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The Status of Alaska Salmon and People

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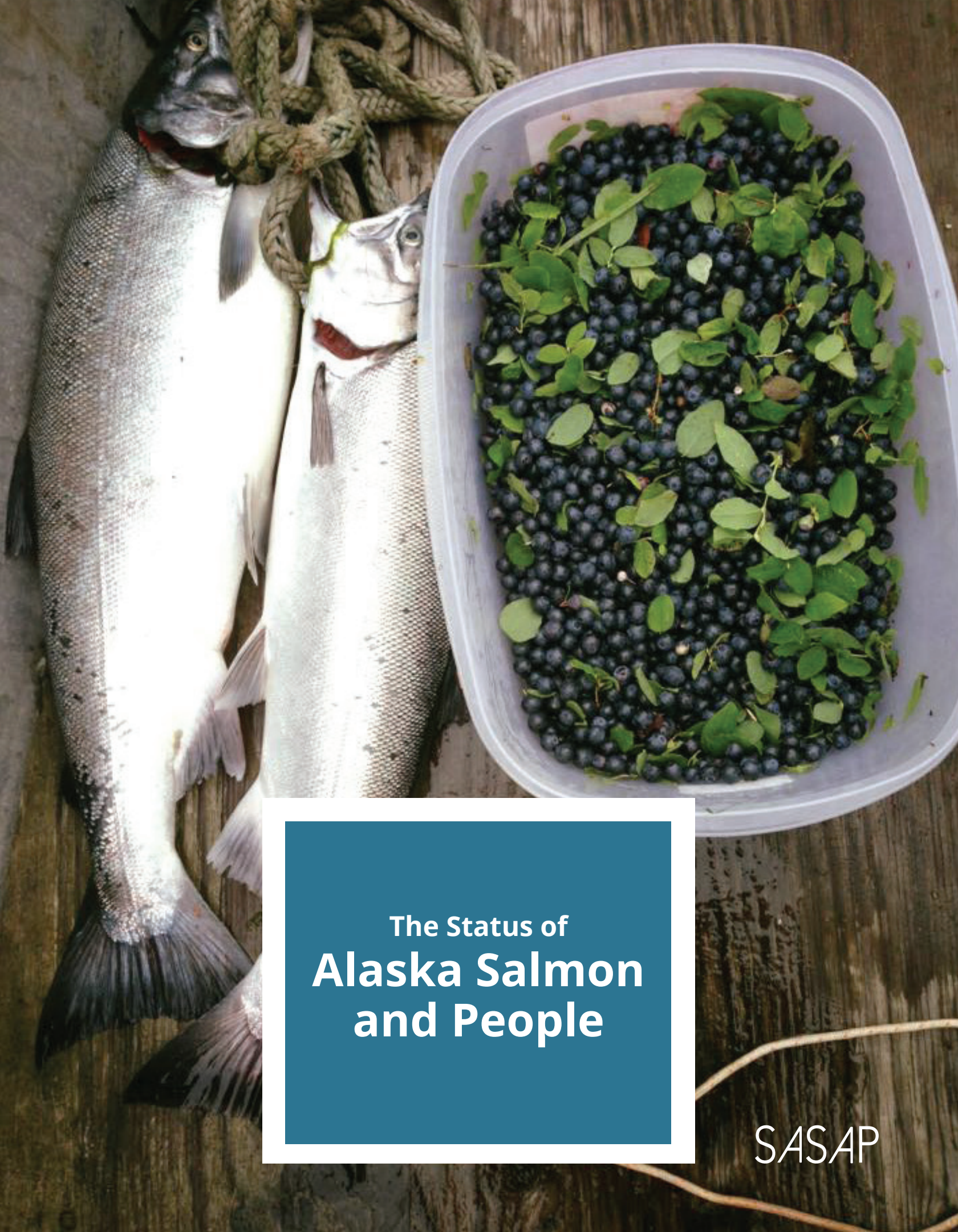
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Project

SASAP: State of Alaska's Salmon and People [View project](#)



The Status of
**Alaska Salmon
and People**

SASAP

A major goal of the Alaska Salmon and People project is to share results of the working groups with salmon stakeholders across Alaska. In addition to academic papers and reports supported by openly accessible data, archived models and analyses, a variety of outreach products and media will be disseminated widely and made available on the SASAP website:

AlaskaSalmonandPeople.org

The National Center for Ecological Analysis and Synthesis (NCEAS) at the University of California, Santa Barbara and Nautilus Impact Investing (NII) are leading a synthesis of data surrounding the state of knowledge of Alaska's Salmon and People (SASAP), in partnership with experts at the University of Alaska in Fairbanks and Anchorage, Indigenous leaders and specialists across resource sectors.

Lead Principal Investigator

Dr. Frank Davis (NCEAS/UCSB), frank.davis@nceas.ucsb.edu

Project Co-Principal Investigator/Alaska Coordinator

Dr. Ian Dutton (NII), ian@nautilusii.com



The National Center for Ecological Analysis and Synthesis is a research center of the University of California, Santa Barbara. NCEAS fosters collaborative synthesis research – assembling interdisciplinary teams to distill existing data, ideas, theories, or methods drawn from many sources, across multiple fields of inquiry – to accelerate the generation of new scientific knowledge on a broad scale.



Nautilus Impact Investing was formed in 2015 in response to the increasing demands for advice on social and environmental investing. Nautilus Impact Investing works globally to help social and environmental project investors and implementers to secure a better return on their investments.

Cover: Silver salmon and blueberries | **Syverine Bentz**

Designed by | **Aviva Shaw**

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Understanding the Status of Alaska Salmon and People

Unlike most global salmon stocks, salmon in Alaska are sustainable across much of their historic range, largely due to a long tradition of community stewardship and a science-based management system. However, the species' long-term viability is under threat on several fronts: climate change, ocean acidification, overfishing, selective fishing, declining research and management budgets, and incompatible development of salmon watersheds, among them.

The sustainability of the Alaska salmon system depends on the long-term maintenance of a connection to people, which is threatened by issues such as inequitable access to salmon fisheries, graying of the fleet, and other social shifts. The State of Alaska's Salmon and People (SASAP) project is a knowledge synthesis that is designed to inform the future of management of Alaska's wild salmon.

The SASAP project specifically seeks to:

- Integrate knowledge across disciplines and agencies, between cultures and users, and across regions and, by doing so, provide a more holistic view of the complex and dynamic system that will serve to influence research priorities, develop and monitor indicators of system health and facilitate equitable and efficient management of the system;
- Create new institutional capacity for interdisciplinary salmon knowledge generation; and
- Establish a shared and credible baseline for integrated knowledge that can be built on over time.

The SASAP process is being supported by a novel data science and synthesis partnership between the National Center for Ecological Analysis and Synthesis (NCEAS) at the University of California, Santa Barbara and more than 100 Indigenous knowledge experts, scientists and educators from academic, community and government organizations throughout Alaska and the United States.

Outputs from the SASAP synthesis will be shared with government tribal, education, research, community and commercial interests to strengthen their understanding of salmon systems and prioritize future research, monitoring and management efforts. The knowledge generated is expected to play a seminal role informing future salmon management and research in Alaska and the North Pacific region.

This booklet is designed to showcase the work of the interdisciplinary SASAP working groups and preview datasets, analyses and reports that will be produced from their work over the next year. We encourage you to reach out to the working group team leaders and NCEAS if you have any questions or would like to access and use these products.

