Climate Change in Southeast Alaska – Informing Sustainable Management of Water Resources and Anadromous Fisheries
April 12-15, 2016
Juneau, Alaska

Hosted by
USFS Tongass National Forest
North Pacific Landscape Conservation Cooperative
Alaska Department of Environmental Conservation
Southeast Alaska Fish Habitat Partnership

Workshop resources can be found online at:
http://www.seakfhp.org/resources/2016-southeast-alaska-climate-workshop/

Climate Change in Southeast Alaska – Informing Sustainable Management of Water Resources and Anadromous Fisheries
April 12-15, 2016

Workshop Purpose

In 2014, the Tongass National Forest worked with EcoAdapt, with support from the Wilburforce Foundation, to conduct a stakeholder workshop and complete a climate change vulnerability assessment of aquatic resources in Southeast Alaska including snow, ice, water, riparian vegetation, and fish. You can find this report at http://ecoadapt.org/data/documents/EcoAdapt_Tongass_VulnerabilityAssessmentReport_FINAL_22Nov214_smallres.pdf.

With support from the North Pacific Landscape Conservation Cooperative, the Southeast Alaska Fish Habitat Partnership, and State of Alaska Department of Environmental Conservation, the Tongass National Forest is convening this workshop to raise awareness to the efforts noted above and to bring scientists together with resource management practitioners to enrich knowledge, foster collaboration, and inform sustainable management of priority aquatic resources. This workshop will specifically focus on:

- Effects of hydrologic regime shifts on rivers, streams, and riparian corridors
- Effects of changes in the hydrologic regime on anadromous fish

Anticipated Outcomes

Share progress and findings of relevant studies, workshop resources will be archived here: http://www.seakfhp.org/resources/2016-southeast-alaska-climate-workshop/
Distribute tools that integrate climate change information with resource management
Identify strategic actions that address knowledge gaps and future collaboration
Integrate traditional knowledge into studies and assessments
Identify long-term data platforms for aquatic resources
Endorse a regional watershed classification to discern hydrologic regime shifts
Develop tools to predict changing ice and snow conditions and implications for hydrologic regimes
Develop tools to predict response of salmon habitat to changing hydrologic regimes

Climate Workshop Planning Team

Julianne Thompson and Sheila Jacobson, Forest Service - Tongass National Forest
Michael Goldstein, Don Martin, and Greg Hayward, Forest Service – Alaska Region
Gordy Reeves and Dave D’Amore, Forest Service Pacific Northwest Research Station
Cindy Hartmann Moore, NOAA Division of Habitat Conservation
Neil Stichert, US Fish and Wildlife Service
Gretchen Pikul and Brock Tabor, Alaska Department of Environmental Conservation
Ray Paddock, Central Council Tlingit Haida Indian Tribes of Alaska
Allison Bidlack, Alaska Coastal Rainforest Center
Sanjay Pyare and Eran Hood, University of Alaska Southeast
Colin Shanley, The Nature Conservancy
Mark Kaelke, Trout Unlimited
Scott Harris, Sitka Conservation Society/Southeast Alaska Watershed Coalition
Debbie Hart, Southeast Alaska Fish Habitat Partnership

Climate Change in Southeast Alaska – Informing Sustainable Management of Water Resources and Anadromous Fisheries
April 12-15, 2016
Westmark Baranof Hotel, Juneau, Alaska

Tuesday, April 12th Informal Social – 5:30 pm Bubble Room at Baranof Hotel

Wednesday, April 13th DAY 1 Climate Workshop

Treadwell Conference Room – Foundational Presentations to All Attendees

7:30 – 8:00 am Coffee and Networking

8:00 – 8:30 am Welcome

- Welcome and Introductions – Julianne Thompson, USFS and Nicole McMurren, Facilitator
  - Frances Houston and Rosa Miller, Dipper House of the Auk Kwaan
  - Earl Stewart, Forest Supervisor, Tongass National Forest
  - Richard Peterson, President, Central Council Tlingit Haida Indian Tribes of Alaska
  - Mary Mahaffy, North Pacific Landscape Conservation Cooperative

8:30 – 10:00 am Keynote Presentations – Climate Models, Local Perspectives

- SE Alaska Climate Change Overview – Julianne Thompson/Michael Goldstein and others, USFS
- Downscaled climate change projections for Southeast Alaska and considerations for use in modeling, management, and planning – Jeremy Littell, Alaska Climate Science Center
- At the Edge of the Wide Water: Southeast Alaska Climate and Pacific Ocean Variability – Rick Thoman, National Weather Service
- Traditional and Subsistence Perspectives – Eli Hanlon, Subsistence User and Commercial Fisherman, Yakutat, Alaska

BREAK 10:00 – 10:30 am

10:30 am – 12:00 pm Keynote Presentations – Planning, Monitoring, Collaboration

- Alaska Monitoring and Assessment Program and Future Monitoring in Southeast Alaska 2017-2020 – Amber Bethe, Alaska Dept. of Environmental Conservation
- Working Together to Collect Environmental Data in Transboundary Waters – Terri Lomax, Alaska Dept. of Environmental Conservation
- Developing a Regional Monitoring Network -- Lessons from around Alaska – Sue Mauger, Cook Inletkeeper
- Southeast Alaska Tribes Approach to Adaptation Planning –Raymond Paddock, Central Council Tlingit Haida Indian Tribes of Alaska
- USFS Approach to Adaptation Planning – Julianne Thompson, USFS

Wednesday, April 13th DAY 1 Climate Workshop

LUNCH 12:00 – 1:30 pm (on your own)

Treadwell Conference Room – Foundational Presentations to All Attendees

1:30 – 5:00 pm Workgroup Themes – Foundational Presentations & Discussion

- Workgroup Overview and Anticipated Outcomes – Julianne Thompson, USFS

Streamflow & Watershed Classification – **Allison Bidlack, Alaska Coastal Rainforest Center and David D'Amore, USFS Pacific Northwest Research Station**

- Overview of Runoff Models – Janet Curran, US Geological Survey
- Regression Approaches to Discharge Modeling, Janet Curran, US Geological Survey
- Runoff Modeling for the Gulf of Alaska Region – Dave Hill, Oregon State University
- Applications of Discharge Models to Climate Impacts – Colin Shanley, The Nature Conservancy
- Session Wrap-up/Breakout Session Reminder

BREAK 3:10 – 3:40 pm

Freshwater Temperature – **Scott Harris, Southeast Alaska Watershed Coalition and Eran Hood, University of Alaska Southeast**

- Overview of Auke Creek Climate Related Studies; How Long term Monitoring Can Help Us Understand Local Adaption – John Joyce, NOAA
- Heterogeneous Climate Change Impacts Are Anticipated at Salmon Spawning Sites on the Copper River Delta: Implications for Natural Resource Managers Across Coastal Alaska – Luca Adelfio, USFS Chugach National Forest
- Spatiotemporal Analysis of Historical and Future Climate Effects on Stream Temperatures in Southeast Alaska – Sanjay Pyare, University of Alaska Southeast

4:55 – 5:00 Day 1 Wrap-up

Evening Social 5:00 – 7:00 Sponsored by the Alaska Coastal Rainforest Center and Trout Unlimited

