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THE STATE OF OUR SALMON

HEARING

BEFORE THE

SUBCOMMITTEE ON OCEANS, ATMOSPHERE, FISHERIES, AND COAST GUARD

OF THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION UNITED STATES SENATE

ONE HUNDRED FIFTEENTH CONGRESS

SECOND SESSION

OCTOBER 20, 2018

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ONE HUNDRED FIFTEENTH CONGRESS

SECOND SESSION

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THE STATE OF OUR SALMON

SATURDAY, OCTOBER 20, 2018

U.S. SENATE,
SUBCOMMITTEE ON OCEANS, ATMOSPHERE, FISHERIES,
AND COAST GUARD,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
Anchorage, AK.

The Committee met, pursuant to notice, at 10:30 a.m. at the Tyonek Room, Dena'ina Civic and Convention Center, 600 West 7th Avenue, Anchorage, Alaska, Hon. Dan Sullivan, Chairman of the Subcommittee, presiding.

Present: Senator Sullivan [presiding].

OPENING STATEMENT OF HON. DAN SULLIVAN, U.S. SENATOR FROM ALASKA

Senator SULLIVAN. The Committee on Commerce, Science, and Transportation will now come to order. I want to begin by apologizing. I was just up giving my remarks for the keynote address, and it went a little long, which is something that we as senators do all the time, so I apologize about that.

But what I do want to do is first thank everybody. I want to thank everybody for being here. I really want to thank our witnesses, which I think everybody is going to see, we have a world class, world class set of witnesses.

And I do want to just begin by giving you an opening of what we are trying to achieve here today with this hearing. First of all, this is an official U.S. Senate Subcommittee hearing, the Subcommittee on Fisheries, NOAA and the Coast Guard. I chair that subcommittee back in Washington. And in addition to my staff here, we have staff from the Commerce Committee in Washington. So all of this will be transcribed, as you are seeing, and this is an official hearing here.

I want to start by thanking our hosts today, the Alaska Federation of Natives. With a robust schedule of events and various other activities adjacent to the annual AFN convention, both time and space is very, very precious. So I want to thank AFN today for providing this meeting room and for all of you for taking the time to be here, particularly our witnesses, which we have a really, really all-star two panels here.

I had no doubt that this hearing would provoke interest. Alaska's fisheries are important to our state's heart and soul. Our fisheries are iconic. We all love salmon. And we are the most important fishery in the country, by far. And one of the most important fisheries in the world, by far.

Every summer when I'm at my family's fish camp on the Yukon, I'm reminded of the important cultural and spiritual sustenance provided by our salmon for all Alaskans. For me there is no more special place in the world, and I know that tens of thousands of Alaskans, whether using their fish wheels, nets or rods or reels, feel the same way when they are catching salmon.

As I constantly remind my colleagues back in D.C., Alaska's fisheries are by far the largest in the nation, accounting for over 50 percent of total domestic landings for the country and tens of thousands of jobs. In many communities, our fisheries are the backbone of their economy. Our fisheries are the heart and soul of many of our Native cultures. And as I constantly remind my colleagues in D.C., we, Alaska, are the super power of seafood for America.

At the same time, we are not without challenges. From Ketchikan to Cordova to Kodiak, from Grayling to Emmonak and everywhere else I've had the privilege of traveling across in our great state, the health of the salmon fishery is always on the forefront of the minds of Alaskans.

In response to their experience and many varying theories of what is occurring, whether ocean acidification, the so-called warm water blob or something entirely different, I called this hearing to review the science behind Alaska's salmon fisheries.

And as I mentioned, I am pleased to have an impressive panel of experts here today to discuss these issues, including our Federal and state managers. Using the best science available is an essential tenet for fisheries management and is necessary for maintaining healthy and sustainable stocks for generations to come.

This hearing is intended to examine current data available and identify information and scientific gaps. Both the state and Federal Government have a role in providing that science. In conjunction with the assistance of our academic and other research institutions, I would argue the knowledge of the fishermen themselves who are closest to the resource and most reliant on its bounty for their livelihoods and subsistence needs are also critical.

Over the course of our state's history, our fisheries have come a long way. Concern over collapsing fisheries and Federal mismanagement motivated many of Alaska's founding fathers to fight for statehood. Salmon, in particular, is a large part of the reason Alaska became a state.

In 1959, the year Alaska became a state, the statewide harvest of salmon was only 25 million fish. Think about that. For a period of that year, Bristol Bay was shut down entirely. Think about that for a second. Shut down entirely with no openings on the horizon.

At the time of statehood, there were many issues: Boundless overfishing from foreign fleets right off our shores, inadequate or nonexistent science, lack of management controls, fish traps that were devastating the sustainability of our fisheries, and others.

But over the last six decades, working together, Alaska's fisheries have grown to become world class. On the Federal level, laws like the Magnuson-Stevens Act led by Don Young and the late great Senator Ted Stevens, kicked out the foreign fleets and increased scientific investment by integrating vigorous science-based standards into the management process.

And on the state level, managers have abided by the sustained yield principles and enshrined in Alaska's Constitution, not without some controversy and pain along the way. The result, last year, the 2017 statewide salmon harvest topped 225 million fish. Twenty-five million at statehood in 1959, 225 million in 2017. In the early 1970s, Bristol Bay saw harvests of around 1 million sockeye. This year over 40 million sockeye, the second highest year on record and the largest run ever. And we are routinely now seeing over 35 million fish harvested annually in Bristol Bay.

Over the past 60 years there have been ups and downs, booms and busts, but the numbers speak for themselves. But lately—and this is an important reason for this hearing—things have not been normal. They have been unusual. While the three largest Alaskan salmon harvests occurred between 2013 and 2017, Congress had to step in with 56 million dollars in relief funds for a pink salmon fishery disaster in 2016. This builds on the disaster declared for the Yukon River, for the Kuskokwim River, for Cook Inlet Chinook in 2012, and Yukon River salmon in 2009.

This year salmon harvests are unlikely to hit preseason forecasts of 147 million fish. Even in some areas that met preseason forecasts, run timing was abnormal, negatively affecting fishermen, coastal communities and fishery-dependent businesses. However, in other areas of Alaska, most notably around Nome and Kotzebue, salmon harvests have never been better.

I am committed to supporting scientific investment to better understand and manage our fisheries so that our wild salmon can continue to sustain us for thousands of years into the future. I will continue to work with all our fishermen across the state: commercial, recreational, charter, and subsistence—to ensure that we have a stable food supply, recreational and subsistence opportunities, and plentiful fishing and processing jobs that provide for vibrant coastal communities.

You may have also seen that we are working on sustainable oceans with a bill that I authored recently and was signed into law just two weeks ago called the "Save Our Seas Act" that deals with the issue of ocean debris and plastics, which is a huge problem, but we are making progress. And we are working on the reauthorization of the Magnuson-Stevens Act.

But I do want to emphasize, the point of this hearing is to be able to ask questions of the experts. Everywhere I go in Alaska, people ask what is happening. And I'm not sure everybody knows, particularly as it relates to the king salmon.

So I'm honored to have our witnesses here, and I want to welcome our witnesses: Chris Oliver, who is the Assistant Administrator for Fisheries for the National Oceanic and Atmospheric Administration, NOAA. Some of you might know that Chris was the top Executive Director for our Pacific fisheries, North Pacific Fisheries Council, for many years. He's an Alaskan who is now the top Federal official in charge of fisheries in America. He is here.

And of course, we have Sam Cotten, who is the Commissioner of the Alaska Department of Fish and Game. Each of you gentlemen will have 5 minutes to deliver an oral statement, and a longer written statement will be included in the record.

Mr. Oliver, the floor is yours.

STATEMENT OF CHRIS OLIVER, ASSISTANT ADMINISTRATOR FOR FISHERIES, NATIONAL MARINE FISHERIES SERVICE, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, U.S. DEPARTMENT OF COMMERCE

Mr. OLIVER. Thank you, Senator. And good morning. And it's great to be back home here in the great State of Alaska.

On the science front, our Alaska Fisheries Science Center collaborates closely with the Alaska Department of Fish and Game in a number of ways, including several integrated ecosystem surveys where data is used to forecast adult salmon returns and to meet our obligations under the Pacific Salmon Treaty.

One example is the collaborative research that we do on Southeast coastal monitoring survey, which is used to produce an annual forecast of pink salmon returns, and we also conduct surveys in the Bering Sea, including a preseason forecast of Yukon River returns.

What are we seeing? Gulf of Alaska pink salmon returns were expectedly low during 2015, 2016, and 2017, and sockeye salmon returns were unexpectedly low during 2018 in most areas of the state. Chinook salmon returns in Southeast reached record lows in 2018.

As you mentioned, in Bristol Bay we set a new record or the second record in 2018, but Chinook salmon returns in Western Alaska are at or below average. We also collect a variety of ecosystem information during these surveys, including sea surface temperature, phytoplankton, zooplankton, forage fisheries and juvenile fish condition. We study that because it's a good indication of how many fish are going to survive to contribute to the future spawning population.

Because we have these long-term data sets, we are better able to understand ecosystem impacts, phenomenonalist events like the blob, which was a large mass of unusually warm water that formed in the eastern Pacific in 2013 and persisted for several years. Our ecosystem surveys during spring and late summer found big changes to the ecosystem as a result of the blob, including less food available for fish along the Gulf shelf than in previous years.

Obviously, salmon returns to the Gulf one to three years after the blob were much lower than predicted. In the context of Federal fisheries management, they are managed in the exclusive economic zone under a fishery management plan developed through the North Pacific Council and approved by Secretary of Commerce, which largely prohibits harvest of salmon in Federal waters.

In 2012 we comprehensively revised the FMP with Amendment 12 to comply with new Magnuson-Stevens Act requirements to more clearly reflect the Council's policy with regard to state of Alaska management authority. In 2013, Cook Inlet commercial fishermen and seafood processors filed a lawsuit in Federal district court challenging Amendment 12.

The Ninth Circuit determined that the Magnuson-Stevens Act does require councils to prepare and submit and FMPs that require conservation and management and that no other provision creates an exception to that statutory requirement, and therefore the Cook Inlet portion of the salmon fishery that we had excluded under our fishery management plan and deferred to the state must be included in the FMP.

In response to that, the Council is considering how to revise that FMP, including an option for continued deferral to the state. Salmon are also, incidentally, caught in federally managed groundfish fisheries, primarily pollock.

And I would note that the Council and NOAA fisheries have taken a number of actions over the past 10 years to greatly reduce that salmon bycatch in both the Bering Sea and the Gulf of Alaska. While bycatch represents a very small fraction overall of the total adult runs that are likely to occur in any one system, we know how important salmon are to the subsistence culture and economy of Alaska, and the Council and our agency take this issue very seriously.

On the international front, there is a component of salmon management signed by Canada and the U.S. in 1985. The Pacific Salmon Treaty provides a management framework for this species. The Treaty resolved longstanding interception disputes between the U.S. and Canada, as well as between Alaska, the northwest states and treaty Indian tribes. Chinook salmon is of coast-wide significance and is negotiated directly by U.S. and Canadian commissioners.

With the current harvest sharing agreement set to expire at the end of this year, U.S. and Canadian representatives met regularly over the past 2 years to negotiate proposed amendments to the five fishing regimes contained in the treaty. That recently achieved agreement, which includes reductions in Chinook harvest levels by all parties and is currently undergoing formal review by the two governments with implementation expected in 2019.

And last I'll speak briefly to the recent pink salmon disaster declaration. In response to a request from Governor Walker in the fall of 2016, the Secretary made a determination of the commercial fishery failure in seven management areas of the state. Congress subsequently appropriated funds to address that. We are currently reviewing the spending plans, or are about to review the spending plans submitted to NOAA to distribute funds that will support individuals, businesses, and fishery-independent communities throughout a range of actions that will improve the long-term sustainability of the fishery.

I will conclude at this point, Mr. Chairman. I see my time is up. Thank you again, and I'd be happy to answer any questions.

[The prepared statement of Mr. Oliver follows:]

PREPARED STATEMENT OF CHRIS OLIVER, ASSISTANT ADMINISTRATOR FOR FISHERIES, NATIONAL MARINE FISHERIES SERVICE, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, U.S. DEPARTMENT OF COMMERCE

Good afternoon, Chairman Sullivan. My name is Chris Oliver and I am the Assistant Administrator for the National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS). Thank you for inviting me to testify today on the state of Alaska salmon. As you know, NMFS is responsible for the stewardship of the Nation's ocean resources and their habitat. We provide vital services for the nation: productive and sustainable fisheries, safe sources of seafood, the recovery and conservation of protected resources, and healthy ecosystems—all backed by sound science and an ecosystem-based approach to management.

Alaska Salmon Science and Stock Status

Salmon have a complex life cycle that involves a freshwater rearing period, followed by a period of ocean feeding prior to their spawning migration back to freshwater. Salmon migrate and feed over great distances during their marine life stage.

While there is great diversity in the range and migratory habits among different species of salmon, there also is a remarkable consistency in the migratory habit within stock groups, which greatly facilitates stock-specific fishery planning. Most salmon stocks are vulnerable to harvest by numerous commercial and sport fisheries in marine areas. Salmon are also taken in rivers and streams during their spawning migration by subsistence, sport, commercial, and personal use fishermen.

The Alaska Fisheries Science Center collaborates with the Alaska Department of Fish and Game (ADF&G) on several integrated ecosystem surveys used to forecast adult salmon returns. One example is our collaborative research efforts with ADF&G on the Southeast Coastal Monitoring survey, which has been conducted for the past 21 years. The results are used to produce an annual forecast of pink salmon returns to Southeast Alaska. We also conduct a survey in the Northern Bering Sea (the Bering Arctic/Subarctic Integrated Survey). One of the products of this survey, produced annually, is a pre-season forecast of Yukon River Chinook salmon returns. In the Southern Bering Sea extension of this survey, we are also able to monitor juvenile Pacific salmon and provide data to resource managers biennially.