Frank Davis, NCEAS, Co-Principal Investigator, SASAP

Ian Dutton, Nautilus Impact Investing, Co-Principal Investigator, SASAP and Data Task Force

Matt Jones, NCEAS, Co-Principal Investigator – Data Task Force

Peter Westley, UAF CFOS, Co-Principal Investigator, SASAP Round 1 Working Groups

Our Approach

The mission of the State of Alaska's Salmon and People project is to create an equitable decision-making platform for all stakeholders by addressing data gaps in Alaska's salmon system through information synthesis, collaboration and stakeholder engagement.

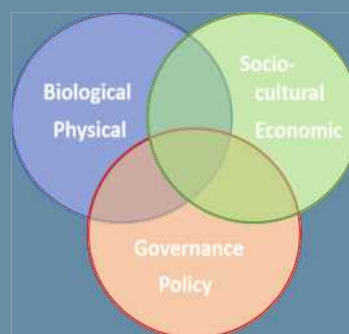
Our approach is to build collaborations — “working groups” — of experts from diverse backgrounds and institutions. The working group synthesis process deliberately emphasizes collaboration between Indigenous knowledge and western science perspectives to bridge information gaps.

Eight working groups have been gathering, synthesizing and sharing Alaska salmon data and information. Each group is composed of experts selected from a range of disciplines, sectors, and geographical regions. They come together to focus and collaborate intensively for up to a week at a time. Each participant brings their data, methods, and experiences for synthesis and analysis, to create new knowledge and understanding.

Our goal is to support the ability of all Alaskans to equitably and knowledgeably participate in management decisions such as resource allocation, policy creation, and governance.

Ultimately, it is collaboration and partnership, rather than simply individual research or action, that results in greater problem-solving capacity for the complex and intertwined social and ecological challenges facing society.

SASAP Synthesis Working Groups



Three working groups are conducting broad scale, cross-cutting analyses of:

- Biophysical information on salmon distribution and habitat
- Sociocultural and economic dimensions of salmon systems
- Governance and Subsistence

Another five groups are focusing on research questions that provide insight into the pressures on salmon and salmon communities, as well as options for response to those pressures:

- Consistency, Causes and Consequences of Salmon Size and Age Declines
- Well-being and Salmon Systems
- Ocean Climate Interactions with At-sea Salmon Competition
- Community-based Engagement with Salmon Science
- Integrated Watershed Management for Salmon in Kenai Lowlands

Disentangling Data: The Data Task Force

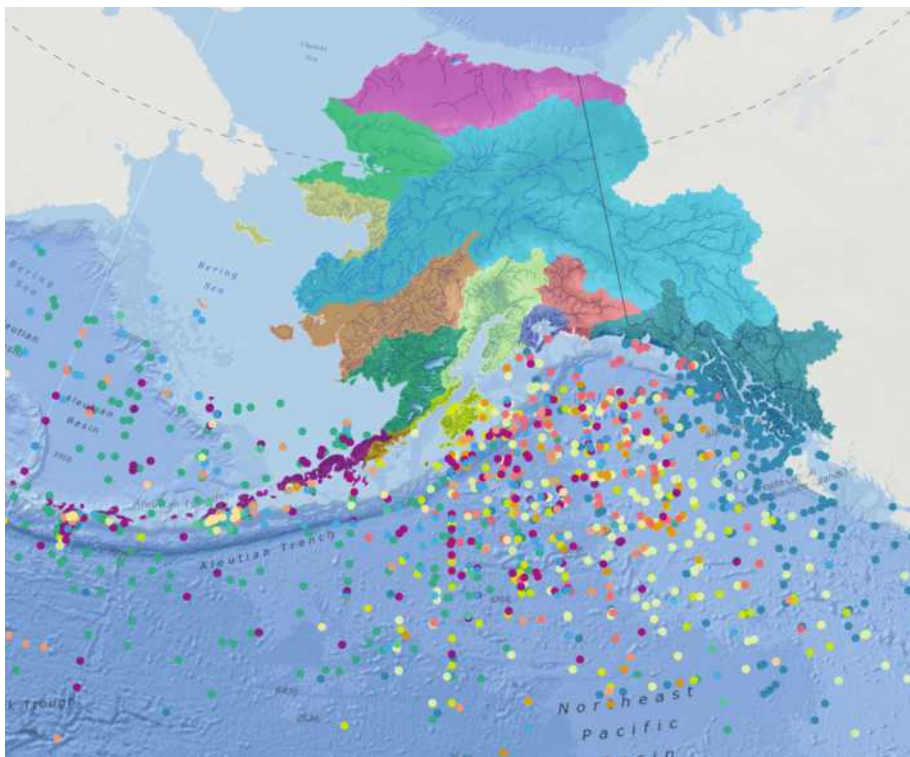
Collection is just one step in the process of transforming data into knowledge.

The more than 100 SASAP researchers who are working together to gather, analyze and synthesize salmon data rely on a very unique and talented team to help clean, analyze, archive and showcase this important information - the Data Task Force (DTF).

The DTF team helps to coordinate data requests from Alaska Department of Fish and Game and other agencies and organizations, then reformats, integrates, and runs quality control on those datasets. All SASAP data will be archived on NCEAS's data archive, knb.ecoinformatics.org, which is accessible to the scientific community. Unique to this project, the DTF will also support the development of a salmon 'data portal', which will allow the data to be more easily discoverable and understandable by all salmon stakeholders.

In just two years, the Data Task Force has integrated more than 9GB of data into 56 datasets. Included in these datasets are, for example, 15 million age, sex, length records of Alaskan salmon from multiple original sources, integrated into a single dataset. They've increased the efficiency of the working groups, enabling more powerful syntheses and a comprehensive view of Alaska's salmon system.

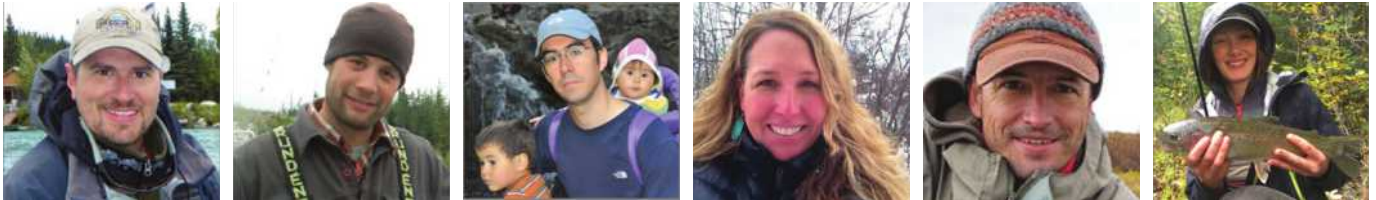
Team Members: Matt Jones, Principal Investigator; Jeanette Clark, Projects Data Coordinator; Jorge Cornejo-Donoso, post-doctoral researcher; Jared Kibele, scientific programmer (all of National Center for Ecological Analysis and Synthesis); Ian Dutton, Co-PI (Nautilus Impact Investing); Madeline Jovanovich, research associate, (University Alaska Fairbanks). The team is assisted by five part-time student interns and three full-time data-fellows working on a 6-month basis.



SASAP researchers are also supported by geospatial analysis experts whose work helps users visualize complex information about Alaska salmon. The map shows documented rivers and streams supporting salmon populations, and the 11 major regions that are the focus of our work.

Colored dots link ocean captures of fish to SASAP region of freshwater returns.
[Map: Leslie Jones, University of Alaska, Anchorage.]

