NWFSC Watershed Program Open House

NOAA Western Regional Center

7600 Sand Point Way NE

Seattle, WA

March 18, 2015

http://www.nwfsc.noaa.gov/research/divisions/fe/wpg/index.cfm

9:00-9:10 Welcome – John Stein, Science and Research Director, Northwest Fisheries Science Center

9:10-9:20 Overview of Watershed Program research – Phil Roni, Program Manager, Northwest Fisheries Science Center

Session 1 – Life-cycle Modelling and Research

9:20-9:40 **Physical, biological, and temporal influences on Chinook salmon egg-to-fry survival.** P. Roni, C. Johnson (WDFW), T. De Boer (WDFW), G. Pess, and A. Dittman (EFS, NWFSC)

Mortality is highest in the early life stages of most fishes and believed to be a factor limiting the recovery of many endangered salmon populations. To determine physical (reach type and location, fine sediment intrusion, scour), biological (parentage; natural spawner density), and temporal factors (year) influencing Chinook salmon *Oncorhynchus tshwaytscha* egg-to-fry survival, we constructed 324 artificial redds in nine reaches over four-years in the Yakima Basin. Average egg-to-fry survival ranged from 49% to 69%. Survival was significantly different among reaches in 2010, but not other years, while parentage (male-female cross), was a significant factor in all years but 2010. Percent fines in egg boxes (<2mm), scour and median particle size differed significantly among years and reaches. While artificial redds were excavated at 900 temperature units, the total days in gravel varied from 83 to 267 depending upon the reach. Regression models indicated that survival and developmental stage were influenced primarily by reach and parentage with percent of fines, days-in-gravel and median particle size, explaining additional variation. Percent fines explained 35% of the variation in survival in 2010, a year with several high flow events. Differences among reaches in survival, developmental stage, scour and fine sediment were largely due to differences between sites in the Cle Elum River or Teanaway River and reaches in Yakima River. Our results suggest that parentage and geographic location are major factors influencing egg-to-fry survival, but their relative influence vary annually depending on the magnitude of high flows and scour during incubation.

9:40-10:00 **Prioritizing habitat restoration for juvenile Chinook salmon in four Puget Sound estuaries**. C. Greene, C. Rice, E. Beamer (Skagit River System Cooperative), E. Brown (Lummi Nation), A. Chapman (Lummi Nation), J. Anderson (WDFW), and C. Ellings (Nisqually Indian Tribe)

Juvenile Chinook salmon are well known for utilizing estuarine habitats within the tidal delta for rearing during outmigration. Several studies have linked population responses to availability of estuary habitat, and support the hypothesis that estuarine habitats are vital rearing areas for juvenile Chinook salmon. However, these coarse-scale studies provide little insight on how specific estuarine habitats contribute to rearing potential for salmon. The large influx of juvenile salmon during outmigration periods can lead to competition for food and space, but the extent to which different habitat types offer optimal conditions for growth, and thereby shape density dependence, is also currently unknown. Without information as to what habitat types are most critical for growth, habitat types are generally treated as having equal value in terms of restoration benefits. However, if specific habitat types offer disproportionate benefits to juvenile Chinook salmon, then this equal valuation is flawed. We postulate that local rearing densities and by extension residency and growth rates are determined by three main drivers: 1) abiotic habitat conditions (e.g., temperature), 2) connectivity to the river mainstem, and 3) availability and type of food in a particular habitat type. We test these predictions in four large river systems (Nooksack, Skagit, Snohomish, and Nisqually) comprising over half of Puget Sound's spawning populations. The analysis incorporates biweekly and annual outmigration estimates from mainstem traps, analysis of local abundance of juvenile fish at various sites within the estuaries, and bioenergetics modeling integrating diet, temperature, and juvenile abundance by habitat type. These analyses are useful for determining the relative contribution of connectivity, cohort population size, and local habitat conditions for growth potential of Chinook salmon using estuarine habitats at early life stages.