- 5:00 pm No host bar and poster set-up
- 5:30 pm Poster Session and appetizers
- 6:00 pm Presentation: Glacial Isostatic Rebound and Lower River-Estuary Environments in Southeast Alaska: Habitat Winners and Losers in the Context of Rising Sea Levels – Lee Benda and Daniel Miller, Terrain Works

Thursday, April 14th Day 2 Climate Workshop

7:30 – 8:00 am Coffee and Networking

Treadwell Conference Room – Foundational Presentations to All Attendees

8:00 – 11:30 am Workgroup Themes Continue – Presentations and Discussion

- Recap Day 1/Share overview for Day 2 – Julianne Thompson, USFS

Freshwater Temperature – Scott Harris, Southeast Alaska Watershed Coalition and Eran Hood, University of Alaska Southeast – Presentations Continued

- Linking Landscape Characteristics and Stream Temperature in the Coastal Temperate Rainforest of Southeast Alaska – Michael Winfree, UAF
- Alaska Stream Temperature Community: Data Storage, Harvesting and Dissemination – Ryan Toohey, USGS
- Session Wrap-up/Breakout Session Reminder

Anadromous Fish and Habitat Ecology – Gordon Reeves, USFS Pacific Northwest Research Station and Sheila Jacobson, Tongass National Forest

- Climate Change and the Freshwater Habitats of Pacific Salmon on the Tongass National Forest – Gordon H. Reeves, USFS PNW Research Station, Corvallis, Oregon
- More than the Sum of the Parts: Integrating Nature's Complexity into Climate Change Impact Assessments for Pacific Salmon – J. Ryan Bellmore, USFS Pacific Northwest Research Station, Juneau, Alaska

BREAK 10:00 – 10:30 am

- Predicting the Response of Salmon Spawning Habitat to Changing Hydrologic Regimes in the Salmon Forests of Southeast Alaska – Matthew Sloat, Wild Salmon Center
- Some Observations on Climate Effects on Salmon Populations in Southeast Alaska Based on Multi-decadal Monitoring of Selected Populations and Fisheries – Leon D. Shaul, ADF&G Commercial Fisheries Division
- Session Wrap-up/Breakout Session Reminder

LUNCH 11:30 am – 12:30 pm (on your own)

Thursday, April 14th Day 2 Climate Workshop

12:30 – 2:15 pm Workgroup Themes – Breakout Sessions and Discussion

- AJ Room – Streamflow & Watershed Classification

- Treadwell Room – Freshwater Temperature
    - Presentation: Stream Temperature Action Plan, Sue Mauger, Cook Inletkeeper

- Douglas Room – Anadromous Fish and Habitat Ecology

BREAK 2:15 – 2:45 pm

2:45 – 3:15 pm Treadwell Room – Workgroup Themes (report from breakout sessions, highlight actions)

3:15 – 4:30 pm How Can Climate Change Information Inform Management Decisions? – Panel/Facilitated Group Discussion

Panel members: Brock Tabor, Alaska Department of Environmental Conservation / Gordon Reeves, USFS PNW Research Station / Greg Hayward, USFS Alaska Region /Janet Curran, USGS / Sue Walker, NMFS / Ray Paddock, CCTHITA /Teri Camery, City and Borough of Juneau

4:30 – 5:00 pm Wrap up, identify next steps

Friday, April 15th – Transboundary Environmental Data Workshop

Workshop goals: Identify areas of collaboration in the collection, summary and distribution of water quality and quantity data in Transboundary Waters

Target audience: individuals with technical expertise or interest in the collection, distribution, and analysis of water quality and quantity data for SE Alaska

Workshop contact Terri Lomax, Alaska Department of Environmental Conservation (email: terri.lomax@alaska.gov phone: 907-269-7635)

Climate Change in Southeast Alaska – Informing Sustainable Management of Water Resources and Anadromous Fisheries
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Keynote Presentation Abstracts:

Title: Downscaled Climate Change Projections for Southeast Alaska and Considerations for Use in Modeling, Management, and Planning
Author: Jeremy Littell, USGS Research Ecologist, Lead Research Scientist, DOI Alaska Climate Science Center, Anchorage, Alaska
Author contact information: jlittell@usgs.gov / (907) 360-9416

Abstract: For the southeast Alaska region, available historical climate data, derived products, and future projections of climate scenarios continue to evolve. I will briefly discuss available archives of data and projections as well as emerging products that may provide new insights and capabilities. I will discuss both the strengths and the sources of uncertainty associated with these projections and briefly describe some best practices that stem from uncertainties and limitations in modeling.

Title: At the Edge of the Wide Water: Southeast Alaska Climate and Pacific Ocean Variability
Author: Rick Thoman, Climate Science and Services Manager, Environmental and Scientific Services Division, National Weather Service Alaska Region, Fairbanks, Alaska
Author contact information: richard.thoman@noaa.gov / (907) 458-3716

Abstract: The environment of Southeast Alaska, from individual storms to seasonal conditions to century scale climate is strongly modulated by what's happening across the Pacific Basin. We'll review some of the known sources of atmosphere variability and see how these have influenced the climate in Southeast over the past century.

Title: Alaska Monitoring and Assessment Program and Future Monitoring in Southeast Alaska 2017-2020
Authors: Amber Bethe, Alaska Department of Environmental Conservation, Alaska Monitoring and Assessment Program, and Terri Lomax, ADEC
Primary author contact information: amber.bethe@alaska.gov / (907) 269-7955

Abstract: The Alaska Department of Environmental Conservation has the responsibility to report and identify causes and sources of water quality impairment by "characterizing all the waters in Alaska". One way this is accomplished is through the Alaska Monitoring and Assessment Program (AKMAP), which is responsible for implementing statistical surveys to assess water quality on a regional basis. AKMAP has surveyed coastal and fresh waters since 2002. Survey goals are to estimate current status and trends, establish associations between indicators of natural and anthropogenic stresses, and determine indicators of the condition of aquatic ecological resources. A combination of random and

targeted sites are surveyed to ensure data is collected across a range of environmental conditions. AKMAP will begin conducting environmental monitoring in Southeast Alaska starting in 2017. Surveys will be conducted in conjunction with EPA's National Aquatic Resource Surveys. Monitoring projects will include lake, river, stream and coastal surveys focusing on one waterbody type each year. Each survey will be designed to select random sites throughout southeast Alaska, monitoring parameters that will provide a baseline environmental health assessment of water quality, sediment, aquatic and riparian habitat, and biological conditions.

Title: Working Together to Collect Environmental Data in Transboundary Waters
Author: Terri Lomax, Alaska Department of Environmental Conservation, Alaska Monitoring and Assessment Program, Program Manager
Author contact information: terri.lomax@alaska.gov / (907) 269-7635

Abstract: The Alaska Department of Environmental Conservation (ADEC), Division of Water has selected the Southeast Alaska region as a focus area for environmental monitoring starting in 2017. Southeast was selected primarily due to concerns over pollutants entering Alaska's waterways from Canadian mining operations. ADEC will coordinate with agencies, tribes and the scientific community to identify areas of collaboration in the collection, summary and distribution of water quality and quantity data in transboundary waters. Understand what monitoring activities are occurring throughout the region is a critical first step to this goal, and DEC is already taking steps to survey entities in the region that conduct environmental monitoring. Based on results from these collaborations, DEC will including environmental monitoring parameters relating to transboundary mining operations.

