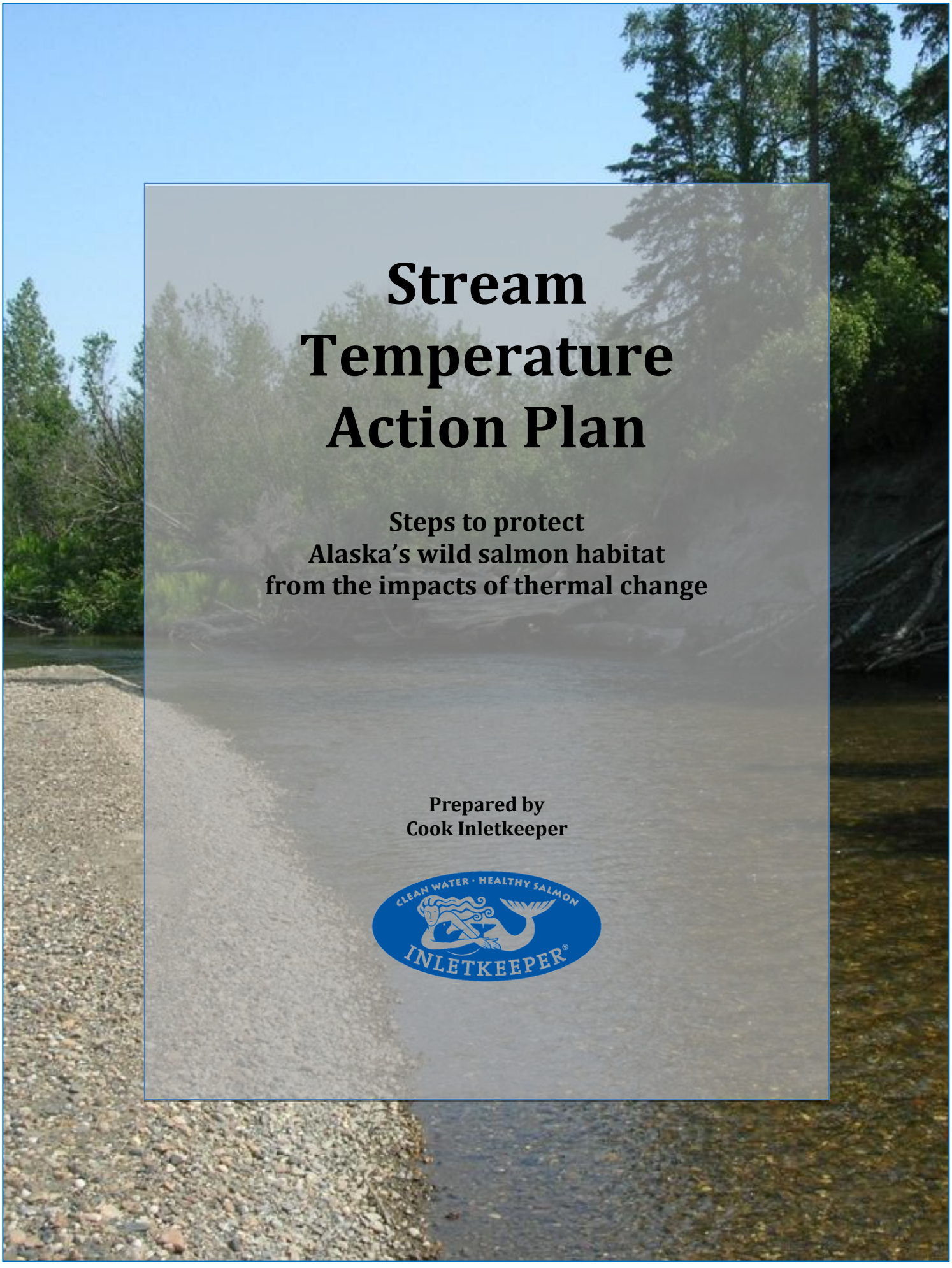


Stream Temperature Action Plan

Steps to protect
Alaska's wild salmon habitat
from the impacts of thermal change

Prepared by
Cook Inletkeeper

Stream Temperature Action Plan

Steps to protect Alaska's wild salmon habitat from the impacts of thermal change

Prepared by

Sue Mauger
Cook Inletkeeper
3734 Ben Walters Lane
Homer, AK 99603
(907) 235-4068
sue@inletkeeper.org
www.inletkeeper.org