So what we are seeing during such surveys? In the Gulf of Alaska, pink salmon returns were unexpectedly low during 2015, 2016, and 2017, and sockeye salmon returns were unexpectedly low during 2018. Chinook salmon returns from the Southeast reached record lows in 2018. In the Eastern Bering Sea, sockeye salmon returns to Bristol Bay during 2018 set a new record high and Chinook salmon returns to Western Alaska appear at or below average.

During the surveys, we also collect a variety of ecosystem information on sea surface temperature, phytoplankton, zooplankton, forage fishes and juvenile fish. The condition of juvenile fish is a good indication of how many fish are going to survive to contribute to the future spawning population. If young fish have been able to find food and are in a good condition, they are more likely to make it through their first winter and become adults.

Because we have long term data sets from these surveys, we are able to better understand the ecosystem impacts from events such as the "blob." The blob was a large mass of unusually warm water that formed in the eastern Pacific Ocean in 2013 and persisted for several years. It formed as the result of a highly unusual atmospheric condition that produced a very strong high-pressure ridge in the Gulf of Alaska during winter, reducing the intensity and frequency of storms. This lack of storm events allowed the surface waters of the Gulf to remain warm. The anomalously warm sea temperatures were not only found at the surface, but as deep as 200m in some places. Surveys during spring and late summer found big changes to the ecosystem as a result the blob, including less food available for fishes than in previous years.

Consequently, salmon returns to the Gulf of Alaska 1 to 3 years after the "blob" event were much lower than predicted. In the Eastern Bering Sea, surface temperatures remain warmer than average and the ecosystem productivity is similar to previous warm water years (*e.g.,* producing less nutritious zooplankton). Our long-term data sets from ecosystem surveys in this region enable us to anticipate how salmon will respond to current warm conditions. For example, juvenile Bristol Bay sockeye salmon are likely to do relatively well because they have sufficient food resources, while the outlook for juvenile western Alaska Chinook salmon is not as good because some of their preferred prey is less abundant in warm conditions.

Overview of Federal Salmon Management

Salmon fisheries in the exclusive economic zone (EEZ) off Alaska are managed under the Fishery Management Plan (FMP) for the salmon fisheries in the EEZ off Alaska. In 2012, the North Pacific Fishery Management Council (Council) comprehensively revised the FMP with Amendment 12 to comply with Magnuson-Stevens Act requirements, such as annual catch limits and accountability measures, and to more clearly reflect the Council's policy with regard to State of Alaska management authority for commercial and sport salmon fisheries in the EEZ. Part of that action was to defer management of three traditional net fishing areas—Cook Inlet, the Alaska Peninsula, and Prince William Sound—to State management. As a result, the State of Alaska manages the fisheries in those three areas in Federal waters.

In 2013, Cook Inlet commercial salmon fishermen and seafood processors filed a lawsuit in Federal district court challenging Amendment 12 and its implementing regulations. The lawsuit focused on Amendment 12's deferral to State management of the Cook Inlet Area. The Ninth Circuit determined that Magnuson-Stevens Act section 302(h)(1) requires a Council to prepare and submit FMPs for each fishery under its authority that requires conservation and management and that no other provision in the Magnuson-Stevens Act creates an exception to this statutory re-

quirement. Because the Council and NMFS concluded that the Cook Inlet salmon fishery requires conservation and management by some entity, the Ninth Circuit found that the Cook Inlet portion of the salmon fishery must be included in the FMP given the statutory language of the Magnuson-Stevens Act.

In response to the Ninth Circuit ruling, the Council is considering how to revise the FMP to manage the salmon fishery that occurs in the Federal waters of Cook Inlet. The Council is considering new management measures that comply with Magnuson-Stevens Act requirements for the salmon fisheries that occur within these three areas, such as status determination criteria, annual catch limits, and accountability measures and is considering an option that would defer to state management. In addition, the Council formed a stakeholder committee, called the Cook Inlet Salmon Committee, to assist in developing the measures to manage the commercial fishery in Cook Inlet. Finally, the Council is scheduled to review a discussion paper and the committee's recommendations at their December 2018 Council meeting.

Salmon are also incidentally caught as bycatch in the federally-managed groundfish fisheries off Alaska, primarily by the pollock fisheries. The Council and NMFS have taken a number of actions to both monitor and reduce salmon bycatch in the Bering Sea and Gulf of Alaska in recent years. Chinook salmon bycatch in the Bering Sea pollock fishery is limited by regulation and pollock fishermen participate in contracts that provide incentives for each vessel to avoid Chinook and chum salmon bycatch at all times. The goal is to allow the pollock fisheries to catch the full total allowable catch while staying within specified salmon bycatch limits. For 2019, Chinook salmon abundance, measured by a State of Alaska index, is below a threshold by the Council, requiring NMFS to further reduce the Chinook salmon bycatch limits for each pollock fishing sector.

Pacific Salmon Treaty

There is an international component of salmon management as well. Signed by Canada and the U.S. in 1985, the Pacific Salmon Treaty provides a framework for the two countries to cooperate on the management of Pacific salmon. A high degree of cooperation is required to prevent overfishing, provide optimum production, and ensure that each country receives benefits that are equivalent to the production of salmon in its waters.

The treaty resolved long-standing salmon interception disputes between the U.S. and Canada as well as between Alaska and Northwest states and treaty Indian tribes. The treaty implementing legislation stipulates that decision-making within the U.S. Section is established by consensus of the U.S. Commissioners from affected states and treaty Indian tribes. Fishing regimes under the treaty (contained in Annex IV) are generally re-negotiated every ten years. Most chapters expire at the end of 2018 and were the subject of re-negotiation recently completed by the Canadian and U.S. Sections to the Commission.

With the current harvest sharing agreement set to expire on December 31, 2018, Canadian and U.S. representatives on the Pacific Salmon Commission met regularly over the course of two years to negotiate proposed amendments to five fishing regimes contained in Annex IV of the treaty. The chapter addressing Chinook salmon was the primary, but not sole, focus of the re-negotiation. While coho, chum, sockeye and pink salmon regimes are largely negotiated by regional representatives, Chinook salmon is of coast-wide significance and negotiated directly by U.S. and Canadian Commissioners. The agreement is currently undergoing formal review by the two governments in an effort to bring the amendments into force by January 2019, and to provisionally apply the proposed amendments, in the event that the final exchange of diplomatic notes is delayed. In addition, NMFS will complete an Endangered Species Act consultation on any new discretionary domestic actions taken as a result of the amendments.

2016 Pink Salmon Failure

In 2016, Alaska experienced abnormally low returns of pink salmon throughout the Gulf of Alaska. In response to a request from Alaska's Governor in the fall of that year, the Secretary of Commerce made the determination, in January 2017, of a commercial fishery failure for pink salmon in seven management areas in State waters. In reaction to multiple fisheries disasters declared on the west coast and Alaska, as well as those related to Hurricanes Maria, Irma, and Harvey, Congress appropriated Federal funds to address these commercial fishery failures in the Bipartisan Budget Act of 2018. Of the $200M of dedicated funds, $56.3M was subsequently directed for disaster relief to address the 2016 Gulf of Alaska pink salmon failure. Eligible recipients must submit spending plans to NOAA for approval. These funds will support individuals, businesses, and fishery dependent communities

through a range of actions that will improve the long term sustainability of the fishery.

This concludes my testimony. Thank you again for the opportunity to testify before you today. I would be happy to answer any questions you may have.

Senator SULLIVAN. Thank you, Mr. Oliver. Commissioner Cotten.

STATEMENT OF SAM COTTEN, COMMISSIONER, ALASKA DEPARTMENT OF FISH AND GAME

Commissioner COTTEN. Thank you, Senator.

Senator SULLIVAN. And I guess our audio system is out throughout the whole building, so everybody will have to project a little so everybody can hear.

Commissioner COTTEN. I can try to do that, Senator. And before I begin, I wanted to say thank you for allowing me to include my leadership staff as part of this exercise today. To my side here is Dr. Jim Hasbrouck, who is a Chief Fisheries Scientist for the Division of Sportfish; Mr. Bill Templin, Chief Fisheries Scientist for the Division of Commercial Fish.

Senator SULLIVAN. Welcome, gentlemen. Thank you for being here.

Commissioner COTTEN. And behind me are other members of the leadership team. Hazel Nelson is the Director of the Division of Subsistence; Tom Brookover, Director of the Division of Sportfish; and Forrest Bowers, Director of the Division of Comm Fish.

Senator SULLIVAN. Thank you.

Commissioner COTTEN. Between this group here, not counting me, there is about 115 years of experience with the Alaska Department of Fish and Game intensely involved with salmon management.

Senator SULLIVAN. We thank you for your service. Thank you.

Commissioner COTTEN. So thank you, Mr. Chairman, for holding this hearing.

My name is Sam Cotten. I am the Commissioner of the State of Alaska Department of Fish and Game. We understand and appreciate the role of the United States in salmon management in Alaska. The Bureau of Indian Affairs oversees fisheries management for the Annette Island Reserve. The U.S. Fish and Wildlife Service has actively managed the Kuskokwim River Chinook salmon subsistence fishery for the past 5 years.

And it's important to note that there is no secret that people that live on the river systems in Alaska have an intense dependence and, as a result, an intense interest in the management. So we make a strong effort to work with the folks that live in these systems and try to gain as much as we can from their local and traditional knowledge.

The Department of Commerce through the North Pacific Fisheries Management Council sets salmon bycatch limits in Federal fisheries. The Department of Commerce and the Department of State are responsible for the approval and ratification of the Pacific Salmon Treaty. And as was pointed out by Mr. Oliver, the Department of Commerce determines and then the U.S. Congress considers whether to fund fishery disasters.

In addition, Alaska participation on the North Pacific Fisheries Management Council is very important, and we are thankful we

have been able to maintain our voting majority. And as the MSA is being reconsidered, we know—we've heard from residents of other states that perhaps we shouldn't have that majority, so we appreciate very much maintaining that.

Senator SULLIVAN. That is going to happen, I can guarantee you, or it won't pass.

Commissioner COTTEN. The Council is currently addressing a recent Ninth Circuit Court decision that has taken away state management in three areas that Alaska has managed since statehood. We believe the court got it wrong and have suggested changes in Federal law that would return that authority to Alaska.

We work with the National Marine Fisheries Service on several fronts, including ocean survey work that is important to both governments. Stable funding of these projects is important. I believe we have a very good, actually outstanding working relationship with the National Marine Fisheries Service at both the regional and national levels. One area of particular concern is with the observer program and its limitations due to funding constraints. The observer program has been improved, but does not enjoy the level of Federal support seen in other regions of the United States. Observer coverage is important for several reasons, and in Alaska we are especially concerned with salmon bycatch in Federal fisheries.

Alaska salmon fisheries have experienced wile variations in recent years. This year Bristol Bay sockeye salmon set records, the largest run in history with the greatest value. Bering Sea systems generally were outstanding, with the exception of Chinook salmon. The Gulf of Alaska saw very poor and in some cases, Chignik in particular, there was no commercial harvest. Pink salmon returns typically vary on odd/even-year cycles. In the past decades, those variations have set records for highs and lows. We are all painfully aware of the extremely poor returns of Chinook salmon throughout the state and many parts of the west coast of the U.S.

Salmon are extremely important to Alaska's people. In the past 4 years, I've traveled throughout the state meeting with people in all regions to hear concerns, occasional complaints and ideas about our salmon and how to best manage it.

Alaska's constitution requires managing fisheries under the sustained yield principle. For salmon we do that using scientifically-based escapement goals to ensure a sufficient number of spawning fish produce future generations. We use our regulatory and permitting framework to protect freshwater salmon habitat.

Alaska prioritizes subsistence use and supports all uses of salmon: Commercial, personal use, sport and guided sport. In upper Cook Inlet, managing fisheries for all users is a major challenge. At least half the state's population lives nearby. Traditional sport and commercial fishermen have been participants for many decades. The sportfish industry, guides, lodges, charters and other businesses that benefit from this important economic sector have grown. The personal use dipnet fisheries are relatively new and very popular—I think last year we issued 30,000 permits—and an important source of fish for people from all parts of Alaska.

Many people enjoy fishing opportunities in the Mat-Su Valley, as well, and pay close attention to the management practices of the

department and the allocation decisions made by the Board of Fisheries.

Governor Walker has created the Cook Inlet Salmon Task Force in an effort to get all users to, in his words, talk to each other rather than talk about each other. We are hopeful the participants who represent all these groups can find some common ground and make recommendations to the Governor and the Boards of Fisheries.

Historically Alaska has seen challenges that we have overcome. Federal management of salmon when Alaska was a territory was a failure by all accounts. With statehood, Alaska took over management and rebuilt our runs. Foreign fleets were able to intercept salmon before they reached our river systems. Thanks to the Magnuson-Stevens Fisheries Act, also known as the 200-mile limit, we have stopped that assault. Those were political solutions that were appropriate and successful.

Today's problems are not political. They require science, more information, more data and more collaboration. We are working with the Federal Government, University of Alaska, other universities, partners from all sectors of Alaska's fishing participants, the North Pacific Research Board, the North Pacific Fisheries Management Council, the North Pacific Anadromous Fish Commission, as well as many other international organizations with an interest in salmon.

2019 is being designated as the year of the salmon. We hope to capitalize on this occasion. We expect there will be many new opportunities to pursue answers and solutions to the questions that surround the state of salmon.

The Alaska Department of Fish and Game is the largest science organization in Alaska. We look forward to advancing the best science available to ensure the long-term health and sustainability of our most important natural resource.

Thank you, Mr. Chairman.

