho exposed to chlorpyrifos at environmentally realistic concentrations.

Keri Baugh, Jeannie Bush, Brian Bill, Kathi Lefebvre, and Vera Trainer. *NOAA Fisheries, Marine Biotoxin Program, Environmental Conservation Division, Northwest Fisheries Science Center, Seattle, WA 98112 ([keri.baugh@noaa.gov](mailto:keri.baugh@noaa.gov)).* **Estimates of specific toxicity in several *Pseudo-nitzschia* species from the Washington coast, based on culture and field studies.** To gain an understanding of the species of *Pseudo-nitzschia* that are the major toxin producers in the Pacific Northwest, representative isolates from the Ecology and Oceanography of Harmful Algal Blooms in the Pacific Northwest (ECOHAB-PNW) study site were grown as clonal cultures. Both particulate and dissolved domoic acid (DA) were measured at various stages of growth using a receptor-binding assay and an enzyme-linked immunosorbent assay respectively, and compared to toxin data obtained during a cruise in September 2003. A clonal *P. multiseriata* culture isolated from a northern beach site contained the highest particulate DA (pDA) level of 70.4 nmol l<sup>-1</sup> and released the highest amount of dissolved DA (dDA, >5 nmol l<sup>-1</sup>), illustrating the potential for this species to cause harm. A clonal *P. australis* isolate also produced relatively high levels of pDA (3.2 nmol l<sup>-1</sup>) and dDA (4.3 nmol l<sup>-1</sup>), whereas *P. delicatissima*, *P. cf. pseudodelicatissima*, *P. pungens* and *P. fraudulenta* produced low or undetectable levels of pDA and dDA. These culture studies suggest that the dDA levels of up to 17.6 nmol l<sup>-1</sup> measured during September 2003 were

owing to toxin produced and released primarily by *P. australis* cells. It is estimated that the maximum specific toxicity reached by *P. australis* at a toxic 'hot spot' off the Washington coast in mid-September 2003 was 94.4 pg cell<sup>-1</sup>.

Brian D. Bill<sup>1</sup>, Frank H. Cox<sup>2</sup>, Rita A. Horner<sup>3</sup> Jerry A. Borchert<sup>2</sup>, Vera L. Trainer<sup>1</sup>, and Shelly Nance<sup>1</sup>. <sup>1</sup>*NOAA Fisheries, Marine Biotoxin Program, Environmental Conservation Division, Northwest Fisheries Science Center, Seattle, WA 98112 ([brian.d.bill@noaa.gov](mailto:brian.d.bill@noaa.gov));* <sup>2</sup>*Food Safety and Shellfish Programs, Washington State Department of Health, Olympia WA 98504;* <sup>3</sup>*School of Oceanography, University of Washington, Seattle, WA 98195.* **The first closure of shellfish harvesting due to elevated levels of domoic acid in Puget Sound, Washington, USA.** The first domoic (DA)-related closure of shellfish harvesting in Puget Sound, Washington, USA, occurred in September 2003. Subsequent beach and shipboard sampling in the area revealed a near mono-specific bloom of the diatom *Pseudo-nitzschia australis*. DA was detected in shellfish, including blue mussels, littleneck, geoduck, and manila clams, and Pacific oysters, over an 80 km<sup>2</sup> area from September 2 through October 22. Cell concentrations as high as 2.9 x 10<sup>6</sup> cells liter<sup>-1</sup> and particulate DA as high as 14.7 nM were detected. Since the early 1990s, *Pseudo-nitzschia* has usually been present in Puget Sound as multiple species populations and low levels of toxicity have been detected in shellfish, but such highly toxic, nearly mono-specific blooms have not been observed previously. We speculate that a more toxic oceanic strain may have been advected from the Pacific Ocean or that local environmental conditions at that time may have been more conducive to toxin production.

Mary Bhuthimethee<sup>1</sup> and Kym C. Jacobson<sup>2</sup>. <sup>1</sup>*Cooperative Institute for Marine Resources Studies, Oregon State University, Newport, OR 97365 ([mary.bhuthimethee@oregonstate.edu](mailto:mary.bhuthimethee@oregonstate.edu));* <sup>2</sup>*NOAA Fisheries, Fish Ecology Division, Hatfield Marine Science Center, Newport, OR 97365.* **Macroparasite communities as an indicator of juvenile Chinook salmon life histories and habitat use in the Columbia River estuary.** Juvenile Pacific salmon utilize the Columbia River (CR) and its estuary as an important transition habitat to acquire resources for survival in the ocean. However, little is known about juvenile salmon life histories and habitat use in this important estuary. Because the CR is also used as a shipping channel and to generate hydroelectric power, it is imperative to understand how salmon rearing habitats are affected by dredging and management of river flows. In this study we examined the macroparasite communities of subyearling Chinook salmon at different habitats in the CR estuary to provide insights into migrating juvenile salmon life histories, residence time, and habitat use. Monthly sampling showed a change in the salmon parasite community at the Lower Elochoman Slough site (LES, upper estuary) in 2002 and 2003, suggesting a turnover in salmon life history types at that location. Salmon appeared to move into the estuary in late winter-early spring with similar parasite communities, or were resident at LES long enough to acquire similar parasites. An abrupt absence of acanthocephalans in June from salmon intestines suggests that fish were at LES for no more than 3-4 months and left as a group. These parasite communities may distinguish differences in diet and habitat utilization between hatchery-reared and naturally-produced salmon.

Keith L. Bosley, Ahna Van Gaest, Ric D. Brodeur, and Chris Harvey. *NOAA Fisheries, Fishery Resource Analysis and Monitoring Division, Northwest Fisheries Science Center, Seattle, WA 98112 ([keith.bosley@noaa.gov](mailto:keith.bosley@noaa.gov)).* **Preliminary findings from a study of juvenile rockfish**

**(genus *Sebastes*) feeding habits off the Oregon coast.** Early life history stages of marine fish suffer high mortality rates making this period a critical determinant of year-class strength. Despite this importance, we know very little about the feeding habits of young-of-the-year rockfish (*Sebastes* spp.)—information crucial to understanding how these fish may be influenced by bottom-up processes. Funding from the N.W.F.S.C. Internal Grants Program was used to initiate a study of the feeding habits of juvenile rockfish collected off the Oregon coast. The predominant species collected in 2006 were darkblotched (*S. crameri*), canary (*S. pinniger*), yellowtail (*S. flavidus*), widow (*S. entomelas*) and black (*S. melanops*) rockfish. Preliminary analysis of gut contents (% number) revealed that darkblotched rockfish had a high degree of variation in diet comprised of all life-history stages of euphausiids, as well as amphipods and copepods. Canary, yellowtail, widow and black rockfishes had a high degree of dietary overlap, comprised primarily of copepods and furcilia-stage euphausiids. There was less overlap in diets between species when % wet weight was examined, with only canary, widow and black rockfish showing significant similarities. Additionally, tissue samples for stable isotope analysis were dissected from the juvenile rockfish and those results will be presented in the poster. Taken together, the stomach content and stable isotope data will advance our understanding of some of the important environmental factors that effect young-of-the-year rockfish during the pelagic phase and the extent to which these factors may influence survival and recruitment.

Paul M. Chittaro, Rachel J. Petrik-Finley, and Phillip S. Levin. *NOAA Fisheries, Science for Ecosystem-based Management Initiative, Fishery Resource Analysis and Monitoring Division, Northwest Fisheries Science Center, Seattle, WA 98112* ([paul.chittaro@noaa.gov](mailto:paul.chittaro@noaa.gov)).

**Toxic nurseries: do English sole from urban nurseries recruit to the adult population?**

Determining where fish live during early life history stages and the extent to which different areas contribute individuals to adult populations is critical for the management and conservation of a species. To establish where subadult English sole reside as juveniles, we used otolith chemistry of juvenile English sole to produce a chemical map of Puget Sound against which subadult otolith chemistry was compared. Examination of the otolith chemistry in subadult fish provided evidence that northern Puget Sound sites and non-urban areas are important for the maintenance of adult populations of English sole.

Tracy Collier<sup>1</sup>, Margaret Krahn<sup>1</sup>, Mark Strom<sup>2</sup>, Rohinee Paranjypte<sup>2</sup>, William Nilsson<sup>2</sup>, Donald Brown<sup>1</sup>, Catherine Sloan<sup>1</sup>, Gina Ylitalo<sup>1</sup>, and Usha Varanasi<sup>3</sup>. <sup>1</sup>*NOAA Fisheries, Environmental Conservation Division, Northwest Fisheries Science Center, Seattle, WA 98112* ([gina.ylitalo@noaa.gov](mailto:gina.ylitalo@noaa.gov)); <sup>2</sup>*NOAA Fisheries, Resource Enhancement and Utilization Technologies Division, Northwest Fisheries Science Center, Seattle, WA 98112*; <sup>3</sup>*NOAA Fisheries, Science Director's Office, Northwest Fisheries Science Center, Seattle, WA 98112*. **Guaranteeing seafood safety after Hurricane Katrina.** The de-watering of New Orleans following Hurricane Katrina created an unprecedented situation regarding the public perception of seafood safety. The floodwaters pumped into nearshore areas of the Gulf of Mexico contained oils, metals, and a wide range of pathogens and enteric bacteria. Our Center was asked to mount an immediate response to this situation, both to collect samples of fish and shrimp from the potentially affected area, as well as providing a wide range of chemical and microbiological analyses. We conducted several sampling efforts from a variety of research vessels and chartered fishing boats, and focused on Atlantic croaker (*Micropogonias undulatus*) and white shrimp (*Litopenaeus setiferus*) as the primary target species. Sampling began on September 13, 2005, within one week after



floodwater pumping began, and continued into December 2005. Samples were analyzed for a suite of organic contaminants, including organochlorines, PBDEs, and PAHs. Samples were also tested for bacterial contamination, including potentially pathogenic *Vibrio* species and fecal contaminants such as *E. coli*. While a range of both chemicals and microbiological substances were detected, none were present in edible tissues at levels that appeared to pose any appreciable risk to human consumers of seafood products from the Gulf, assuming normal seafood preparation practices were followed. We found no evidence of increased levels of contaminants immediately following the hurricane, however the lack of baseline data hampered that determination. Sampling resumed in April 2006 to determine if this trend persists.