August 2012

Acknowledgements

Cook Inletkeeper thanks Laura Eldred, Dan Rinella, Jason Leppi, Dan Isaak, Jon Gerken, Jeff Anderson, Robert Ruffner, Jeff Davis, Alan Peck, Ann Rappoport, Becky Shaftel, Bill Rice, Brian Winnestaffer, Christian Zimmerman, Corinne Smith, Dave Meyer, Doug McBride, Gary Solin, Heather Leba, Janet Curran, Jeff Shearer, Jessica Winnestaffer, Joe Klein, John Trawicki, Kate (Malloy) Harper, Larry Rundquist, Marcus Geist, Mary Price, Melanie Trost, Michael Swaim, Phil Brna, Theresa Tanner, Tim Stevens and Will Frost for their contributions to temperature discussions over the last five years. Support for the development of this document was provided by an Alaska Clean Water Action grant from the Alaska Department of Environmental Conservation.

Mauger, S. 2012. Stream Temperature Action Plan: Steps to protect Alaska's wild salmon habitat from the impacts of thermal change. Cook Inletkeeper, Homer, Alaska. 10p.

Introduction

Alaskans are witnessing the greatest warming of any region in the United States[1], and Alaska's salmon are experiencing the effects of global climate change across the full range of their habitat - from streams to sea and back[2]. Water temperature plays a critical role in all phases of the salmonid lifecycle, especially in freshwater systems where fish hatch from eggs and later return to spawn. Warm stream temperatures are frequently associated with increased stress in fish, making them increasingly vulnerable to pollution, predation and disease[3]. Because temperature plays a critical role in salmonid reproduction and survivorship - and because wild, healthy salmon support vital sport, commercial, subsistence and personal use fisheries across Alaska - there is a pressing need to assess water temperatures in Alaska's stream habitats. Without such basic information, it is impossible to gauge the health of salmon habitats and resources, and equally difficult to develop management responses to improve watershed resiliency to climate change.

The purpose of the Stream Temperature Action Plan is to identify the highest priority actions for the next 5-10 years that will lead to greater protection of Alaska's wild salmon habitat as thermal change continues. We have focused this plan on stream temperatures but encourage similar efforts to understand marine, nearshore and lake water temperatures which also influence the health of salmon populations. By implementing these priority actions in data collection, protection, and research in the Cook Inlet watershed and 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.

Cook Inletkeeper has developed this Stream Temperature Action Plan based on a decade of temperature monitoring experience and numerous multi-agency discussions. No one organization or agency will be able to tackle all of these needs. Through collaboration and coordinated discussions, these priority actions can be accomplished over the next 10 years through partnerships of federal, state, Tribal and non-profit organizations. Cook Inletkeeper is committed to help facilitate these collaborations and discussions with the goal of protecting Alaska's wild salmon habitat from the impacts of thermal change.

[1] (CIFAR) Cooperative Institute for Arctic Research. 2000. Impacts of Climate Change in the United States: Alaska. Cooperative Institute for Arctic Research, University of Alaska, Fairbanks.
[2] Taylor, S.G. 2008. Climate warming causes phonological shift in Pink Salmon, *Oncorhynchus gorbuscha*, behavior at Auke Creek, Alaska. Global Change Biology 14: 229-235.
[3] Richter A. and S.A. Kolmes. 2005. Maximum temperature limits for Chinook, coho, and chum salmon, and steelhead trout in the Pacific Northwest. Reviews in Fisheries Science, 13:23-49.

Goal 1: Improve our understanding of current thermal regimes in Alaska's salmon streams.