[The prepared statement of Commissioner Cotten follows:]

PREPARED STATEMENT OF SAM COTTEN, COMMISSIONER, ALASKA DEPARTMENT OF FISH AND GAME

Good morning Senator Sullivan. Thanks for holding this hearing. My name is Sam Cotten and I am the Commissioner of the State of Alaska Department of Fish and Game. We understand and appreciate the role of the United States in salmon management in Alaska. The Bureau of Indian Affairs (BIA) oversees fishery management for the Annette Island Reserve. The U.S. Fish and Wildlife (USFWS) service has actively managed the Kuskokwim River Chinook salmon subsistence fishery for the past five years. The Department of Commerce, through the North Pacific Fishery Management Council (NPFMC), sets salmon bycatch limits in Federal fisheries. The Department of Commerce and State of Alaska are responsible for approval and ratification of the Pacific Salmon Treaty. The Department of Commerce determines, and the United States Congress considers, funding for fishery disasters in our state.

In addition, Alaska's participation on the NPFMC is very important and we are thankful we have been able to maintain our voting majority. The Council is currently addressing a recent Ninth Circuit decision that has taken away state salmon management in three areas that Alaska has managed since statehood. We believe the court got it wrong and have suggested changes in Federal law that would return the authority to Alaska.

We work with the National Marine Fisheries Service (NMFS) on several fronts including ocean survey work that is important to both governments. Stable funding of these projects is important. I believe we have a very good working relationship with NMFS at both the regional and national levels. One area of particular concern

is with the observer program and its limitations due to funding constraints. The observer program has been improved but does not enjoy the level of Federal support seen in other regions of the United States. Observer coverage is important for several reasons. In Alaska we are especially concerned with salmon bycatch in Federal fisheries.

Alaska salmon fisheries have experienced wild variations in recent years. This year, Bristol Bay sockeye salmon set records as the largest run in history with the greatest value. Bering Sea systems generally were outstanding, with the exception of Chinook salmon. The Gulf of Alaska saw very poor runs and, in some cases—Chignik in particular, there was no commercial harvest.

Pink salmon returns typically vary on odd/even-year cycles. In the past decade those variations have set records for highs and lows. We are all painfully aware of the extremely poor returns of Chinook salmon throughout the state.

Salmon are extremely important to Alaska's people. In the past four years I have traveled throughout the state, meeting with people in all regions to hear concerns, complaints and ideas about our salmon and its management.

Alaska's constitution requires managing fisheries under the sustained yield principle. For salmon, we do that using scientifically based escapement goals to insure a sufficient number of spawning fish are available to produce future generations. We use our regulatory and permitting framework to protect freshwater salmon habitat.

Alaska prioritizes subsistence use and supports all uses of salmon: commercial, personal use, sport and guided sport. In upper Cook Inlet, managing fisheries for all users is a major challenge. At least half of the state's population lives nearby. Traditional sport and commercial fishermen have been participants for many decades. The sport fish industry; guides, lodges, charter and other businesses that benefit from this important economic sector have grown. The personal use dipnet fisheries are relatively new, very popular (30,000 permits) and an important source of fish for people from all parts of Alaska. Many people enjoy fishing opportunities in the Mat-Su and pay close attention to the management practices of the department and the allocation decisions of the Board of Fisheries (BOF). Gov. Walker has created the Cook Inlet Salmon Task Force in an effort to get all users to talk to each other rather than about each other. We are hopeful the participants who represent all groups can find some common ground and make recommendations to the governor and the Board of Fisheries.

Historically, Alaska has seen challenges that we have overcome. Federal management of salmon when Alaska was a territory was a failure by all accounts. With statehood Alaska took over management and rebuilt our runs. Foreign fleets were able to intercept salmon before they reached our river systems; thanks to the Magnuson-Stevens Fisheries Act, also known as the 200-mile limit, we have stopped that assault.

Those were political solutions that were appropriate and successful. Today's problems are not political. They require better science, more information, more data and more collaborative approaches. Alaska occupies the center of the Pacific salmon range and Alaskans feel the effect when changes happen within that environment. For this reason, we are working with a wide range of local, national and international partners with an interest in salmon including the Federal government, the University of Alaska and other universities, partners from all sectors of Alaska's fishing participants, the North Pacific Research Board (NPRB), the NPFMC, and the North Pacific Anadromous Fish Commission. 2019 is being designated as the Year of the Salmon. We hope to capitalize on this occasion. We expect there to be many new opportunities to pursue answers and solutions to the questions that surround the state of the salmon.

The Alaska Department of Fish and Game is the largest science organization in Alaska. We look forward to advancing the best science available to insure the long-term health and sustainability of our most important natural resource.

Senator SULLIVAN. Thank you, Commissioner. And I do want to emphasize again for everybody here that literally at the witness table right now we have the top Federal official on these issues in the country and the top state official. And they are both very well respected, and I'm very honored that both of them could make the time today to help us. Help us.

And let me begin, because you both touched on it and I touched on it in my opening statement, but obviously, particularly salmon, the cooperation between the feds and the state is really important.

And I know that you two are the top people, so maybe this is a difficult question, but how is that cooperation going, particularly as it relates to salmon? And are there ways that we can improve it, particularly as it relates to Alaska's runs?

Mr. Oliver you kind of have a unique perspective because you were in the Alaska seat not too long ago.

Mr. OLIVER. Yes, sir. Thank you, Mr. Chairman. And I'll provide an initial answer briefly. I did spend 27 years working here in Alaska with the North Pacific Fisheries Management Council, and through that got to observe firsthand how that cooperative relationship works. And now on the Federal side, I can say that I believe it's a very good working relationship. We have for many years largely deferred to the scientific expertise that exists within the state of Alaska, and I'm heartened today that we have those experts here at the table because, while I may be the top Federal official, I'm probably not the greatest person to ask the really nitty-gritty science questions, but——

Senator SULLIVAN. Those are coming in a minute, so don't worry. We will make sure the bench gets some exercise.

Mr. OLIVER. Yes, sir. And I think, through our management process, that we interact with the Board of Fish, that the interaction with Fish and Game and our North Pacific Council, through our interactions with the Pacific Salmon Treaty, I think it was a difficult year during those negotiations, and some hard decisions to be made, but in the end we reached an agreement, and I think that is a reflection of the great working relationship that we have.

Senator SULLIVAN. Good. Commissioner Cotten.

Commissioner COTTEN. Thank you, Mr. Chairman. Ever since Chris Oliver became the Director, Alaska has gained a lot of confidence in our ability to work with the United States Government, and it's already—there has been some fruit borne already. As soon as he got into office, there was additional money advanced to Alaska for additional observer coverage, which is really important to us.

We work with the United States Government on a lot of different research projects that are important to both governments. The United States has treaty obligations, and a lot of the research supports that. And it also helps us forecasting and predicting runs of fish. So there is a large amount of research that takes place that benefits both the United States and the state of Alaska and benefits the salmon.

Senator SULLIVAN. So let me ask a related question. And it goes to data. And again, this could be for all the members here, particularly the scientists, but what we are trying to do on the Federal side is make sure that Chris Oliver and NOAA and his team are fully, fully, fully funded, best science, best data available.

What do you see, either of you or anyone else who wants to answer this, in terms of lack of data that we need to address, whether it's at the state or particularly at the Federal level, and is there anything that stands out right now that our scientists, whether in Alaska or at the state level. I think that we need to put a lot more money in to figure out what some of the challenges are and what some of the mysteries are? But is there any area where lack of data on a particular topic stands out that we need to really focus on? And it can be in state waters or, you know, the focus of this hear-

ing is more Federal, but since we have state and Federal officials, I think it's a really important question and would welcome your frank response.

Commissioner COTTEN. I could begin by saying that, again, we do enjoy a—a good working relationship and support the efforts that the United States is putting forth as far as some research projects.

One of the concerns has been the stability of the funding level. For example, the salmon research in Southeast that the United States conducts has some variances as far as funding, and the state has been paying for some of that. It has been at times difficult to do that. A few years back the state of Alaska embarked on a major project on Chinook research. Due to budget constraints, we have had to cut back on some of that. We would appreciate, I think, some extra support on that.

Senator SULLIVAN. Where are we, Mr. Oliver, on specific Chinook research dollars at NOAA or within NMFS? I know the Chinook issue is not just Alaska, but I want to focus on Alaska.

Mr. OLIVER. Yes. Mr. Chairman, with regard to—I can't speak specifically to the various research. Sam mentioned the Southeast Alaska Pink Salmon Coastal Monitoring Program. I mentioned the disaster funding that's recently been allocated. And certainly with our overall budget limitations that we are operating under, I'm hopeful that the spin plan for that will cover some of that important research. It's a great opportunity to put a little long-term stability in that.

Pacific Salmon Treaty implementation is a big, open-ended question. The funding for that has ranged—and that's largely related to the Chinook salmon agreement. Funding for that has ranged from 10 million to 14 million dollars over the past 5 years. Our 2019 budget includes roughly $11 million, I think $11.5 million for that. And I know that based on the recent renegotiation of the treaty, that funding level is likely inadequate, certainly inadequate to support the state's contributions to those efforts. And so that's an area that we are going to be challenged on.

I think that had those—had those negotiations been completed earlier but they got protracted and it's taken almost a year longer than expected, we may have been able to get some additional funding requests into the 2020 budget, but it is clear right now there are a number of aspects to the agreement that are currently unfunded that are going to be a challenge for all of us to get support for.

Senator SULLIVAN. I know you are looking at it, but I'm wondering where. As you mentioned on the implementation of the Treaty, there are a number of us who believe that that's going to cost a fair amount of money, both on the implementation and the science and data to monitor it. Are you looking at putting a robust budget request as part of the implementation of the Pacific Salmon Treaty? You have numbers that you can hand to us?

Mr. OLIVER. The original numbers that I've seen that were compiled by the non-U.S. commissioners which we recently received are on the order of initially 57 million dollars, I believe, and a similar amount in the out years. And that—that I believe, of course, includes support for the various state programs that, as I under-

stand, heretofore have only been covered roughly 15 percent by that funding, and I believe this agreement is looking at something closer to 80 percent. Again those are unfunded, and those kind of numbers were not included in the 2020 budget request.

Whether and to what extent—you know how the budget process works, Senator. Whether in the current budget climate that we are operating within, whether and to what extent we as an agency can forward that budget request remains uncertain at this point.

Senator SULLIVAN. Well, as the Chairman of the Committee that oversees that, we will be very interested. And the more robust the request that you think fits the need. Obviously you will need to coordinate closely with the state and the other parties to the treaty. So we will be looking forward to working with you on that.

Commissioner, do you have a view on that?

Commissioner COTTEN. One other quick point. Again, I appreciate Congress' swift action on the disaster funds, and we included in the spending plan for those disaster funds some research that we thought was very important. But at this point, if you don't mind, I would like to ask our chief fisheries scientists to weigh in on the question of research needs, additional help from the United States.

STATEMENT OF BILL TEMPLIN, M.S., CHIEF FISHERIES SCIENTIST, DIVISION OF COMMERCIAL FISHERIES, ALASKA DEPARTMENT OF FISH AND GAME

Mr. TEMPLIN. So Senator, thank you for the opportunity to address you today. For the record, my name is Bill Templin. I'm the Chief Fisheries Scientist for the commercial fisheries side of the department.

Alaska's Department of Fish and Game has a long history of collaboration with the National Marine Fisheries Service, especially through the Ted Stevens Marine Institute. We work together on many, many different—a wide range of different types of projects, including Chinook salmon research that began in the 1970s in Southeast Alaska through the Little Port Walter Research Station, which has been an excellent place to work and provide the infrastructure for the research that was needed for a young state to develop many of its program around Chinook salmon and other hatcheries.

In the marine waters of the state and near to the state, we collaborate on the surveys that have already been mentioned, the one in Southeast Alaska, the coastal monitoring survey. In fact, over recent years, the state has taken on more and more of the responsibilities of that and, in fact, for the next several years, we will, through the disaster funds, will be putting some of that money toward supporting that program.

And then further north in the north Bering Sea, there is a survey that began looking at the loss of sea ice, northern sea ice which was, during the process of working together with our Federal counterparts there, we realized that we could develop a really good forecasting tool for Chinook salmon to the Yukon River, which is important for the people of the state, as well as for meeting treaty needs, which is a Federal/state responsibility on that river.

Those programs all have gone together in a very highly cooperative way, which is really kind of interesting to me. I've seen a lot of other collaborations not go so well.

We are—the concern that we have, though, is that as funding—base funding for those types of activities has receded, we have had to work more and more annually trying to find some sort of funding to keep it going one more year, one more year, one more year, which takes, of course, a lot of time, both Federal and state scientists to write proposals to seek funding opportunities and a lot of uncertainty about whether or not we are going to be able to charter a boat or purchase new nets year to year.

So all the fundamentals are there in terms of collaboration, data sharing, a combined purpose of why we are out there. What really holds us back at this point in time is just being able to find some sort of stable funding to keep things going.

Senator SULLIVAN. Let me ask just kind of a topic that I've been trying to focus on a lot. And I know it might put Mr. Oliver a little bit on the spot, but one of the things that I have been concerned about and I've raised it with Secretary of Commerce Ross and Admiral Gallaudet.

You mentioned the Ted Stevens Research Center. And as you know, there is kind of a split where a lot of that research is done. Some of it is in Juneau and other places throughout the state. A lot of it is in Seattle. And I've had concerns that there has been a migration of NOAA jobs and scientists from our state to Seattle and other states in the Pacific Northwest, despite the fact that their job is to focus on our fisheries.

I have been pressing this fairly hard, and NOAA kind of tap dances a little bit, have you seen that, or is that a problem? Would it be better to have more scientists in the state as opposed to studying Alaska fisheries from Seattle? You can be very honest with me because I'd like you to answer yes.