Biophysical State of the Alaska Salmon System



Team Members: Peter Westley, Lead, University of Alaska Fairbanks; Daniel Rinella, Co-Lead, US Fish and Wildlife Service; Jorge Cornejo-Donoso, NCEAS; Leslie Jones, University of Alaska Anchorage; Matthew Sloat, Wild Salmon Center; Madeline Jovanovich University of Alaska Fairbanks; supported by additional working group members Rebecca Shaftel, University of Alaska Anchorage; Stephanie Quinn-Davidson, Yukon River Intertribal Fish Commission; and Richard Brenner, Alaska Dept. of Fish and Game (advisor)

The goal of Biophysical Working Group is to produce a unifying source of information that describes how the status of Alaska salmon and their habitats differs across regions.

The Biophysical Working Group is focused on the following key questions:

- What are the patterns of biological diversity within and among species across regions (*Figure 1*)?
- How do patterns of physical habitat and drivers of habitat quality vary across regions (*Figure 2*)?
- Does habitat diversity relate to biological diversity across regions? If so, in what way?
- How do biological and physical factors interact with sociocultural, economic and governance domains of salmon systems?

To address these questions, we are bringing together many different datasets and describing through quantitative summaries:

- Escapement and productivity (recruits per spawner) by stock complexes and species
- Extent of hatchery enhancement across regions
- Known amount of anadromous waters in each region
- Natural and human-influenced drivers of freshwater habitat by region (e.g. floodplain structure and channel complexity, sinuosity and slope, presence of invasive species, culvert fish passage, hydrologic drivers and land-use impacts)
- Historic and contemporary climate
- Marine distribution of salmon stocks
- Changes in age and size structure of stocks within and among regions
- Regional challenges (e.g. urbanization in Matanuska-Susitna, transboundary mining in Southeast Alaska, and large-scale hydro projects proposed on the Canadian Yukon)

Contrasting Patterns of Biological Diversity between Regions

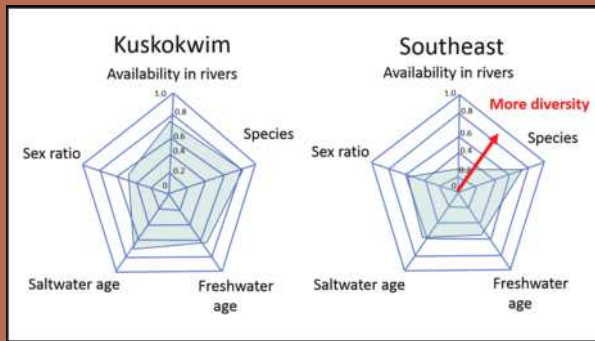
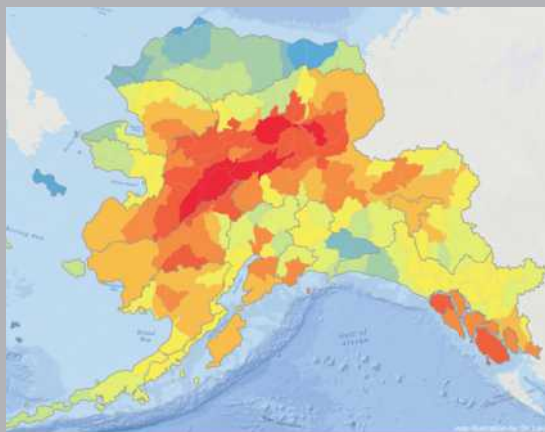


Figure 1. Combined datasets on the number and timing of adult salmon (pooled by species) entering rivers in the Kuskokwim and Southeast regions, species composition, sex ratio, and freshwater and saltwater age. Diversity is measured on a scale between 0 and 1 using the Simpson Diversity Index such that increasing values correspond to more diversity. This plot suggests the Kuskokwim and Southeast regions

contrast most with regard to the availability of salmon in rivers, with the Kuskokwim having more days during the year when salmon are in rivers, compared to Southeast.

A Mosaic of Warming Temperatures Across Alaska



Temperature (°C)

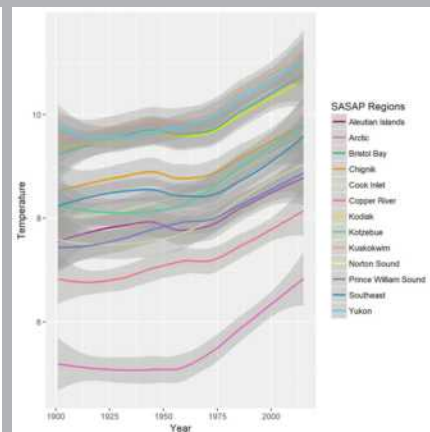
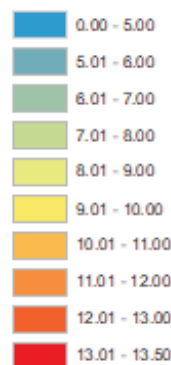


Figure 2. Thermal diversity within watersheds is an important determinant of salmon growth and productivity during the summer months



Image | Andrew Hendry

Left panel: Regional climate patterns such as air temperature can be used as an (imperfect) indicator of stream temperature and is an important driver of in-stream habitat quality

Right panel: Contemporary average air temperature over summer months (May through August) shown across the state, and historical trends from 1990-2015

Sociocultural Dimensions of Salmon Systems

Team: Dr. Courtney Carothers, University of Alaska Fairbanks; Dr. Jessica Black (Gwich'in Athabascan) University of Alaska Fairbanks; Danielle Ringer, University of Alaska Fairbanks; Jesse Coleman, University of Alaska Fairbanks; Erika Gavenus, National Center for Ecological Analysis and Synthesis

Advisors: Alex Whiting, Native Village of Kotzebue; Ben Stevens (Koyukon Athabascan) Yukon River Intertribal Fish Commission; Caroline Brown, Alaska Department of Fish and Game; Dr. Jim Fall, Alaska Department of Fish and Game; Julie Raymond-Yakoubian, Kawerak; Liza Mack (Aleut) University of Alaska Fairbanks; Dr. Patricia Clay, NOAA Fisheries; Dr. Rachel Donkersloot, Alaska Marine Conservation Council; Rob Sanderson Jr. (Haida) Central Council Tlingit & Haida Indian Tribes of Alaska; Dr. Steve Langdon, University of Alaska Anchorage (*emeritus*).

Alaska's salmon ecosystems support a wide range of social and cultural values for people. Salmon are a cultural keystone species for many of the Indigenous cultures in Alaska and contribute to the physical, social, economic, cultural, spiritual, psychological and emotional well-being of people in communities across the state. They form the backbone of the commercial fishing economy and are highly valued for food procurement and resident and tourist recreation. Overall, salmon play integral and diverse roles in the society, cultures, and economies of Alaska.

In this state of knowledge synthesis of the social and cultural dimensions of salmon systems in Alaska, we are exploring three guiding topics:

- Social and cultural values and relationships between salmon and people
- Trends in human populations and uses of salmon
- Key threats to salmon-dependent communities

We are identifying and synthesizing existing knowledge about sociocultural aspects of salmon systems while acknowledging that these dimensions are not always well documented in print or available data sources. We have been collecting and summarizing three general types of data: *published qualitative information* – manuscripts, journal articles, reports; *quantitative information* – federal, state, and tribal data; and *archival/oral information* – oral histories, archived records, and Indigenous knowledge), sourced with help from the NCEAS Data Task Force and working group advisors.

One of our major goals is to increase the visibility of important sociocultural dimensions of salmon systems that are often overlooked. We aim to create final products that highlight these relationships and would especially like to acknowledge and express our appreciation for our advisors, who have directed us to make the outputs useful and accessible for diverse Alaska stakeholders.