10:00-10:20 **Approaches to defining reference conditions for river restoration planning**. T. Beechie

Reference conditions or reference regimes can be defined using three general approaches, historical analysis, contemporary reference sites, and theoretical or empirical models. For large features (e.g., floodplain channels and ponds) historical data and maps are generally reliable. For smaller features (e.g., pools and riffles in small tributaries), field data from contemporary reference sites are a reasonable surrogate for historical data. Models are generally used for features that have no historical information or present day reference sites (e.g., beaver pond habitat). Each of these approaches contributes to a watershed-wide understanding of current biophysical conditions relative to potential conditions, which helps create not only a guiding vision for restoration, but also helps quantify and locate the largest or most important restoration opportunities. Common uses of geomorphic and biological reference conditions include identifying key areas for habitat protection or restoration, and informing the choice of restoration targets. Examples of use of each of these three approaches to define reference regimes in western USA illustrate how historical information and current research: 1) highlight

key restoration opportunities, 2) focus restoration effort in areas that can produce the largest ecological benefit, and 3) contribute to estimating restoration potential and assessing likelihood of achieving restoration goals.

10:20-10:40 **Defining fish habitat from a geomorphic perspective**. M.P. Beakes (NOAA contractor, NRC research associate), and T. Beechie

The conservation and restoration of freshwater habitat is an essential step towards effective management of Pacific salmon. Here we use a habitat classification scheme grounded in fluvial geomorphology to discretize and quantify salmon habitat in the Wenatchee River basin (WRB). We couple this classification scheme with historical and contemporary datasets to estimate the current and potential habitat available to WRB salmonids. Our aim is to locate regions of the watershed where the current habitat availability is less than what it can potentially provide, identify potential drivers of habitat loss, and translate habitat availability into salmonid production capacity. For example, we estimate that the juvenile Chinook production capacity of WRB tributaries (bankfull width < 8 m) is currently ~10% less than what they can potentially support, which is associated with a ~23% reduction in the current availability of pool habitat relative to what WRB tributaries can potentially provide. We posit that the amount of pool habitat within WRB tributaries is associated with the abundance of large wood that each tributary contains. Regression analyses reveal that large wood abundance within a tributary reach is significantly ($P < 0.001$) and positively correlated with pool habitat availability. As well, tributaries with less pool habitat contain significantly less large wood ($P < 0.001$) compared to reference sites. This study expands a framework for identifying mechanistic linkages of habitat loss while providing robust estimates of habitat availability and salmonid production capacity at spatial scales relevant to salmon populations and fisheries management.

BREAK 10:40-11:00

11:00-11:20 **Incorporating life-history diversity into estimates of Skagit River Chinook salmon production**. C. Phillis (NOAA contractor, Ocean Associates), C. Greene, J. Anderson (WDFW), E. Beamer (Skagit River System Cooperative), and C. Ruff (Skagit River System Cooperative)

Understanding how various habitat features influence production and carrying capacity of watersheds, and how life history variation of out-migrants responds to these habitat factors, is critical for setting escapement levels and meeting population recovery goals that are directly tied to the productive potential of a watershed. Here we illustrate how these concepts can be applied to improve conservation efforts using Skagit River Chinook salmon, a population with extensive history of status monitoring at multiple life stages and complementary watershed habitat data. Long-term monitoring data reveal five juvenile life history types (LHTs), including parr and yearling that rear upstream, and fry that rear downstream in either the delta (delta

fry) or non-natal streams (non-natal fry), or migrate directly to the nearshore (migrant fry). We identify habitats limiting Skagit River Chinook salmon production using a limiting factors analysis framework modified to produce LHTs in proportion to available LHT-specific rearing habitat (i.e. density-dependent migration). To estimate the relative contribution of each LHT to adult returns we integrate size-specific variation in marine survival for the LHTs by applying a standard allometric model scaled to overall trends in marine survival for Skagit River populations. With our model we explore what habitat restoration scenarios targeting juvenile rearing habitat can meet Skagit River recovery goals for adult abundance. We also illustrate the consequences of narrowing juvenile life history variation on the harvest levels the population can support.