Mr. TEMPLIN. Yes, sir.

Senator SULLIVAN. I know Mr. Oliver might have a harder time, but it's a really serious question.

Mr. TEMPLIN. It's always good to have more science and more information. When we are data limited, we have to be very conservative in the way that we manage our resources. So as far as your question goes, yes, it's very useful to have more—valuable, even, to have more scientists and more resources in Alaska. As to how——

Senator SULLIVAN. Have you seen in your experience a migration from, for example, Juneau down to Seattle on the scientists anecdotally?

Commissioner COTTEN. Mr. Chairman, can I jump into it?

Senator SULLIVAN. Yes, please.

Commissioner COTTEN. I don't know that I've seen a major migration there. I think we have a good science center in Alaska.

Senator SULLIVAN. We do.

Commissioner COTTEN. In fact, I remember speaking with Ted Stevens years ago about the whole premise that the Alaska Fisheries Science Center is not in Alaska, and I know that troubled him. And as a result of that concern, he——

Senator SULLIVAN. It troubled me, as well.

Commissioner COTTEN. I think we got some established science activity in Alaska.

Senator SULLIVAN. Yes.

Commissioner COTTEN. But it's still the Alaska Fisheries Science Center in Seattle.

Senator SULLIVAN. Yes.

Commissioner COTTEN. And that contributes to a lot of people's feeling that Alaska remains in colonial status in regard to fisheries.

Senator SULLIVAN. The Alaska Marine Debris Office Program of NOAA also resides outside of Alaska, because I've said to some of my Senate colleagues, you would never put the study for the center on the Grand Canyon in Illinois. You would put it in Arizona. So it's an issue. It's actually a serious issue that I think some of the Federal agencies need to take more seriously.

Commissioner COTTEN. Thank you for recognizing that.

Senator SULLIVAN. After that wind-up, Mr. Oliver, would you care to comment?

Mr. OLIVER. Thank you, Senator. I know this is an issue we have talked about before. And I know we did some research over the past several months on that. And we responded, you know, in terms of staffing. NOAA employs about 535 employees in the state of Alaska to carry out missions and work of all of NOAA's line and staff offices. And we did some number crunching and, notwithstanding the fundamental disconnect to the point that the Alaska Fisheries Science Center is in Seattle, that analysis shows that NOAA staff focused on Alaska issues have not relocated or moved outside of Alaska at an accelerated rate relative to the opposite of——

Senator SULLIVAN. But you do have a lot of openings in Alaska, is that correct?

Mr. OLIVER. We are working hard to fill more than 100 vacancies in the state of Alaska, many of those within fisheries. Currently we have about 230 employees that are located in Seattle that work primarily on Alaska issues, but we also have over 200 in Alaska that work on Alaska issues. And some of our key leadership positions are and will continue to be in Alaska.

Senator SULLIVAN. Well, we want to help you certainly fill the vacancies, right, because I think that's really critical, and that's where Admiral Gallaudet and I did come to some agreement that the vacancies are really important. I think the state would agree with that, wouldn't you, Commissioner, filling those NOAA vacancies that currently exist for positions in Alaska?

Commissioner COTTEN. I'm not sure.

Mr. OLIVER. We are working toward that, Senator.

Senator SULLIVAN. You know, we have been talking about data, but I also want to talk about broader management tools that are available both on the Federal and state side. We have been talking about data gaps, but are there tools that you think are also lacking that make your ability on either side, state or Federal, to more sustainably and actively manage our fisheries in a way that, you know, we all want in terms of, you know, abundance in terms of harvest, but also sustainability in terms of future generations?

Commissioner COTTEN. Mr. Chairman, again, I'll probably ask our expert panel here to help me on this, but generally we have

sound fundamental tools within the Department of Fish and Game right now. The Board of Fisheries examines each fishery in Alaska on a three-year cycle. So every three years if there is new information, that gets considered. Opportunities to change management structures are regularly available.

In addition, the board delegates and statutes allow the department to make in-season management decisions based on unexpected events or new information. So we begin with a pretty solid fundamental flexible and well-designed system that allows us to manage, especially under changing and unexpected circumstances.

I think we can step back to the whole question of collaboration with the U.S. and additional data management that will help us on that. And I'd ask if either Bill or any of the directors might want to contribute to the question of additional management tools that we should have.

STATEMENT OF JAMES HASBROUCK, PH.D., CHIEF FISHERIES SCIENTIST, DIVISION OF SPORT FISH, ALASKA DEPARTMENT OF FISH AND GAME

Dr. HASBROUCK. Yes. For the record, I'm Jim Hasbrouck. I'm the Chief Fisheries Scientist for the Division of Sport Fish. And like my counterparts here, I thank you, Senator Sullivan, for your invitation and spending this time with us today.

There is a lot of variation in salmon runs that we are seeing. We—as the Commissioner has mentioned, we do have the flexibility within the state to manage those fisheries, but there is a lot of uncertainty that's going on, and even more so with the variation in salmon runs that we are seeing.

And I think one thing that is very helpful in the collaboration that goes on between the State and the Federal Government is the kinds of data and research that we tend to collect in the state are looking at harvesting fish. So we primarily focus our research and stock assessment efforts on adults: What's being harvested, what's the escapement?

What the Federal Government can largely bring and has been bringing to the table, you have heard some of that already in that they have expertise and capacity for looking at juveniles and what's going on in the marine environment. And with those two things combined together, we can start to get a much better idea on factors that are affecting salmon production in the state of Alaska.

It is a very collaborative effort. It is a very positive effort between the Federal and the state government, not only with the Alaska Department of Fish and Game and NOAA, but also with the Council itself. And my understanding is that the North Pacific Fisheries Management Council is one of the top councils in the state. I think that's largely a function of the members of the Council itself, but it's also a function of Mr. Oliver's leadership while he was the Executive Director. And the people that are on the Council, people that are on the Board of Fish, people that are in the agencies are very much interested in salmon resources, fisheries resources in general, but today we are talking specifically about salmon resources, concerns for those resources, and wanting to put the best available science toward managing those fisheries.

Senator SULLIVAN. So tools, right now you think you have adequate management tools? Again, and this is state and Federal.

Dr. HASBROUCK. I think that the tools that we have are very good. I think that the more information we can bring to the table in managing fisheries for things like better understanding productivity, better understanding run timing of adults, are there factors in the ocean environment that may be impacting production and affecting things like run timing, which with those kinds of information, reduces the uncertainty which then improves management.

Mr. OLIVER. Just a comment. Senator Sullivan, from the Federal side I can't really comment on the tools relative to the direct management of salmon fisheries as they have since about 1959 been outstandingly managed by the state, and we don't have a real Federal role, except in that areas, for example, that deal with the bycatch of salmon in the groundfish fisheries. We do manage the groundfish fisheries. And I mentioned earlier programs that we have put in place since, I believe, 2010.

We have a system of management in our—for example, our Bering Sea pollock fisheries that provides that fleet a tremendous amount of flexibility in how they operate, when they fish, where, ability to avoid salmon hotspots, but also that system allows us to put a tremendous amount of onus on the industry to do just that, to avoid that. We put caps on them. We put a staggered cap that provides a performance standard that incentivizes their ability to avoid salmon. And those kind of management tools are very important for managing that side of the equation.

Senator SULLIVAN. Let me ask Mr. Oliver kind of a question that integrates the data challenges and the management challenges. Particularly given your background where you are now and what job you had previously, can you walk us through an example of how data or research collected at the Federal level so, say, one of the Alaska fisheries science centers, the Seattle or Juneau base, the Pacific Marine Environmental Lab, or even something from outside the government, say, from a university is synthesized and applied through the Council process to affect the fisheries management decision? How does that work so people understand that, and maybe on the state side, as well?

And that's the kind of key. You take the data, you analyze the data, you get the data. Hopefully, there are no gaps in the data. Then you use that to actually use the tools available that you have to make decisions that impact all of us. So how does that work? Can you walk us through an example of that?

Mr. OLIVER. I may not be able to walk you through a specific example, Senator. Actually, one of the people at this table to my left with Fish and Game may be in actually a better position because they are the ones that are actually using whatever information it is that we glean that then crosswalks into the management system at the state level.

I can tell you—this gets a little bit to one of your data gap questions. A lot of the information that's relevant to management comes through our comprehensive groundfish observer program. We collect a lot of genetic information now throughout the year on a wide range of fisheries that tell us where the salmon that are being caught come from in terms of their rivers of origin. And that pro-

vides information that not only informs the Council on its bycatch management decisions, but I believe it also is greatly informative to the scientists and the managers at the Alaska Department of Fish and Game level in terms of how that information feeds into their NCs and their in-river management decisions.

And again, I don't have my team of experts that could probably answer that question better for you, but I suspect some of the folks to my left might be able to give you a better idea of specific information that is collected at the Federal level and how that's used in state management.

I'm using the microphone by habit. I don't know if it's actually working.

Senator SULLIVAN. I don't think they are working.

Commissioner COTTEN. I think Mr. Oliver hit on one of the key elements of data that's collected through the United States that the state really depends on, and that's the genetic samples taken from the Chinook salmon, typically in the pollock fisheries, but other groundfish fisheries. For example, in the Bering Sea, the vast majority of the Chinook salmon taken as bycatch are Alaska-bound fish. Western Alaska rivers are the home of most of those fish, at least the majority. As a result, we pay very close attention to those numbers. We are strong advocates for reduced—in fact, just this year we have reduced the bycatch levels that are allowed in the Bering Sea based on low abundance.

Contrast that with the Gulf of Alaska where we see the genetic work that displays the fact that probably 80 percent plus of the Chinook salmon that are taken as bycatch in the Gulf of Alaska are not Alaska origin. They are important to somebody, but they aren't necessarily affecting productivity in Alaska.

Senator SULLIVAN. Do you know that when you see the genetic makeup of the salmon?

Commissioner COTTEN. Yes. We are able to identify Pacific Northwest. There are some from Southeast Alaska hatcheries, a small percentage from Alaska streams and the Gulf of Alaska, but the bulk of it, the Pacific Northwest, British Columbia and Southeast Alaska hatcheries.

Senator SULLIVAN. Any thoughts from the scientists on that question? Commissioner, not that you are a scientist or anything.

Commissioner COTTEN. You got it right, though.

Mr. TEMPLIN. So Senator Sullivan, this is Bill Templin again. You had asked for a specific example of how information that's collected can be used to—can flow through the pipeline and make it to actually making management good decisions. I'd invite people to consider what we did this last summer in Southeast Alaska with unprecedented restrictions on Chinook salmon fishing in Southeast Alaska because we knew that the runs to Southeast Alaska streams would be lower than—in some cases historically low, lower than—especially lower than our escapement goals, especially if we allowed fishing as usual.

And that information actually came from a variety of sources, but one of the sources was the Southeast Alaska Coastal Monitoring Program where we noted a couple years ago that there was a curious lack of Chinook salmon juveniles in the harvest in our sampling. And that gave us a signal that we could then use to both

manage Alaska's fisheries, but also collaborate with our Canadian counterparts in order to meet treaty needs along the northern border of Canada with Alaska.

So that was an excellent example of how information flowed from a lot of different places, including a very valuable survey in Southeast Alaska to a couple years later, actually, making management decisions.

Senator SULLIVAN. So you mentioned on the state side the genetic material data from the feds is one of the key data points. Does the state see that you are getting enough of that, an adequate amount and timely?

Mr. TEMPLIN. Senator Sullivan, again, before I had this job, I was our department's principle geneticist, and actually worked as we began to develop many of these programs, including the one that's currently used for looking at bycatch in the Gulf of Alaska and Bering Sea. That was—that capability was developed through a lot of collaborations across the state of Alaska. A lot of different funding sources came together to produce the genetic baseline that could then be used to look at the genetic stock composition of the bycatch. And it's, again, a good example of collaboration.

Senator SULLIVAN. But do you think you are getting a full amount? Do you need more of that? If it's key, which you have all said it is, does the Federal Government's cooperation and availability of that information come to the state in quantities and quality that you think is adequate, or could it be improved?

Mr. TEMPLIN. So there could be more—more funding to develop the underlying information that's necessary for managing the five main North American species of Pacific salmon.

Alaska sits square in the middle of—it's in the heart of the salmon world. You know, we have got salmon to the west of us and salmon to the east of us, but we are smack dab in the middle right at the top of the north Pacific and occupying the east coast of the Bering Sea where most salmon go to grow. We are encountering fish from everywhere from Korea to—to potentially sometimes California.

There are five species. We have—we have—in order to answer questions like what's in the bycatch or what's in our coastal fisheries, we have had to put together information through the North Pacific Anadromous Fish Commission collaborating with other countries. We have been able to do that for chum salmon, for Chinook salmon, and mostly for sockeye salmon. What's missing is coho salmon and pink salmon, which are becoming a fairly important species also economically.

So yes, there could be more resources put together to fund that underlying information from which applications could then be built.

Senator SULLIVAN. OK. Let me ask kind of the question that I think most people are interested in and why I would imagine a lot of people are attending this hearing and, to be frank, one of the reasons that I wanted to hold this here in Alaska and have heard from so many of our fellow Alaskans on this topic. But, you know, it's kind of a broad-based question, but I appreciate you guys looking to dive into it.

I mentioned in my opening statement some of the historical kind of ups and downs in terms of returns on the salmon really since

statehood, but even if you look way back even 100 years, you talk to the people, the Alaska Native people who we are celebrating and honoring and really thankful that we're here at AFN. But you talk to some of them, and there are stories, even lore of 100 years, 150 years ago massive crashes on some of the major rivers that caused starvation.