Title: Developing a Regional Monitoring Network -- Lessons from around Alaska
Author: Sue Mauger, Cook Inletkeeper
Author contact information: sue@inletkeeper.org

Abstract: With the rapidly warming climate, and recent studies projecting decreased salmon habitat elsewhere, collaborative partnerships are growing among federal and state agencies, non-governmental organizations and Native Tribes to collect water temperature data to assess regional-scale changes. The development of minimum data collection standards for Alaska creates an opportunity for rapid, but structured, growth in comparable stream temperature monitoring efforts in Alaska that can be used to understand current and future trends in thermal regimes. These trends can inform strategies for maintaining ecosystem resilience. Examples of sampling designs, implementation plans, and data management challenges from Cook Inlet, Bristol Bay and the Kodiak Archipelago will be highlighted to assist in the discussion about developing a regional monitoring network in SE Alaska.

Streamflow & Watershed Classification Session Abstracts:

Title: Hydrology of Southeast Alaska Watersheds and Methods for Estimating Freshwater Discharge
Author: Janet Curran, USGS
Author contact information: jcurran@usgs.gov

Abstract: Streams draining Southeast Alaska watersheds exhibit a remarkably wide range of seasonality, daily variability, and response to streamflow drivers. The respective timing of snowmelt, glacier melt, and rainfall can explain many seasonal patterns in long-term daily mean discharge data. The relative influence of these drivers can also explain patterns of daily variability in the long-term data, for example, the extreme daily variability in rainfall-dominated watersheds, and patterns of annual peak flows. Annual streamflow patterns may have links to decadal-scale or long-term climate variability. Effective approaches for estimating, or modeling, freshwater discharge metrics from Southeast Alaska consider the hydrologic nature of the watershed, the temporal and spatial scale of the input data used to build the model, and the suitability of the type of output, like daily flows or flood frequency statistics, for the user needs. Models may be statistical, such as regression equations typically based on historical data, or physically-based, such as energy-balance models. Adapting models to expected future climate variables requires careful consideration of the model basis and input data.

Title: Methods and Tools for Estimating Flood Frequency and other Streamflow Statistics in Alaska: A Regression-Based Approach to Modeling Streamflow Statistics
Authors: Janet Curran[1], Nancy Barth[2], Andrea Veilleux[1], and Robert Ourso[1]
Primary author contact information: jcurran@usgs.gov
[1] U.S. Geological Survey, [2] U.S. Geological Survey, presently University of Iowa

Abstract: Estimates of the magnitude and frequency of floods are needed for water-resources planning, management, and design applications. The USGS has updated estimates of flood frequency statistics for streamgages in Alaska and methods for estimating flood magnitude and frequency for ungaged streams. The USGS Alaska flood frequency update includes new estimates of flood frequency statistics from annual peak flow data at 387 gages with 10 years of record, revised drainage area boundaries for streamgages, revised basin characteristics, two new regional skew areas and values, a new regional skew exclusion area, restructuring of streamflow analysis regions into a single region, and new regression equations for estimating flood frequency statistics at ungaged sites. Variables for the new regression equations include drainage area and mean annual precipitation. The updated statistics and regression equations are being incorporated into the first Alaska application of StreamStats, available for streams within the Cook Inlet Basin. A web-based application developed from topographic and hydrographic data, StreamStats facilitates public access to data and statistics for streamgages, and provides tools for obtaining basin characteristics and flood-frequency estimates for ungaged streams. Additional USGS regression-based streamflow statistics modeling available for Southeast Alaska includes regressions developed from daily mean

flow data for estimating annual high-duration flows, summer monthly low-duration flows, and seasonal low-flow frequency.

Title: High-resolution Modeling of Coastal Freshwater Discharge and Glacier Mass Balance in the Gulf of Alaska Watershed

Authors: Beamer, J., Hill, D.F., Arendt, A., Liston, G.
Author contact information: David Hill - david.hill@oregonstate.edu

Abstract: A comprehensive study of the Gulf of Alaska (GOA) drainage basin was carried out to improve understanding of the coastal freshwater discharge (FWD) and glacier volume loss (GVL). Hydrologic processes during the period 1980-2014 were modeled using a suite of physically based, spatially distributed weather, energy-balance snow/ice melt, soil water balance, and runoff routing models at a high resolution (1 km horizontal grid; daily time step). Meteorological forcing was provided by the North American Regional Reanalysis (NARR), Modern Era Retrospective Analysis for Research and Applications (MERRA), and Climate Forecast System Reanalysis (CFSR) datasets. Streamflow and glacier mass balance modeled using MERRA and CFSR compared well with observations in four watersheds used for calibration in the study domain. However, only CFSR produced regional seasonal and long term trends in water balance that compared favorably with independent Gravity Recovery and Climate Experiment (GRACE) and airborne altimetry data. Mean annual runoff using CFSR was 760 km3 yr-1, 8% of which was derived from the long-term removal of stored water from glaciers (glacier volume loss). The annual runoff from CFSR was partitioned into 63% snowmelt, 17% glacier ice melt, and 20% rainfall. Glacier runoff, taken as the sum of rainfall, snow and ice melt occurring each season on glacier surfaces, was 38% of the total seasonal runoff, with the remaining runoff sourced from non-glacier surfaces. Our simulations suggest that existing GRACE solutions, previously reported to represent glacier mass balance alone, are actually measuring the full water budget of land and ice surfaces.

(Beamer, J., Hill, D.F., Arendt, A., Liston, G., 2016, "High-resolution modeling of coastal freshwater discharge and glacier mass balance in the Gulf of Alaska watershed," Water Resources Research, in press.)

Title: Climate Change Sensitivity Index for Pacific Salmon Habitat in Southeast Alaska

Authors: Colin Shanley & David Albert, The Nature Conservancy, Juneau, Alaska
Primary author contact information: cshanley@tnc.org

Abstract: Global climate change may become one of the most pressing challenges to Pacific Salmon conservation and management for southeast Alaska in the 21st Century. Predicted hydrologic change associated with climate change will likely challenge the ability of specific stocks to adapt to new flow regimes and resulting shifts in spawning and rearing habitats. Current research suggests egg-to-fry survival may be one of the most important freshwater limiting factors in Pacific Salmon's northern range due to

more frequent flooding events predicted to scour eggs from mobile spawning substrates. A watershed-scale hydroclimatic sensitivity index was developed to map this hypothesis with an historical stream gauge station dataset and monthly multiple regression-based discharge models. The relative change from present to future watershed conditions predicted for the spawning and incubation period (September to March) was quantified using an ensemble global climate model average (ECHAM5, HadCM3, and CGCM3.1) and three global greenhouse gas emission scenarios (B1, A1B, and A2) projected to the year 2080. The models showed the region's diverse physiography and climatology resulted in a relatively predictable pattern of change: northern mainland and steeper, snow-fed mountainous watersheds exhibited the greatest increases in discharge, an earlier spring melt, and a transition into rain-fed hydrologic patterns. Predicted streamflow increases for all watersheds ranged from approximately 1-fold to 3-fold for the spawning and incubation period, with increased peak flows in the spring and fall. The hydroclimatic sensitivity index was then combined with an index of currently mapped salmon habitat and species diversity to develop a research and conservation priority matrix, highlighting potentially vulnerable to resilient high-value watersheds. The resulting matrix and observed trends are put forth as a framework to prioritize long-term monitoring plans, mitigation experiments, and finer-scale climate impact and adaptation studies.