11:20-11:40 **Assessing size selective mortality during initial life stages for Puget Sound Chinook salmon: implications for early marine survival**. J.W. Chamberlin, D. Beauchamp (Washington Cooperative Fish and Wildlife Unit, University of Washington, School of Aquatic and Fishery Sciences, and U.S Geological Survey), and M. Gamble (Washington Cooperative Fish and Wildlife Unit, University of Washington, School of Aquatic and Fishery Sciences)

Survival of Chinook and coho salmon in the Salish Sea (Puget Sound and the Strait of Georgia) has decreased significantly since the mid-late 1970's and remain low presently. These recent dramatic declines in smolt-to-adult survival have prompted a significant international effort aimed at investigating the mechanisms affecting survival, specifically during the early marine period. The primary factors affecting growth and survival can be diagnosed by linking stage-specific growth and size-selective mortality (SSM). The timing and relative magnitude of SSM can be determined by serial sampling of size distributions at successive life stages using both direct measurements of body size and back-calculated estimates from scales. Critical growth periods are identified by the stage-specific occurrence of SSM, evident through disproportionate reductions in the contribution of smaller members to subsequent life stages. We can then diagnose factors that affect growth during critical periods through bioenergetics modeling simulations informed by targeted sampling of diet, growth and environmental conditions. This approach could potentially improve run forecasting and focus restoration efforts. We compared life stage specific SSM and identified critical growth periods among four major populations of Chinook salmon in Puget Sound. We analyzed scale growth patterns for Chinook salmon from freshwater, estuarine, nearshore marine, and offshore/epi-pelagic habitats for all populations and compared them to length frequency distributions to determine magnitude and timing of SSM during the early marine migratory period. Results were used to isolate population specific critical growth periods for further analysis.

Session 2 – Monitoring and Management Tools

11:40-12:00 **An update on the Puget Sound Habitat Status and Trend Monitoring project.** G.R. Pess, T.J. Beechie, K. Fresh (FE, NWFSC), J. Hall, M.C. Liermann, P. Roni, M. Rowse (CB, NWFSC), O. Stefankiv (NOAA contractor, Oceans Associates), and B. Timpane-Padgham (NOAA contractor, Ocean Associates)

The objective of the Puget Sound habitat status and trend monitoring program is to develop long-term, high quality salmonid habitat data that is focused upon the marine nearshore, delta, main stem rivers, and floodplain habitats — all of which are critical to the maintenance and recovery of listed ESA Chinook salmonids. Each habitat type includes several metrics that were selected using five evaluation criteria, and are measured at the satellite, aerial photography, and field data scale. The sample design is spatially balanced, random, and stratified according to land use, geomorphic characteristics, and major population groups. Protocols were developed and tested, sites were selected and sampled, and preliminary analysis completed for either all or a subset of the metrics associated with three of four habitat types. Analysis was based on a series of methods and results questions. We attempted to answer methods questions related to the accuracy and precision of habitat metrics, and the quantification of observation and process error. Results-based questions focused on the current status of habitats by land cover class, geomorphic types, and major salmonid population groups. Preliminary results suggest that land cover class can result in a reduction in floodplain habitat quantity (i.e. % disconnected floodplains) or habitat quality (i.e. greater proportion of braided vs. side channel nodes) across Puget Sound. Delta habitat metrics such as tidal channel and distributary channel length also differ among major population groups. Future work will focus on delta and nearshore habitat metrics and protocols as well as fish-habitat linkages.

12:00-12:20 **Strait of Juan de Fuca Intensively Monitored Watershed: results from first 10 years and future direction.** T. Bennett, P. Roni, K. Hanson, J. Hall, M. McHenry (Lower Elwha Klallam Tribe), R. Moses (Lower Elwha Klallam Tribe), W. Ehinger (WA Dept. of Ecology), R. Bilby (Weyerhaeuser), J. Walter (Weyerhaeuser), and R. Tarosky (Weyerhaeuser)

The Strait of Juan de Fuca Intensively Monitored Watershed (IMW) was initiated in 2004 to test the watershed scale response of steelhead (*Oncorhynchus mykiss*) and coho salmon (*O. kisutch*) to watershed restoration. The "Straits" IMW includes two treatment watersheds (East Twin River and Deep Creek) and one control watershed (West Twin River). Restoration treatments completed include LWD placement, road removal, culvert removal, off-channel habitat creation, and riparian planting. Monitoring of physical habitat and coho and steelhead parr densities began in 2004 using the EPAs EMAP site selection and sampling protocols. Smolt and adult monitoring predates the IMW program, and began as early as 1998 in some watersheds. Preliminary results suggest some improvements in pool habitat and adult and smolt surveys

indicate small increases in steelhead adults and smolts in East Twin and coho adults in Deep Creek. Results from Passive Integrated Transponder (PIT) tagging have revealed some interesting findings, including a large outmigration of age-0 coho in the fall that contribute to adult returns, juvenile migration among watersheds, and varying adult coho return time and age. Current research has only partially answered our original questions and has raised many new ones. Given that restoration treatments were completed fairly recently and habitat typically does not respond immediately to treatment, additional years of monitoring are needed to determine watershed-scale fish response to restoration. Moving forward, other types of restoration and monitoring activities such as nutrient addition and otolith analysis to augment PIT tag results are being planned.