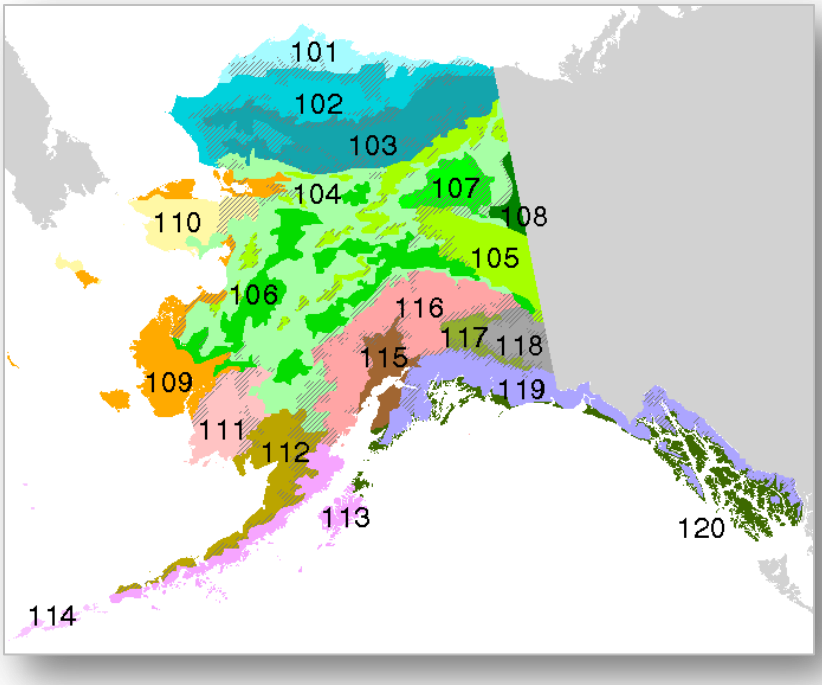
Issue: Despite the critical role temperature plays throughout the salmonid lifecycle, we have very limited, and poorly accessible, water temperature data for salmon streams in Alaska.

Solution: We will never be able to monitor all freshwater systems in Alaska due to their vast number and remoteness, but by carefully designing regional assessments that capture gradients of watershed characteristics across larger landscapes, we can describe the range of current natural variability in stream temperature profiles. We need to establish a set of minimum standards to ensure sufficient data quality so data sharing and interpretation is possible between assessments. And finally, we need a state-wide online resource to identify where data are available.

Objective 1: Monitor temperatures across the full range of the most important environmental gradients that affect thermal regimes to understand current variation among streams.

Priority Action 1.1.a Complete the Cook Inlet Stream Temperature Monitoring Network regional assessment to characterize the range of variability in stream temperature profiles by 2013. Cook Inletkeeper coordinates this 5-year effort to collect data in 48 non-glacial streams in the Cook Inlet watershed with the involvement of 15 partnering entities.

Priority Action 1.1.b Initiate 5-year regional assessments in the following ecoregions: Bristol Bay-Nushagak Lowlands (#112), Ahklun and Kilbuck Mountains (#111), Subarctic Coastal Plains (#109), Pacific Coastal Mountains (#119), Coastal Western Hemlock-Sitka Spruce Forests (#120), Interior Forested Lowlands and Uplands (#104), Interior Bottomlands (#106) by 2017. Priority should be given to economically significant, non-glacial regions in sub-arctic Alaska with strong existing partnership networks. Newly formed Landscape Conservation Cooperatives (LCCs) and Fish Habitat Partnerships are good potential entities to take the lead on this action.



From Gallant, A.L.; Binnian, E.F.; Omernik, J.M.; and Shasby, M.B. 1995. Ecoregions of Alaska. U.S. Geological Survey Professional Paper 1567, 73p.

Objective 2: Develop minimum standards to ensure sufficient data quality and facilitate more data sharing among agencies and organizations.