Tom Cooney and Damon Holzer. *NOAA Fisheries, Conservation Biology Division, Northwest Fisheries Science Center, Seattle, WA 98112* ([tom.cooney@noaa.gov](mailto:tom.cooney@noaa.gov)). **Evaluating the intrinsic potential of steelhead spawning within Interior Columbia Basin streams.** Within the Interior Columbia Basin (ICB), steelhead spawn and rear in streams flowing through a broad spectrum of natural environments. Even with the modern spatial constriction of available habitat, spawning occurs in landscapes ranging from low elevation semi-arid basins to moisture rich alpine cirques, often in the same watershed. This ecological kaleidoscope of potential occupancy has made habitat modeling a challenging task. However, certain common geomorphologies exist within favored spawning and rearing streams even among highly divergent ecotypes. In order to evaluate steelhead habitats within ICB populations, we developed a GIS based model for calculating intrinsic spawning potential. This metric has enabled us to quantify and qualify habitat based on how spawning preferences relate to local stream features and watershed characteristics. Of primary interest were datasets describing spawning distribution, instream geomorphology, and adjoining landforms, from which we established model parameters by comparing mapped steelhead distribution to stream physiography. In general, we utilized spawning surveys and stream transect juvenile sampling data to describe relative densities of steelhead in geospatially specific stream reaches. Mapped distributions were then evaluated against stream attributes calculated from common spatial data themes. These included Digital Elevation Models (DEM), the National Hydrography Dataset (NHD), climatic data from the National Climatic Data Center (NCDC), and soil features from the Natural Resource Conservation Service (NRCS). Using the results from this analysis, we were able to identify a set of significant relationships between observed spawning use and landscape attributes. These correlations formed the rationale for how our model was calibrated.

Andrew Dittman<sup>1</sup>, Darran May<sup>2</sup>, David Baldwin<sup>3</sup>, Nat Scholz<sup>3</sup>, and Jaime Athos<sup>1</sup>. <sup>1</sup>*Physiology Program, Resource Enhancement and Utilization Technologies Division, Northwest Fisheries Science Center, Seattle, WA 98112* ([andy.dittman@noaa.gov](mailto:andy.dittman@noaa.gov)); <sup>2</sup>*School of Aquatic and Fisheries Sciences, University of Washington, Seattle, WA 98195*; <sup>3</sup>*Ecotoxicology Program, Environmental Conservation Division, Northwest Fisheries Science Center, Seattle, WA 98112*. **Life stage and odorant-induced changes in odorant receptor expression and olfactory sensitivity in coho salmon (*Oncorhynchus kisutch*).** Over the lifetime of an organism, the sensitivity of the olfactory system to specific odors may change in response to developmental changes, hormones, environmental stimuli, and odorant exposure. Salmon provide an excellent model for studying such changes because almost every aspect of their lives is influenced by olfaction and they experience dramatic developmental and environmental transitions (smolting, maturation, freshwater vs. oceanic rearing). Furthermore, the homing migrations of salmon are

governed by olfactory discrimination of home stream odors that juvenile salmon learn (imprint to) prior to their seaward migrations. Our previous studies demonstrated that salmon imprinted to the odorant phenylethyl alcohol developed a long-term sensitization of peripheral olfactory neurons to this odorant. To further examine the mechanism of peripheral sensitization during imprinting, we exposed juvenile coho salmon to L- Arginine during smolting, the presumptive sensitive period for imprinting. Arginine is a potent salmon odorant for which a candidate odorant receptor has been identified. To assess life stage and olfactory imprinting associated changes in the sensitivity of the olfactory system to arginine, we recorded electrical field potentials (electro-olfactograms) generated in response to arginine and measured mRNA expressions levels of the candidate arginine receptor at several life stages. Our results suggest that olfactory sensitivity and odorant receptor expression changes over the lifetime of the salmon and that previous odor exposure can influence olfactory responses. Funded by the BPA, the NWFSC, and the HSRG.

Andrew Dittman<sup>1</sup>, [Darran May](#)<sup>2</sup>, Donald Larsen<sup>1</sup>, Mary Moser<sup>3</sup>, Mark Johnston<sup>4</sup>, and David Fast<sup>4</sup>. <sup>1</sup>*Physiology Program, Resource Enhancement and Utilization Technologies Division, Northwest Fisheries Science Center, Seattle, WA 98112*; <sup>2</sup>*School of Aquatic and Fisheries Sciences, University of Washington, Seattle, WA 98195 ([darran.may@noaa.gov](mailto:darran.may@noaa.gov))*; <sup>3</sup>*Migrational Behavior Program, Fish Ecology Division, Northwest Fisheries Science Center, Seattle, WA 98112*; <sup>4</sup>*Yakama Nation, Toppenish, WA 98948*. **Can hatchery supplementation promote recolonization of underutilized spawning habitat? Homing patterns of hatchery-reared and wild Yakima River Spring Chinook salmon.** A number of conservation and supplementation hatchery programs utilize satellite acclimation facilities to “seed” or repopulate underutilized rivers or streams. The effectiveness of releases from satellite facilities for ensuring successful imprinting, minimizing straying and contributing to salmon recovery has not been demonstrated. The goal of this project was to describe the spatial and temporal patterns of homing and spawning by wild salmon and salmon released from acclimation facilities in the upper Yakima River (Washington). Specifically, we examined the spatial patterns of homing and spawning of spring chinook salmon released as part of the Yakima/Klickitat Fisheries Project (YKFP) supplementation program relative to a central hatchery, 3 acclimation facilities, wild spawning fish and available habitat. Over four years (2002-2005), we comprehensively surveyed the spawning area of the Upper Yakima River spring chinook population and GPS mapped and sampled (length, sex, origin) every carcass recovered (n=7391; 28.9% of total run). Results from this study indicated that juveniles released from different acclimation sites had significantly different adult spawning distributions within the sub-basin but homing patterns confirmed tradeoffs between homing and habitat selection. Ultimately, these studies will shed light on the efficacy of supplementation to re-establish natural spawning in underutilized habitat. Funded by the NWFSC and NOAA Fisheries.

[Bich-Thuy Eberhart](#)<sup>1</sup>, Rick Stevens<sup>2</sup>, Sylvester Spencer<sup>1</sup>, John Wekell<sup>1</sup>, Scott Solberg<sup>2</sup>, Clem Furlong<sup>2</sup> and Vera Trainer<sup>1</sup>. <sup>1</sup>*NOAA Fisheries, Marine Biotoxins Program, Environmental Conservation Division, Northwest Fisheries Science Center, Seattle, WA 98112 ([bich-thuy.le.eberhart@noaa.gov](mailto:bich-thuy.le.eberhart@noaa.gov))*; <sup>2</sup>*Department of Genome Sciences and Medicine, Division of Medical Genetics, University of Washington, Seattle, WA 98195*. **Application of a polyclonal antibody in the development of methods for detecting domoic acid.** Polyclonal antiserum raised in rabbits against ovalbumin (OVA)-domoic acid conjugate was employed in the

development of methods to detect domoic acid (DA), a neurotoxin produced by diatoms of the genus *Pseudo-nitzschia*. The DA molecule was coupled to the carrier protein (OVA) through one of its three carboxyl groups using a carbodiimide reaction. This immunogen produced an anti-DA serum that is sensitive and specific to free DA. We have successfully used the resulting antibody in an indirect competitive enzyme-linked immunosorbent assay (cELISA) to determine DA levels in contaminated shellfish. This antibody is also being tested in a new surface plasmon resonance (SPR) detector system developed at the University of Washington, which uses minute changes in surface refractive index to detect analytes. Recent advances in SPR sensor technology make it possible to use our anti-DA antibody to develop a small, compact, battery-operated system for real-time monitoring of DA in the field. The SPR detector system is a competition-based assay where a low concentration of antibody is exposed to the immobilized DA conjugate attached on the gold sensor surface. A mixture of antibody plus sample or standard is then added to the flow cell over the sensor. Rates of antibody binding to the domoate immobilized on the sensor surface are determined in the absence and presence of varying concentrations of DA in the sample or standard. Since very dilute concentrations of antibody are needed for the competition assay, many assays may be carried out with small amount of antibody. We are presently testing the prototype unit for establishing DA standard curves, examining matrix effects and determining detection limits.

Erica Fruh<sup>1</sup>, Jessica Trantham<sup>2</sup> and Victor Simon<sup>1</sup>. <sup>1</sup>*NOAA Fisheries, Fishery Resource Analysis and Monitoring Division, Hatfield Marine Science Center, Newport, OR 97365* ([erica.fruh@noaa.gov](mailto:erica.fruh@noaa.gov)); <sup>2</sup>*The Wildlife Conservation Society, New York, NY 10460*. **Confirming sex determination in longspine (*Sebastes altivelis*) and shortspine (*S. alascanus*) thornyheads.** Determining the sex of thornyheads (*Sebastes alascanus* and *S. altivelis*) can be difficult at certain times of the year under field conditions. When in the resting stage, thornyhead gonads atrophy, making macroscopic identification difficult and inaccurate. The purpose of this study was to examine thornyhead gonads both macroscopically and microscopically, to test sex determinations and obtain an error rate for field classifications. A total of 2330 longspine and shortspine thornyheads were retained from the 2003 Northwest Fisheries Science Center (NWFSC) West Coast Groundfish survey. Specimens were collected throughout the latitudinal range (32°34.2'-48°26.4' N) at depths of 88-1280 m from June to October. Fork length ranged from 7 to 35 cm for longspine and 7 to 72 cm for shortspine thornyhead. In the laboratory, frozen specimens were thawed, dissected and an initial determination of sex made macroscopically (following a procedure similar to that used in the field on unfrozen samples). Subsequently, a portion of the gonadal material from each fish was placed on a slide and stained with aceto-carmine. The stain's differential absorption by gonadal tissue allowed oocytes to be easily identified using a microscope. An error rate of 13% was found, with the majority of the incorrectly sexed fish being small, less than 25 cm in length. Throughout the sampling period, the highest frequency of misidentification occurred in fish collected in the months of June and October. There was also a higher incidence of misidentification in fish caught above 40° N latitude.

Thomas P. Good<sup>1</sup>, Jeffrey A. June<sup>2</sup> and Ginny Broadhurst<sup>3</sup>. <sup>1</sup>*NOAA Fisheries, Conservation Biology Division, Northwest Fisheries Science Center, Seattle, WA 98112* ([tom.good@noaa.gov](mailto:tom.good@noaa.gov)); <sup>2</sup>*Natural Resource Consultants, Seattle, WA 98119*; <sup>3</sup>*Northwest Straits Commission, Mt. Vernon, WA 98273*. **Out of sight, out of mind: derelict fishing gear and its**

**impacts on the marine fauna of the Puget Sound-Georgia Straits basin.** Derelict fishing gear--lost or abandoned commercial and recreational fishing nets, lines, pots, and traps that sit or float underwater--can remain in the marine environment for years, damaging benthic habitat and entangling and trapping marine organisms. Since 2002, a public-private partnership has conducted surveys of inland marine waters of Washington to assess the derelict fishing gear problem. Post survey operations have removed 400 derelict gillnets and 1000 derelict crab pots and traps from Puget Sound and the Straits of Georgia and Juan de Fuca using boats and dive teams. We have collected data on gear location, habitat type, water depth, type/vintage, length and height, and if the net was actively fishing, as well as the number, identity and disposition (alive or dead) of marine organisms entangled. We have thus far identified 9 marine mammals, 110 birds, 1500 fish (1/2 alive), and 4500 invertebrates (3/4 alive) recovered from derelict gear. With over 2,500 derelict nets and pots yet to be recovered throughout Washington's inland waters, we are only beginning to understand the risk posed by derelict fishing gear to marine wildlife, particularly threatened and endangered species, and we must not allow this problem to remain hidden below the surface.