12:20-12:40 **Using a life cycle modeling approach for coho salmon (*Oncorhynchus kisutch*) to better understand recolonization in two tributaries to the Elwha River during dam removal.** M. Liermann, M. McHenry (Lower Elwha Klallam Tribe), J. McMillan (Trout Unlimited), R. Moses (Lower Elwha Klallam Tribe), T. Bennett, and G. Pess

We developed a life cycle model describing the population dynamics of coho salmon in two tributaries of the Elwha River during the first two years of recolonization. The tributaries, Little River and Indian Creek, are above the former Elwha Dam which blocked passage of all salmon and Steelhead for over 100 years. Several sources of data were collected over three years for multiple life stages. These included: a) coho salmon spawning surveys documenting the location and timing of spawning, b) summer snorkel surveys describing the distribution and abundance of parr over much of the anadromous zones, c) electrofishing surveys of selected reaches with PIT tagging, d) PIT recoveries from surveys and two fixed readers at the tributary mouths, and e) screw trap captures at the mouths of both tributaries. The model incorporates simple mechanistic components, describing fecundity, incubation, growth, survival, and migration. We describe differences in model results for the two tributaries and years and discuss potential reasons for these differences.

<u>LUNCH 12:40-2:00</u> (Poster authors available)

2:00-2:20 **River recovery post dam removal: What's been happening on the Elwha?** S. Morley, G. Pess, M. Liermann, J. Duda (USGS), J. McMillan (Trout Unlimited), K. Denton (Lower Elwha Klallam Tribe contractor), M. McHenry (Lower Elwha Klallam Tribe), M. Elofson (Lower Elwha Klallam Tribe), R. Moses (Lower Elwha Klallam Tribe), R. Peters (USFWS), S. Brenkman (NPS), and P. Crain (NPS)

Simultaneous removal of two hydroelectric dams on the Elwha River of Washington State began in 2011 and was completed in 2014. Downstream transport of the approximately 21 million m^3 of sediment stored in the reservoirs has substantially increased background river

turbidity levels, filled mainstem pools and floodplain channels, and altered overall bed elevation and sediment size below the former dams. The majority of sediment released to date has been deposited in nearshore marine habitats. Despite high levels of disturbance during dam removal, recolonization by anadromous fishes has been rapid. Lamprey, steelhead, and Chinook, pink, and sockeye salmon have all naturally recolonized above the former Elwha Dam. Over 1,000 redds were observed in the middle Elwha in 2014 and juvenile salmonids are dispersing to colonize new habitats. In late summer of 2014, Chinook and bull trout moved upstream of Glines Canyon. Benthic production has been adversely affected during the active dam removal period. Benthic invertebrate density below the Elwha dam decreased 95% and was comprised of relatively few taxa. Invertebrate drift densities have also decreased, and terrestrial taxa comprised a larger proportion of juvenile salmonid diet than previously. Over the long term, we expect benthic production to recover and foodweb complexity to increase as remaining reservoir sediments are transported through the system and anadromous fish continue to recolonize newly opened habitats of the Elwha River.