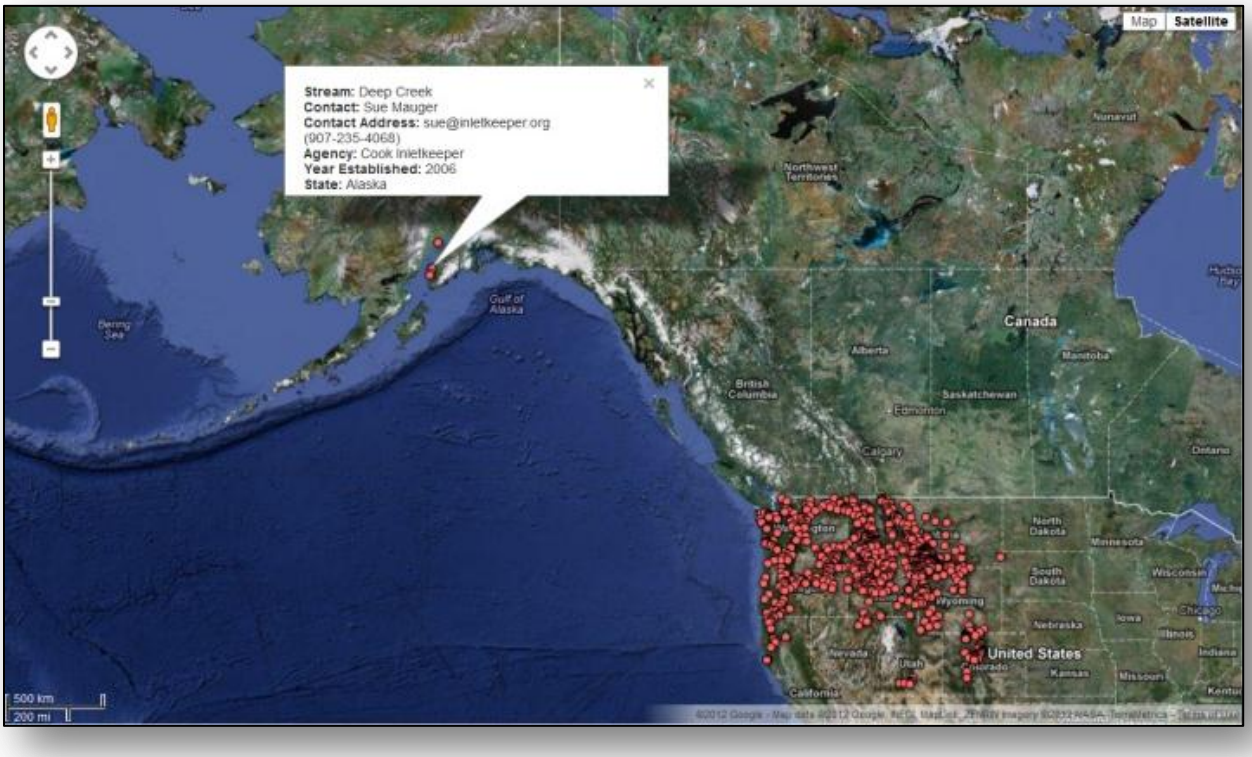
Priority Action 1.2.a Establish a state-wide temperature working group with representatives of federal, state, Tribal, university and non-governmental agencies in 2013. This could be a sub-committee of an existing working group or a new interagency effort.

Priority Action 1.2.b Through the temperature working group, develop state-wide minimum standards for site selection criteria, data collection protocols, quality assurance measures and analysis techniques by 2014. Numerous agency-specific or regional protocols exist which can provide the foundation for Alaska-approved methods.

Objective 3: Create a state-wide online resource to identify where temperature data are available.

Priority Action 1.3.a Create an online mapping interface to identify stream temperature data sets with contact information for users to acquire data directly from the data-collecting entity by 2015.

Priority Action 1.3.b Designate an entity tasked with maintaining the online mapping tool with dedicated funding by 2015.



Example of a Google-map interface developed by the Rocky Mountain Research Station – Boise Aquatics Sciences Lab to identify full-year stream temperature monitoring sites.

Goal 2: Refine data collection for fisheries management and modeling applications.

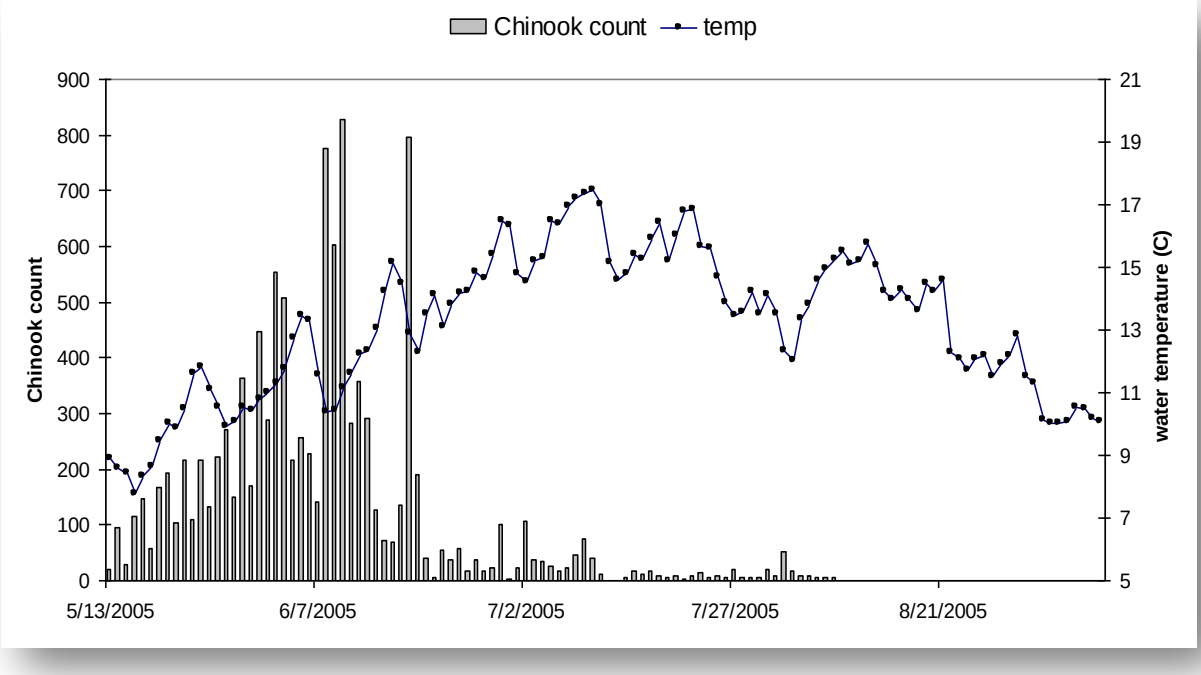
Issue: Project-specific efforts to collect stream temperature data are often of short-duration (1-3 years), collected in the ice-free months (May–October), and then stored on a local computer. These data are often of little use to fisheries managers looking for in-season information or to climate and hydrologic modelers needing full-year water and air temperature datasets.