Adam Goodwin, Kate Macneale, and Beth Sanderson. *NOAA Fisheries, Environmental Conservation Division, Northwest Fisheries Science Center, Seattle WA 98112*

[adam.goodwin@noaa.gov](mailto:adam.goodwin@noaa.gov). **Do non-native brook trout affect feeding habits of native salmon in Idaho streams?** The destructive consequences of invasive species are well known and undisputed, yet the implications of one such invasion that took place in the 1800s have not been examined. Non-native Brook trout (*Salvelinus fontinalis*) abundance has an inverse relationship with juvenile Chinook salmon (*Oncorhynchus tshawytscha*) survival rate, however the direct impact that brook trout have on this threatened species is uncertain. In 2004, we examined the stomach contents of more than 100 fish across four streams in Central Idaho (South Fork Salmon, Curtis, Bear Valley, and Elk Creek) as well as fish densities and aquatic invertebrate drift, hoping to determine whether the diet of juvenile salmon and steelhead differs with increasing brook trout density. Brook trout diet does not significantly overlap with that of Chinook, yet the diets of native juvenile steelhead trout (*Oncorhynchus mykiss*) and brook trout overlap considerably (48 to 75%). In streams with lower brook trout densities, Chinook have a slight preference for mayflies, although the trend was not statistically significant. Combined, our results indicate that a behavioral division of habitat occurring beneath the surface, rather than direct competition for prey, might be the cause of the Chinook's decreased survival rate.

John Harms<sup>1</sup>, Jim Benante<sup>2</sup>, and Matt Barnhart<sup>2</sup>. <sup>1</sup>*NOAA Fisheries, Fisheries Resource Analysis and Monitoring Division, Northwest Fisheries Science Center, Seattle, WA 98112*

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**Methods and preliminary results from a hook and line survey for shelf rockfish in the Southern California Bight.** Historically, there has been limited information on the abundance of structure-associated rockfish species important to the sport/recreational community within the Southern California Bight (SCB). This region contains a considerable amount of rocky bottom which is the preferred habitat of some important species of rockfish, but it is difficult to sample with the annual trawl survey, so a different method of surveying these habitats needed to be developed. In 2003, the NWFSC, in cooperation with PSMFC and the local fishing industry, initiated a hook and line survey for shelf rockfish within the SCB. Fishermen have provided considerable input into the survey in areas including gear configuration, site selection, and



sampling operations. The goals of the 2003 pilot project included assessing the feasibility of a habitat-specific survey, using hook and line gear to sample those habitats, and collecting CPUE and biological information to develop an index of relative abundance for shelf rockfish in the region. In 2004, site selection was modified to target specific GPS locations, and effort was partitioned between fixed and randomly-selected points. In 2006, the survey moved to a wholly fixed site design. Some preliminary data that will be presented include catch rate comparisons for bocaccio and vermilion rockfish between 2004 and 2005, identification of areas of high and low abundances for those species, and a summary of their length frequency distributions during the sampling period.

Larry Hufnagle, Nick Tolimieri, Steve de Blois, Rebecca Thomas, Kelly Andrews, and Greg Williams. *NOAA Fisheries, Fisheries Resource Analysis and Monitoring Division, Northwest Fisheries Science Center, Seattle, WA 98112* ([lawrence.c.hufnagle@noaa.gov](mailto:lawrence.c.hufnagle@noaa.gov)). **Advancements in fisheries acoustics: from splitbeam to multibeam.** The purpose of this project is to develop and test a new acoustic method of surveying rockfishes (Sebastes) by using water-column multibeam sonar. During this pilot study data collected by the multibeam sonar will be compared to data collected by splitbeam echo sounders and diver observations. The long-term aim is to improve NOAA's ability to assess rockfish stocks in areas where traditional methods (e.g., trawling) are unable to sample. Current trawl surveys provide poor information on population status of rockfishes since many (if not most) species primarily inhabit untrawlable, rocky habitat. A number of economically important species including widow (Sebastes entomelas), yellowtail (S. flavidus), black (S. melanops) and dusky rockfish (S. ciliatus) show semi-pelagic behavior by inhabiting the water column over rocky structures and kelp—thus making them ideal candidates for acoustic enumeration.

Lyndal Johnson<sup>1</sup>, Bernadita Anulacion<sup>1</sup>, Dan Lomax<sup>1</sup>, O. Paul Olson<sup>1</sup>, Catherine Sloan<sup>1</sup>, Julann Spromberg<sup>1</sup>, Sean Sol<sup>1</sup>, Maryjean Willis<sup>1</sup>, Gina Ylitalo<sup>1</sup>, Mary Arkoosh<sup>2</sup>, Joseph Dietrich<sup>2</sup>, Paul Moran<sup>1</sup>, Frank Loge<sup>3</sup>, Jennifer Morace<sup>4</sup>, and Jill Leary<sup>5</sup>. <sup>1</sup>*NOAA Fisheries, Environmental Conservation Division, Northwest Fisheries Science Center, Seattle, WA 98112* ([lyndal.l.johnson@noaa.gov](mailto:lyndal.l.johnson@noaa.gov)); <sup>2</sup>*NOAA Fisheries, Environmental Conservation Division, Hatfield Marine Science Center, Newport, OR 97365*; <sup>3</sup>*NOAA Fisheries, Conservation Biology Division, Northwest Fisheries Science Center, Seattle, WA 98112*; <sup>4</sup>*Department of Civil and Environmental Engineering, University of California at Davis, Davis, CA 95616*; <sup>5</sup>*U.S. Geological Survey, Oregon Water Science Center, Portland, OR 97216*; <sup>6</sup>*Lower Columbia River Estuary Partnership, Portland, OR 97204*. **Toxic contaminants in outmigrant juvenile salmon from the lower Columbia River estuary.** In a collaborative project with USGS and the Lower Columbia Estuary Partnership, NWFSC scientists are monitoring concentrations of contaminants in the Lower Columbia Estuary environment and in outmigrant juvenile salmon to evaluate their potential risk to the productivity of ESA-listed Columbia River salmon stocks. Contaminant levels have been determined in juvenile Chinook salmon, water, and sediment samples from six sites in the Lower Columbia River and Estuary, from Bonneville to the estuary mouth, as well as in juvenile Chinook salmon and food samples from six hatcheries along the Columbia. Juvenile Chinook are exposed to PCBs, DDTs, PBDEs and PAHs via their diet, with especially high concentrations of contaminants in stomach contents of fish from sites in the Portland/Vancouver area. Contaminant levels in bodies and stomach contents of some fish are above thresholds for effects on salmon health, such as delayed mortality, poor growth, and

reduced disease resistance. Salmon from the Portland sites also show signs of exposure to estrogenic compounds. Food and bodies of juvenile Chinook collected from Columbia River hatcheries contain low to moderate concentrations of PCBs, DDTs, and low molecular weight PAHs, which likely contribute to background levels of DDTs and PCBs found in outmigrant salmon. Moreover, concentrations of copper and organophosphate pesticides in the water column were at levels that could interfere with olfaction in salmon at some sites. Field data are being used in bioaccumulation and population models to better understand pathways of exposure for salmon, and potential impacts on stock recovery.

Richard Kang, Jeff Cowen, Rod Davidson, Vathsala Desilva, Bob Gref, Priya Jhangiani, Robert Larson, Robert Marsicek, Adam Mouton, Vimal Nair, Martin Park, Abdul Sait, Yazan Suleiman, Brendan Sylvander. *NOAA Fisheries, Scientific Data Management Team, Northwest Fisheries Science Center, Seattle, WA 98112* ([richard.kang@noaa.gov](mailto:richard.kang@noaa.gov)). **Scientific data management at the Northwest Fisheries Science Center.** The Scientific Data Management (SDM) Team at the Northwest Fisheries Science Center (NWFSC) develops and maintains a coordinated approach to managing data and integrating their use in scientific research related to endangered species recovery and marine species management in the Pacific Northwest. To this end, SDM provides expertise in database design, application development, and Geographic Information Systems (GIS), for desktop clients and over the web. SDM works with NWFSC and NWR researchers and staff to collect, synthesize, organize and report diverse sets of data, including restoration and recovery project data (PCSRF, PNSHP); monitoring and evaluation data (ISEMP, habitat, water quality); and biological and physical data (salmonid abundance, artificial propagation, genetics, bird predation, oceanographic). Additionally, we offer tools and applications to facilitate analysis and collaboration among Center staff and with external partners (SWAM tool for ArcView, ArcSDE database project space, Matlab/STAR-P modeling, Oracle Collaboration Suite).

Isaac C. Kaplan, Chris J. Harvey, Ian J. Stewart, and Phillip S. Levin. *NOAA Fisheries, Fishery Resource Analysis and Monitoring Division, Northwest Fisheries Science Center, Seattle, WA 98112* ([isaac.kaplan.@noaa.gov](mailto:isaac.kaplan.@noaa.gov)). **An ecosystem model of the California Current: incorporating biological indicators in fisheries stock assessment and decision rules.** Fish populations off the US west coast experience dramatic changes in reproduction and growth due to the dynamic oceanography of the region, including El Niño-Southern Oscillation and the Pacific Decadal Oscillation. Fisheries managers need a modeling framework to test management strategies that incorporate this environmental variability. To address this need, we built a spatially explicit ecosystem model of the California Current System, extending from the US/Canada border to Point Conception, California, and out to the 1200m isobath. The model structure (Atlantis) includes the trophic dynamics of 54 functional groups in the food web, including habitat-forming species like kelp, corals and sponges, as well as phytoplankton, zooplankton, vertebrates, benthos, and cephalopods. The model is forced with a high-resolution ROMS oceanographic model, and by fisheries catches for 1981-2004. Model outputs reproduce observed seasonal patterns of primary productivity, and are consistent with estimates of historical fish and mammal abundance. We use the model to identify indicator species of climate shifts (copepods and euphausiids), and to show how these biological indicators can be included in stock assessments and management decisions. Biological indicators can inform statistical estimates of reproduction, reducing the uncertainty in this key demographic parameter. The abundance of groups like copepods and euphausiids can also serve as warning flags to tell

managers to adjust fish catches even before changes in productivity are detectable in fish stocks. Simulation tests show that incorporation of biological indicators in assessment and management decisions leads to improved short term forecasts of stock size, and higher and more constant catches of target species.