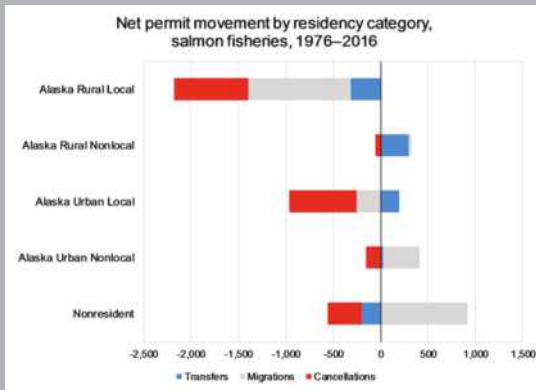
Long-term People and Salmon Relationships



Jessica Black processing subsistence salmon on the Yukon River (2017)

People have been connected to salmon in Alaska for at least 11,800 years, and salmon continue to play key roles in the health and well-being of many of Alaska's Indigenous cultures. Radical changes throughout time have impacted traditional ways of life and salmon-people relationships ranging from colonization (disease, slavery, boarding schools, resource extraction) to changes in resource access and management (federal and state governance shifts, tensions between fisheries users, privatization of access). These waves of change continue to transform relationships between people and salmon and fishing practices today.

Sociocultural Disconnects and Inequities



Movement of commercial salmon permits from the Commercial Fisheries Entry Commission, 1976-2016

Inequities in the salmon-people system have emerged as a critical point of consideration and are evident in the criminalization of subsistence, the dramatic loss of rural local fishing rights, and graying of the commercial fishing fleet. The loss of fish camps and legal battles over subsistence rights have caused deep stress between traditional practices and resource management systems. Statewide, commercial fishing rights have shifted toward urban and non-Alaskans, and many rural youth and communities struggle to gain access to sustainable fishing livelihoods. These collective factors have motivated a concerted effort to better understand these issues and find opportunities for improvement.

Socio-economic Dimensions of Salmon Systems

Principal Investigator: Dr. Tobias Schwoerer, University of Alaska Anchorage Institute of Social and Economic Research (ISER)

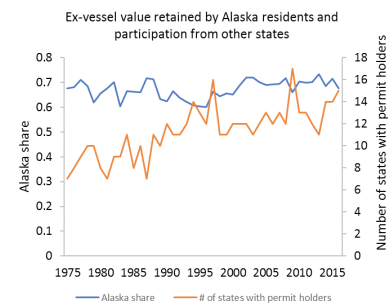
Team Members/Advisors: NCEAS data team; Dr. Gunner Knapp, (*emeritus*, ISER); Dr. Steve Langdon, University of Alaska Anchorage (*emeritus*)

Participation, Earnings, and Risk – the Alaska factor

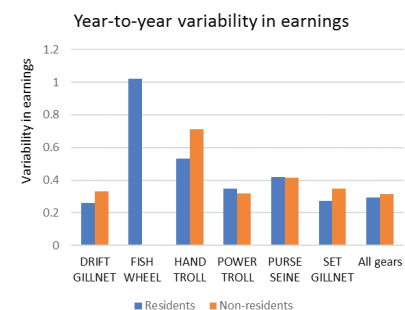
Participation in Alaska's commercial salmon fisheries is risky business. While salmon fisheries have historically been highly valuable, earnings are subject to variability in salmon returns, market forces and other factors. In the end, however, earnings by Alaskans have been more stable than earnings by non-residents, evidence of the value of local knowledge that reduces risk for local fishers.

To better understand the economic benefits of salmon to Alaskans, we compiled relevant data available from Alaska Department of Fish and Game, Commercial Fisheries Entry Commission, Alaska Department of Revenue, Alaska Department of Labor and other institutions. Our analysis follows the following objectives:

- Compile, archive, and share relevant historical socio-economic data about Alaska's salmon system
- Identify key indicators of socio-economic characteristics to show historical trends
- Integrate socio-economic indicators with others that describe biophysical, socio-cultural, and governance
- Explore evolving historical relationships between salmon and salmon users to visualize trends overlooked in the past
- Inform and support evidence-based policy aimed at sustainable and equitable decision making



Alaska residents retain about 2/3 of total harvest value of Alaska's commercial salmon fisheries, despite increased participation from out-of-state permit-holders.



Alaskans' share of earnings varies by gear type. For example, the share of earnings has risen in power troll fisheries yet fallen in set gillnet fisheries.

Governance and Subsistence

Team Lead: Dr. Steve Langdon, University of Alaska Anchorage (*emeritus*); Co-Lead: Dr. Taylor Brelsford, University of Alaska Anchorage; Co-Lead: Dr. Jim Fall, Alaska Department of Fish and Game, Subsistence Division

Team Members: Wilson Justin (Ahtna) Mt. Sanford Tribal Consortium and Chistochina Enterprises; Mike Williams (Yupiaq) Akiak Native Community and Kuskokwim River Inter-Tribal Fish Commission; Nicole Kimball, Pacific Seafood Processors Association



The Governance of Salmon Utilization and Conservation

Our working group is describing the governance of salmon utilization through time, beginning with Indigenous patterns at contact, continuing through the Russian period and US territorial period to the current situation of State and Federal shared jurisdiction. For each period, the basic framework of laws, institutions, processes and procedures will be described and discussed. Documents to be accessed include Federal records, Territorial records, Constitution, key laws and court decisions, Board of Fish policies, and Alaska Department of Fish and Game (ADFG) policies.

Contemporary Alaska salmon governance is implemented through three intertwined jurisdictions: the Alaska Board of Fisheries, the Federal Subsistence Board, and the North Pacific Fisheries Management Council. Our analysis is examining statewide and distinctive Alaska fisheries management regional characteristics, as well as activities related to the governance of salmon and people occurring in other locations such as borough commissions, tribal organizations, and village communities.

Research conducted under the Governance component covers the following topics:

- Constitutional foundations and principal laws governing salmon conservation, utilizations, and habitat protection
- Judicial review and significant court cases
- Regulatory structures and processes (decisions and outcomes) and regulatory provisions (fisheries management plans)
- Advisory bodies, and emerging institutions such as the Kuskokwim River Inter Tribal Fisheries Commission
- Citizen engagement with salmon governance, NGOs, awareness campaigns and initiatives
- Enforcement patterns
- Prospects for institutional adaptation to climate change and declining fiscal resources

Important data sources that will contribute to the discussion include: Board of Fisheries proposals (by region, by proponent, type of proposal outcomes); Board of Fisheries members, chairman and requirements for Board action; State Advisory Committees types and patterns of activity; Federal Subsistence Board proposals and outcomes; North Pacific Fisheries Management Council salmon actions; and North Pacific Fisheries Management Council Advisory Panels.

Key governance challenges to be addressed include: climate change, development, declining funding, governance alignments, geographic disjunction, ideological and interest divides.

Salmon Subsistence

Salmon subsistence will be described including traditional indigenous patterns of use, legal definition (state and federal), and the history of governance under state and federal laws. Information on harvest levels and patterns of utilization by Alaska regions over the past 20 years will be compiled. The management tool of “Amounts Needed for Subsistence” will be examined. In addition, data on personal use and educational permit fisheries will be presented. Documents and statistical records based on fish calendars and interviews constructed by ADFG Subsistence Division personnel will be accessed, reviewed and synthesized.

Special attention will be paid to traditional beliefs about human-salmon relations, and the significance of new tribal-federal management initiatives for the consideration of Indigenous knowledge.



Representatives of the Kuskokwim River Intertribal Fish Commission (KRITFC), AVCP and US Fish and Wildlife who were signatories to the Memorandum of Understanding concerning salmon governance on the Kuskowkim River. The KRITFC is composed of 33 tribal communities who live on the Kuskokwim River.