2:20-2:40 **Life history diversity of steelhead (*Oncorhynchus mykiss*) in two coastal Washington watersheds**. J. Hall, P. Roni, T. Bennett, J. McMillan (Trout Unlimited, Wild Steelhead Initiative), K. Hanson, and G. Pess

Understanding life history diversity and factors that influence expression of resident (rainbow trout) and anadromous (steelhead) *Oncorhynchus mykiss* life history types are key to developing effective population conservation and recovery strategies. To this end, we used implanted passive integrated transponder (PIT) tags to monitor *O. mykiss* migration, growth, and survival in two coastal Washington watersheds. Our results indicate that while *O. mykiss* expressed a diversity of anadromous life history strategies, no evidence of residency was observed. While a majority of *O. mykiss* migrated to the ocean in their first fall or winter, these parr migrants produced no adults. Adults were only produced by smolts that reared in the river for at least one winter, with fish rearing through two or three winters producing most adults. Our study indicates that the smallest fish or slowest growing fish during their first year of life may in fact be those that remain in the stream and produce smolt migrants that provide the largest contribution to the population, while the fish that attain a larger size earlier in life leave earlier but ultimately do not produce adults. While we were unable to clearly link a limited number of measured habitat conditions to the expression of anadromous life history types in our study, continued investigation of the factors that control the expression of anadromous life history strategies could improve population recovery and conservation efforts given the clear disparity between the most successful and the most common life history types observed in these populations.

2:40-3:00 **Restoration monitoring in the Snohomish River estuary, Puget Sound—project and landscape contexts**. C. Rice, J. Hall, J. Chamberlin, T. Zackey (Tulalip Tribes), M. Rustay (Snohomish County), F. Leonetti (Snohomish County), Holly Zox (Independent), and P. Roni.

Our comprehensive restoration monitoring in the Snohomish River estuary has been underway since 2009. It consists of intensive, project level monitoring embedded in an estuary-wide program that provides invaluable context for individual projects, but also allows assessment of cumulative effects of multiple projects. The Snohomish River is the second largest watershed in Puget Sound and home to a rich community of fish and wildlife, including wild Chinook salmon (*Oncorhynchus tshawytscha*) and bull trout (*Salvelinus confluentus*), both listed as "threatened" under the Endangered Species Act. Despite major historical habitat loss (approximately 85% of 4,000 hectares), the Snohomish estuary has unusually high potential for restoration. Restoration of up to 45% of historical estuarine wetlands in the next decade is realistic. We have intensively monitored fish use across the Snohomish estuary for over a decade, and in 2009 began comprehensive pre-project monitoring of elevation, hydrology, and biota (vegetation, invertebrates, birds, mammals, and fishes) at Qwuloolt, a 150 hectare site scheduled to have tidal influence returned in late 2015. In 2011 we improved the spatial and temporal extent of estuary-wide fish and environmental sampling. As a result we've documented pre-breach conditions at Qwuloolt; and estuary-wide, seasonal, and interannual patterns of juvenile salmon abundance and size, fish assemblage composition, and temperature and salinity variation. Major environmental gradients such as hydrologic connectivity, and biological attributes such as species composition and hatchery releases, influence wild fish use of estuaries and must be understood in estuary restoration planning, design, and monitoring.

BREAK 3:00-3:20

3:20-3:40 **Programmatic approach to evaluating habitat improvement in the Columbia Basin.** P. Roni, J. O'Neal (Tetra Tech EC, Inc.), G. Pess, R. Scranton (BPA), and J. Keeton (NOAA affiliate)

In their recent review of research, monitoring, and evaluation projects, both the Northwest Power and Conservation Council and the Independent Scientific Review Panel recommended that the Bonneville Power Administration (BPA) and its partners develop a consistent, rigorous, and cost-effective approach for evaluation of habitat restoration actions implemented under the Council's Fish and Wildlife Program. In response to this, we developed a programmatic action effectiveness monitoring (AEM) program for evaluation of habitat restoration actions in the Columbia River basin. Here we describe the basic approach being used to evaluate new and completed barrier removal, instream habitat improvement, floodplain, riparian planting and fencing projects and preliminary results from the first year of monitoring. A multiple before-after-impact-control (MBACI) design is being used to evaluate a subset of new actions and an extensive post-treatment (EPT) design for actions implemented prior to 2014. Habitat and fish

data are being collected using protocols consistent with those of the Salmon Recovery Funding Board and the Columbia Habitat Monitoring Program. A total of 56 projects across all action types were sampled in 2014 with several additional projects planned for inclusion in the program in 2015 and 2016. As an example, we provide a summary of results of post-treatment monitoring of 18 barrier removal projects sampled in summer of 2014. Initial results indicate that all sites continue to allow passage of migratory fishes. Based on results of 2014 pilot season, we provide recommendations for improvements in the AEM Program for 2015 including modifications in sample size, stratification and protocols.