Solution: Real-time monitoring stations are needed to provide in-season information for fisheries managers in key watersheds. There's an additional need for long-term (>20 years) monitoring stations using paired air and water sensors to establish the relationship between air and water temperature at more local scales, which will improve our ability to predict future water temperature conditions based on climate scenarios.

Objective 1: Provide real time data for fisheries managers.

Priority Action 2.1.a In coordination with the Alaska Department of Fish & Game (ADF&G), prioritize key watersheds with stream gages and fish weirs or other escapement counting capabilities and create a strategic plan, identifying funding, to establish real-time temperature monitoring stations by 2014.

Priority Action 2.1.b Establish real-time monitoring stations with online access to in-season information for fisheries managers in highest priority watersheds by 2017.



Example of a post-season analysis using ADF&G Anchor River weir data of Chinook salmon movement through the weir and water temperature. Generally, large movements of fish correspond with a decrease in water temperatures, especially when daily water temperatures were above 13°C.

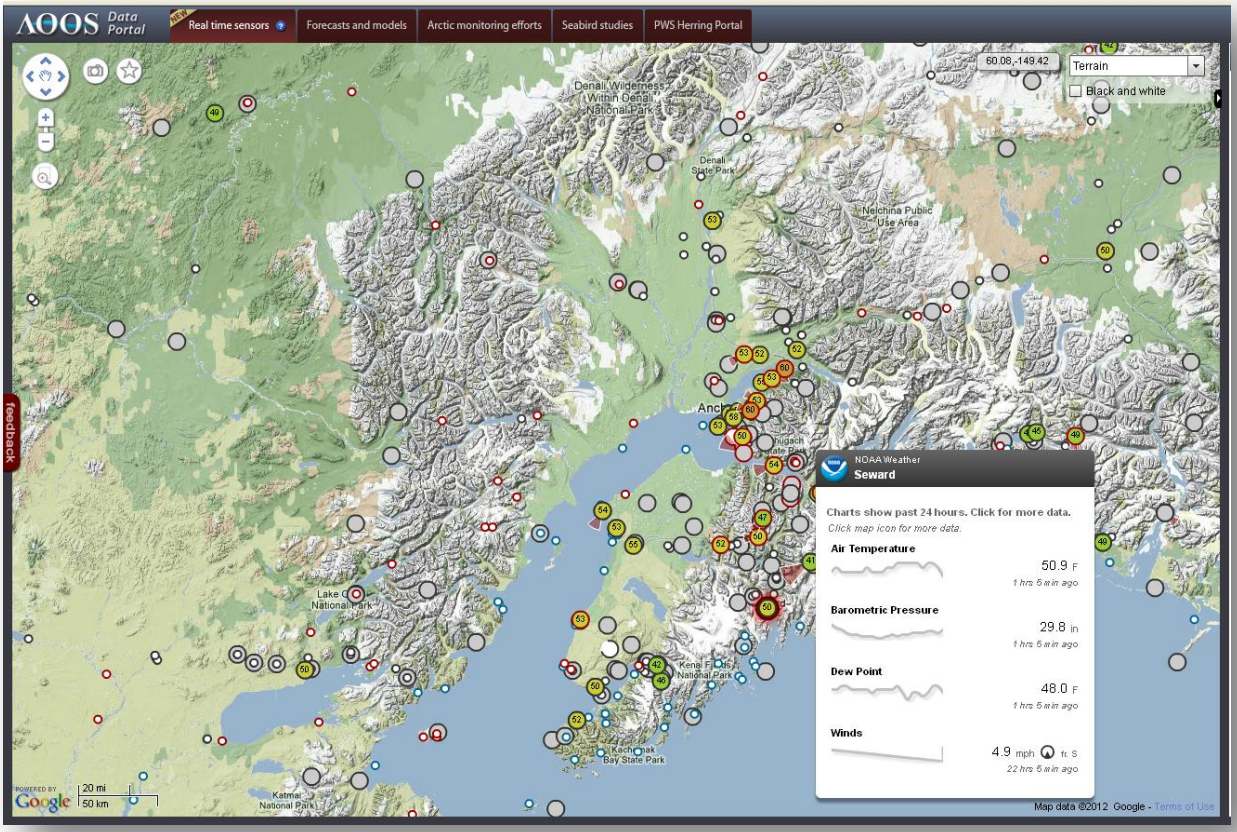
Objective 2: Provide long-term datasets for climate and hydrologic modeling applications.