Consistency, Causes, and Consequences of Declining Size and Age of Alaskan Salmon



(Image | Ginger Gillquist)

Principal Investigators: Eric P. Palkovacs, University of California Santa Cruz; Peter Westley, University of Alaska Fairbanks; Bert Lewis, Alaska Department of Fish and Game

Team Members: Marissa L. Baskett, University of California Davis; Stephanie M. Carlson, University of California Berkeley; Andrew P. Hendry, McGill University; Holly Kindsvater, Rutgers University; John Reynolds, Simon Fraser University; Katie Kobayashi and Krista Oke, University of California Santa Cruz; Madeline Jovanovich, University of Alaska Fairbanks; Neala Kendall, Washington Department of Fish and Wildlife; Steve Munch and Curry Cunningham, NOAA Fisheries

Advisors: Rich Brenner, Alaska Department of Fish and Game; Gale Vick, Tanana Chiefs Conference

Decreases in the body size of returning adult salmon have been noted for several Alaskan salmon species.

Salmon age and size underlie many important aspects of ecological function and the value of salmon for human use. Declines in size of salmon can result from decreases in growth and loss of the oldest age classes. Despite evidence for decreased size and age of spawning adult salmon for some species and rivers, a comprehensive synthesis of size and age trends across species and populations is currently lacking. As well, several potential causes of size and age shifts have been proposed, including fisheries, climate change, and competition at sea, however the consistency of these changes across populations and the contributions of the various potential drivers are also unknown.

Our working group is synthesizing existing data on Alaskan salmon size and age trends across all five species of Pacific salmon and across Alaska's regions to assess whether declines in size and age noted for some populations are widespread. Specifically, we are asking:

1. *Consistency:* How consistent are changes in size and age across species, regions and populations?
2. *Causes:* How are changes in size and age related to variation in fisheries, climate change, density dependence at sea and other potential drivers?
3. *Consequences:* What are the consequences of age and size declines for the ecological, economic and cultural value of salmon?

Workflow from data collection to Analysis



Field collection of length data



Age determined from scales



Data compiled in ADFG data sets



Datasets synthesized and analyses conducted

The synthesis of the ADFG salmon size and age data archive produced an unprecedented biological dataset, derived from data collected on over 13 million salmon over the past 50 years. This large dataset will allow us to:

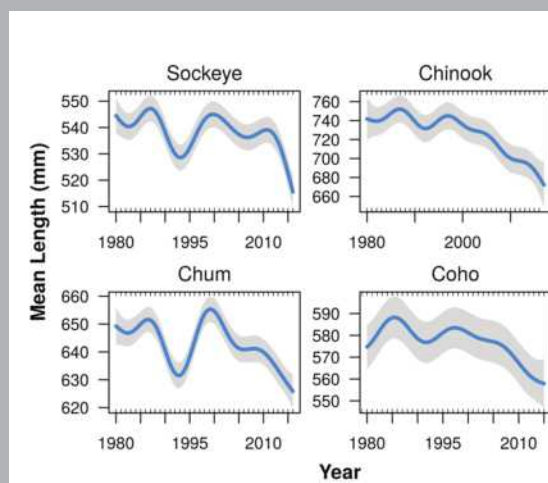
- test for consistency of length and age trends among species and across regions
- investigate relative contributions of changes in growth rate and age structure to overall changes in size
- examine the relationships between size and age changes and potential causal drivers, including fishing mortality, climate change and competition at sea
- investigate the consequences of size changes for ecosystems and human uses

Size and age changes have the potential to impact population productivity, stability, and biomass of salmon. We are exploring the ecological implications of these changes for coastal ecosystems and the economic and cultural value of salmon for the people of Alaska.

Our data synthesis will contribute basic insights into the causes and consequences of contemporary trait changes in wild populations and provide insights into how to successfully manage economically and culturally important biological resources in an era of rapid environmental change.



Sockeye salmon is one of the species declining in age and size across regions of Alaska
(Image | Andrew Hendry)



The size of salmon returning to Alaska rivers is declining across species.

Well-Being and Alaska Salmon Systems

Image | Ginger Gillquist



Team: Dr. Rachel Donkersloot, Alaska Marine Conservation Council; Dr. Courtney Carothers, Dr. Jessica Black (Gwich'in Athabascan), Danielle Ringer, Jesse Coleman, and January Scott (Tlingit), all of University of Alaska Fairbanks; Erika Gavenus, National Center for Ecological Analysis and Synthesis.

Advisors: Caroline Brown, Alaska Department of Fish and Game; Patricia Clay, NOAA Fisheries; Ann Fienup-Riordon, Calista Elders Council; Sara Jo Breslow, Center for Creative Conservation; Carlos Garcia-Quijano, University of Rhode Island; Steve Langdon, University of Alaska Anchorage (*emeritus*); Liza Mack (Aleut) University of Alaska Fairbanks; Melissa Poe, NOAA Affiliate/Washington Sea Grant; Julie Raymond-Yakoubian, Kawerak Incorporated; Andrea Akalleq Sanders (Yup'ik) Alaska Native Policy Center; Wilson Justin (Ahtna) Mt. Sanford Tribal Consortium and Chistochina

Enterprises; Jim Fall, Alaska Department of Fish and Game; Jonathan Samuelson (Yup'ik) Georgetown Tribe and Kuskokwim River Inter-tribal Fish Commission; Freddie Christiansen (Alutiiq) Old Harbor Native Corporation; Mike Williams (Yupiaq) Akiak Native Community and Kuskokwim River Inter-Tribal Fish Commission; William Voinot-Baron, University of Wisconsin-Madison

Human well-being has been widely promoted as an important dimension of sustainability, and is increasingly gaining application in fisheries. Efforts to measure well-being and to incorporate these dimensions into resource governance and decision-making remain hamstrung by availability of data and broad assumptions about important components of quality of life and well-being.

In the context of Alaska salmon systems, clearly defined measures are needed to create a baseline and monitor well-being variables, especially given current management concerns surrounding climate change, resource development, and in many cases, the alienation of long-standing fishing communities and local resource users from the resource base (e.g., out-migration of fishing permits from rural and Alaska Native communities).

This 'state of the knowledge' synthesis is driven by a cross-disciplinary and cross-cultural dialogue with the aim of understanding interdependencies between sociocultural and ecological systems, salmon-human connections and contributions to well-being in Alaska, and relationships between management and well-being. We pay special attention to well-being concepts inclusive of Indigenous people's priorities and perspectives.

Workgroup members include Indigenous and non-Indigenous researchers, practitioners, and knowledge bearers from diverse communities across Alaska, and other expertise representing a range of disciplines, organizations and governmental bodies.