So right now we have had these ups and downs historically. We are seeing really historically strong sockeye runs in parts of the state, you know, Bristol Bay being a really important area. And then we are seeing weak Chinook runs pretty much everywhere, although my understanding is there are a few rivers that have had strong runs. Why do you think that's happening? And I'll just open that up. I know it's a hard question. Pretty simple question, but really hard. But I think it's the question that's on literally thousands of Alaskans' minds.

And I think you guys are the best scientists and observers of this. You know, is there something we can do to start to address that, try to address that?

Yes, sir.

Commissioner COTTEN. Thank you, Mr. Chairman. I'll start, but I will quickly defer to the science crew here. But I think most people are aware that the two systems, the Gulf of Alaska and the Bering Sea, have performed quite differently in the past few years, as we have already discussed. Bristol Bay and Norton Sound this year was a tremendous run that hadn't been seen at those levels before. So it—and then the Gulf of Alaska quite the opposite, poor runs.

And so we feel that the freshwater environment and Alaska's habitat, salmon rearing areas are in good shape, so we don't believe it's—that's the root of the problem. When you ask scientists to explain why that happens, it usually ends up with a phrase "ocean conditions."

So that's where I'm going to start to defer here, but we have certainly seen that with, as everybody is aware, some of the climatic changes, warm water, which produces a lot of other problems for not only the salmon, but the food that they need. So ocean conditions is the phrase that's often used. And so I would again ask for some supplemental contributions.

Senator SULLIVAN. Putting it in historical perspective, was it ocean conditions in the 1960s and 1970s where the runs were weak? Was it ocean conditions in 1959, as we talked about, where the, you know, total runs for all salmon in Alaska was very paltry? I mean, is that something that kind of just, like, ebbs and flows? Is it ocean conditions that caused the Yukon to crash 150 years ago? I'm not 100 percent accurate, but there has been horrible runs in the history, if you research it, in our state where they have not always been strong. I know I'm asking a really hard question.

Commissioner COTTEN. I'll take one more stab at it. I think Chris wants to jump in, too. But it's clear that back in the 1960s when the United States was managing it, there were a lot of complaints about how it was managed, how careful, how precautionary the approach was. So that's changed.

That doesn't mean to suggest that there couldn't have been ocean conditions as a contributor back then, as well. But I know that the

Japanese and other fleets got very good at figuring out where our salmon were once they got out beyond 12 miles. So that was a contributor that's no longer there, but that doesn't, again, preclude the potential that ocean conditions played a role there. So if you get back 150 years when there wasn't escapement goal management, that's possibly—I mean, the reason you manage that way is to try to assure the greatest level of productivity. So that's changed, as well.

But I would at this point ask the science crew to weigh in on other elements of ocean conditions.

Mr. OLIVER. I hesitate to make this general comment, but I will, recognizing that this is just sort of a personal observation, not any position of the U.S. Government. But when you look at all the science advances we have had over 100 years in our science, in our technologies and the amount of information that we have on ocean conditions, salmon biology and other things, notwithstanding all of that information, you know, there are some things, particularly if you go back far enough in time, I firmly believe there are some aspects of Mother Nature that we will never fully understand.

And having said that, I'm hopeful that the scientists to my left can give a better answer than that.

Senator SULLIVAN. Mr. Oliver teed you up really nicely.

Dr. HASBROUCK. Well, this is Jim Hasbrouck again. I don't know that we have any definitive answers. I guess natural variation is something that we deal with with salmon. That's—that's just life. And sometimes there are catastrophic failures in salmon runs. I don't know that what we saw in the 1950s that caused the creation of Alaska as a state or in the 1960s and mid 1970s where ocean conditions could have played a part.

I think that there is—the underlying idea is that there was probably too much harvest that was going on. That doesn't seem to be the case now, but what's going on in the ocean that is causing these changes we don't really know for sure. We have a world class Chinook salmon assessment program in Southeast Alaska that fairly clearly shows that what went on at least with those four indicator stocks in Southeast Alaska was marine environment. We didn't see a change in freshwater production for those four Chinook salmon stocks, but we saw a dramatic decline in marine survival. We've also seen some——

Senator SULLIVAN. Can you unpack that? What does that mean, "dramatic decline in marine survival"? Is that predation? What is that?

Dr. HASBROUCK. That's ocean conditions that we don't fully understand what is really going on. When these juveniles go out to the ocean, are they not finding enough food? Is there predation that's going on that hasn't happened in the past, at least to the degree—we have heard in meetings about increased abundance of killer whales and other marine mammals that feed and prefer to feed on salmon, especially Chinook salmon.

So there are a variety of things that are going on out there, and trying to tease them apart—and it's probably some kind of combination of factors. So to try to say, oh, it must be the blob, oh, it must be this, it must be that, that's extremely difficult to do because all of these things are interacting with each other. And try-

ing to separate out those cause and effect is an extremely difficult thing to do.

Senator SULLIVAN. So what about the flip side? Why do we think the sockeye salmon runs in certain parts of the state have been so historically strong?

Mr. TEMPLIN. What we can, Senator—again, this is Bill Templin, for the record. We can start by looking at what it probably isn't. Right? So it's probably not habitat. Alaska's habitat is largely intact. It's probably not fishing pressure because we fish in a very conservative manner with the intent to have sustained yield.

It probably is—it could be associated with their freshwater life history, especially for those with longer period of time in freshwater, but those don't seem to be driving it as much as the common factor of ocean conditions. Why does the Gulf—why did the Gulf have some poor, really poor runs this year while the Bristol Bay had really good runs?

We would point to ocean conditions, but also which ocean that they were in. They were—the ones in the bay and the ones in Norton Sound and on the Yukon were probably in the Bering Sea, whereas the fish in the Gulf probably spent most of their time in the Gulf of Alaska. So one was a good place to be a young fish, and one was a bad place to be a young fish.

That's the—again trying to tease out why within that very complex system is very difficult.

Senator SULLIVAN. I know we are going to get to the next panel, and you guys have been very patient, and I really appreciate everybody coming on a Saturday. And I think most people can see this is a very, very, very smart group of state and Federal officials who care a lot about this topic.

So strong runs somewhere, but weak king runs pretty much all over the state, which concerns everybody. And then all these theories on ocean conditions: Bycatch, the blob, ocean acidification, offshore production. It wasn't kings, but I think the Coast Guard caught the Chinese vessel here recently with 80 million tons of illegally harvested salmon. But I mean, that's not good for any fishery. Predation.

Are there theories from the scientists that you think are more likely than others? And I think the key question for me is we don't really know and everybody is trying to figure it out. What more can we be doing, and this really goes to Mr. Oliver because it's in the Federal waters, what more can we be doing to actually figure this out, recognizing, as you said, Mr. Oliver, that, you know, Mother Nature and the oceans are complex systems?

But for the scientists, do you have a theory that you and your decades of experience believe is more probable than other theories, or do you really think it's kind of a combo, or we just don't know? And then if we don't know, what can we do to know more?

Mr. OLIVER. If I might just give a general answer. I mentioned earlier in my testimony that during the offshore surveys that we do, they collect a variety of ecosystem information, not just sea surface temperature, but temperature throughout the water column, phytoplankton production, zooplankton production, forage fish and basically juvenile fish conditions. Some of these species feed pri-

marily on zooplankton when they are at sea while others feed on forage fish.

And those presence or magnitude of those vary across—whether it's different in the Gulf or different in the Bering Sea. And that may explain—and now—so that's when I say different ocean conditions. And clearly ocean conditions are not ideal for some of these species that we are not seeing return in the numbers that they used to. And that doesn't—that may explain why you had a good Bristol Bay run for sockeye and a poor Western Alaska run for Chinook, but it doesn't necessarily explain the overall Chinook reduction everywhere.

I do know that we, working with Fish and Game through our Alaska Fisheries Science Center, are trying to model these ecosystem indicators specifically testing the inclusion of those indicators with different forecast models for two specific fisheries—Southeast Alaska pink and Yukon River Chinook—to determine if we can make correlations between those—at least those kind of ocean conditions and the magnitude of the runs over time.

So there are—these are relatively new modeling efforts. And so those are the kind of things that we need to do more of to see if we can get a better answer to what's up with Mother Nature.

Senator SULLIVAN. We will work with you if you need more resources or authorities to get to the bottom of the question. Can I ask just the state of Alaska officials on—again, I know it's not necessarily in your realm given that it's out in the ocean, but you are all scientists and have been looking at it. Is there a theory or, you know, one of these concerns that you think is more likely than not to be playing a role, particularly as it relates to the negative king returns?

Commissioner COTTEN. Let me just say that the—it's not salmon, but two years ago we discovered that there was an 80 percent decline in Pacific cod in the Gulf of Alaska, and we learned that as a result of survey work by the United States Government that we appreciate and cooperate with. And that was, I think, a consensus—maybe not a proven fact, but a consensus—that there was a warm water event that affected those codfish. Warm water has less oxygen. It creates a very difficult environment.

A lot of the red salmon that were leaving freshwater, the ones that were supposed to have returned in 2018, faced that warm water event, as well. So that may not be what the scientists would say is the conclusion, but it's a leading candidate for the reason why.

Senator SULLIVAN. OK. Good. Other views on that? I know it's a hard question, but I think it's why a lot of people are here.

Mr. TEMPLIN. Again, Senator Sullivan, this is Bill Templin again. We have—again, in collaboration with our Federal counterparts, have been able to conduct some research which is zeroing in, not necessarily why particularly, but when some of the mortality happens, some of the factors which lead to either a strong or a weak run. And for most species, it appears to be in their early life history in the ocean.

Senator SULLIVAN. Is that new?

Mr. TEMPLIN. That's not necessarily new. The idea has been around for a while, but we're now gaining the information that al-

lows us to say more definitively that, yes, it is in the early life. In their early experience in the ocean, that's when they—it's kind of a make or break for that—for that run for that brood year of fish when they arrive in the ocean.

So we are gaining the information that's allowing us to focus in on certain periods of time in the life history of a salmon. Tying that, then, mortality event to a specific factor is much, much more difficult, but I believe that we are—if we can continue to do the research both in the Gulf and in the Bering Sea, that we will be able to kind of figure out what factors are affecting it.

There is a very strong relationship between this warm water event and negative effects on runs. So it's potentially the—could be the explanation for the 2016 collapse of pink salmon. Those pink salmon would have been juveniles entering the Gulf at the same time.

I also want to point out that there is a whole 'nother ocean that's opening up right now that we really don't have a lot of experience on, but the salmon are beginning to occupy that environment. And for us to be precautionary, thinking ahead and properly thinking about sustainability, we should be looking at gaining more information about the Arctic Ocean, as well.

Dr. HASBROUCK. Jim Hasbrouck. Kind of a final thought on this question, at least for me, is that we collect the data and do some modeling, as Mr. Oliver talked about, especially looking at more of an ecosystem approach so we can collect the data and we can develop models. He's right. You can look at correlation, but correlation doesn't explain cause and effect.

So one of the beauties is that by collecting this data and developing models, we get more informed. That allows us to develop some hypotheses. We can then go out and test those hypotheses. I know this sounds pretty geeky, but I'm a scientist, so bear with me. It's that collecting of that data to do some modeling to develop some kind of hypotheses that you can then go out and test which helps us improve our ability to look at cause and effect.

Senator SULLIVAN. Well, listen. I want to thank the witnesses. I do think that this panel demonstrates that we don't have all the answers, but I do think it's reassuring to see we have some of the smartest people in the state and in the country working on this. We are all concerned about it, and we need to know what more we can do at the Federal level, in particular, to help you, but I really appreciate, Commissioner, you and your team and Mr. Oliver traveling several thousand miles to come up for this hearing. It means a lot.

So we are going to switch out to our next panel and fix our audio system, but I think everybody should give a round of applause.

[Applause.]

[A break was taken.]

Senator SULLIVAN. OK. We are going to get started with our second panel. And one thing I do want to mention, should have mentioned at the top, so if we have lost some participants in the audience, what we are going to do in my office, we will set up a website that will be up and running by Monday. The way these Senate hearings work is that the record stays open for two weeks that you can provide additional questions to the record for the witnesses, in-

cluding the last witnesses. I forgot to mention to them, but their work might not be over.

And so what we would like to be able to do, we will put on my web page, my Senate web page, website, we will put a page there that if any of you have questions that you wanted to be asked, submit them to us on the web page, and then we will submit them for the record for the hearing. So that way people who came and, you know, might be a little disappointed that they couldn't ask questions from the audience, the way these Senate hearings work is you do it through the Committee members. So we will make that happen.

So I know a couple of individuals came up, actually had some really good questions that I might even ask this panel. Really good ones. But if you want, we will be able to get more questions to these panelists and the previous panel that we had before.

So we will begin the second panel. And the whole goal here was not only to get the government officials, but some of our top scientists and others who have been focused on these issues for, again, years and years and years.

So I'd like to welcome our second panel of witnesses. Milo Adkison, who is a Ph.D. and Professor and Chair of the Department of Fisheries, the College of Fisheries and Ocean Sciences at the University of Fairbanks; Matt Baker, who is also a Ph.D. and Science Director of the North Pacific Research Board; Karen Gillis, who is the Executive Director of the Bering Sea Fishermen's Association; Katrina Hoffman, who is the President and CEO of the Prince William Sound Science Officer; and Mary Sattler Peltola, the Executive Director of the Kuskokwim River Inter-Tribal Fish Commission.

Each of you have will have 5 minutes to deliver an open oral statement, and a longer written statement will be included in the record for each of you. And if you saw the first panel, I'm likely to ask you very similar questions. So why don't we begin with Mr. Adkison.