Priority Action 2.2.a Develop a strategic sampling plan for long-term stream monitoring stations with the spatial density and proximity to stream gages and weather stations that will be valuable to modelers by 2014.

Priority Action 2.2.b Establish 6-10 long-term, year-round stream monitoring stations with paired water and air temperature sensors in Cook Inlet by 2015.

Priority Action 2.2.c Establish a minimum of 50 (6-8 per ecoregion identified in Goal 1) long-term, year-round stream monitoring stations with paired water and air temperature sensors around the state by 2022.

Priority Action 2.2.d Coordinate with the Alaska Ocean Observing System (AOOS) and their network of real time sensors and model outputs to make long-term stream monitoring data available online by 2015.



E*xample of the AOOS online data portal with real time sensors (shown) and forecast and model output maps.*

Goal 3: Target cold water habitat protection efforts.

Issue: Water temperature varies greatly across watersheds due to stream morphology, land cover, glacial contribution, and groundwater influence as well as to the climatic drivers of air temperature and precipitation. Certain streams types are more sensitive to the impacts of climate change and are warming more rapidly than others. In response to the inevitability of some degree of regional warming, we need to develop adaptation measures to improve watershed resilience to thermal change.

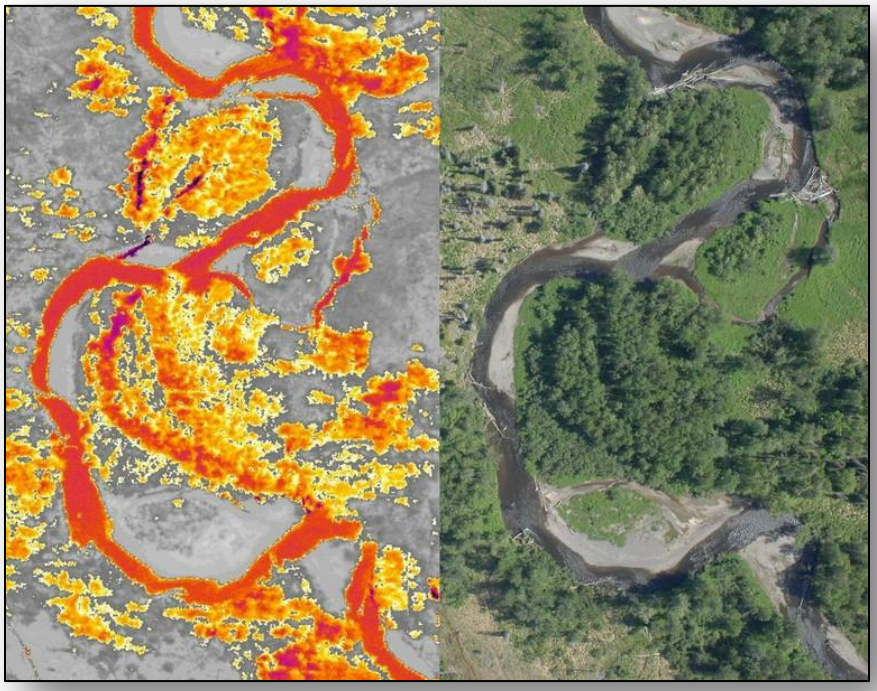
Solution: As we gain more understanding of current stream temperature profiles and can assess which streams are most vulnerable to the impacts of climate change, we need to implement conservation and protection measures to help keep cold water cold and reduce additional stressors to freshwater systems that are warm and will get warmer.