3:40-4:00 **Dam them all! A beaver's guide to restoring streams**. M.M. Pollock, J. Castro (US Fish and Wildlife Service), C. Jordan (CB, NWFSC), K. Woodruff (US Forest Service), and G. Lewallen (Portland State University)

Beaver restoration techniques are a suite of process-based approaches that are often much less expensive and much more effective than many traditional stream restoration techniques. Thus they are becoming increasingly popular. We provide an overview of the basic beaver restoration techniques, including construction of beaver dam analogues, reintroduction of beaver, mitigation of the undesirable effects of beaver, such as culvert blockage, tree cutting and flooding, and identification of sites that are suitable for beaver restoration. We also discuss some of the regulatory issues surrounding the use of beaver restoration techniques in Washington, Oregon, and California. We conclude that beaver restoration techniques are an extremely cost-effective suite of approaches for restoring salmonid habitat, increasing water storage, expanding riparian habitat, reconnecting floodplains, enhancing biological diversity, and in general helping to create and maintain dynamic stream ecosystems.

4:00-4:20 **Using stable isotopes to quantify ecosystem effects of adult Pacific salmon on river food webs and applications to restoration and conservation.** P.M. Kiffney, J.M. Cram (Washington Department of Fish and Wildlife), M. Liermann, S. Naman (University of British Columbia), H. Berge (King County Watershed Assessment Team), K. Burton (Seattle Public Utilities), P. Faulds (Seattle Public Utilities), M. Koehler (Seattle Public Utilities), and D. Burrows (EFS, NWFSC)

Spawning migrations of Pacific salmon deliver energy and matter accumulated in the productive Pacific Ocean to relatively unproductive watersheds of the Pacific Northwest. Fluxes of these material subsidies vary widely in time and space, but in general they are critical determinants of terrestrial and aquatic food webs that potentially feedback to affect future salmon populations. Natural abundances of the stable isotopes of N and C measured in aquatic and terrestrial organisms are commonly used to quantify these material transfers because of isotopic differences in marine-derived N and C relative to most terrestrial sources. Although there are some key constraints in the use of stable isotopes in natural systems (e.g., fractionation, time lags), some researchers have suggested they can be applied to salmon management because of the biological significance of material subsidies delivered by these fish.

We present results from two experiments where we manipulated salmon carcass biomass density and used natural abundances of C and N stable isotopes to measure the incorporation of salmon-derived N and C by river organisms and the ecological significance of this assimilation. In addition, we present results from a large-scale experiment in the Cedar River, WA where Pacific salmon were reintroduced in 2003 after a 100-yr absence, which indicates a potential change in the trophic ecology of resident rainbow trout as evident in changes in the C and N stable isotopes measured in their tissue. We use these combined results to suggest the magnitude of salmon fluxes necessary to affect ecosystem processes in their natal watersheds.

4:20-4:30 Closing Comments – Phil Roni

Posters

(Displayed in the room across the foyer from the auditorium. Authors available during lunch)

California Current Integrated Ecosystem Assessment of habitat indicators . A.L. Collins (NOAA contractor, Ocean Associates), and C.M. Greene.

Integrated Ecosystem Assessments (IEAs) synthesize information at multiple scales and across sectors on ecosystem attributes and associated human dimensions in order to inform ecosystem based management (EBM). For the past five years, the IEA approach has been used to examine components of the California Current Large Marine Ecosystem (CCLME). In the CCLME, habitat is an important new addition to the IEA because human activities and climate drivers occur in the context of habitat. However, effective habitat science and management is hindered by a lack of understanding species-habitat interactions and habitat status. To address these knowledge gaps, a conceptual model was developed identifying four macrohabitat groups (freshwater, estuary and nearshore, pelagic, and seafloor environment) and links these macrohabitats to other IEA activities, such as environmental drivers and anthropogenic pressures. For each macrohabitats, priority indicators for habitat quantity, habitat quality, and the main anthropogenic pressures impacting habitats have been selected and the status and trends of these indicators are being examined. These are the beginning steps to understanding habitat status and health of the CCLME. Continued development of the Habitat Component of the IEA will include risk analysis to ecosystem components and management strategy evaluation. The addition of a Habitat Component to the IEA will not only advance our understanding of the important role that habitat plays in the CCLME, but will also improve the utility of IEA as a tool for EBM.