STATEMENT OF DR. MILO ADKISON, PH.D., PROFESSOR AND CHAIR DEPARTMENT OF FISHERIES, COLLEGE OF FISHERIES AND OCEAN SCIENCES, UNIVERSITY OF ALASKA FAIRBANKS

Dr. ADKISON. All right. My name is Milo Adkison. Good morning, Senator Sullivan. Thanks for the opportunity to testify on behalf of my colleagues at the University. As you noted, I'm Professor and Chair of the Department of Fisheries at UAF. And I would also note, since we are at AFN, I'm a member of the Curyung Tribe of Dillingham.

I want to start off by talking about the state of salmon. Actually, I think you have covered a lot of it in the beginning. Large fluctuations in salmon abundance are normal. They have been going on for thousands of years. We are currently on a 40-year run of really strong returns to Alaska, but there are some exceptions. In Western Alaska we have had a couple of decades of poor runs. The statewide decline of Chinook is more recent, and then the blob seems to have been responsible for some even more recent problems.

The University is always very involved in looking at the causes of these salmon declines. I just saw a paper by some university colleagues and some other researchers that concluded that the blob probably wouldn't have happened if there hadn't been some contribution from human-caused global warming.

With Chinook salmon—the earlier panel talked about this a bit—we have identified growth in freshwater and the first year at sea is critical periods for determining survival. Second-year growth in the ocean seems to be influential in whether Chinook salmon come back early, and if they come back early, they're going to be small. And one of our researchers found evidence of significant oceanic predation by salmon sharks.

We are looking at the vulnerability of different salmon populations to the spread of invasive species like Elodea and pike in Southcentral Alaska. Hatchery interactions with wild stocks are a big concern. I was just at a meeting Tuesday. Board of Fish was dealing with it. Our faculty have been pretty involved with looking at the potential loss of fitness when you have got different disparate stocks interbreeding and the amount of implications of hatchery straying. I think further research on hatchery straying is something that would be very valuable.

I'm going to assert that habitat is the key to maintaining salmon stocks in Alaska. In the other parts of the world, salmon populations have been lost or drastically reduced. It's mainly been because of degradation of habitat. This is big things like dams, but it's also the nickel and dime stuff, like water diversions and urbanization and things like that. And I think our salmon stocks will be resilient, too, if Fish and Game messes up and overfishes for we have these environmental phenomenon like the blob. If our habitat is intact, our salmon will bounce back.

So I think further research is needed to identify critical habitats and to prioritize conservation and restoration efforts.

I'll also point out that warming and ocean acidification also cause habitat degradation and disrupt prey resources for our salmon. So additional studies on these phenomenon would be really useful. And arresting warming and acidification is a high priority for maintaining viable salmon populations in Alaska.

Finally, the other thing I want to talk about is our communities. Rural residents and our indigenous people are losing access to our salmon resources. Fishing permits are migrating away from our rural communities. And the remaining permit holders are getting older because younger people are having trouble getting access to capital that they need to get permits and fishing gear and boats.

And so studies of financial mechanisms to support new entrants or changes to management that make it less expensive to enter into fisheries would be very useful.

The University supports salmon and salmon-dependent communities in a whole bunch of ways. We have got undergraduate and technical programs. We train the managers and scientists. Your first panel had several of our alumni, I noticed. And it's not just our fisheries department. It's everybody from the oceanographers to the social scientists. I'd like to highlight our Marine Advisory Program agents. They are out in the communities. They provide technical expertise directly to the processors and the fishermen. And

then we partner with organizations throughout the state, including, I think, every organization that's been on these two panels.

I'll just conclude by saying that large fluctuations in salmon abundance are natural. They do cause a lot of pain. These disaster mitigation funds are very helpful and necessary, but I'm less worried about that these ups and downs than I am long-term trends.

What's going to kill our salmon stocks are erosion of habitat. What's going to kill our communities is erosion of access to our salmon resources. So I would like to see some resources put into addressing these longer-term issues.

And I think I'll conclude there. And thank you for the opportunity to testify.

[The prepared statement of Dr. Adkison follows:]

PREPARED STATEMENT OF DR. MILO ADKISON, PROFESSOR AND CHAIR, DEPARTMENT OF FISHERIES, COLLEGE OF FISHERIES AND OCEAN SCIENCES, UNIVERSITY OF ALASKA FAIRBANKS

Introduction

Good morning Mr. Chairman and distinguished members of the Committee. I am honored to testify today. My name is Milo Adkison. I am Professor and Chair of the Department of Fisheries in the College of Fisheries and Ocean Sciences at the University of Alaska Fairbanks. As we are at the AFN convention, I will also note that I am a member of the Curyung Tribe of Dillingham.

The state of salmon and some relevant research

Lake sediment cores show us that large fluctuations in salmon abundance have occurred for thousands of years. Alaska is currently on a 40-year run of very strong salmon production, with some exceptions. These include poor production of several salmon species in Western Alaska for the last two decades, a recent state-wide decline in Chinook stocks, and some recent poor production possibly associated with an oceanic phenomenon known as "the Blob" which disrupted food webs in the North Pacific. A team of scientists from the University of Alaska and other institutions has recently shown that the "Blob" cannot be explained without human-caused global warming.

The University is heavily involved in studying the causes of salmon fluctuations and poor production in some areas. On Chinook declines, we have identified growth in freshwater and the first year at sea as critical periods for determining survival, found that second-year ocean growth affects whether they choose to spawn early and thus at a smaller size, and discovered evidence of significant oceanic predation by salmon sharks. Invasive species such as Elodea and pike in southcentral Alaska are also affecting salmon, and we're assessing the vulnerability of different populations to their spread. Hatchery interactions with wild stocks are a current concern; our faculty have been leaders in addressing the potential loss of fitness when disparate stocks interbreed, in showing that hatchery strays can sometimes be a large component of the wild population, but that they may not always be effective in spawning. *Further research on hatchery straying would be useful in advancing the state of knowledge.*

Habitat is the key to maintaining Alaska's salmon

In the Pacific Northwest, and prior to that on the East Coast and in Europe, salmon populations have been lost or drastically reduced. The main driver of decline and the lack of recovery has been man-made habitat degradation. These alterations include big changes like dams, but also cumulative small impacts like road runoff, water diversion, stream channelization, urbanization, etc.

Alaska's salmon will be resistant to accidental overfishing and unusual environmental phenomena like "the Blob" if we maintain our watersheds. *Further research is needed to identify critical habitat and prioritize conservation and restoration efforts.*

Warming and ocean acidification also contribute to habitat degradation. Warming degrades habitat and facilitates the spread of noxious invasive species. Acidification affects the vitality of important salmon prey resources, and can disrupt the marine ecosystem. *Additional studies are needed to improve understanding and to mitigate these impacts.* Arresting the warming and acidification is a high priority for maintaining healthy salmon stocks.

Access to the fisheries is the key to maintaining salmon-dependent communities

Rural residents and indigenous people are losing access to our salmon resources. Fishing permits are migrating away from rural communities. The remaining permit holders are getting older, as the younger generation finds it increasingly difficult to gain entry to fisheries. Research has shown that rural residents have less access to the capital necessary to buy the permits, vessels, and gear they need to go fishing. *Studies of financial mechanisms to support new entrants or of changes in management that would reduce the amount of capital necessary for entry are warranted.* A high school student in rural Alaska should have a realistic path to entering the fisheries that supported their parents and grandparents.

Rural residents also have more difficulty participating in the fisheries management processes such as the Board of Fish or the North Pacific Fishery Management Council. Our studies show this is due both to the logistics and expense of participation, and to bureaucratic barriers to meaningful participation. The university and other groups have undertaken efforts to reduce these barriers.

The University of Alaska supports salmon and salmon-dependent communities

At the University, we have robust undergraduate and technical programs in Fisheries. Our graduate program produces our managers and scientists; I recently counted over 100 graduates that have gone to the Alaska Department of Fish and Game and over 80 to Federal agencies. These students undertake much of our research as an integral part of their education.

Our salmon and salmon community research involves much more than our fisheries program. Our oceanographers and marine biologists are studying changes in the salmon's ecosystems as the ocean warms and acidifies, and our economists and social scientists are studying markets and community well-being.

Our Marine Advisory Program agents in the College of Fisheries and Ocean Sciences who live in the fishing communities provide training and technical expertise for processors, fishermen, and young aspiring fishermen. The annual Young Fishermen's Summit is one good example. The University of Alaska is a resource to and collaborator with salmon stakeholders throughout the state, which I think includes all of the organizations on today's panels.

Summary statement

Large fluctuations in salmon abundance are natural, inevitable, and painful to salmon-dependent communities. We can help the stakeholders when this happens, and maybe change our management so that they are more resilient. Hopefully we'll get better at predicting these ups and downs.

But, it's not the ups and downs that I worry about—it's the long-term trends. The slow erosion of habitat is what has caused salmon loss in other parts of the world. Other worrisome trends are the spread of invasive species, global warming, and ocean acidification. There are troubling social trends as well. The erosion of our fishing communities' access to the salmon resources has profound effects on the viability of these communities.

I would like to see resources dedicated to tackling long-term concerns, to maintaining the viability and resiliency of our salmon and salmon-dependent communities. The University of Alaska already serves as the institution that brings together different stakeholder groups around science-based approaches for the best stewardship of Alaska salmon. We look forward to continuing in this role to ensure that salmon remain a central part of Alaskan life for generations to come.

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Senator SULLIVAN. Great. Thank you, Dr. Adkison. Dr. Baker.

STATEMENT OF DR. MATTHEW BAKER, PH.D., SCIENCE DIRECTOR, NORTH PACIFIC RESEARCH BOARD

Dr. BAKER. Thank you, Senator, for the opportunity to testify today. So my name is Matthew Baker. I'm the Science Director of the North Pacific Research Board, a Congressionally created marine science funding organization that's based here in Anchorage, Alaska.

My training is in quantitative fisheries science in part under Milo and looking at optimal management of salmon resources in Alaska, and I also have experience working in the red and king salmon fisheries in Bristol Bay.

My primary role at NPRB is to direct the development of our scientific program to inform March ecosystem understanding and sustainable fisheries management, and to reflect the interest and the priorities of the institutions that are represented on our Board, as well as stakeholders more broadly in Alaska. And I'm joined today by Betsy Baker, who is our Executive Director, as well as Danielle Dickson, who is our Senior Program Manager.

So just for some context, the North Pacific Research Board was created in 1997 through Congress to recommend marine research in Alaska to the U.S. Secretary of Congress. Those projects that are approved by the Secretary then go through a competitive process, in part funded by interest earned on the Environmental Improvement and Restoration Fund. Those funds are then used to conduct research activities on fisheries and marine ecosystems more broadly in the North Pacific Ocean.

So NPRB prioritizes collaborative research that enhances both effective fishery management and broader marine understanding. Our Board is comprised of 20 different members representing Federal, state, Native Alaska, commercial fishing, oil and gas, academic and conservation interests. We also have a science panel, an advisory panel and staff.

So we have three main research programs. One, our core program is oriented toward discipline-specific information; a second is integrated ecosystem research programs, which looks at more broad-scale integrated understanding of mechanisms within the marine environment; and then we also have a long-term monitoring program that looks at changes in environmental conditions and variability. All three of those programs have had some focus on informing management of Alaska's salmon fisheries. And we

also developed a large data repository as a function of the research done in that area.

Since 2002 NPRB has provided $114 million in research. Salmon-specific studies have included—have been funded in 20 of 22 years. And actually, the proposal or the request for proposals that we put out just this year is looking at research on anomalous changes in the abundance of sockeye salmon across a broad geographic range. In addition to the research that's salmon specific, we fund a variety of oceanographic and other studies that have some direct relevance to understanding salmon, particularly critical habitat, as Milo had mentioned, oceanographic conditions, marine competition and carrying capacity, environmental metrics that might be informative to forecasting recruitment, run size, run timing, run strength, stock assessment tools and models, data support, and social and economic considerations that are relevant to fisheries management.

So since 2002, 51, or about 11 percent, of our awards have included salmon and their project descriptions, and 32 of those have been primarily salmon focused.

We are a marine oriented organization, so I thought I would just sort of hit on the areas within the marine environment that are potentially relevant as research needs or data gaps. Those might include: Marine carrying capacity, thresholds and density-dependent constraints; modeling life history and stage-specific mortality; genetic sampling and categorization of various stocks and substocks; species interactions, both between salmon species and other species, and spatial and diet overlap; improved methods for run timing and stock size forecasts; regional oceanographic models on understanding the physical influences on stock distribution and growth and survival; oceanographic processes, particularly related to the first year of ocean survival, as others have hit on already; and then forage species and their relative availability to salmon.

So I think as an institution we are well positioned to coordinate between a variety of different institutions. As an example, Danielle Dickson is working with state and Federal scientists to pull together some ecological forecasting to better understand how to predict salmon run timing.

We are also working with the National Center for Analysis and Synthesis on a few different initiatives: Coupling Climate and Salmon, and the State of Alaska Salmon and People projects, which are occurring—which occurred in the summer and in the fall, and then we've also put monies toward a 2019 workshop on salmon status and trends.

So I think we work quite closely with all the institutions represented here and on the previous panel, and I think we do better work as we work together on that. And I think that's a role that we can help to facilitate. So we look forward to hearing more about how we might contribute to those efforts. And thanks for the opportunity to testify today.

[The prepared statement of Dr. Baker follows:]

PREPARED STATEMENT OF DR. MATTHEW BAKER, PH.D., SCIENCE DIRECTOR, NORTH PACIFIC RESEARCH BOARD

Mr. Chairman, and Members of the Subcommittee joining the hearing remotely, thank you for the opportunity to testify before you today.