Freshwater Temperature Session Abstracts:

Title: Overview of Auke Creek Climate Related Studies; How Long Term Monitoring Can Help Us Understand Local Adaption
Author: John Joyce, NOAA, Alaska Fisheries Science Center
Author contact information: John.Joyce@noaa.gov

Abstract: The Auke Lake Watershed supports a variety of anadromous fish species. Populations of Pink, Chum, Sockeye and Coho Salmon, Dolly Varden Char and Cutthroat Trout migrate to and from the watershed via Auke Creek. There is a long history of biological survey and enhancement work in the watershed dating back to the early 1900s. In 1979/80 a weir was constructed just above tidewater on Auke Creek which allowed complete census of migrating juvenile and adult fish. Daily count data, environmental data, and biological data from wild migrating fish and experimental groups of enhanced fish provides a valuable analytical framework for understanding how changes in temperature and flow patterns impact the migratory behavior and productivity of anadromous fishes in a low elevation lake watershed. Water temperature and flow are primary environmental factors impacting both juvenile and adult salmon migration timing. NOAA research partnerships with University of Alaska, Alaska Department of Fish and Game, and U.S. Fish and Wildlife Service scientists have provided insight into how changes in climate-impacted environmental variables are affecting the anadromous fish populations of the Auke Lake Watershed. Trends in temperature and flow patterns have impacted juvenile and adult migratory timing, generally resulting in earlier mid-point migration dates and in some cases considerable compression in the migratory timing window. The implications of these results and those from a variety of climate related studies of Auke Creek will be reviewed.

Title: Heterogeneous Climate Change Impacts Are Anticipated at Salmon Spawning Sites on the Copper River Delta: Implications for Natural Resource Managers in Southern Alaska

Authors: L.A. Adelfio[1], S.M. Wondzell[2], N.J. Mantua[3], and G.H. Reeves[2]
Primary author contact information: ladelfio@fs.fed.us
[1] Chugach National Forest
[2] Pacific Northwest Research Station, Corvallis Forestry Sciences Lab
[3] NOAA/NMFS Southwest Fisheries Science Center

Abstract: Climatic changes are projected to impact Pacific Salmon egg incubation by increasing the magnitude and frequency of winter floods and by raising water temperatures. More powerful and more frequent winter floods could reduce the survival of salmon eggs by increasing streambed scour. Projected increases in water temperature may accelerate embryo development, impacting juvenile viability. We collected water temperature and stream stage data year-round and surveyed channel geometry at salmon spawning reaches on the Copper River Delta, a large coastal foreland in Southcentral Alaska. We calculated streambed scour and compared water temperatures during climatological mean and anomalously warm incubation periods to elucidate potential climate change impacts. Mean streambed scour depth during floods varied between sites from low (<3 cm) to high (>25 cm). Monthly mean air and water temperatures were highly correlated, however, differences in catchment geomorphology and water flowpaths (shallow vs. deep groundwater) led to high spatial variability in water temperatures across the landscape. The magnitude and seasonality of thermal unit (^{o}C/day) accumulation within spawning gravels varied significantly between severe and mild winters at shallow flowpath sites, but not at groundwater upwelling sites. We present two take-home messages: 1) Both temperature and scour responses to climatic changes are likely to vary across the landscape, even at small spatial scales, because of heterogeneity in catchment and channel characteristics and upwelling of groundwater. 2) The influence of climate change on water temperature may be greatest in spring (MAM), when seasonal snow and ice melt has historically attenuated temperature increases. We observed significant increases in MAM water temperatures after anomalously mild winters, when low elevation snowpack was absent.

Title: Spatiotemporal Analysis of Historical and Future Climate Effects on Stream Temperatures in Southeast Alaska

Authors: Sanjay Pyare, Ethan Nichols, and Eran W. Hood, University of Alaska Southeast, Juneau, Alaska
Primary author contact information: sanjay.pyare@uas.alaska.edu

Abstract: Stream temperature data is important for assaying the effects of climate change, however efforts to generate longitudinal stream temperature datasets have been limited and not well coordinated across southeastern Alaska. Moreover, to inform resource managers of future conditions, we don't have the time and resources to wait for the results of decadal-scale studies of thermal change in streams. In 2013, we initiated a study of historical patterns in stream temperatures across the southeast region and, along

with retrospective and future GCM based projections, are modeling future possible conditions in stream temperature and associated hydro-ecological variables. To date, an extensive "data rescue" effort has led to the compilation of a database of ~85 stream temperature records that vary in length from 3 months to 50 years; about half of which were ultimately of sufficient accuracy and duration for analysis of either past conditions (n=17 with records ≥10 yrs) or downscaling analysis for future conditions (n=58 with ≥ 2 yrs). Here we report on results from ongoing analyses of past trends across years and at seasonal temporal scales for the following 5 variables: stream temperature, stream temperature variability (i.e., residuals), degree days (accumulated thermal units; ATUs), degree-day variability, and the timing (median date) of ATUs. We'll also discuss the contexts of the PDO and possible landscape controls, like alpine composition of a watershed, on these results. Finally, unlike other regions where simple air/stream temperature analyses have yielded poor results, our downscaling analysis suggest greater promise for the use of regional GCMs to describe changes in stream temperatures (min r = 0.76); implying future increases of 0.3-1.1C in stream temperatures and a 9.8-37% in ATUs per decade thru 2085 for non-glacial watersheds.

Title: Linking Landscape Characteristics and Stream Temperature in the Coastal Temperate Rainforest of Southeast Alaska.

Authors: Michael Winfree[1], Eran Hood[2], Sveta Stuefer[1], Chris Arp[1], Daniel Schindler[3], Sanjay Pyare[2]
Primary author contact information: mwinfree2@alaska.edu
[1] University of Alaska Fairbanks
[2] University of Alaska Southeast
[3] University of Washington

Abstract: The coastal temperate rainforest (CTR) of southeast Alaska is being strongly affected by climate change, with mean annual air temperatures expected to increase by 1.7-3.7°C by the end of the century. This projected temperature increase will have a variety of effects on landcover and hydrology in the CTR. Ultimately these climate-driven changes have the potential to alter the physical characteristics of aquatic habitats in coastal streams within the region. However, there remains considerable uncertainty about how projected climate warming will influence streamwater thermal regimes in southeast Alaska. Reasons for this uncertainty include: 1) the influence of geomorphic and landscape conditions on streamwater temperature has not been comprehensively evaluated, and 2) hydrologic regimes are highly variable because of inter-watershed differences in the proportion of streamflow derived from rainfall, snowfall, and glacial melt. In an effort to address these data gaps, stream temperature data were collected in over fifty salmon bearing watersheds throughout the CTR in 2014 – 2015 in a collaborative effort with Federal agencies and local non-profit organizations. Year-round in situ stream temperature sampling occurred at hourly to sub-hourly intervals. Landcover characteristics (e.g. wetland, lake, and glacial coverage) and geomorphic characteristics (e.g. slope and aspect) of monitored watersheds were quantified using GIS. Results from this research will improve our understanding of the dynamics of streamwater thermal regimes across the landscape of southeast Alaska and assist resource

managers in making informed decisions for aquatic resources in the face of a changing climate.