Accuracy assessment of aerial photography sampling in the Puget Sound Habitat Status and Trend Monitoring project. O. Stefankiv (NOAA contractor, Oceans Associates), J. Hall, T.J. Beechie, G.R. Pess, M.C. Liermann, B. Timpane-Padgham (NOAA contractor, Ocean Associates), P. Roni, K. Fresh (FE, NWFSC), and M. Rowse (CB, NWFSC)

Habitat status and trend monitoring is an important component of evaluating progress towards recovery of listed salmonid species in Puget Sound region. However due to the lack of consistent methods for large habitat types such as the nearshore, deltas, floodplains, and mainstem rivers (> 25m bankfull width) it has been difficult to report status and trend information. We have recently initiated the development of such a habitat monitoring effort and have implemented a hierarchical monitoring strategy that examines three spatial scales of resolution – satellite, aerial photography, and field scale. The middle resolution, or aerial photography scale, has perhaps the greatest utility for each of these habitat types because of the combination of coverage and resolution. However the quantification of error due to differences in observers is unknown. We conducted an aerial photography accuracy assessment of data collected from 12 mainstem and floodplain sample locations in order to determine the level of error associated with observer variation. We found that the percent difference in measurements and identification of bank features, such as levee bank, had higher variation between observers than habitat edge features, such as bar edge, and large scale features, such as side channels. These differences can be attributed to the lack of visibility of bank features due to the presence of canopy, thus these features should be measured on the field scale. In conclusion, we discuss the challenges associated with the identification and measurement of habitat attributes from aerial photography, and outline implications for aerial photograph sampling protocol development.

Enterprise data management to facilitate scientific research. B. Sylvander (OMI, NWFSC), R. Kang (OMI, NWFSC), R. Davidson (NOAA contractor, ERT), R. Marsicek (NOAA contractor, ERT), P. Roni, K. Hanson, and T. Bennett

The Watershed Program approached the Scientific Data Management (SDM) team to help them manage data associated with the Intensively Monitored Watersheds (IMW) project, which seeks to determine the effects of watershed restoration on salmon abundance. SDM has helped transition from manually loading and storing data in multiple locations using spreadsheets and personal databases into a web-accessible relational database with automated data loading and retrieval on demand, with consistent queries over multiple years. Work for this project included data process flow diagramming, metadata documentation, data cleanup (QA/QC), data migration from a desktop application to a web enabled application, automated machine processing of raw field data, automated analysis, query and extraction, and enhanced presentation of analyzed outputs.

Land classification of Puget Sound and riparian assessments. B. Timpane-Padgham (NOAA contractor, Ocean Associates), T.J. Beechie, G.R. Pess, K. Fresh (FE, NWFSC), M. Rowse (CB, NWFSC), J. Hall, M.C. Liermann, P. Roni, and O. Stefankiv (NOAA contractor, Oceans Associates)

Riparian areas are critical for maintaining in-stream habitat of salmonids in Puget Sound (PS). In this study we examined the status and character of riparian land-cover as part of the Puget Sound-wide habitat status and trends monitoring program. The primary metrics investigated were percent forest and impervious land-cover, and average buffer width along rivers within PS. The primary questions addressed were:

- What is the accuracy of different land-cover data sets?
- What is the status of riparian areas in PS?
- What is the status of forested buffers along mainstem rivers in PS?

For the accuracy assessment, Landsat images from the Coastal Change Analysis Program (CCAP) and digital aerial photography from the National Agriculture Imagery Program (NAIP) were compared to aerial photography basemaps at 100 randomly generated points within the floodplain area at 32 sites. Regressions of %impervious and %forest from CCAP and NAIP against manually classified land cover produced R^2 values between 0.84 and 0.87 and slopes generally near 1, indicating similar accuracy and precision in both data sets. We used both data sets to report the status of riparian areas by major population group (MPG), geomorphic class, and land-cover class at 124 sites across PS. Patterns were generally as expected, with lowest percent forest cover and the narrowest buffers in urban areas, and lowest percent impervious area in forested sites. By utilizing satellite and aerial photography data we are able to monitor the status and trends of riparian areas over a larger area and at a greater number of sites.