My name is Matthew Baker. I am the Science Director of the North Pacific Research Board (NPRB), a Congressionally created marine science funding organization based in Anchorage, Alaska. My formal education is in marine ecology, statistics, and quantitative fisheries science through training at Columbia University and the University of Washington, where I contributed to the research developed in the Fisheries Research Institute and Alaska Salmon Program, programs active in Alaska since the 1940s. My graduate research focused on stock assessment and optimal management of salmon resources in Alaska. I also have experience working as crew in the Red and King salmon fisheries in Bristol Bay. Subsequent and current areas of research include groundfish distribution, survey design, multiplies fishery management, forage fish demographics and forage fish-salmon interactions. My primary role at NPRB is to direct the development of our scientific program to inform marine ecosystem understanding and sustainable fishery management and to reflect the interests and priorities of the institutions represented on our Board and to serve the needs of stakeholders in Alaska.

I am joined today by Dr. Betsy Baker, NPRB Executive Director and Danielle Dickson, NPRB Senior Program Manager and Chief Officer for Collaboration and Synthesis.

I. NPRB: Funding Alaska Fishery and Ecosystem Science since 2002

In 1997 Congress established the North Pacific Research Board (NPRB) to recommend marine research to the U.S. Secretary of Commerce (Secretary) relating to the waters off of Alaska.[1] Research projects approved by the Secretary are funded through a competitive grant program using a portion of the interest earned on the Environmental Improvement and Restoration Fund (HEIR), which Congress created in the same enabling legislation. These funds must be used to conduct research activities on, or relating to, fisheries and marine ecosystems in the North Pacific Ocean, Gulf of Alaska, Bering Sea, Aleutian Islands, and Arctic. NPRB prioritizes collaborative research that improves understanding of marine ecosystems and enhances effective fishery management and sustainable use of marine resources. The enabling legislation directs the Board to address pressing fishery management and marine ecosystem information needs. The Board is composed of twenty members, representing federal, state, Alaska Native, commercial fishing, oil and gas, academic, and conservation interests (Appendix A). The Board is supported by a Science Panel, an Advisory Panel, and NPRB staff.

Figure 1: NPRB supports research in the marine systems of the North Pacific, including the Gulf of Alaska (Strait of Juan de Fuca to Unimak Pass), Bering Sea (Alaska Peninsula to the Kamchatka Peninsula and north to the Bering Strait), Aleutian Islands (Unimak Pass to the Commander Islands), Chukchi Sea (Point Barrow to Cape Billings), Beaufort Sea (Point Barrow to Victoria Island), and processes in the North Pacific and Arctic Ocean basins relevant to these regions.

NPRB supports three marine science research programs, as well as graduate student research awards:

[1] Department of the Interior and Related Agencies Appropriations Act, 1998, PL 105–83, Title IV, Sec. 401, codified at 43 USC 1474d.

- IERP—Integrated ecosystem research programs in which dozens of scientists integrate their disciplinary expertise over five to seven years and multiple research cruises in specific geographic regions (to date the Gulf of Alaska, Bering Sea, and Arctic Ocean);
- CORE—Discipline-specific research by individual or small groups of scientists. The Core program was formerly known as the Annual program; and
- LTM—Long-term monitoring of oceanographic conditions in three locations, two in the Gulf of Alaska and one on the Northeast Chukchi shelf off the state's northwest coast.

Integrated Ecosystem Research Programs provide information about mechanistic processes that structure marine ecosystems and drive change. The Core Program provides funds for research projects focused by discipline, including socioeconomic studies as well as natural science research. NPRB's Long-Term Monitoring Program is designed to provide stable funding in five-year increments, potentially over decades, for collecting data that provide useful indices of ecosystem conditions and variability. All three research programs, detailed below, have yielded results relevant to informing the management of Alaska's salmon fisheries.

In addition to research results, NPRB funding has also created a substantial data repository for data generated by NPRB research. It is intended as a public repository for completed projects that includes data and metadata published through the NPRB Research Workspace, accessible through a public data portal *http://projects.nprb.org/* and via our data partner Axiom Data Systems and DataOne, an international data platform.

Since NPRB began funding research in 2002 it has provided over $114 million in research sub-awards to 492 projects, based at 162 academic, community, and other research institutions:

II. Salmon relevant research funded by the North Pacific Research Board 2002–2018

Salmon-specific studies have been funded in 20 of the 22 years that NPRB has awarded Annual (now Core) Program research funds. The call for proposals published in October 2018 for projects that will be reviewed in 2019 requests research proposals to address "anomalous changes in abundance of sockeye salmon within a system or across a broad geographic range." In addition to research specifically targeting salmon, much of the research NPRB funds is relevant to understanding

issues related to critical habitat, oceanographic conditions, species interactions relevant to marine competition and carrying capacity, environmental metrics informative to forecasting recruitment, run strength and timing, tools and approaches to improve stock assessment modeling, and social and economic considerations that can help inform management of Alaska's salmon fisheries.

Three salmon-specific projects were among the funded by NPRB in our first year of operation alone, which was 2002:

- *Application of new sonar technology to reducing salmon bycatch in pollock fisheries*—Alaska Fisheries Science Center (AFSC) ($121,918).
- *North Pacific anadromous fish commission salmon tagging*—North Pacific Anadromous Fish Commission ($190,800).
- *Genetic stock identification of western Alaska sockeye salmon*—NMFS, ADF&G, Auke Bay Laboratory, AFSC ($216,515).

A non-salmon specific study that first year that was also relevant to salmon fisheries was *Detecting change in the Bering Sea,* a joint project of the Alaska Fisheries Science Center and NOAA Pacific Marine Environmental Laboratory ($124,084).

Of the 453 Core projects NPRB funded between 2002 and 2018, 51—or 11 percent—include salmon in their project descriptions have some implications for salmon management. Thirty-two of those projects targeted salmon as the primary species studied in the Gulf of Alaska (GOA) and the Bering Sea/Aleutian Islands (BSAI) Large Marine Ecosystems (LMEs). Those studies were evenly split between Bristol Bay, the Copper River, and the Yukon River. All three NPRB Integrated Ecosystem Research Programs—in the Bering, the Gulf and the Arctic—have included salmon either as a species studied, or as one affected by other factors examined by these programs.

A. NPRB Integrated Ecosystem Research relevant to Alaska Salmon Fisheries

NPRB's Integrated Ecosystem Research Programs (IERPs) use a multi-disciplinary approach to examine ecological processes in detail and provide a wealth of information that is relevant to addressing a wide variety of resource management questions. Here we highlight some examples of how these programs provide data and products that inform the management of Alaska's salmon fisheries.

Gulf of Alaska and Bering Sea IERPs

The *Gulf of Alaska IERP* (2010–2018), although focused on drivers of groundfish recruitment, provided data on salmon distribution and diet that were relevant to examining the role of salmon as competitors and predators of groundfish. The year 2011 was an anomalously low production year in the Gulf of Alaska and in 2011 salmon were in relatively poor body condition and stomach content analysis indicated lower feeding rates. The Gulf of Alaska IERP did not collect data during 2014–16 when anomalously warm conditions persisted in the Gulf of Alaska, however, data collected by NOAA scientists and others who participated in our GOA synthesis project provide evidence that poor prey quality in those years likely affected all salmon species in Gulf of Alaska waters. Scientists suggest that the Gulf of Alaska has demonstrated resilience to anomalous conditions that occur in any given year, but the *persistence* of anomalous conditions may have lasting effects on fish production and ecosystem dynamics.

The *Bering Sea IERP* (2007–2016) reached similar conclusions with respect to pollock. When warm water conditions persisted over several years 2001–2005, pollock recruitment was negatively affected because zooplankton prey were limited (Hunt *et al.,* 2011). The persistence of warm or cold conditions over consecutive years, termed a "stanza", can affect ecosystem dynamics more profoundly than interannual variability that oscillates year to year.

The Gulf of Alaska IERP did not collect data 2014–2016 during persistent anomalous warm water conditions because the program was designed several years in advance to conduct research cruises mid-way through the funding period. However, the program developed oceanographic models that incorporate biological processes and those models could be used to examine questions specific to salmon ecology and the production of their prey. The current models run from 2000 to 2013 and could be run into subsequent years to examine the conditions that salmon experience when they are in the offshore marine environment.

The Gulf of Alaska IERP also provided insights into ecosystem dynamics in the Gulf of Alaska and contributed to identifying indices for the Ecosystem Considerations chapter of the North Pacific Fishery Management Council Stock Assessment and Fishery Evaluation report. As a result of this research and recognition of distinct dynamics in eastern and western sections of this ecosystem, the indices used to hindcast conditions in this ecosystem are now separated into eastern and western

sections. This development is relevant to the management of all fish species in the Gulf of Alaska. The program also developed oceanographic models that incorporate biological processes, which might be used to examine questions specific to salmon ecology and production of prey resources. The current models run from 2000 to 2013 and could be run into subsequent years to examine conditions salmon experience in the offshore marine environment.

The Gulf of Alaska IERP synthesis included genetic analyses of salmon captured in southeast Alaska in July 2011–2015 and found that juvenile salmon in the Gulf of Alaska in mid-summer are predominantly from the Columbia River, comprising nearly 80 percent of the samples. The study provides valuable information about the timing and speed of Chinook migrations. The results indicate that collaboration to combine data from surveys along the North American coastal migration pathway can provide information relevant to understanding stock-specific and inter-annual variation in the survival of juvenile salmon. Furthermore, sampling in the Gulf of Alaska may allow assessment of the marine survival of juvenile Columbia River Chinook salmon two years prior to their return to the river as adults (Van Doornik *et al.,* in prep.).

Research associated with the Bering Sea IERP on "calorie-sheds" supports the notion that collection of data across vast geographic regions is warranted to understand the factors influencing the health and survival of species throughout their range. Subsistence communities are especially concerned about cumulative impacts on migratory species.

Arctic IERP

The *Arctic IERP* currently underway (2016–2021) will provide information relevant to addressing concerns about food security for Arctic residents and will collect data related to salmon, specifically. The focus of the program is on how reductions in Arctic sea ice and associated changes in the physical environment will influence the flow of energy through the ecosystem in the Chukchi Sea. The program includes examining the environmental factors that influence the distribution and abundance of fish in the U.S. Arctic, including pink and chum salmon. The program includes social science research that examines the relative influences of environmental and socioeconomic factors in determining food security for Arctic residents. The research includes consideration of local and traditional knowledge and members of Arctic communities participate in annual science meetings.

NPRB is providing $7 million in base funding for the Arctic Program and leveraging partner funding from the Bureau of Ocean Energy Management, the Collaborative Alaskan Arctic Studies Program (formerly the North Slope Borough/Shell Baseline Studies Program), the Office of Naval Research Marine Mammals and Biology Program and in-kind contributions from NOAA (Alaska Fisheries Science Center and Pacific Marine Environmental Laboratory), the University of Alaska Fairbanks, the U.S. Fish & Wildlife Service, and the National Science Foundation. The combined support for the program totals >$18 million.

B. NPRB discipline-specific research relevant to Alaska Salmon Fisheries

Of the 65 Core (formerly Annual) projects that named salmon in their abstracts, we identify 32 as having management application to salmon. Those 32 projects are highlighted in Appendix C, which includes all 65 projects naming salmon. In addition, we summarize below six Core projects of particular relevance to salmon management:

- NPRB project 0202—*Application of new sonar technology to reducing salmon bycatch in pollock fisheries*—applied advanced sonar technology to a cooperative industry/government effort to modify pelagic trawls to reduce salmon bycatch in Alaska pollock fisheries. Dual-frequency Identification SONar (DIDSON) provided detailed observations of the behavior of these two species within pelagic trawls and observations informed the development and testing of salmon excluder designs. Excluder development has progressed through repeating this sequence of behavior observations, expert feedback, concept development, design, model testing, full-scale observations and performance experiments. Performance experiments indicate that more than 12 percent of the salmon escape, with a pollock loss less than 3 percent.
- NPRB project 0327—*Early marine ecology of juvenile chum salmon in Kuskokwim Bay, Alaska*—investigated estuarine residence of juvenile chum salmon, a stage of high mortality that may ultimately determine year class strength. Results included spatial and temporal patterns of estuarine distribution, diet, and condition of chum salmon juveniles in Kuskokwim Bay and a spatially-explicit foraging/bioenergetic modeling that assessed growth potential of Kuskokwim Bay habitats for outmigrating juvenile chum salmon. Results in-

dicated that timing of outmigration is highly important to condition, growth, and subsequent survival probability.

- NPRB project 1111—*Over-winter Survival of Bristol Bay Sockeye Salmon at Sea*—addressed variability in adult sockeye salmon returns and related uncertainty in harvest forecasts and economic returns. This project used historical measures of scale growth (1960s–2010) and juvenile sockeye salmon in the Bering Sea (2000–2010) to investigate whether productivity shifts of sockeye salmon since the 1960s are related to shifts in ocean productivity that affect early marine salmon growth and overwinter survival and whether salmon growth and survival are lower during "cold" water years when prey availability and growth are reduced.
- NPRB project 1423—*Defining critical periods for Yukon and Kuskokwim river Chinook salmon*—found that Chinook in the Yukon-Kuskokwim region grow more slowly under warm water conditions, likely because their prey are less available. This annual project finding was complemented by the Bering Sea Integrated Ecosystem Research Program (2007–2016), which described mechanisms that limited pollock growth and survival in the Bering Sea when warm water conditions persisted over multiple years. A similar mechanism may affect Chinook.
- NPRB project 1619—*Relative rate of survival (RRS) of pink salmon in PWS*—Returns from hatchery releases of pink and chum salmon provide 51–97 million adult salmon to harvests, contributing up to 25 percent of the exvessel value of the statewide harvest. The Alaska Hatchery Research Program (AHRP) sought to reduce uncertainty about straying and genetic interactions between hatchery and wild stocks and used genetic parentage analysis to estimate the relative reproductive success of hatchery-origin pink salmon in natural streams to investigate the potential for a reduction in fitness due to hatchery straying and to inform resource management decisions regarding hatchery production.
- NPRB project 1702—*Data and information in salmon stock-recruitment analysis*—is an ongoing review that emphasizes the diverse types of primary data (*e.g.,* counts, indices, model-derived reconstructions), auxiliary data (habitat quantity and characteristics, environmental covariates), and considerations of model structure, to determine their effects on the quality of estimates of the stock-recruitment relationship. Best practices will be emphasized to provide guidance to stock-recruitment analysts.