Title: Alaska Stream Temperature Community: Data Storage, Harvesting and Dissemination

Author: Ryan Toohey, USGS Alaska Science Center
Author contact information: rtoohey@usgs.gov

Abstract: In Fall 2015, a workshop was conducted to learn from the Alaskan stream temperature community how they currently manage their data. While some state and federal agencies have their own data formats and data management guidelines, many smaller data collecting entities do not have compatible protocols or databases to store their information. As a result, State and Federal agencies are unlikely to be able to host and distribute other partners' data yet all are important for being able to assess landscape or regional level change occurring throughout Alaska. In the workshop, we asked the following questions: 1) What are the essential metadata and formatting requirements for non-agency data to be aggregated with agency data?, 2) How can we utilize existing resources and platforms to harvest/access and store environmental data from a wide variety of stakeholders for multi-scale analysis?, 3) What lessons, barriers and solutions can we learn from recent statewide and national efforts?, 4) What are the data provider requirements for dissemination and usage of this data?, 5) How can we increase reliability and sustainability (both financially and participant buy-in) of such a data system? The answers to these questions for our workshop participants will be presented.

Title: Stream Temperature Action Plan

Author: Sue Mauger, Cook Inletkeeper
Author contact information: sue@inletkeeper.org

Abstract: In 2012, Cook Inletkeeper developed a Stream Temperature Action Plan to identify the highest priority actions for the next 10 years that will lead to greater protection of Alaska's wild salmon habitat as thermal change continues. The strategic plan grew out of many multi-agency discussions and the successful implementation of the Cook Inlet stream temperature monitoring network in southcentral Alaska. By implementing these priority actions in data collection, protection, and research throughout Alaska, we expect to achieve the following goals: 1) improve our understanding of current thermal regimes in Alaska's salmon streams; 2) refine data collection for fisheries management and modeling applications; 3) target cold water habitat protection efforts; 4) fill stream network data gaps; and 5) direct relevant fisheries and habitat research. Through collaboration and coordinated discussions, these priority actions can be strategically accomplished through Fish Habitat Partnerships, Landscape Conservation Cooperatives and other federal, state, Tribal and non-profit organizational efforts. This plan can serve as a template to develop more targeted regional action plans or can be revised to incorporate emerging state-wide needs.

Anadromous Fish and Habitat Ecology Session Abstracts:

Title: Climate Change and the Freshwater Habitats of Pacific Salmon on the Tongass National Forest
Author: Gordon H. Reeves, PNW Research Station, USDA Forest Service, Corvallis, Oregon
Author contact information: gordon.reeves@oregonstate.edu

Abstract: The freshwater habitats of Pacific salmon throughout Southeast Alaska are likely to be affected by climate change, with the specific effects and their magnitude likely to vary widely. A major impact is expected to be elevated water temperatures and increased flows in the winter. Elevated winter water temperatures will increase development rates of eggs and fry, resulting in smaller fry emerging earlier. These effects will likely be most pronounced in more areas where current winter temperatures are near freezing. Higher, more variable flows could increase scouring of developing eggs and displacement of newly emerged fry. However, this impact will be minimal if the floodplain in areas where salmon spawn are not compromised by roads or infrastructure. But, scour impacts could be exacerbated if the size of returning adults decreases as a result of reduced marine growth rates, which in turn result from elevated marine temperatures and increased acidification. Stream flows at the time of adult returns may also decline, which would potentially limit access to spawning areas. These effects could be compounded when low flows are accompanied by elevated water temperatures, which in the past have resulted in extensive fish kills in some areas such as in southeast Alaska. Rises in sea level will potentially decrease available spawning areas. The reduction in quantity and quality of current habitat could be offset if areas that are currently marginal or unsuitable become more productive as a result of climate change. The significance of the changes will also vary between the species.

Title: More than the Sum of the Parts: Integrating Nature's Complexity into Climate Change Impact Assessments for Pacific Salmon
Authors: J. Ryan Bellmore and Rick Edwards, Forest Service, Pacific Northwest Research Station, Juneau, Alaska
Primary author contact information: jbellmore@fs.fed.us

Abstract: Although salmon are arguably the most economically/culturally important occupant of these ecosystems, they represent only a small fraction of the species that call these watersheds home. This broader network of organisms—which includes humans—are connected to salmon via countless ecological interactions. These organisms can effect salmon growth and survival, both directly and indirectly, by influencing the availability of food, the strength of competition, and the intensity of predation. Consequently, understanding how salmon populations respond to climate change will require holistic approaches that embrace the rich complexity of these unique ecosystems. Here we discuss: (1) the pathways by which these complex ecological interactions can influence salmon as climate changes; (2) critical gaps in our knowledge of that may limit our understanding; and (3) holistic empirical and modeling approaches that can be used to fill

knowledge gaps and predict ecosystem-level responses. Although it may seem daunting at first, integrating these complexities into climate change impact assessments will foster a deeper understanding of how these unique systems function, which will improve our ability to project outcomes for fishes and people.

Title: Predicting the Response of Salmon Spawning Habitat to Changing Hydrologic Regimes in the Salmon Forests of Southeast Alaska

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Abstract: Pacific salmon (Oncorhynchus spp.) are an integral ecological, economic, and cultural component the Tongass National Forest (TNF) in southeast Alaska. However, because of potential impacts of climate change (increasing temperatures and altered precipitation patterns and hydrographs) the continued health and productivity of these populations is uncertain. How will critical habitats that support salmon respond to changing temperature, precipitation, and hydrologic regimes within the region? Here, we assess potential responses of salmon spawning habitat to changing climatic and hydrologic regimes in southeast Alaska. We use a series of physical models that link climate change, streamflow, and channel morphology to conduct a spatially-explicit analysis of stream channel response potential within the region, including the potential for increased streambed scour and consequent risk to salmonid embryos. We predict a median increase in mean annual flood magnitudes of 18% and 28% by the 2040s and 2080s, respectively. Our analysis indicates considerable diversity among watersheds in the response of salmon habitat to these hydrologic changes. Response diversity was driven by three interacting factors: valley and reach-scale morphology, the pace and mode of channel responses to altered hydrology, and differences in habitat preferences among salmon species. Our results illustrate the importance of accounting for climate-induced geomorphic responses when assessing salmon habitat vulnerabilities, especially in topographically complex regions such as southeast Alaska.