Steve Katz<sup>1</sup>, [Katie Barnas](mailto:katie.barnas@noaa.gov)<sup>1</sup>, Jeanne M. Rumps<sup>2</sup>, V Ryan Hicks<sup>3</sup>, Jeff Cowen<sup>3</sup>, Mark D. Morehead<sup>2</sup>, Robin Jenkinson<sup>4</sup>, Stephen R. Clayton<sup>2</sup>, and Peter Goodwin<sup>2</sup>. <sup>1</sup>*NOAA Fisheries, Conservation Biology Division, Northwest Fisheries Science Center, Seattle, WA 98112* ([katie.barnas@noaa.gov](mailto:katie.barnas@noaa.gov)); <sup>2</sup>*Center for Ecohydraulics Research, University of Idaho*; <sup>3</sup>*Scientific Data Management Team, Northwest Fisheries Science Center, Seattle, WA 98112*; <sup>4</sup>*University of Idaho, Department of Fish, Wildlife and Range Resources, Moscow, ID 83844*. **Freshwater habitat restoration actions in the Pacific Northwest: a decade's investment in habitat improvement.**

Across the Pacific Northwest, both public and private agents are working to improve freshwater habitat for a variety of reasons, including improving conditions for threatened and endangered salmon. Projects are initiated with little or no knowledge of specific linkages between restoration actions and responses of target species. Effectiveness monitoring of these actions is required to redress this lack of mechanistic understanding, but such monitoring depends on detailed restoration information—i.e. implementation monitoring. Consequently, we assembled a database of spatially referenced, project-level data on over 23,000 restoration actions initiated at over 35,000 locations in Washington, Oregon, Idaho and Montana over the last 15 years. Data sources included Federal, State, local, NGO, and tribal contributors. Combing disparate data sources created challenges ranging from data standardization (what defines a project or location), to data validation and the legalities of data sharing. Despite these difficulties, the database allowed us to select a subset of projects (47) for interviews with individuals directly involved in restoration. One-third of the projects surveyed did not conduct sufficient monitoring to evaluate effectiveness (measurement of pre- and post- physical, biological, or chemical/water quality parameters). While a large majority (70%) of respondents reported successful projects, 43% either had no success criteria or were unaware of any criteria for their project. Just as importantly, 66% of respondents anticipate a need for on-going project maintenance, but less than half have maintenance funds available. These findings suggest that establishing a connection between project implementation and effectiveness is currently not a component of project design.

Aimee Keller, Erica Fruh, Victor Simon, Beth Horness, Vanessa Tuttle, Keith Bosley, Dan Kamikawa and John Buchanan. *NOAA Fisheries, Fishery Resource Analysis and Monitoring Division, Northwest Fisheries Science Center, Seattle, WA 98112* ([aimee.keller@noaa.gov](mailto:aimee.keller@noaa.gov)).

**The Northwest Fisheries Science Center's West Coast Groundfish Trawl Survey: design, operations, methods and results.** The Northwest Fisheries Science Center's Fishery Resource Analysis and Monitoring Division (FRAM) completed the ninth in an ongoing series of groundfish bottom trawl surveys in 2006. The survey targeted the commercial groundfish resources inhabiting depths of 55 to 1,280 m from the U.S. – Canadian to the U.S.-Mexican border using chartered West Coast commercial trawlers. These annual surveys, conducted by FRAM since 1998, are designed to monitor long-term trends in distribution and abundance of west coast groundfish, especially those species of management concern. In 2006, 688 primary sampling sites, and associated secondary sites, were selected randomly prior to the start of the survey. Catches were sorted to species, aggregate or other appropriate taxonomic level and then

weighed using an electronic, motion-compensated scale. Although biological sampling effort continues to include Dover sole (*Microstomus pacificus*), shortspine thornyhead (*Sebastolobus alascanus*), longspine thornyhead (*Sebastolobus altivelis*), and sablefish (*Anoplopoma fimbria*), focus has increasingly shifted to encompass all groundfish species of management concern. Up to 100 length measurements, sex determinations, and individual weights and up to 25 otoliths were collected per haul for these species. Here we describe the design, operations, and methods utilized during the groundfish survey and summarize data collected from 1998 - 2005.

Cathy Laetz<sup>1</sup>, David Baldwin<sup>1</sup>, Vincent Hebert<sup>2</sup>, John Stark<sup>3</sup>, and Nathaniel Scholz<sup>1</sup>. <sup>1</sup>NOAA Fisheries, Environmental Conservation Division, Northwest Fisheries Science Center, Seattle, WA 98112 ([cathy.laetz@noaa.gov](mailto:cathy.laetz@noaa.gov)); <sup>2</sup>Food and Environmental Quality Laboratory, Washington State University, Richland, WA 99354; <sup>3</sup>Puyallup Research and Extension Center, Washington State University, Puyallup, WA 98371. **Synergistic toxicity in juvenile Coho salmon exposed to mixtures of organophosphate and carbamate insecticides.** Organophosphate and carbamate insecticides are commonly detected in surface waters that provide habitat for threatened and endangered species of Pacific salmon (*Oncorhynchus sp.*) on the west coast of the United States. These pesticides inhibit the activity of the enzyme acetylcholinesterase (AChE), thereby interfering with chemical signaling (neurotransmission) at nerve synapses. Mixtures of these pesticides are frequently detected in the environment, but the effects of these mixtures on the neurobiology and behavior of salmon and other fish are poorly understood. Previous work in our lab found that *in vitro* treatments with mixtures of organophosphate and carbamate pesticides produced dose-additive toxicity, as measured by AChE inhibition. To determine if *in vivo* exposure also produces additive toxicity, we exposed juvenile coho salmon (*Oncorhynchus kisutch*) to sublethal concentrations of the pesticides diazinon, malathion, chlorpyrifos, carbaryl and carbofuran both individually and as binary mixtures. Single pesticide exposures produced dose-dependent inhibition of brain AChE. However, AChE inhibition was greater than expected after exposure to mixtures, indicating synergistic (i.e., greater-than-additive) toxicity for many of the binary mixtures. Moreover, several mixtures containing organophosphates caused mortality at concentrations that were sublethal in single pesticide exposures. These results indicate dose-additive models of toxicity may underestimate the risks that mixtures of organophosphates and carbamates pose to salmon throughout the Pacific Northwest.

Peter Lawson<sup>1</sup>, Renee Bellinger<sup>2</sup>, Paul Moran<sup>1</sup>, David Teel<sup>1</sup>, and Michael Banks<sup>2</sup>. <sup>1</sup>NOAA Fisheries, Conservation Biology Division, Hatfield Marine Science Center, Newport, OR 97365 ([peter.w.lawson@noaa.gov](mailto:peter.w.lawson@noaa.gov)); <sup>2</sup>Coastal Oregon Marine Experiment Station, Hatfield Marine Science Center, Newport, OR 97365. **Genetic Stock Identification (GSI) technology transfer to fishery management.** Genetic markers using microsatellites can be used to identify Chinook salmon stocks at a level that is useful for fisheries management. The NWFSC has coordinated a 5 year project to build a standardized data base (GAPS) of Chinook salmon microsatellites that enables coastal genetics laboratories to identify individuals from 165 stocks from 42 reporting groups of Chinook salmon from the Pacific Northwest. These identifications can be made within 24 hours of collecting the sample. Ocean fisheries in 2006 were severely restricted to protect natural fall Chinook salmon escapement to the Klamath River. These fishery restrictions caused coastal communities to lose many millions of dollars in economic activity. Genetic Stock Identification (GSI) has been proposed as a way to identify Klamath fall Chinook caught in the ocean fisheries and to use this information to provide fishermen access to stronger runs while



avoiding the weak Klamath stock. The Coastal Marine Experiment Station at Oregon State University, along with the Oregon Salmon Commission, Oregon Sea Grant, NMFS/NWFSC, and others have teamed up to develop techniques for using GSI in ocean fisheries. The project, called Cooperative Research on Oregon Ocean Salmon (CROOS), employed 80 fishermen to collect genetic samples along with geographical positioning system (GPS) coordinates, sea surface temperatures, depth of catch, and other information for each fish caught during the regular season openings off the Oregon coast in 2006. Using these data they have produced fine-scale maps of the stock composition and distribution of catch and effort. The project is developing coordinated sampling programs coast-wide and seeks to use the information gathered for fishery management, research into the ocean ecology of adult Chinook salmon, and marketing. The project is key to transferring GSI technology and the GAPS data base to practical applications. The NWFSC's role includes laboratory work, theoretical development of GSI theory, software and database development, management models, interface with fishery management, and collaborative project coordination.

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**Evaluating potential health impacts of polybrominated diphenyl ether (PBDE) flame retardants: endocrine disrupting and developmental toxicity in two fish models.**

Polybrominated diphenyl ethers (PBDEs) are flame retardant chemicals used in plastics, polyurethane foams, and textiles. Concerns about the health risks of PBDEs arose recently because PBDEs have become pervasive environmental contaminants and levels in animal tissues are increasing, yet little is known about their toxicity in any laboratory model animal. We are examining the potential biological effects of the PBDE congener 2,2',4,4'-tetrabromodiphenyl ether (PBDE-47) using two model fishes: fathead minnow and zebrafish. Breeding pairs of adult fathead minnows were given oral doses of PBDE-47 bioencapsulated in brine shrimp for 21 days. The effects of PBDE-47 exposure on plasma thyroid hormone (TH) levels and expression of genes for pituitary thyroid-stimulating hormone  $\alpha$  subunit (TSH $\beta$ ) and TH receptors were assessed. Minnows treated with PBDE-47 had depressed plasma levels of thyroxine (T<sub>4</sub>) and altered expression of genes for TSH $\beta$  in the pituitary and TH receptors in the brain. Early developmental effects of PBDEs were examined in zebrafish embryos exposed continuously to dissolved PBDE-47 beginning at 3-5 hrs post-fertilization (hpf). Larvae treated with PBDE-47 delayed hatching, were smaller in body size and developed a dorsally-curved tail that was first detectable at 72 hpf. Further examination showed that PBDE-47 induced an elevation in heart rate, which subsequently developed into a cardiac arrhythmia. This arrhythmia may have contributed to the elevated mortality seen in larvae exposed to high levels of PBDE-47. Taken together, our findings indicate that PBDE-47 can disrupt the thyroid system and cause developmental abnormalities in fish, underscoring concerns that rising PBDE contamination may impact animal populations and human health.