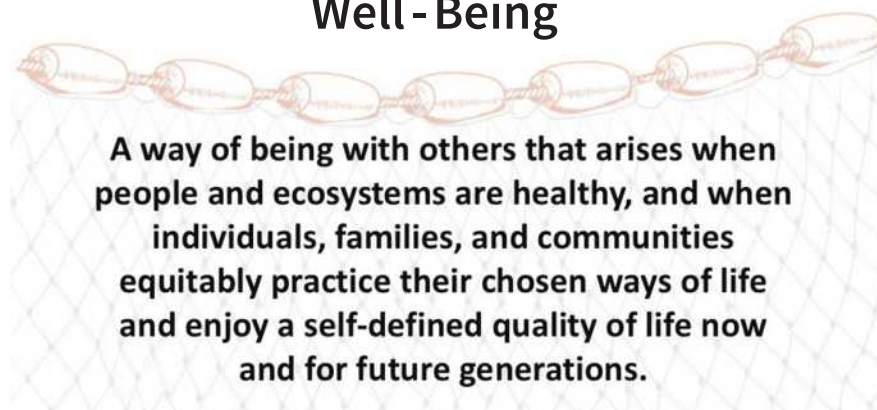
As a first step, our workgroup developed a definition of well-being. We next identified key ‘domains’, which in the context of Alaska salmon systems include science and management-based concepts such as *economy* (e.g., employment, income) and *environment* (e.g., resource abundance, environmental health). We also identified fundamental, yet often-overlooked, dimensions of well-being, such as *culture and identity*, *place attachments*, *social relationships*, *generational continuity* and *self-determination*. What does well-being look like in light of all of these realms of Alaska salmon systems? How do we know if well-being is being met? How might we measure it?

Additional questions informing our work include:

- How do salmon-human connections contribute to various forms of well-being?
- How have human well-being concepts been incorporated into fishery management decision-making processes?
- What well-being measures can or should be applied to governance of Alaska’s salmon resource?
- What information gaps exist?
- What can be done to enhance well-being in the context of Alaska salmon systems?

The diversity of our workgroup lends great insight into how to ethically, respectfully, and meaningfully work across diverse cultures, worldviews, and ways of knowing. Our work will contribute to the development of best practices for research and other efforts that attempt to respect a plurality of knowledges and ways of being.

Well - Being



A key objective of our workgroup is to develop and refine “indicators” of well-being and identify a conceptual framework for better integrating well-being concepts into the governance of Alaska salmon systems. Identifying viable measures for well-being in the context of Alaska salmon systems that are inclusive of Indigenous priorities and conceptions of well-being can help us to better assess and contribute to the future sustainability of Alaska’s human-salmon systems.



Sign from Bristol Bay demonstrating the importance of multi-generational ties to fishing livelihoods

Interacting Effects of Ocean Climate and At-Sea Competition on Alaskan Salmon

The Ocean Climate Working Group is focusing on the effects of ocean conditions, climate, and density dependence on marine survival and growth of Pacific salmon.

Ocean conditions for salmon changed dramatically in 1977, but other important changes have occurred since then including a warming trend and increasing abundance of salmon in the North Pacific. Effects of these changes appear to be unique in different oceanic regions.

The Ocean Climate group is focused on examining ecological patterns in salmon that originate along the west coast of North America, the Gulf of Alaska and the Bering Sea. In addition, we are examining data currently available that suggest salmon are becoming more common in marine waters, lagoons and rivers in the Arctic region of Alaska.

Our working group consists of specialists in a variety of disciplines, including oceanography, fishery science, ecological modeling and climate science. All our members appreciate the complexity of Pacific salmon life histories, and we are focused on understanding how salmon are adapting to changing ocean conditions.

We are building our knowledge through data syntheses from recent oceanographic studies and long-term salmon population monitoring. By accounting for the interplay between climate and at-sea competitive processes across broad ocean domains, the Ocean and Climate Working Group is:

- helping to inform decision-makers on changes in salmon survival and production, and on the important drivers of these changes
- describing changes in marine growth of selected populations of sockeye salmon to understand how recent anomalously warm ocean conditions have influenced growth rates
- summarizing monitoring data to improve understanding of range extension and potential colonization of Pacific salmon in the Arctic region

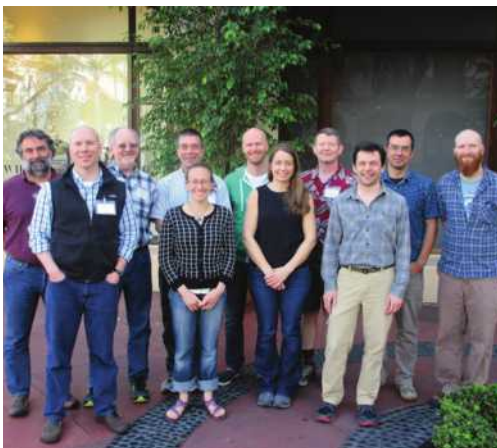
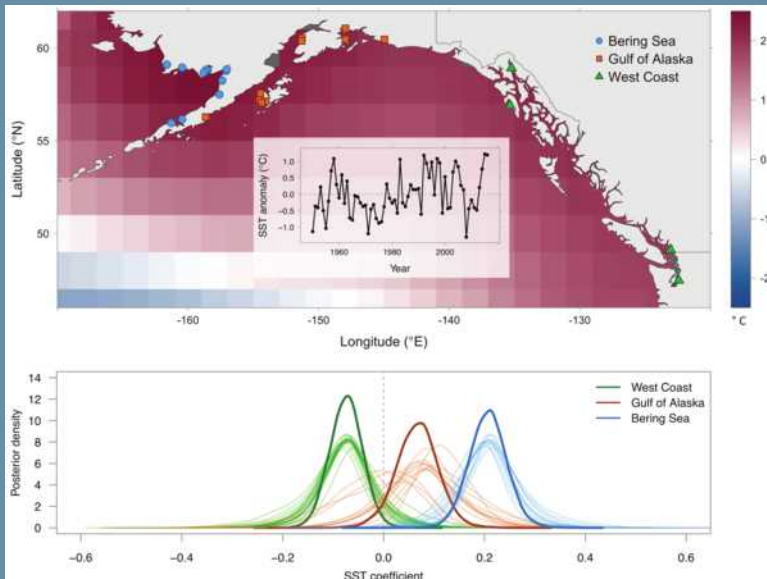


Image | Ginger Gillquist

Principal Investigators: Peter S. Rand, Ph.D, Robert W. Campbell, Ph.D, Kristen B. Gorman, Ph.D, Prince William Sound Science Center

Team Members/Advisors: Andrew Gray, Ed Farley, NOAA Fisheries Auke Bay, Bay Laboratories; Greg Ruggerone, Natural Resources Consultants Inc.; Brendan Connors, Jim Irvine and Karen Dunmall, Fisheries and Oceans Canada; Mike Malick, NOAA Northwest Fisheries Science Center; Milo Adkison, University of Alaska Fairbanks College of Fisheries and Ocean Sciences; Todd Sformo, North Slope Borough; Trent Sutton, University of Alaska Fairbanks; Christian Zimmerman, US Geological Survey

Effects of Sea Surface Temperature (SST) on Sockeye Salmon Survival



Variability in SST (deviations from the average) across the North Pacific and the estimated effects of SST variability on sockeye salmon survival rates.

Top: Map of sea surface temperature anomalies (deviations from the average temperature) across the North Pacific for April 2016. Points on map show ocean entry locations for 46 sockeye salmon populations used in the analysis. Inset shows a time series of SST anomalies from 1950 through 2016.

Bottom: Distributions of the estimated effects of SST on survival of sockeye salmon populations by region. Thick darker lines indicate the average effect across all stocks in a region and thin lighter lines indicate effects on individual stocks. Positive SST coefficients indicate that higher SST is associated with higher sockeye salmon survival for that region/stock. Negative SST coefficients indicate that higher SST is associated with lower survival for that region/stock.