Title: Some Observations on Climate Effects on Salmon Populations in Southeast Alaska Based on Multi-decadal Monitoring of Selected Populations and Fisheries

Author: Leon D. Shaul, Alaska Department of Fish and Game, Commercial Fisheries Division

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Abstract: Observations from the Berners River drainage suggest that the freshwater life history phase of coho salmon populations in some mainland rivers may benefit from climatic warming in the short-to-intermediate term. Smolt production was strongly correlated with summer-fall rainfall prior to 2005, but decreased by 38% during a period of cold spring temperatures combined with high average snow accumulation, reaching a

nadir in spring 2007 after a winter of record snowfall and high wildlife mortality in the drainage, before fully recovering after 2012. We hypothesize that increased mortality of large juveniles occurred in off-channel habitats as a result of low oxygen concentrations caused by extended ice and snow cover. Relationships between Juneau air temperature and the Pacific Decadal Oscillation since 1944 indicate that radiative warming will likely be most influential on Southeast salmon populations during summer and fall in short coastal and island streams, whereas late-winter and spring temperatures will likely remain closely coupled with ocean temperatures linked to cyclical North Pacific climate. Pink salmon have increased in both abundance and size, leading to speculation that the species is a climate-change winner that will influence other species in both positive and negative ways. Freshwater production of coho salmon at Ford Arm Creek has shown a strong positive relationship with pink salmon escapement, in an apparent response to marine-derived nutrient (MDN) enrichment, with coho production approximately doubling from a low number pink salmon spawners to a saturation level above which no further benefit was observed. However, further increases in pink salmon escapement have led to an increasing frequency of catastrophic pre-spawn mortality of all species present in the creek, as well as rearing juvenile mortality. Ford Arm Creek appears to have become increasingly sensitive to large pink salmon escapements, with recent mortality events occurring at lower spawner densities and after fewer rainless days than in the past, possibly as a result of increasing oxygen demand from bacterial decomposition as a cumulative legacy of recent large escapements. A warming climate is expected to exacerbate this relationship. In a recent paper, we found a strong negative relationship between the biomass of pink salmon in the Gulf of Alaska and the size of returning adult coho salmon, with negative effects also indicated for marine survival, female-to-male ratio, and per capita reproductive potential in the Berners River population. We infer that the underlying mechanism is intraguild predation by pink salmon on minimal armhook squid (Berryteuthis anonychus), which are the principle offshore prey of coho salmon and are both a direct competitors and prey of pink salmon. Increasing size of planktivores (pink salmon and 2-ocean sockeye salmon), in contrast with marked size declines in coho and chinook salmon, suggests that intraguild predation by pink salmon may be reducing the average trophic level in the offshore forage base in a way similar to the phenomenon of “fishing down marine food webs”, and that pink salmon are both causal agents and beneficiaries of this process.

Poster Session Abstracts:

Title: Glacial Isostatic Rebound and Lower River-Estuary Environments in Southeast Alaska: Habitat Winners and Losers in the Context of Rising Sea Levels

Authors: Lee Benda and Daniel Miller, TerrainWorks
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Abstract: The lower river-estuary environment is one of the most biologically productive and diverse habitats in southeast Alaska and it is comprised of four interconnected landforms: (1) river deltas or estuaries with subtidal and intertidal environments, (2) supratidal salt marshes, (3) non-forested river valleys dominated by meadows and

wetlands, and (4) low gradient rivers with forested floodplains. The evolving areal extent and distribution of lower river-estuary habitats depend on the interplay among watershed erosion and sedimentation, depositional environments, isostatic rebound from past glaciation and sea level changes. In the northern half of the Alexander Archipelago, a latitudinal gradient of glacial isostatic rebound (5 – 30 mm yr^{-1}) is causing a seaward extension and areal increase of river-estuary environments. In these areas, lower river-estuary habitats are projected to increase significantly over the next century, thus offsetting climate change increases in sea level and losses of habitats. In the southern half of the Archipelago, very low or neutral isostatic rebound, in combination with minimal river sedimentation in some areas, has resulted in smaller lower river-estuary environments where climate change increases in sea level will lead to landward migration of coast lines and habitat modifications. Combining information on the current spatial extent of lower river-estuary environments, regionally variable uplift rates and predicted climate-change-related increases in sea level could be used to forecast decadal to century scale increases, or decreases, in the current spatial distributions of river-estuary habitats, cumulatively across southeast Alaska. Quantifying the associated losses and gains in river habitats for salmon and in estuary habitats for marine and non-marine species (including those affecting subsistence food gathering) will require modeling the seaward extension of those environments due to isostatic uplift and the landward migration of coast lines due to rising sea levels. We are currently seeking partners and support to evaluate the trajectories of riverine-estuary habitats, including the effects of climate change induced sea level rise, across southeast Alaska.

Title: Salmonidae Incognito: How Do You Protect Salmon If You Don't Know Where They Live?

Authors: Lee Benda, Daniel Miller, and Kevin Andras, TerrainWorks
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Abstract: The Southeast Alaska region, inclusive of the Alexander Archipelago and the large rivers (Stikine and Taku) that extend into British Columbia, constitutes one of the last strongholds of wild Pacific Salmon. To manage resource development and to protect salmon in this trans-boundary region, including in the context of climate change, federal, state and provincial agencies need to know the locations and abundance of habitats accurately and know the locations and properties of the landscape features that are essential for salmon viability, including floodplains, riparian areas, and erosion risk, among other attributes. We investigated how well agencies are able to know the locations and abundance of salmon habitats, using an area in northern Chichagof Island as a demonstration.

Using advanced technologies developed by TerrainWorks (NetMap Tools), we examined how different resolutions of digital elevation data (30m, 20m, 5m and 1m LiDAR) influence the spatial extent of the river networks that are mapped from them. We then applied thresholds of river channel morphology, including waterfalls, and salmon habitat models to further identify potential salmon habitats in NetMap's virtual watersheds. We compared these salmon stream maps to the extent of salmon streams contained within the

Alaska Dept. of Fish & Game Anadromous Waters Catalogue (AWC, which requires field-based fish verification) and the U.S. Forest Service's SEAK-hydro salmon stream extent. The LiDAR based salmon stream extent was 400% greater than the AWC, 200% greater than the SEAK-hydro, and from 300% to 400% greater than the derived salmon streams using the 5m (IfSAR), 20m and 30m river networks. The newly available IfSAR 5m DEMs, although an improvement in digital topography over the 20m and 30m DEMs, do not improve detection of salmon streams above that of the 20m DEM because the surface radar is compromised by vegetation. The SEAK-hydro salmon streams (relying in part on ground observations of fish) are more extensive compared to the 20m and 5m DEM derived salmon stream extents, although still limited compared to the LiDAR salmon networks. The AWC fades as a credible scientific source of salmon extent in the face of increasing digital technologies.

This finding provides insights into the potential seriousness of the problem and the scope of the challenge. Currently, southeast Alaska has IfSAR 5m and British Columbia has 25m digital elevation data and both are found to be notably inadequate for accurately detecting salmon streams and other landscape features essential for salmon viability. In the early part of the 21st century as humans are mapping other planets in detail, the federal, state, and provincial agencies responsible for managing and protecting the salmon resource, and the private companies involved with resource extraction, and even the public in this region, do not know the spatial extent and locations of the majority of salmon streams!

How do you protect salmon in southeast Alaska and coastal B.C. if you don't know where they live? Management and conservation of salmon habitats in this region will never be fully realized without acquisition of LiDAR topographic data across all coastal watersheds and island archipelagos. Once available, advanced mapping technologies can be used to derive as complete as possible river networks, including the spatial extent of potential salmon habitats. Ultimately, digital virtual watersheds and their smart river networks can be used to measure salmon habitat quantity and quality, and also to help guide resource development with the aim of protecting salmon habitats, and other aquatic and terrestrial species.

Title: Salmonidae Incognito: A Crowdfunding Campaign to Detect and Map Critical Salmon Habitats
Author: Lee Benda, TerrainWorks
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Abstract: Southeast Alaska and the adjoining coastal British Columbia landscape constitute one of the last environmental strongholds of wild Pacific Salmon. Across this 60,000 mi2 (155,000 km2) region analysis of existing low quality topographic maps reveals that the extent of salmon streams are underestimated by 200% (Alaska) to 400% (B.C.) or by 60,000 miles (100,000 kilometers), a length of unidentified, unmapped and unprotected salmon habitat that would stretch around the world two and a half times! The total length of all unmapped streams in this region is estimated at 260,000 miles (420,000

km), a length greater than the distance to the moon. How do you protect streams, rivers and critical salmon habitats if they are not on a map and you don't know where they are?