J. Adam Luckenbach<sup>1,2</sup>, Dimitar B. Iliev<sup>3</sup>, Frederick W. Goetz<sup>3</sup>, Graham Young<sup>2</sup>, and Penny Swanson<sup>1</sup>. <sup>1</sup>*NOAA Fisheries, Northwest Fisheries Science Center, Seattle, WA 98112*

([adam.luckenbach@noaa.gov](mailto:adam.luckenbach@noaa.gov)); <sup>2</sup>*School of Aquatic & Fishery Sciences, University of Washington, Seattle, WA 98195*; <sup>3</sup>*Great Lakes WATER Institute, University of Wisconsin, Milwaukee, WI 53201*. **Genomic biomarkers for assessing fish reproductive health.**

Urbanization, coastal population growth, agricultural practices and climate change have greatly affected water quality throughout our aquatic ecosystems. Many chemicals contaminating fish and aquatic ecosystems are known to disrupt endocrine function, potentially leading to impaired development and reproduction of wildlife and humans. To evaluate relationships between environmental conditions/contaminants and fish reproductive health, researchers require modern, comprehensive bioassessment tools. Thus the aim of this research is to develop tools to measure large-scale gene expression in the gonad as a way to assess reproductive health. As a first step toward this goal, genes that respond to known environmental stressors must be identified. Using suppression subtractive hybridization (SSH) we are working to identify genes that are specifically up- or down-regulated in the coho salmon ovary during normal development and after exposure to environmental stressors, such as xenoestrogens and prolonged feed restriction. Our focus is on immature fish with gonads in early stages of gametogenesis, because it is during these stages development that salmon are migrating to sea through contaminated waterways and estuaries. Using SSH we have recently identified a number of differentially expressed genes during the normal progression of early stages of oogenesis in coho salmon. Ultimately as we continue this work, including future exposure studies, we plan to utilize the suite of genes identified by SSH and other important genes related to gametogenesis found in the fish EST databases, to construct a custom oligonucleotide microarray that will serve as a ‘fingerprint’ for assessing the reproductive health of salmon in their native habitat.

Kate Macneale, Peter Kiffney, Julann Spromberg, David Baldwin, and Nat Scholz. *NOAA Fisheries, Environmental Conservation Division, Northwest Fisheries Science Center, Seattle, WA 98112* ([kate.macneale@noaa.gov](mailto:kate.macneale@noaa.gov)). **Effects of pesticides on salmonid food webs: current knowledge and uncertainties, and implications for endangered salmon.** The risk pesticides pose to anadromous salmonids in the Pacific Northwest is an emerging concern for researchers, managers and regulators. For salmonids listed as threatened or endangered under the US Endangered Species Act, there is an urgent need to quantify the direct and indirect effects of pesticide exposure. Because pesticides are effective at killing the very invertebrates on which salmon depend, we are particularly interested in impacts that currently-used pesticides have on salmonid prey. We present conceptual models illustrating our current understanding of the spatial and temporal impacts pesticides have on freshwater salmonid food webs. For example, an hour-long exposure of a cocktail of pesticides at a concentration sublethal to fish may reduce benthic invertebrate densities, and consequently the density of invertebrates available to fish in the drift, for months following exposure and for significant distances downstream of the exposure. These indirect effects on prey are being incorporated into models analyzing direct impacts on fish behavior and population growth. In addition, we identify data gaps and present suggestions for research and monitoring that will help fill those gaps.

Sarah McCarthy<sup>1</sup>, Julann Spromberg<sup>1</sup>, John Incardona<sup>1</sup>, Blake Feist<sup>1</sup>, Jenifer McIntyre<sup>2</sup>, Jana Labenia<sup>1</sup>, Mark Myers<sup>1</sup>, Laura Reed<sup>3</sup>, Katherine Lynch<sup>3</sup>, Jay Davis<sup>4</sup>, Linda Rhodes<sup>1</sup>, Gina Ylitalo<sup>1</sup>, Tracy Collier<sup>1</sup>, and Nathaniel Scholz<sup>1</sup>. <sup>1</sup>*NOAA Fisheries, Environmental Conservation Division, Northwest Fisheries Science Center, Seattle, WA 98112* ([sarah.mccarthy@noaa.gov](mailto:sarah.mccarthy@noaa.gov)); <sup>2</sup>*University of Washington, School of Aquatic and Fishery Sciences, Seattle, WA 98195*; <sup>3</sup>*City of*

Seattle, Seattle Public Utilities, Seattle WA 98124; <sup>4</sup>USFWS, Western Washington Fish and Wildlife Office, Lacey, WA 98503. **Impacts of stormwater runoff on coho salmon in restored urban streams.** Beginning in the late 1990s, several agencies in the greater Seattle area began conducting fall surveys for spawning salmon to evaluate the effectiveness of local stream restoration efforts. These surveys detected a surprisingly high rate of mortality among migratory coho females that were in good physical condition, but had not yet spawned. In addition, adult coho from several different streams showed a similar progression of symptoms (disorientation, lethargy, loss of equilibrium, gaping, fin splaying) that rapidly led to the death of the affected animals. In recent years, pre-spawn mortality (PSM) has been observed in many lowland urban streams, with overall rates ranging from ~ 25% to 90% of the fall runs. Continuous daily surveys of wild coho spawners in a forested reference stream in northwest Washington revealed < 1% PSM. Although the precise cause of PSM in urban streams is not yet known, conventional water quality parameters (i.e., temperature and dissolved oxygen) and disease do not appear to be causal. Rather, the weight of evidence suggests that adult coho, which enter small urban streams following fall storm events, are acutely sensitive to non-point source stormwater runoff containing pollutants that originate from highly developed landscapes. These findings have important implications for restoration and conservation efforts in urban and urbanizing watersheds, respectively. This project was supported by the NOAA Coastal Services Center, the NOAA Coastal Storms Program, the U.S. Fish and Wildlife Service's National Contaminants Program, and the City of Seattle.

Janifer McIntyre<sup>1</sup>, David Baldwin<sup>2</sup>, James Meador<sup>2</sup>, Nathaniel Scholz<sup>2</sup>. <sup>1</sup>University of Washington, School of Aquatic and Fishery Sciences, Seattle, WA 98195 ([jmcintyr@u.washington.edu](mailto:jmcintyr@u.washington.edu)); <sup>2</sup>NOAA Fisheries, Environmental Conservation Division, Northwest Fisheries Science Center, Seattle, WA 98112. **Chemosensory deprivation of juvenile coho salmon exposed to dissolved copper under varying water quality conditions.** Dissolved copper concentrations in stormwater often reach levels known to impact olfaction and olfactory-mediated behaviors in salmon under laboratory conditions. A wealth of literature, integrated into the Biotic Ligand Model, shows that water quality affects the toxicity of copper at the fish gill. Does water quality affect the toxicity of copper at the olfactory epithelium? Is dissolved copper bioavailable to the salmon nose in western U.S. streams? We exposed juvenile coho salmon (*Oncorhynchus kisutch*) to artificial waters of variable hardness (0.2-1.6mM Ca), alkalinity (0.2-3.2mM HCO<sub>3</sub><sup>-</sup>), DOC (0-6mg/L), and pH (7.6 vs 8.6). Electro-olfactograms were used to quantify the olfactory response before and after a 30-min exposure to 20 µg/L Cu. At the end of the copper exposure in the lowest-ion water, olfactory response was reduced by 82%. Olfactory response was independent of pH, weakly correlated with hardness and alkalinity, but correlated strongly with DOC concentration. Ionic copper measurements and copper speciation modeling showed that copper bound to carbonates were bioavailable to the salmon olfactory epithelium. Our results suggest that hardness, alkalinity, and pH in natural waters of the western U.S. are not protective against the neurotoxic effects of copper, whereas DOC may have significant protective effects if present at sufficiently high levels.

Mark Myers, Bernadita Anulacion, Barb French, William Reichert, Cathy Laetz, Jon Buzitis, and Tracy Collier. NOAA Fisheries, Environmental Conservation Division, Northwest Fisheries Science Center, Seattle WA 98112 ([mark.s.myers@noaa.gov](mailto:mark.s.myers@noaa.gov)). **Improved flatfish health following remediation of a PAH-contaminated site in Eagle Harbor, Puget Sound,**

**Washington.** Eagle Harbor became a Superfund site in 1987 due to high sediment concentrations of polycyclic aromatic hydrocarbons (PAHs) released chronically (1903-1988) from a nearby creosoting facility. Early studies here with English sole (1983-86) demonstrated high prevalences (up to ~80%) of toxicopathic liver lesions, including neoplasms, which have been consistently associated with PAH exposure in multiple field studies, and induced by injections of a PAH-rich fraction extracted from Eagle Harbor sediment. Before remediation, lesion prevalences and other biomarker values for PAH exposure and effect in English sole from Eagle Harbor were among the highest in Puget Sound. In 1993-1994, a clean sediment cap was placed over 54 acres of the most contaminated portions of Eagle Harbor, with a secondary cap added between 2000-2002, to sequester PAH-contaminated sediments. Lesion prevalences and biomarker values just before capping were reduced, consistent with facility closure in 1988 and shore-based source controls. Data on lesion risk, hepatic CYP1A, and biliary fluorescent aromatic compounds (FACs) from fish collected just after and at regular intervals up to ~2 years after primary capping were highly variable relative to pre-capping values. However, over the entire monitoring period (142 months) since capping, but particularly after ~3 years, there was a significantly decreasing trend in hepatic lesion risk, and for biliary FACs and hepatic DNA adducts in English sole. Hepatic lesion risk has been consistently low (> 0.20) compared to risk at capping (1.0), from ~4 years after primary capping through April 2005. These results show that the sediment capping process has been effective in reducing PAH exposure and associated biological effects in resident flatfish, and that longer term monitoring of pollutant responses in biological resources, such as resident fish, is necessary and far superior to monitoring of only sediment contaminants, in order to demonstrate the efficacy of this type of contaminant remediation.