The Ocean Climate Working Group is led by staff from Prince William Sound Science Center (PWSSC) located in Cordova, Alaska. The NCEAS SASAP program is aligned well with the mission of PWSSC to advance community resilience and the understanding and sustainable use of ecosystems. PWSSC focuses on the Prince William Sound and Copper River Region, the Gulf of Alaska, and beyond, and salmon fisheries contribute in significant ways to local communities in this part of Alaska. Advancements in our understanding of salmon through the NCEAS SASAP program will help improve how these salmon fisheries are managed for the benefit of future generations. www.pwssc.org



Image | Teal Barmore

Community Based Monitoring: Using Participatory Modeling to Empower Community Engagement in Salmon Science



The CBM Working Group is comprised of modelers, salmon population dynamics experts, CBM practitioners, and regional stakeholders from the Arctic-Yukon-Kuskokwim (AYK) region of Alaska, home to the largest subsistence salmon fisheries in the world.

Principal Investigators: Michael L. Jones, Department of Fisheries and Wildlife Quantitative Fisheries Center, Michigan State University

Key Modelers: Sam Truesdell, Quantitative Fisheries Center; Brendan Connors, ESSA Technologies Ltd.; Lewis Coggins, U.S. Fish & Wildlife Service; Matthew Catalano, Auburn University, School of Fisheries; Ben Staton, Auburn University, School of Fisheries; Steve Fleischman, Alaska Department of Fish and Game

Other Team Members: Joe Spaeder, AYK Sustainable Salmon Initiative; Daniel Schindler, University of Washington; Milo Adkison, University of Alaska Fairbanks College of Fisheries and Ocean; Bill Bechtol, Bechtol Research; Zach Liller, Alaska Department of Fish and Game; Nick Smith, Alaska Department of Fish and Game; Stephanie Quinn-Davidson, Yukon River Inter-Tribal Fish Commission; Lamont Albertson, Kuskokwim River Salmon Management Working Group; Greg Roscicza, Orutsaramiut Native Council; Nick Kameroff, Kuskokwim River Intertribal Fish Commission; Janessa Esquible, Orutsaramiut Native Council; Kevin Whitworth, Up-River Stakeholder; Laura Loucks, Clayoquot Biosphere Trust



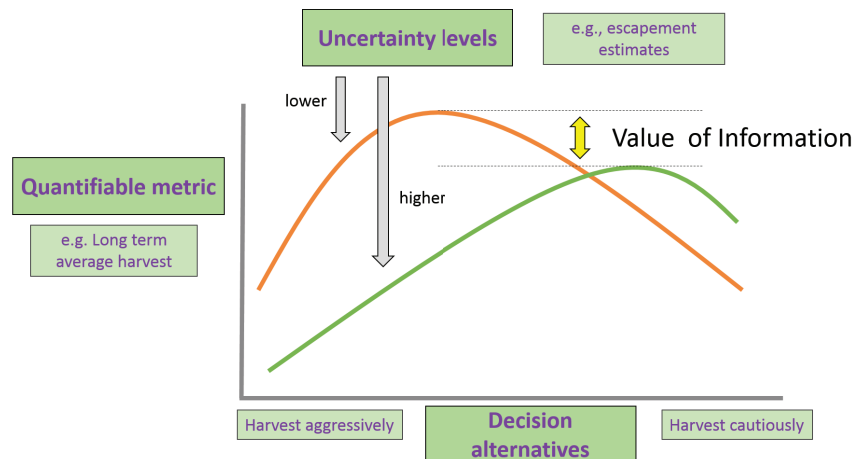
Avery Hoffman, Orutsaramiut Native Council Summer Youth Representative, conducts harvest surveys at the Bethel area fish camps and attempts to recruit local fishermen to participate in the Chinook Salmon Age-Sex-Length Sampling Program. Here, Avery is showing a subsistence sampler how to properly sample his subsistence-caught Chinook.

The Community Based Monitoring (CBM) Working Group is synthesizing ideas for monitoring of salmon populations and the fisheries that depend upon them

Community Based Monitoring (CBM) is increasingly contributing to the management of natural resources in rural Alaska. Our group has been working with Yukon communities to develop CBM systems, and our discussions have centered around linking two key questions:

First: Can we define the most critical information needs for guiding wise and sustainable management of subsistence fisheries, especially in data-poor regions such as Western Alaska?

To define critical information needs, we applied simulation models of salmon fisheries to an approach known as “Value of Information” analysis. The basic idea is to use the models to determine how much we can improve decision-making by reducing uncertainty in a particular aspect of the model. The improvement is measured in terms of forecasted outcomes that relate to objectives of stakeholders. One example: likelihood of being able to meet subsistence needs in the future. (Figure 1.)



As uncertainty levels are reduced (green line → orange line), both the preferred decision (peak of each curve), and the value associated with the decision, change.



Anna Pavila, Alaska Native Science & Engineering Program student, conducting harvest surveys in the Bethel area fish camps.

Second: How can we empower subsistence users to help fill critical information needs? To address this question, we engaged regional stakeholders and CBM practitioners to learn about their experiences with information gathering. We identified intersections between the capacity of stakeholders to carry out CBM, key information needs our modeling work has identified, and learned about early experiences with CBM in the lower Kuskokwim River (Figure 2.)

Kenai Lowlands Salmon Research Synthesis and Design Tools for Integrated Watershed Management



Principal Investigators: Coowe Walker, Kachemak Bay National Estuarine Research Reserve; Mark Rains, University of South Florida; Ryan King, Baylor University; Charles Simenstad, University of Washington; Dennis Whigham, Smithsonian Environmental Research Center

Team Members/Advisors: Syverine Abrahamson, Chris Guo, and Steve Baird, all of Kachemak Bay National

Estuarine Research Reserve; Ginny Litchfield and Brian Blossom, Alaska Department of Fish and Game; Karyn Noyes and Willy Dunne, Kenai Peninsula Borough; Sue Mauger, Cook Inlet Keeper; Katie McCafferty, U.S. Army Corps of Engineers; Michael Opheim, Seldovia Village Tribe; Mandy Bernard, Mountains to Sea; Alice Rademacher and Jacob Argueta, Kachemak Bay National Estuarine Research Reserve

The Kenai Lowlands Working Group engages multiple local stakeholders to share and communicate the connectedness of salmon habitats throughout the four major watersheds of the Kenai Lowlands.

Unlike many parts of Alaska, land ownership on the Kenai Lowlands is predominately private, especially in the headwater regions. Current watershed research and information in the Kenai Lowlands is abundant but can be inaccessible or fragmented for stakeholder use in salmon policy and management decisions.

Our working group brings diverse perspectives to analyze and share available data and information. We work collaboratively with landowners, resource managers, land use planners, and regulators to identify key landscape elements that promote productivity and resilience in salmon producing watersheds. We also identify conservation strategies consistent with long-term sustainability of a healthy and functional ecosystem.

We are integrating data and watershed habitat and hydrological models for the Kenai Lowlands, and conducting workshops that engage tribal leaders, environmental planners, borough officials, local and agencies, students and researchers. These actions will lead to the development of an updateable geospatial support tool for use in salmon management and decision making, allowing users to visualize how potential development activities and conservation measures can incorporate sustaining landscape connection supporting salmon habitat.