Current digital topographic data available in southeast Alaska and coastal B.C. are inadequate for improving the mapping of salmon habitats, and other watershed features essential for salmon survival (floodplains, riparian areas, erosion risk etc.). Developing higher resolution topographic data to detect unidentified salmon streams and other important landforms will require laser altimetry (LiDAR digital elevation data). Acquiring LiDAR across the entire 60,000 mi2 region will cost 10 million dollars or more. Although the U.S government is pursuing LiDAR in the lower 48 states and Hawaii, they consider LiDAR acquisition in Alaska cost prohibitive and unaffordable. The Alaska state government under current oil revenue shortfall and conservation NGOs and foundations that support more limited projects, are not adequate sources of funding. Thus, TerrainWorks is proposing to crowdfund the acquisition of LiDAR to detect and map critical salmon habitats, across all, or some portion of southeast Alaska and coastal B.C. in support of conservation planning and sustainable resource use. The unique rewards-based component of the campaign will include: (1) supporters naming newly discovered salmon streams and other landscape features within an online geographic catalogue and (2) supporters receiving high resolution digital topographic imagery inclusive of their geographic place names.

The "Salmonidae Incognito" crowdfunding campaign will require comprehensive media outreach to potential institutional co-sponsors and to large markets of potential supporters including: 1) Alaska Natives and B.C. First Nations, 2) Commercial Fishing Industry, 3) Cruise Ship Industry, 4) Alaska Airlines, 5) other tourist venues, 6) major conservation NGOs, and 7) agencies, including U.S. Forest Service and ADF&G, among others. Foundations and environmental philanthropists could also be tapped for contributions. Media coverage would extend across Alaskan newspapers and TV, National Public Radio, the New York Times and High Country News, among others. The Salmonidae Incognito campaign will launch within 60 days to coincide with the onset of the 2016 Alaska tourist season. TerrainWorks will administer the crowdfunding campaign and seeks institutional co-sponsors.

Title: The Alaska Monitoring and Assessment Program and Future Monitoring in Southeast Alaska 2017-2020

Authors: Amber Bethe and Terri Lomax, Alaska Department of Environmental Conservation, Alaska Monitoring and Assessment Program
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Abstract: The Alaska Department of Environmental Conservation has the responsibility to report and identify causes and sources of water quality impairment by "characterizing all the waters in Alaska". One way this is accomplished is through the Alaska Monitoring and Assessment Program (AKMAP), which is responsible for implementing statistical surveys to assess water quality on a regional basis. AKMAP has surveyed coastal and fresh waters since 2002. Survey goals are to estimate current status and trends, establish

associations between indicators of natural and anthropogenic stresses, and determine indicators of the condition of aquatic ecological resources. A combination of random and targeted sites are surveyed to ensure data is collected across a range of environmental conditions. AKMAP will begin conducting environmental monitoring in Southeast Alaska starting in 2017. Surveys will be conducted in conjunction with EPA's National Aquatic Resource Surveys. Monitoring projects will include lake, river, stream and coastal surveys focusing on one waterbody type each year. Each survey will be designed to select random sites throughout southeast Alaska, monitoring parameters that will provide a baseline environmental health assessment of water quality, sediment, aquatic and riparian habitat, and biological conditions.

Title: Geomorphology and Sustainable Subsistence Habitats
Authors: Adelaide (Di) Johnson and Linda Kruger, USDA Forest Service Pacific Northwest Research Station
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Abstract: Climatic, tectonic, and human-related impacts are changing the distribution of shoreline habitats and species associated with food resources. There is a need to summarize current and future shoreline geomorphic – biotic relationships and better understand potential impacts to native customary and traditional gathering patterns. By strategically integrating Native knowledge and observations, we create an inclusive vulnerability assessment strategy resulting in a win-win opportunity for resource users and research scientists alike.

We merged the NOAA ShoreZone database with results from over sixty student intern discussions in six southeast Alaska Native communities. Geomorphic trends and community observations were summarized to assess potential threats within a spatial context.

Given current land uplift, tectonic shift, and sea level rise rates over the next 100 years, coastlines of southeast Alaska will emerge 1.8 in the north and will submerge -0.2 to the south; a pattern having spatially variable implications to shore benthic species. Our summary of coastal resources provides a framework to guide communities planning for anticipated change; a basis from which communities in southeast Alaska and elsewhere, can assess resource vulnerabilities and resilience.

Title: Distributed Sensor Networks to Improve Hydroclimatology and Ecoclimatology in Alaska
Author: Jeremy S. Littell, US Geological Survey and DOI Alaska Climate Science Center
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Abstract: At subregional scales, most of the uncertainty associated with projecting climate, ecosystem, and hydrologic responses to climate change stems from uncertainties in global-to-regional climate modeling and macroscale ecological responses. However, as resolution becomes finer, many more local processes potentially affect variation, and local responses may be considerably greater or less than the regional average. Downscaled climate projections used to drive state-and-transition vegetation models or distributed hydrologic models, for example, assume that the sub-grid variation averages out and represents the sum of responses across the grid. For temperature, soil moisture, and snowpack responses, however, the variation most critical for understanding ecosystem responses may be driven by a disproportionately small fraction of the landscape and projection therefore requires measurements of the variation from the coarse scale model estimates. Here I present a network of distributed measurement sites from Southeast to Interior Alaska across three biomes and preliminary results from the first two years of measurement in interior and southcentral Alaska. I demonstrate approaches for constraining local variation in microclimate and hydroclimate as well as the sources of potential bias associated with less expensive sensor networks, how those vary from standards in the lower 48, and discuss differences expected in SE Alaska.

Title: Transboundary Environmental Monitoring Workshop

Authors: Terri Lomax and Amber Bethe, Alaska Department of Environmental Conservation, Alaska Monitoring and Assessment Program
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Abstract: The Alaska Department of Environmental Conservation (ADEC), Division of Water has selected the Southeast Alaska region as a focus area for environmental monitoring starting in 2017. Southeast was selected primarily due to concerns over pollutants entering Alaska's waterways from Canadian mining operations. To gather information about existing monitoring activities in the region and identify potential partners in monitoring efforts, ADEC is hosting a 1-day Transboundary Environmental Data Workshop on April 15, 2016. The goal of this workshop is to bring agencies, tribes, and the scientific community together to identify areas of collaboration in the collection, summary and distribution of water quality and quantity data in transboundary waters. Understanding what monitoring activities are occurring throughout the region is a critical first step in this goal, and as a part of the workshop a survey on monitoring activities is being conducted.

Title: How Will Changing Freshwater Discharge in Southeast Alaska Affect Early Marine Survival of Juvenile Salmon?