Kathleen Neely<sup>1</sup> and Karl D. Shearer<sup>2</sup>. <sup>1</sup>*NOAA Fisheries, Conservation Biology Division, Northwest Fisheries Science Center, Seattle, WA 98112 ([kathleen.neely@noaa.gov](mailto:kathleen.neely@noaa.gov));* <sup>2</sup>*NOAA Fisheries, Resource Enhancement and Utilization Technology Division, Northwest Fisheries Science Center, Seattle, WA 98112.* **A comparison of feed intake, growth, and nutrient and energy utilization between a domesticated strain of coho salmon (*Oncorhynchus kisutch*) and its parent stock.** Feed intake, growth and nutrient and energy utilization of a domesticated strain (12 generations of selection for rapid growth) of coho salmon (*Oncorhynchus kisutch*) were compared to that of this strain's parent stock. Fish were reared under identical conditions from fertilization to 184 days post hatch. Fish were fed a commercial salmon feed, either to satiation or a predetermined ration. Fish were sampled fortnightly to determine weight gain and whole body composition. After the growth trial the satiation fish were fed feed containing Y2O3 to determine nutrient and energy digestibility. When fed to satiation, the domesticated strain ingested 53% more feed and grew at a higher rate (SGR) 5.09 vs. 3.81. When pair fed, the domesticated strain had higher FCE (gain/feed, 1.63 vs 1.42) and PER (67.0 vs. 60.0%). Digestibility of macronutrients and energy did not differ significantly. At the end of the study the parent-stock fish had significantly higher levels of whole body lipid. The results of this study indicate that faster growth of the domestic strain was the result of the multiplicative affects of greater feed intake and the sparing, by lipid, of protein for growth. Our findings will be related to the findings of similar experiments.

William B. Nilsson<sup>1</sup>, Anne E. Mataia<sup>1</sup>, Raymond S. Febus<sup>1</sup>, Vera L. Trainer<sup>2</sup>, and Mark S. Strom<sup>1</sup>. <sup>1</sup>*NOAA Fisheries, Resource Enhancement and Utilization Technology Division and the*



West Coast Center for Oceans and Human Health, Northwest Fisheries Science Center, Seattle, WA 98112 ([william.nilsson@noaa.gov](mailto:william.nilsson@noaa.gov)); <sup>2</sup>NOAA Fisheries, Environmental Conservation Division and the West Coast Center for Oceans and Human Health, Northwest Fisheries Science Center, Seattle, WA 98112. **Detection and quantification of *Vibrio parahaemolyticus* in Pacific Northwest estuarine and marine environments by real-time quantitative polymerase chain reaction (qPCR) analysis.** *Vibrio parahaemolyticus* (Vp), a bacterium that is a natural member of the estuarine and marine bacterial community, is a major cause of a seafood-related illness known as Vibriosis. This disease is usually associated with the consumption of raw or under-cooked shellfish and is typically characterized by self-limiting gastroenteritis. Many outbreaks of Vibriosis have occurred in the Pacific Northwest. Most recently, a large outbreak in the summer of 2006 was traced to shellfish cultured in the Puget Sound. Prevention of similar disease outbreaks in the future will be dependent upon development of more effective risk assessment tools. We have applied a real-time quantitative polymerase chain reaction (qPCR) assay for detection of Vp in environmental samples. Samples for qPCR analysis were collected in association with the 2005 and 2006 ECOHAB cruises from Puget Sound, the Strait of Juan de Fuca, the Juan de Fuca Eddy and most of the length of the Washington Coast. Near-shore samples in the area of commercial shellfish operations were also collected and analyzed by qPCR. The results of these efforts will be described and the implications of the findings will be related to what is known about the ecology of Vp. In addition, the potential value of qPCR as a risk assessment tool will be discussed.

Dawn Noren. NOAA Fisheries, Marine Mammal Program, Conservation Biology Division, Northwest Fisheries Science Center, Seattle, WA 98112. **Behavior of Southern Resident killer whales in the presence of vessels in San Juan Islands, Washington.** Southern Resident killer whales (SRKW) suffered a 20% population decline from 1996 to 2001. One of the potential risk factors to these whales is vessel disturbance. Focal follows of adult SRKW were conducted to assess behavioral responses to vessel presence. Swim speeds, respiration rates, dive durations (DD), surface durations (SD), surface active behaviors (SABs), number of vessels present within 1000 meters of the focal whale, and distances between the focal whale and nearest vessels were recorded. Preliminary results demonstrate no relationship between DD and the number of vessels present. Relationships between the number of vessels present and SD are complex and may differ between the sexes. In males, SD and the ratio between SD and the previous DD are nonlinearly related to the number of vessels present. Both decrease with increasing number of vessels but only when there are fewer than 15 vessels present within 1000 m of the whale. Furthermore, there is no relationship between the number of vessels present and the rate of SABs. However, the occurrence of SAB bouts may be related to vessel operation practices. In general, SABs occurred most often when the nearest vessel was transiting. The peak in SABs occurred when the nearest vessel transited within 100-225 m of whales. Fewer SABs occurred when the nearest vessel was stationary. These preliminary results suggest that vessels may cause short-term, minor changes in killer whale behavior. Further research, particularly in the fields of energetics and acoustics, is needed to fully understand the magnitude of vessel impacts.

O. Paul Olson<sup>1</sup>, Lyndal L. Johnson<sup>1</sup>, Gina M. Ylitalo<sup>1</sup>, Casimir Rice<sup>1</sup>, Tracy K. Collier<sup>1</sup>, and Jeff Cordell<sup>2</sup>. <sup>1</sup>NOAA Fisheries, Environmental Conservation Division, Northwest Fisheries Science Center, Seattle, WA 98112 ([o.paul.olson@noaa.gov](mailto:o.paul.olson@noaa.gov)); <sup>2</sup>University of Washington. **Monitoring of restoration performance in Commencement Bay, Washington: fish assemblage,**

**anadromous fish usage, health, and degree of chemical contamination.** Commencement Bay, WA was the first Superfund site designated in marine waters of the United States. Under the NRDA process, several sites have been subject to restoration activities; of these, seven sites were sampled in 2002 and 2003 for fish assemblage composition, sediment chemistry, and tissue and stomach content residue analysis in selected species (Chinook, coho, pink and chum salmon, and Pacific staghorn sculpin). This poster presents the results of the first two years of a multi year monitoring effort. The objectives were to monitor potential changes in fish usage, and degree of chemical contaminants in sediments and fish after restoration of these sites. Sampling showed that all sites were being utilized by fish species, with differences in fish assemblage and salmon usage which largely reflected the habitat types. Species richness as well as total number of fish captured increased from spring to maximum values in early summer. Hatchery Chinook and coho greatly outnumbered unmarked juveniles in both sampling years. Juvenile hatchery Chinook and coho were larger than unmarked juveniles in both sampling years, although only significantly so in 2002. Diet analysis of Chinook revealed a shift to fish prey at sizes over 90mm at most sites. There was evidence of chemical contamination in fish and sediments from all sites. Sediments at all sites were contaminated by PAHs at concentrations above sediment cleanup goals, and DDTs were unexpectedly high at one site, with evidence of a relatively fresh source of DDT. Body burdens of PCBs in juvenile Chinook and chum salmon from two sites were at threshold concentrations associated with adverse effects in salmon. These results raise interesting questions regarding restoration of small sites in a larger Superfund site undergoing remedial activities.

Sandra O'Neill<sup>1</sup>, [Gina Ylitalo](#)<sup>2</sup>, Donald Brown<sup>2</sup>, James West<sup>1</sup>, Catherine Sloan<sup>2</sup>, Jennie Bolton<sup>2</sup> and Margaret Krahn<sup>2</sup>. <sup>1</sup>*Washington Department of Fish and Wildlife, Olympia WA 98501*; <sup>2</sup>*NOAA Fisheries, Environmental Conservation Division, Northwest Fisheries Science Center, Seattle, WA 98112* ([gina.ylitalo@noaa.gov](mailto:gina.ylitalo@noaa.gov)). **Persistent organic pollutants in southern resident killer whales: potential sources from Pacific salmon.** Previous studies indicated that southern resident killer whales (*Orcinus orca*) contain higher concentrations of persistent organic pollutants (POPs) than found in northern residents and other north Pacific “fish-eating” killer whales. Elevated contaminant levels in southern residents may be due to dietary differences among these whale populations or to regional differences in POP concentrations in their prey. Free ranging populations of anadromous Pacific salmon, known prey of southern and northern residents, generally have low levels of POPs, as most of their growth occurs in open waters of the Pacific Ocean. However, the five Pacific salmon species 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. Overall, concentrations of POPs were higher in coho and Chinook populations that have more coastal distributions than those measured in salmon species with more oceanic distributions. Regional variation in POP exposure was also evident in Chinook salmon and appears to be associated with differences in marine distribution of these species. For example, Fall Chinook returning to Puget Sound had 2 to 6 times more PCBs and 5 to 17 times more PBDEs than other populations of Summer/ Fall Chinook. Similarly, concentrations of PCBs and PBDEs were 3 and 5 times higher in southern residents than northern residents. In addition to contamination, regional differences in caloric content of Chinook salmon from Puget Sound further reduce their quality as prey to southern resident killer whales.

Melanie Paquin. *NOAA Fisheries, Conservation Biology Division, Northwest Fisheries Science Center, Seattle, WA 98112* ([melanie.paquin@noaa.gov](mailto:melanie.paquin@noaa.gov)). **Does supplementation work? Analysis of long-term effects of hatchery releases on Snake River basin steelhead populations.** This study characterizes the genetic structure of Snake River Basin steelhead populations by comparing the distribution of genetic variation in wild steelhead populations (those with little or no hatchery influence) to naturally-produced steelhead populations (those with varying levels of influence from hatchery fish). Fifty-one steelhead populations from throughout three Snake River sub-basins: the Lower Snake, Clearwater, and Salmon were analyzed. “Wild” and “naturally-produced” populations were used to test the hypothesis that introgression by steelhead hatchery fish has diminished naturally occurring genetic variation among Snake River Basin steelhead populations. Analysis of 14 microsatellite loci was used to estimate levels of gene flow and to identify geographic areas that contain genetically differentiated populations. Results from FST pairwise comparison analysis show overall genetic variation is low within the Lower Snake River sub-basin relative to the other two sub-basins. More importantly, patterns of genetic variation between populations within the sub-basins were similar for wild and naturally-produced populations. This suggests that hatchery introgression, especially from non-indigenous hatchery sources, has not dramatically influenced the genetic structure of the Snake River steelhead populations. The results reported here support recent studies of reproductive success in hatchery-origin steelhead and suggest that non-indigenous or highly domesticated stocks may have relatively little success reproducing in the wild.