Objective 1: Protect waters that are currently cold.

Priority Action 3.1.a Identify streams which have significant private and unprotected public land ownership status and high potential for development over the next 20 years by 2015.

Priority Action 3.1.b Use thermal infrared imagery to identify thermal refuges – areas within a stream which are consistently colder than adjacent areas in the summer - which can help reduce overall maximum stream temperature in high priority streams by 2018.

Priority Action 3.1.c Work with local land trust organizations to secure conservation easements or other land trust agreements to protect key thermal refuges by 2022.



Thermal infrared imagery (left) with corresponding aerial image (right) showing cold water inputs (purple) to the mainstem of the Anchor River (orange).

Objective 2: Reduce thermal stressors to "temperature sensitive streams".

Priority Action 3.2.a Identify which streams exceed the State of Alaska's water temperature criteria for the protection of fish based on regional assessments described under Goal 1 by 2018.

Priority Action 3.2.b Through local fish habitat partnerships, work with city and borough assemblies to develop stream protection plans in key watersheds with riparian and upland vegetation protection measures and impervious surface controls by 2020.

Priority Action 3.2.c In streams with high development pressure and potential water withdrawal activity, collect stream flow data and apply for a Reservation of Water through Alaska Department of Natural Resource's Reservation of Water process by 2021.

Priority Action 3.2.d Work with the Alaska Department of Fish & Game and other partners to recommend rules under the Anadromous Fish Act and the Alaska Fish Passage Act that provide clear standards for fish habitat protection by 2019.

Goal 4: Fill stream network data gap.

Issue: In Alaska, we lack an accurate hydrography or stream network GIS layer. While the rest of the country is anticipating the release of NHDPlus (version2), Alaska is not even included in the original National Hydrography Dataset (NHD). NHD is a powerful tool which links individual stream reaches within a river network and greatly increases analytical capabilities.

Solution: We need to educate resource managers and decision makers on the value of a stream network layer for Alaska and its importance in understanding climate change impacts in Alaska's salmon streams. By explaining the utility of filling this foundational data gap, we will prioritize the development of NHDPlus for Alaska.

Objective 1: Acquire NHDPlus for Alaska.

Priority Action 4.1.a Collaborate with Fish Habitat Partnerships, Landscape Conservation Cooperatives and the State of Alaska to garner congressional support for the development of NHDPlus for Alaska by 2016.

Priority Action 4.1.b Work with the U.S. Geological Survey to prioritize development of NHDPlus for Alaska and make it widely available by 2020.

Goal 5: Direct relevant fisheries and habitat research.

Issue: Our awareness that stream temperature may be a factor in current and future Alaska wild salmon productivity and survival is relatively recent. Not until monitoring projects began reporting maximum temperatures above 20°C in the last 10 years, and the reality of climate change became more apparent on the Alaska landscape, has this critical water quality parameter received much attention. Consequently, research on thermal stress on Alaska's wild salmon is scant. In addition, our ability to discern population impacts during the freshwater phase of the salmon life cycle is extremely limited. In many Alaska streams we use weirs and sonar technology to monitor adult migration back into the watershed, but rarely do we count how many juveniles actually leave a stream. As a result, when unexpectedly low returns occur, unfavorable marine conditions are often blamed. Until we can better account for out-migrating fish we will likely underestimate thermal impacts to salmon populations occurring in the freshwater environment.

Solution: We need to determine if Alaska's wild salmon populations are more or less tolerant to thermal variation than the fish - typically from southern parts of the range – used in previous laboratory studies. And we need to understand how thermal stress during freshwater rearing periods can impact salmon productivity.

Objective 1: Assess relevance of threshold temperatures to Alaska salmon.

Priority Action 5.1.a Create and maintain an online annotated bibliography of research papers dealing with salmon, temperature and climate change in Alaska to facilitate new thermal studies by 2016.