Authors: Megan McPhee[1], Michael Kohan[1,2], and Joe Orsi[3]
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Abstract: The freshwater/marine interface supports Pacific salmon as they transition to marine life. Freshwater discharge supports this transition, providing flows for migration

of smolts as well as buffering osmoregulatory transformation. In the Gulf of Alaska, freshwater inputs also influence water column stability, and thus the dynamics of phytoplankton and zooplankton. Fresh water drives the Alaska Coastal Current, which advects additional production northward. Therefore, freshwater discharge is expected to have substantial effects on growth and survival of salmon. We examined this hypothesis in chum salmon from Southeast Alaska, using information on size, condition and abundance of chum salmon in their first summer of marine life, as well as overall marine survival rates. In support of this hypothesis, enhanced water column stability was associated with greater condition of juvenile chum salmon, and Royer's index of freshwater discharge was correlated with greater abundance of juvenile chum salmon as well as greater overall survival. These results suggest that in the near future, increased freshwater discharge is likely to enhance marine survival of chum salmon. However, it is not known over what range of discharges this relationship may hold, and the timing of freshwater discharge will undoubtedly influence this relationship over longer time frames.

Title: ShoreZone Imaging and Mapping in Alaska

Authors: Cindy Hartmann Moore[1], Steve Lewis[2], and G. Carl Schoch[3]
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Abstract: ShoreZone is a coastal marine habitat mapping system, in which spatially referenced aerial imagery is collected specifically for classification. The resulting dataset includes imagery with mapped geomorphic and biological attributes in a searchable geospatial dataset. The imagery provides a useful baseline and visual reference. The mapped features include: shoreline morphology, substrates, and biotic resources such as eelgrass, canopy kelps, salt marshes and other habitat descriptors. There are many applications for this data including: oil spill contingency planning, habitat research, and coastal resource management.

Approximately 114,627 km of ShoreZone imagery exists for the Pacific Northwest coastline including the entire shoreline of Oregon (1,340 km), Washington (4,933 km), British Columbia (37,619 km), and 70,735 km of the Alaskan coastline. The Alaska ShoreZone imaging and mapping project is on-going with ~ 86% of the coast imaged and mapped or with mapping in progress and ~ 14% (11,265 km) of the coastline remaining to be imaged. The Alaska imagery can be viewed online at http://alaskafisheries.noaa.gov/shorezone/.

The Alaska ShoreZone program is built on a foundation of multiple funding and contributing partners, including state and federal governmental agencies, nonprofit organizations, and private industry, as well as resource managers, scientists, and spatial data specialists. The multi-organization program provides a framework to build on and

supports a contiguous, integrated coastal resource database that extends from Southeast Alaska through the Gulf of Alaska, the Alaska Peninsula, Bristol Bay, and northwards to Kotzebue Sound, and the Chukchi and Beaufort Seas.

The program goal is to have all of the Alaskan shoreline imaged and mapped using the ShoreZone protocol and to make this data web accessible. The partnership is actively seeking additional partners to help accomplish this goal.

Title: Analysis of Select Stream Discharge Models in Southeast Alaska
Author: Terry Schwarz, Alaska Department of Natural Resources
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Abstract: Analysis of error was undertaken on four regionally-based statistical streamflow models in Southeast Alaska for the purpose of determining the overall fitness of the models when compared to current USGS gage records. Modern and historic data were utilized in a Geographic Information System (GIS) to extract basin characteristics for use as model variables. Spatial, temporal, and basin attribute trends were examined to establish if any factors showed an obvious relationship to relative model error. On average all models over-predicated discharge, with a mean relative error ranging from -0.1% to 20% and standard deviation of error ranging from 20% to 60%. No basin characteristics had strong correlation with model error. A cyclic trend was found in the error of the Mean Monthly Discharge (QAM) models, suggesting seasonal changes in modern streamflow statistics possibly due to climate change. No obvious trend in the spatial distribution of error was found, possibly because of the clustered nature of test gages.

Title: A Practitioner's Guide for Exploring Water Quality Patterns Using Principal Components Analysis and Procrustes
Authors: Chris Sergeant[1], Eric Starkey[2], Krista Bartz[3], Marcia Wilson[4], and Franz Mueter[5]
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Abstract: To design sustainable water quality monitoring programs, practitioners must choose meaningful variables, justify the extent of measurements, and demonstrate that program objectives were successfully achieved. Consequently, data must be analyzed

across several variables and from multiple sites and seasons. Multivariate ordination is common throughout the water quality literature, but methods vary widely and could benefit from greater standardization. We present a seven-step framework for conducting PCA and associated tests. The last step is dedicated to conducting Procrustes analysis, a valuable but rarely used test within the water quality field that describes the degree of concordance between separate multivariate data matrices and provides residual values for similar points across each matrix. We illustrate these tools using three water quality case studies in US parklands. The case studies demonstrate how multivariate analysis answers applied monitoring questions such as (1) do data from separate monitoring locations describe similar water quality regimes, and (2) what time periods exhibit the greatest water quality regime variability? We provide data and annotated R code for recreating case study results and crafting new code for similar monitoring applications.

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Title: Alaska Water Quality Standards for Temperature
Author: Brock Tabor, Division of Water, Alaska Department of Environmental Conservation
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Abstract: Alaska's water quality standards for temperature are considered to be the most protective in the Pacific Northwest. In addition to the use of biologic criteria for the establishment of state criteria, numerous other policy and technical tools, including use of a stream monitoring network, can serve to protect aquatic life and other designated uses.

Title: Alaska Stream Temperature Community: Data Storage, Harvesting and Dissemination
Author: Ryan Toohey, USGS Alaska Science Center, DOI Alaska Climate Science Center
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Abstract: In fall 2015, a workshop was conducted to learn from the Alaskan stream temperature community how they currently manage their data. While some state and federal agencies have their own data formats and data management guidelines, many smaller data collecting entities do not have compatible protocols or databases to store their information. As a result, State and Federal agencies are unlikely to be able to host and distribute other partners' data yet all are important for being able to assess landscape or regional level change occurring throughout Alaska. In the workshop, we asked the following questions: 1) What are the essential metadata and formatting requirements for non-agency data to be aggregated with agency data?, 2) How can we utilize existing resources and platforms to harvest/access and store environmental data from a wide variety of stakeholders for multi-scale analysis?, 3) What lessons, barriers and solutions can we learn from recent statewide and national efforts?, 4) What are the data provider requirements for dissemination and usage of this data?, 5) How can we increase

reliability and sustainability (both financially and participant buy-in) of such a data system? The answers to these questions for our workshop participants will be presented.

Title: Using Historical Aerial Photography to Visualize Climate Change

Authors: Emil Tucker and Joni Johnson, Tongass National Forest
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Abstract: Climate science in southeastern Alaska largely focuses on the Juneau icefield and glacier mass balance. We use a time series of black & white and color aerial photography - beginning in 1962 and progressing through 2010 to focus on the emerging and rapidly changing landscape at the terminus of the Patterson Glacier and one of its tributaries in central southeastern Alaska. In this 50-year snapshot of glacial recession the dramatic changes to the glacier face location expose a valley for the first time in centuries. The 1962 aerial imagery shows an extensive glacially-dammed lake in the lower reach of the tributary. By 1977, lake appears recently drained and early successional deciduous plants are colonizing the upper portion of the lake while the outwash channel cuts down through the glacial debris. By 2010 the mouth of the creek has been colonized by a dense willow thicket (Sitka willow dominant) and Sitka alder has encroached upon the creek. Understanding the nature and pace of these changes can help us to manage new landscapes that are opened up as the ice retreats and give us another way to look at the early post-glacial history of southeast Alaska.