William T. Peterson<sup>1</sup>, Rian C. Hooff<sup>2</sup>, Cheryl A. Morgan<sup>3</sup>, Karen L. Hunter<sup>3</sup>, Edmundo Casillas<sup>1</sup>, and John W. Ferguson<sup>1</sup>. <sup>1</sup>*NOAA Fisheries, Fish Ecology Division, Northwest Fisheries Science Center, Seattle, WA 98112* ([bill.peterson@noaa.gov](mailto:bill.peterson@noaa.gov)); <sup>2</sup>*Department of Biological and Environmental Sciences, Washington State University, Vancouver, WA*; <sup>3</sup>*Oregon State University, Newport, OR 97365*. **Ocean conditions and salmon survival in the Northern California Current.** We developed three sets of ecosystem indicators to aid in understanding the ecological interactions between juvenile salmon and coastal oceanographic conditions for use in predicting adult salmon returns to Pacific Northwest rivers. The first set of indicators is based on large-scale oceanic and atmospheric conditions in the North Pacific Ocean, and consists of the Pacific Decadal Oscillation and the Multivariate El Niño Southern Oscillation Index. These metrics help gauge the influence of basin-scale winds and ocean currents on local ocean dynamics off the coast of Washington and Oregon. The second set of indicators is based on local observations of physical and biological ocean conditions off Newport, Oregon. They include measures of upwelling, water temperature and salinity characteristics, and plankton species compositions. The third set of indicators consists of estimates of juvenile salmonids, forage fish, and Pacific hake abundance. From this combination of physical and biological indicators we forecast adult salmon returns. Almost all of the 14 individual ecosystem indices measured in 2005 point to low adult returns of coho salmon in 2006 and spring Chinook salmon in 2007. This information will be used by fishery managers to set harvest levels, and by river managers to interpret salmon recovery actions taken in freshwater in the context of ocean productivity.

Megan Petrie, Skip Tezak, and Barry Berejikian. *NOAA Fisheries, Resource Enhancement and Utilization Technologies Division, Manchester Research Station, Manchester, WA 98353* ([megan.e.petrie@noaa.gov](mailto:megan.e.petrie@noaa.gov)). **Movement and behavior of steelhead (*Onchorhynchus mykiss*)**

**smolts through Hood Canal.** Unexplained declines in Hood Canal and Puget Sound steelhead populations have been detected in the last 10 to 20 years, and have been shown to contrast markedly with the relatively stable condition of populations along the Washington and Oregon coasts. This discrepancy between the health of Coastal as opposed to Puget Sound steelhead populations indicates that nearshore smolt migration may constitute a major cause of mortality. Acoustic telemetry was used to investigate survival, migration timing, and migratory behavior of steelhead smolts from four Hood Canal streams and one Strait of Juan de Fuca stream. Estimated survival rates for wild smolts from river mouths to the northern end of Hood Canal was 71% for Skokomish (n = 21), 67% for Dewatto (n = 9), and 85% for Big Beef Creek (n = 48), and 76% for hatchery-reared smolts released into the Hamma Hamma River (n = 29). Residence time and migration patterns within Hood Canal were highly variable within and among populations. The extended duration of residence in Hood Canal exhibited by some fish suggests that it may provide growth opportunities and function as more than simply a migration corridor. Evidence of a tendency to migrate along the shoreline was not found, as receivers positioned in nearshore habitats did not detect a disproportionately large number of migrants. Detailed knowledge of steelhead survival and patterns of nearshore habitat use not only aid in determining causes of population decline, but also help define extinction risk and recovery actions for this potentially ESA-listed species.

Rachel J. Petrik-Finley, Paul M. Chittaro, and Phillip S. Levin. *NOAA Fisheries, Science for Ecosystem-based Management Initiative, Fishery Resource Analysis and Monitoring Division, Northwest Fisheries Science Center, Seattle, WA 98112* ([rachel.petrik-finley@noaa.gov](mailto:rachel.petrik-finley@noaa.gov)). **Toxic nurseries: settlement and recruitment of English sole in urban and rural nursery habitats of Puget Sound.** Urban growth and industrial development in coastal regions are in danger of encroaching on habitats critical to recreationally and commercially important species. Essential nursery habitats for young-of-the-year English sole in Puget Sound may be threatened by high levels of urban and industrial development and heavy inputs of chemical contaminants. We used monthly field surveys to evaluate settlement at sites at sites throughout Puget Sound, and examined a suite of habitat and community variables that may impact growth and survival in juvenile sole. We observed strong latitudinal gradients in settlement of young-of-the-year English sole with northern sites and sites along the western side of Puget Sound receiving the highest abundance of settlers. Settlement was also lower at sites near to and in urban areas. Preliminary analysis of contaminant exposure indicates juvenile English sole are exposed to some toxins (*i.e.* polyaromatic hydrocarbons) even at nursery sites far from urban development.

Sudheesh Ponnerassery, Samuel Crane<sup>†</sup>, and Mark Strom. *NOAA Fisheries, Resource Enhancement and Utilization Technologies Division, Northwest Fisheries Science Center, Seattle, WA 98112* ([sudheesh.ponnerassery@noaa.gov](mailto:sudheesh.ponnerassery@noaa.gov); [mark.strom@noaa.gov](mailto:mark.strom@noaa.gov)); <sup>†</sup> *Present address: Department of Biology, City University of New York and the Institute for Comparative Genomics at the American Museum of Natural History, New York, NY 10024.* **Inhibition of sortase enzyme activity of *Renibacterium salmoninarum* dramatically reduces adherence and prevents invasion of chinook salmon cells *in vitro*.** *Renibacterium salmoninarum* is a Gram-positive bacterium and the causal agent of bacterial kidney disease (BKD), a chronic systemic infection in salmonid fishes worldwide. Genome sequencing of the bacterium identified a sortase homologue and 9 open reading frames specifying proteins presumably translocated to the bacterial cell wall mediated by the sortase enzyme. The sortase and sortase substrates



identified by the bioinformatic analyses were found to be constitutively transcribed in *R. salmoninarum*. Inhibition of sortase activity by phenyl vinyl sulfone (PVS) significantly reduced the adherence of the bacterium to chinook salmon fibronectin when assayed by an ELISA procedure. In addition, the ability of the PVS treated bacteria to adhere to chinook salmon embryo cells (CHSE-214) *in vitro* was dramatically reduced compared to that of untreated bacteria. More importantly, PVS treated bacteria with reduced adherence properties were also unable to invade and grow inside CHSE-214 cells as demonstrated by an intracellular growth assay and by light microscopy. In addition the PVS-treated bacteria could not produce any cytotoxicity to CHSE-214 cells, whereas, untreated bacteria produced cytotoxicity in few days. These findings clearly show that inhibition of sortase activity by small molecule drugs like PVS can interfere with the ability of *R. salmoninarum* to adhere and colonize fish cells, thereby possibly reducing its virulence. Further research will probe the effect of the drug in reducing the colonization of *R. salmoninarum* in salmonids *in vivo* and as an antivirulence chemotherapeutic drug for the treatment of BKD.

Sudheesh Ponnerassery, and Mark Strom. NOAA Fisheries, Resource Enhancement and Utilization Technologies Division, Northwest Fisheries Science Center, Seattle, WA 98112 ([sudheesh.ponnerassery@noaa.gov](mailto:sudheesh.ponnerassery@noaa.gov); [mark.strom@noaa.gov](mailto:mark.strom@noaa.gov)). **Induced macrolide antibiotic resistance in the salmonid pathogen *Renibacterium salmoninarum*.** Bacterial kidney disease caused by *Renibacterium salmoninarum* is a chronic disease affecting salmonids worldwide. The macrolide antibiotics erythromycin and azithromycin have been used to treat the disease in fish with limited success, and the possibility of drug resistance development is a major concern. This study was carried out to investigate the potential of the bacterium to develop induced resistance to these drugs and to identify the genes involved in the context of the recently sequenced genome of the bacteria. *R. salmoninarum* was induced to resist up to 2 mg/ml erythromycin and 2µg/ml azithromycin after growing the bacteria in selective kidney disease medium (SKDM-2) in the presence of macrolide drugs starting from 0.00195 µg/ml and then inoculating the cultures to increasingly higher concentrations of drugs. The transcription of six macrolide resistance genes was analyzed by reverse transcription - PCR. Transcription of a methyl transferase gene and a gene specifying a macrolide efflux protein was induced following drug treatment even at sub clinical doses. The induced macrolide resistance phenotype was found to be stable for two subcultures when the induced bacteria were grown in SKDM-2 medium in the absence of any antibiotic. Induced macrolide resistance was also observed when the bacteria previously grown in the presence of macrolide drugs were used to infect a CHSE-214 cells. The finding that the bacteria were able to resist sub-clinical doses of these drugs points to possible resistance development in salmon hatcheries after prophylactic macrolide treatment of BKD.

Adelaide C. E. Rhodes and Michael B. Rust. NOAA Fisheries, Resource Enhancement and Utilization Technologies Division, Northwest Fisheries Science Center, Seattle, WA 98112 ([adelaide.rhodes@noaa.gov](mailto:adelaide.rhodes@noaa.gov)). **Seed quality: engineering larval diets to increase growth and reduce disease transmission.** Hatchery production of healthy, hardy fingerlings is crucial to the development of stock enhancement protocols. Not only does mitigation of the risk of disease start in the hatchery, fingerlings that are not physically robust will not survive as well when released to the wild. Diet, disease and economics are the three biggest challenges encountered by hatcheries that wish to optimize post-release fingerling survival and quality. We review

developments in fingerling production related to innovative diets and associated disease management techniques. For example, the use of the traditional live feeds, *Artemia* and rotifers, can have nutritional limitations, as well as introduce unwanted microbial organisms and pathogens into the larval rearing system. These live feeds can be improved nutritionally with focused enrichments that provide the essential fatty acids and vitamins which ensure good growth and normal development. Probiotics used with these live feeds can reduce the risk of introducing unwanted pathogens. The development of alternative live feeds such as copepods or cladocerans, which can be sterilized before introduction, can also offer an alternative for increasing nutritional value and reducing disease transmission. The early introduction of microparticulate diets needs to be further developed to reduce potential disease vectors, to increase growth and reduce economic costs to the hatcheries. This review will discuss how hatcheries can use the latest larval feeding techniques to reduce the cost of fingerling production, improve larval growth and development, and reduce the risk of disease transmission.