Priority Action 5.1.b Perform laboratory studies to evaluate whether Alaska's instantaneous water temperature criteria and threshold values of 13, 15, and 20°C are physiologically and behaviorally relevant to Alaska's regional salmon populations by 2017.

Objective 2: Encourage more watershed-based research on salmon productivity to better understand freshwater survival versus marine survival.

Priority Action 5.2.a In coordination with ADF&G, identify streams which provide good study areas to investigate juvenile survival and thermal impacts during freshwater rearing periods by 2016. Target important Chinook salmon streams to address growing concerns about the recent low returns.

Priority Action 5.2.b Conduct juvenile survival and thermal impact research across watersheds with different stream temperature profiles by 2019.

25 Steps by 2022: Priority Action Timeline

2013 Priority Actions

1.1.a Complete the Cook Inlet Stream Temperature Monitoring Network regional assessment to characterize the range of variability in stream temperature profiles.

1.2.a Establish a state-wide temperature working group with representatives of federal, state, Tribal, university and non-governmental agencies.

2014 Priority Actions

1.2.b Through the temperature working group, develop state-wide minimum standards for site selection criteria, data collection protocols, quality assurance measures and analysis techniques.

2.1.a In coordination with the Alaska Department of Fish and Game, prioritize key watersheds with stream gauges and fish weirs or other escapement counting capabilities and create a strategic plan, identifying funding, to establish real-time temperature monitoring stations.

2.2.a Develop a strategic sampling plan for long-term monitoring stations with the spatial density and proximity to stream gages and weather stations that will be valuable to modelers.

2015 Priority Actions

1.3.a Create an online mapping interface to identify stream temperature data sets with contact information for users to acquire data directly from the data-collecting entity.

1.3.b Designate an entity tasked with maintaining the online mapping tool with dedicated funding.

2.2.b Establish 6-10 long-term, year-round stream monitoring stations with paired water and air temperature sensors in Cook Inlet.

2.2.d Coordinate with the Alaska Ocean Observing System and their network of real time sensors and model outputs to make long-term stream monitoring data available online.

3.1.a Identify streams which have significant private and unprotected public land ownership status and high potential for development over the next 20 years.

2016 Priority Actions

4.1.a Collaborate with Fish Habitat Partnerships, Landscape Conservation Cooperatives and the State of Alaska to garner congressional support for the development of NHDPlus for Alaska.

5.1.a Create and maintain an online annotated bibliography of research papers dealing with salmon, temperature and climate change in Alaska to facilitate new thermal studies.

5.2.a In coordination with ADF&G, identify streams which provide good study areas to investigate juvenile survival and thermal impacts during freshwater rearing periods.

2017 Priority Actions

1.1.b Initiate 5-year regional assessments in 7 key ecoregions.

2.1.b Establish real-time monitoring stations with online access to in-season information for fisheries managers in highest priority watersheds.

5.1.b Perform laboratory studies to evaluate whether Alaska's instantaneous water temperature criteria and threshold values of 13, 15, and 20^{o}C are physiologically and behaviorally relevant to Alaska's regional salmon populations.

2018 Priority Actions

3.1.b Use thermal infrared imagery to identify thermal refuges – areas within a stream which are consistently colder than adjacent areas in the summer - which can help reduce overall maximum stream temperature in high priority streams.

3.2.a Identify which streams are most likely to exceed the state of Alaska's water temperature criteria for the protection of fish based on regional assessments.

2019 Priority Actions

3.2.d Work with ADF&G and other partners to recommend rules under the Anadromous Fish Act and the Alaska Fish Passage Act that provide clear standards for fish habitat protection.

5.2.b Conduct juvenile survival and thermal impact research across watersheds with different stream temperature profiles.

2020 Priority Actions

3.2.b Through local fish habitat partnerships, work with city and borough assemblies to develop stream protection plans in key watersheds with riparian and upland vegetation protection measures and impervious surface controls.

4.1.b Work with U.S. Geological Survey to prioritize development of NHDPlus for Alaska and make it widely available.

2021 Priority Actions

3.2.c In streams with high development pressure and potential water withdrawal activity, collect stream flow data and apply for a Reservation of Water through Alaska Department of Natural Resource's Reservation of Water process.

2022 Priority Actions

2.2.c Establish a minimum of 50 long-term, year-round stream monitoring stations with paired water and air temperature sensors around the state.

3.1.c Work with local land trust organizations to secure conservation easements or other land trust agreements to protect key thermal refuges.