Anticipated Results & Benefits

- Regional ecosystem-based understanding of salmon habitat
- Integration of stakeholder perspectives and place-based research into salmon watershed models
- New insights into pressures affecting salmon systems and their relationships with salmon people
- Identification of research gaps to guide future studies
- Increased community stewardship for greater salmon resiliency

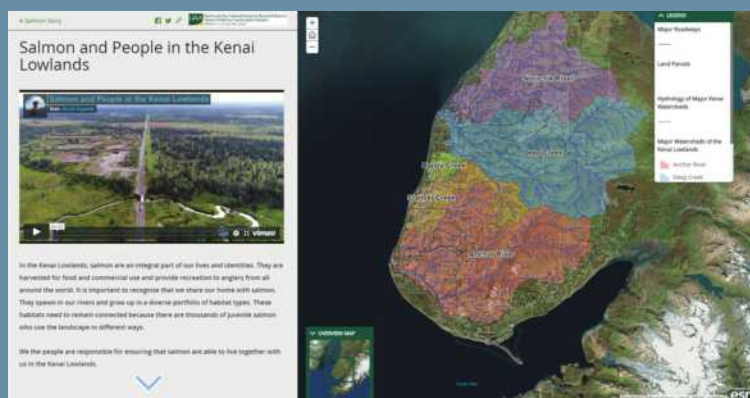
A Salmon Story - Salmon and People in the Kenai Lowlands

As the human population in the Kenai Lowlands grows, it is increasingly important to understand that salmon and people depend on one another and that this age-old dependence stretches across the entire landscape.

One of our group's major outreach products is a geospatial 'StoryMap' that provides the background for people to make decisions that support maintaining the connectedness of the Kenai Lowland watersheds to benefit salmon resources.

"The Story of Salmon and People in the Kenai Lowlands" explores the relationship between humans, salmon, and the landscape they share. For the past 16 years, the Kachemak Bay National Estuarine Research Reserve and its partners have been studying the biologic and chemical interactions within their watersheds in relation to salmon and stream productivity, examining habitat usage of estuarine systems by juvenile salmon, and the connection between head-water nutrients (carbon, nitrogen) and their impact on watershed-scale stream productivity.

This story map aims to communicate these scientific conclusions to both the general public and land managers. Find a link to the story map on the Kenai Lowlands Working Group page at AlaskaSalmonandPeople.org.



Researchers from KBNERR pose at a sample site along the Chakok River where they have been taking water samples and calculating stream discharge.



Alders are an important source of nitrogen for salmon downstream

Alaska Salmon and People: Communicating Results

The Alaska Salmon and People project was undertaken in the belief that access to current, relevant, and targeted data will support and inspire Alaskans to take action to sustain the well-being of salmon and the people who depend on them.

AlaskaSalmonandPeople.org

Data summaries, reports, and links to journal articles, data visualization graphics, story maps and more will be accessible from the Alaska Salmon and People website. One highlight is the upcoming salmon 'data portal', an online tool to help data be more easily discoverable and understandable by all salmon stakeholders.

The Salmon Survey

A major goal of the Alaska Salmon and People data synthesis project is to share results with the full spectrum of salmon users, advocates, and decision-makers.

To ensure we reach the full range of salmon stakeholders with relevant content in the most efficient and effective way possible, we developed a communica-

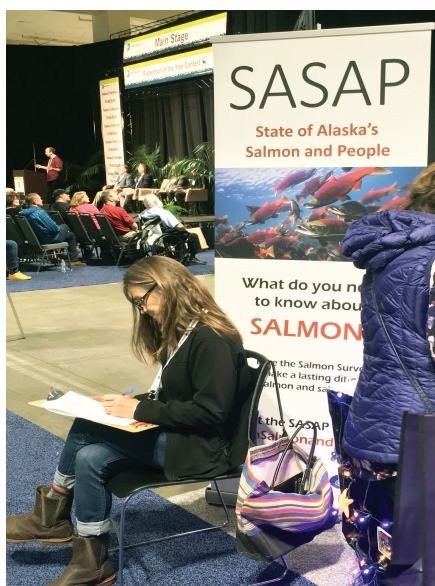
tion survey and disseminated it broadly from July through December, 2017. Prepared with assistance from Nautilus' First Alaskans Summer Intern Carissa Larson, the survey was refined with input from SASAP researchers, village council members, fishermen, educators and other salmon stakeholders.

We sought opinions in three areas of salmon communication:

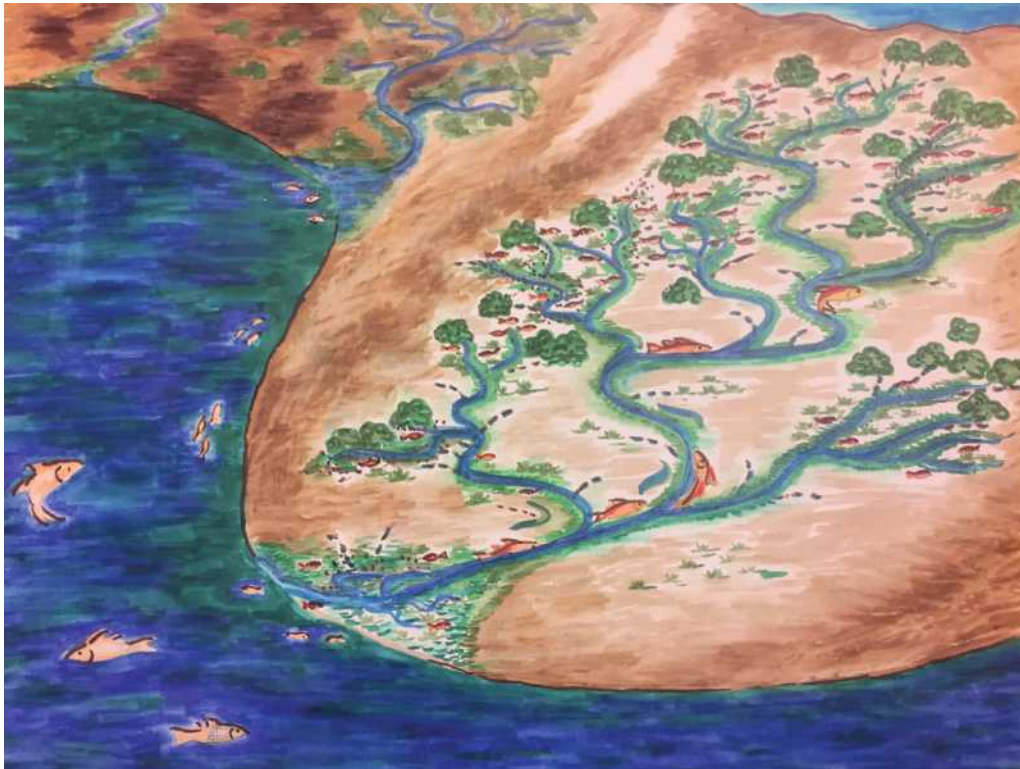
1. Where are stakeholders currently going for information on salmon and fishing? Whom do they trust most for accessible, useful information?
2. What types of communication formats are salmon stakeholders most likely to use (online sources, conferences, printed resources...)
3. What information coming from SASAP is most relevant to individual stakeholders?

A targeted effort was made to obtain a representative sample from the diverse array of Alaska's salmon users. SASAP staff promoted the survey at tabling events at local and national fishery and science meetings (Kodiak, Kenai, and Mat-Su science and FHP symposiums...); at state-wide events (Alaska Forum on the Environment, Alaska Federation of Natives...); and through online industry and community newsletters and social media. We also conducted several phone surveys with rural residents.

Over 300 survey responses were recorded. As soon as the data are analyzed, we will use it to guide our outreach. Information will be available on the SASAP Website.



Filling out a survey at the SASAP table at the Pacific Marine Expo, the largest commercial fishing exposition on the west coast



(Artist | Coowe Walker, KBNERR)

The story of salmon and people is the relationship between humans and salmon, and the landscapes they both share.

SASAP

The Alaska Salmon and People project connects knowledge across disciplines and agencies, between cultures and users, and among regions to create new institutional capacity that allows the generation of interdisciplinary salmon knowledge and establishes a foundation for integrated knowledge that can be built on over time.

What do YOU need to know about Alaska Salmon and People?

AlaskaSalmonandPeople.org