Suzanne Russell and Morgan Schneider. *NOAA Fisheries, Socioeconomics Program, Science Director's Office, Northwest Fisheries Science Center, Seattle, WA 98112*

([suzanne.russell@noaa.gov](mailto:suzanne.russell@noaa.gov)). **Describing the Southern Resident Killer Whale (SRKW) watching industry of the greater Puget Sound.** Orca whales, also known as killer whales (*Orcinus orca*), are cultural icons for the human residents of the Pacific Northwest's Puget Sound. They recently received an endangered listing under the Endangered Species Act, and are protected under the Marine Mammal Protection Act. In a research atmosphere where ecosystem science is emphasized, it is instinctive to discuss the biological elements of an ecosystem. However, when reflecting on an ecosystem, it is important to understand that humans are part of the ecosystem as well. In this case, while biological research on the SRKW itself is beginning to answer ecosystem questions, there is little information on the connection of these animals with humans. As social scientists, we study the human dimension of ecosystems, working to better understand people and their relationship to marine resources. In this instance, we are interested in better understanding the relationship of people to the SRKW. Specifically, we have identified a unique relationship between the whale watching industry of the Greater Puget Sound and the SRKW. We aim to more clearly understand this connection. As with fishermen who depend on healthy fish stocks, this industry depends on a healthy and resilient population of Southern Resident Killer Whales. This poster touches on research efforts to describe the people involved in the industry. Insights into the reasons people participate in the industry as well as their backgrounds help clarify their connection to the significant marine resource that is the SRKW.

Beth Sanderson<sup>1</sup>, Michelle Rub<sup>2</sup> and Katie Barnas<sup>2</sup>. *NOAA Fisheries, Environmental Conservation Division, Northwest Fisheries Science Center, Seattle, WA 98112* ([beth.sanderson@noaa.gov](mailto:beth.sanderson@noaa.gov)); <sup>2</sup>*NOAA Fisheries, Conservation Biology Division, Northwest Fisheries Science Center, Seattle, WA 98112*. **Non-indigenous species of the Pacific Northwest: an overlooked risk?** Non-indigenous species are recognized as one of the major threats to global diversity and have been cited as a cause of decline in 42% of species listed under the US Endangered Species Act. The Pacific Northwest is home to more than a thousand aquatic and terrestrial non-indigenous species, yet the effects of most of these species on native populations, communities and ecosystems remain unknown. During their life cycle, salmonids traverse large geographic areas spanning freshwater, estuary and ocean habitats where they encounter numerous non-native species. To date, the cumulative impact of non-indigenous

species on salmonids has not been described or quantified. We examine the extent to which introduced species are a potentially important risk to threatened and endangered salmon, ultimately by contributing to higher levels of life-cycle mortality. We identify and categorize all documented introduced species in the Pacific Northwest, including fish, invertebrates, birds, plants, amphibians and others. Where data exist, we quantify the impact of non-indigenous and range-expansion species on populations of threatened and endangered salmonids. For example, birds and fish predators are reported to consume 0-40% of juvenile salmon in some habitats. These data indicate that the impact of non-indigenous species on salmon is equal to or greater than commonly addressed impacts (habitat, harvest, hatcheries and hydro-system) and suggest that managing non-indigenous species impacts may be imperative for the recovery of these fish.

Carla Stehr, Lyndal Johnson, Gina Yitalo, Don Brown, John Incardona and Tracy Collier. *NOAA Fisheries, Environmental Conservation Division, Northwest Fisheries Science Center, Seattle, WA 98112* ([carla.m.stehr@noaa.gov](mailto:carla.m.stehr@noaa.gov)). **Environmental chemistry and toxicology studies in the Environmental Conservation Division: past, present and future.** The Environmental Conservation Division (ECD) was established in 1972 to study chemical pollution and effects on the health of marine organisms. At that time, it was thought that fish could not metabolize many chemical contaminants. However, in 1975, ECD scientists showed that polycyclic aromatic hydrocarbons (PAHs) were indeed metabolized by fish. In 1976, the National Analytical Facility was established to analyze contaminants in the marine environment. In the 1980's, ECD scientists showed a link between PAH exposure and liver tumors in fish. Indicators of contaminant exposure were developed, validated and used in laboratory and field monitoring studies. Sublethal effects such as reproductive impairment were identified. In 1989 and the 1990's, our expertise was called on to help assess the extent of environmental damage after oil spills such as the Exxon Valdez. Damage assessment studies were also conducted in industrial areas of Puget Sound. New technologies continue to be added, including utilizing zebrafish as a vertebrate model system to quickly evaluate effects of contaminants on fish, and adapting molecular biology tools to identify mechanisms of cellular damage. Analytical methods are updated or developed to measure emerging contaminants in fish and marine mammals. Currently, the roles of chemicals, including those found in storm water run-off, are being studied with regard to salmon recovery. We continue to develop and apply new technologies as we build on more than 30 years of ecotoxicology studies to determine effects of human activities on the health and fitness of wild fish, especially Pacific Salmon and marine fish.

Mark S. Strom<sup>1</sup>, Greg Wiens<sup>2</sup>, Dan Rockey<sup>3</sup>, Donald Chen<sup>1,4</sup>, and Samuel Crane<sup>1,4</sup>. <sup>1</sup>*NOAA Fisheries, Resource Enhancement and Utilization Technologies Division, Northwest Fisheries Science Center, Seattle, WA 98112* ([mark.strom@noaa.gov](mailto:mark.strom@noaa.gov)); <sup>2</sup>*National Center for Cool and Cold Water Aquaculture, USDA/ARS, Leetown, WV 25430*; <sup>3</sup>*College of Veterinary Medicine, Oregon State University, Corvallis, OR 97331*; <sup>4</sup>*Undergraduate Research Program, University of Washington, Seattle, WA 98195*; † *Present address: Department of Biology, City University of New York and the Institute for Comparative Genomics at the American Museum of Natural History, New York, NY 10024.* **The *Renibacterium salmoninarum* genome sequencing project.** *Renibacterium salmoninarum*, a Gram-positive bacterium and member of the Micrococcaceae family, is the causative agent of bacterial kidney disease (BKD) in salmonids. BKD remains a high priority for hatcheries, aquaculture, and conservation programs designed to maintain salmon stocks listed under the Endangered Species Act. Treatment of BKD remains

problematic, and currently available antibiotics and vaccines are not completely efficacious. In order to identify virulence factors, vaccine candidates, and targets for novel therapeutics to control the pathogen in salmon, a project to completely sequence and annotate the genome of *Renibacterium salmoninarum* was carried out. Here we summarize the process and first findings from *in silico* analysis of the complete genome of *R. salmoninarum*.

Penny Swanson<sup>1</sup>, Jon T. Dickey<sup>2</sup>, Larissa Felli<sup>2</sup>, Kathy Cooper<sup>2</sup>, Graham Young<sup>2</sup>, and Irvin B. Schulz<sup>3</sup>. <sup>1</sup>*NOAA Fisheries, Resource Enhancement and Utilization Technologies Division, Northwest Fisheries Science Center, Seattle, WA 98112 ([penny.swanson@noaa.gov](mailto:penny.swanson@noaa.gov));* <sup>2</sup>*School of Aquatic & Fishery Sciences, University of Washington, Seattle, WA 98195;* <sup>3</sup>*Battelle Marine Sciences Laboratory, Pacific Northwest Division, Sequim, WA 98362.* **Reproductive performance of adult salmon exposed to an environmental estrogen during juvenile life history stages.** A variety of environmental contaminants disrupt reproduction by binding to estrogen receptors. The most biologically potent is ethynylestradiol (EE2), a synthetic estrogen used in oral contraceptives that is present in surface waters as a result of sewage discharges. The objective of this study was to determine if exposure to EE2 during juvenile life history stages alters survival after seawater entry, growth and reproduction. Individually tagged 1+ age coho salmon were exposed to three concentrations of EE2 (0, 0.25, 2.5, and 25 ng/L; 2 tanks per treatment, 60 fish per tank) via tank water for 2 weeks during the later phases of smoltification. The duration of exposure was intended to mimic a typical downstream migration period. Two weeks after the exposure, tissue and blood samples were collected from a subset of fish to assess acute effects of the exposure on the reproductive endocrine system. The remaining fish were transferred to a common tank of seawater and reared to maturity at age 3 when fish were transferred back to fresh water for spawning. Our results demonstrated that water borne exposure to EE2 for two weeks induces inappropriate hormone production in juveniles, including suppression of genes involved in steroid biosynthesis. Despite the disruption of the endocrine system at juvenile life-history stages, there were no significant effects on survival, growth, fecundity or fertility of adults. These results suggest that the reproductive endocrine system of smolts is disrupted by EE2, even at very low levels. However, the acute disruption did not appear to have long-term effects on adult fertility and survival.

Chau Tran, Beth Sanderson, Kate Macneale, and Holly Coe. *NOAA Fisheries, Environmental Conservation Division, Northwest Fisheries Science Center, Seattle, WA 98112 ([chau.tran@noaa.gov](mailto:chau.tran@noaa.gov)).* **Assessing nutrient limitation in salmonid streams of the Salmon River basin in Idaho.** Spawning adult salmonids deliver marine-derived nutrients vital to the ecology of nutrient-poor streams throughout the Pacific Northwest. In Idaho, declining stocks of endangered chinook salmon has affected stream productivity of the Salmon River basin. To determine the magnitude and mechanisms of nutrient limitation we placed in-stream nutrient diffusing substrates to measure algal biomass accrual in control, N, P, and N+P treatments. Past results indicate primary N limitation and N+P co-limitation in most study streams, though patterns of significantly lower chlorophyll *a* in P treatments versus control treatments reoccur yearly, and across multiple streams. We continue to explore this inhibitory algal growth response in P treatments in 2006 using a spectrum of P concentrations and the addition of tea tree oil as a possible bacteria inhibitor. In contrast, we also present data from a similar experiment we conducted in Washington State, where endangered salmonids reside in P-limited streams. Understanding and identifying specific patterns of nutrient limitation is a critical first step in



assessing whether nutrient additions are appropriate restoration measures for streams with declining adult salmon returns.

Vanessa Tuttle. *NOAA Fisheries, Fishery Resource Analysis and Monitoring Division, Northwest Fisheries Science Center, Seattle, WA 98112* ([vanessa.tuttle@noaa.gov](mailto:vanessa.tuttle@noaa.gov)). **Historical bycatch trends and changes in today's fishing.** The at-sea Pacific hake (*Merluccius productus*) fishery is a good example of how a pointed change has been made in fishing effort towards avoiding specific bycatch species with varying degrees of success. Sixteen years of historical catch data indicate high interannual variability in overall rockfish bycatch with recent sharp declines, while the overall hake catch has increased in recent years. Bycatch avoidance in the hake fishery is accomplished in several ways, primarily by altering fishing depth, time of day, and fishing area. Results of these changes are shifts in bycatch species composition, which is evident with rockfish bycatch declining, squid bycatch increasing, and salmon bycatch remaining consistent. Regulations have created strict fishery bycatch limits for both canary and widow rockfish in the hake fishery. In 2006, ten individual tows, out of approximately 3000 total, caught 74% of the allotted widow bycatch quota. Continued efforts to reduce bycatch are essential in fisheries which have potentially season-limiting bycatch caps.