C. NPRB Long-Term Monitoring work relevant to Alaska Salmon Fisheries

NPRB currently funds three Long-Term Monitoring projects:[2]

- *The North Pacific Continuous Plankton Recorder Project* is a ship of opportunity monitoring program that has operated since 2000 using commercial ships to collect samples of phytoplankton and zooplankton, and selected aspects of the physical environment, along their regular routes of passage on a seasonal basis. Project scientists recently found that pink salmon predation induces a trophic cascade in plankton populations in the southern Bering Sea and around the Aleutian Islands (Batten *et al.,* 2018). The results support the idea that abundant pink salmon may affect the growth and survival of the other four species of salmon that occur in this region.
- *The Seward Line Project* has operated in the Gulf of Alaska for over 20 years and provides oceanographic data and other indices of ecosystem health and variability. The project has expanded over the years as new funding partners are added to the consortium and was recently established as a National Science Foundation Long-Term Ecological Research Site. NPRB recently committed to providing funding for another five years (FY20–24).
- *The Chukchi Ecosystem Observatory* consists of an array of moored instruments that collect data on the Chukchi Sea shelf near Hanna Shoal year-round. A wide range of data are collected to address physical, chemical, and biological oceanography, sediment flux, timing and magnitude of plankton blooms, and fish and marine mammal migratory patterns. A similar moored array will be added in the Gulf of Alaska soon that is associated with the Seward Line

[2] The Gulf of Alaska Seward Line *https://www.gulfwatchalaska.org/monitoring/environmental-drivers/the-seward-line-marine-ecosystem-monitoring-in-the-northern-gulf-of-alaska/;* The North Pacific Continuous Plankton Recorder Survey *https://www.pices.int/projects/tcprsotnp/default.aspx/;* and The Chukchi Ecosystem Observatory *https://www.uaf.edu/cfos/research/projects/ne-chukchi-sea-moored-eco/*.

project. Such instrumentation provides valuable information about the ecosystem that should prove useful to addressing questions relevant to salmon.

D. NPRB data relevant to informing Alaska's Salmon Fisheries

All projects funded by NPRB are required to submit the data they generate to NPRB, which works with Axiom Data Science locally and with DataOne, an international data platform, to make it available to the NPRB science community and, after the required two-year embargo period passes, to the public. NPRB implemented comprehensive data publication processes in 2016 to improve overall access to the data. NPRB has started with the most recent projects (2014–2018) and is working to fully vet, process and release data from past projects. Archived data from legacy projects (pre-2014 awards) will be available through the NPRB web portal in the future.

III. Future research: Promising directions, and Research needs

A. Promising directions—Research and data coordination

NPRB is interested in maximizing the use of NPRB-funded products and is actively working to create synergies with other organizations. NPRB's Chief Officer for Collaboration and Synthesis, Danielle Dickson, is working to foster collaboration with other organizations and demonstrating that NPRB can serve to coordinate Alaska marine research whether that research is funded directly by NPRB or not.

Salmon run timing—supporting coordination between state and Federal salmon managers. One relevant example is an ecological forecasting project coordinated by NPRB staff and supported by NOAA that involves collaboration among NOAA and ADF&G staff to develop a salmon run timing model for Cook Inlet. The run timing model will examine the relative influence of offshore and nearshore marine environmental conditions and will make use of data derived from various NPRB-funded projects, including indices of zooplankton prey derived from the *Gulf of Alaska IERP* model, zooplankton measurements collected by the *Seward Line* Long-Term Monitoring project over the past two decades, and runoff modeled by NPRB Core Program *project 904.* The model will use decades worth of salmon time series data collected by ADF&G and environmental data provided by NOAA Fisheries, National Weather Service, National Ocean Service, U.S. Geological Survey, and the Alaska Ocean Observing System. A separate salmon run timing model for Yukon River Chinook salmon supported by AOOS, NOAA, and ADF&G typically uses sea ice as an important predictor of run timing but the virtually ice-free conditions experienced in 2018 complicated the forecast and illustrated the importance of identifying other relevant environmental indices (*Postseason Analysis of the 2018 Yukon River Chinook Run Timing Forecast*). Projects such as these illustrate the power of coordinating research across various organizations to forecast biological and ecological events and this approach could be applied to other species or geographic areas.

NPRB is uniquely positioned to facilitate conversation about opportunities to coordinate marine research across a variety of organizations and sectors. The broad representation of the Board, including federal, state, industry, conservation, and Alaska Native interest seats, ensures that a wide variety of stakeholder voices are included in these discussions. The Board presents an opportunity for those stakeholder groups to leverage one another's resources, expertise, and perspectives to advance marine science in Alaska. NPRB staff have unique experience in developing research programs that address stakeholder concerns, building partnerships to fund such research, and implementing programs that achieve remarkable coordination and collaboration across disciplines and institutions.

In some respects, despite Alaska's vast geographic area, coordinating research in Alaska is tenable because the community is tightly-knit. In both the scientific research community and the stakeholder community, the same individuals are often engaged in conversation in a variety of forums.

Just two examples of NPRB staff involved in research and data coordination with other research organizations suggest promising research coordination directions:

Salmon Data: coordination and data gaps. NPRB Science Director Matthew Baker's participation in two activities sponsored by the National Center for Analysis and Synthesis (NCEAS): Coupling Climate and Salmon (June 2018); and the State of Alaska Salmon and People knowledge synthesis project (November 2018). These multi-institutional discussions are directly relevant to identifying data streams useful to support salmon research and have important insights relevant to informing future directions in salmon management.

Cross-organizational collaboration. The Federal *Interagency Arctic Research Policy Committee (IARPC) Collaborations* model works well to coordinate Arctic research within and beyond Federal agencies. The Collaborations model actively solicits non-federal participants, bringing together scientists from Federal, State, academic, NGO, industry, indigenous and international organizations to share their work. The Collaborations model could be applied more broadly to improve coordination for other areas of Alaska and nationwide. NPRB staff member Danielle Dickson serves as Co-Lead of the IARPC Marine Ecosystems Collaboration Team. In that forum she works to coordinate Arctic research with other organizations. The success of such a model relies on strong participation; agency staff from Alaska field offices and headquarters of each Federal agency, and non-federal researchers from other public and private entities should be encouraged to participate in IARPC.

B. Research and funding needs

Research needs

NPRB focuses exclusively on the marine environment. Given that perspective applied to a set of anadromous species, research needs relevant to the management of Alaska's salmon fisheries might include:

- Further analyses on marine carrying capacity, thresholds, and density dependent constraints
- Further understanding and modeling of life cycle and stage-specific mortality
- Further research on inter-species interactions among salmon and spatial and diet overlap of salmon species and stocks in the marine environment
- Further genetic sampling and categorization of various stocks and substocks
- Improved methods for run timing and stock-size forecasts
- Integrated regional oceanographic models that provide insight into stock distribution, growth and survival
- Understanding of oceanographic processes that determine plankton production and first year ocean survival for smolts
- Increased research on forage species and relative availability to salmon stocks

Leveraging existing initiatives to share data and management practices

As part of the North Pacific Anadromous Fish Commission International Year of the Salmon 2019 (IYS—with projects from 2018–22) and recent National Center for Ecological Analysis and Synthesis salmon projects, multiple research-oriented sessions have been convened to address issues related to effective salmon use, management and conservation. NPRB has provided conference support for a January 2019 IYS workshop on Salmon Status and Trends. There is an opportunity to leverage these findings and conclusions to further inform state and Federal salmon management.

Funding Needs

NPRB relies almost entirely on competitive annual grants from NOAA to fund the research described in this testimony but, as described in the next paragraph, those grant funds have diminished over time due to market influences. NPRB is grateful for the additional funds available through funding partnerships, which comprise a small percentage of our overall funding: For the Core (formerly Annual) program, NPRB has developed funding partnerships with the Oil Spill Recovery Institute and is in discussion with other potential partners; for the Integrated Ecosystem Research Programs (IERPs) with the National Science Foundation, Bureau of Ocean Energy Management, the Collaborative Alaskan Arctic Studies Program (formerly the North Slope Borough/Shell Baseline Studies Program), the Office of Naval Research Marine Mammal and Biology Program and in-kind contributions from NOAA from NOAA (Alaska Fisheries Science Center and Pacific Marine Environmental Laboratory), the University of Alaska Fairbanks, the U.S. Fish & Wildlife Service, and the National Science Foundation. NPRB is actively working to develop additional funding partnerships.

By law, NPRB receives 20 percent of interest earned on the Environmental Improvement and Restoration Fund established in the same law that created NPRB. However, EIRF investments are limited by law to interest bearing obligations of the United States. NPRB is feeling very acutely the negative Impact of sustained low yield on 10-year Treasury Notes on monies made available to NPRB for science funding. In recent years grants based on those yields have dropped from almost $9 million in 2011 to $6.9 million in FY 2019, severely restricting our ability to fund our research programs at levels that provide scientists with the support they need.

For example, in 2019 funding for the discipline-specific Core Program will drop from $4.5 to $4 million; the program used to be known as the "Annual Program" but was recently renamed the Core program to reflect the fact that annual funding of the program could not necessarily be guaranteed. Although the Board recently committed $1 million for the synthesis phase of the Arctic IERP, set-asides for future integrated ecosystem research programs are pending clarity on NPRB's near-term funding.

Concluding Remarks

Thanks to the foresight of Senator Ted Stevens and his congressional colleagues in establishing the North Pacific Research Board in 1997, NPRB has been able to contribute valuable research relevant to the management of Alaska's salmon fisheries in the sixteen years we have awarded research funds. As each of the organizations and witnesses testifying today at this hearing make clear, the value of our research is multiplied when we work together. We appreciate the opportunity to highlight NPRB research and to demonstrate and learn from all of these witnesses new ways we can combine our collective research and expertise to help improve management of Alaska's salmon fisheries.

Thank you for your consideration of our testimony. We look forward to answering your questions.

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APPENDIX A

NPRB BOARD COMPOSITION

As codified in 43 U.S.C. § 1474d, the Board is composed of 20 members:

- Ten seats are ex-officio representatives or their designees, with no official term length:

  Secretary of Commerce,
  Secretary of State, Secretary of the Interior,
  Commandant of the Coast Guard,
  Director of the Office of Naval Research,
  the Alaska Commissioner of Fish and Game,
  Chairman of the North Pacific Fishery Management Council,
  Chairman of the Arctic Research Commission,
  Director of the Oil Spill Recovery Institute, and
  Director of the Alaska SeaLife Center.

- Nine seats are held by members appointed by the Secretary of Commerce from nominations provided by the governors of

  Alaska (five seats),
  Washington (three seats), and
  Oregon (one seat).

These board members serve for three-year terms and may be reappointed. The five Alaska seats must represent fishing interests, Alaska Natives, conservation interests, academia, and oil and gas interests.

- One seat is appointed by the Secretary of Commerce from a Board nomination to represent fishing interests. This is also a three-year term appointment but is not renewable.

APPENDIX B

ABBREVIATIONS

ADF&G	Alaska Department of Fish and Game
AFSC	Alaska Fisheries Science Center
BOEM	Bureau of Ocean and Energy Management
BSAI	Bering Sea/Aleutian Islands
DIDSON	Dual-frequency Identification SONar
DFO	Department of Fisheries and Oceans Canada
EIRF	Environmental Improvement and Restoration Fund
GOA	Gulf of Alaska
IARPC	Interagency Arctic Research Policy Committee (Federal)
IERP	Integrated Ecosystem Research Program
IYS	International Year of the Salmon (NPAFC)
LME	Large Marine Ecosystems
LTER	Long-Term Ecological Research Site (NSF)
LTM	Long-term Monitoring
NCEAS	National Center for Ecological Analysis and Synthesis
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPAFC	North Pacific Anadromous Fish Commission
NPRB	North Pacific Research Board
NSF	National Science Foundation
PMEL	Pacific Marine Environmental Laboratory
PWSSC	Prince William Sounds Science Center
UA	University of Alaska
UAF	University of Alaska Fairbanks
UAS	University of Alaska Southeast
USFS	U.S. Forest Service

Appendix C

NPRB Core/Annual Projects including salmon in the described research

Project	Year	NPRB Project Title	Awarded	Status	Theme	LME	Lead Institution
0202	2002	Application of new sonar technology to reducing salmon bycatch in pollock fisheries	$121,918	closed	Fishes & Invertebrates	GOA	AFSC
0204	2002	North Pacific Anadromous Fish Commission Salmon Tagging	$190,800	closed	Fishes & Invertebrates	BSAI	North Pacific Anadromous Fish Commission
0205	2002	Genetic stock identification of western Alaska sockeye salmon	$216,515	closed	Fishes & Invertebrates	GOA	ADF&G, AFSC
0303	2003	North Pacific Anadromous Fish Commission Cooperative Research: genetic stock identification	$499,080	closed	Fishes & Invertebrates	BSAI	ADF&G, AFSC
0310	2003	Estuaries as essential fish habitat for salmonids: assessing residence time and habitat use	$400,022	closed	Fishes & Invertebrates	GOA	PWSSC, USFS, Pacific Northwest Research Station
0311	2003	Establishing a statewide data warehouse of salmon size, age and growth records	$43,066	closed	Fishes & Invertebrates	GOA	ADF&G
0317	2003	Pre-season forecast of Bristol Bay sockeye salmon migration timing based on oceanographic and biological variable	$24,930	closed	Fishes & Invertebrates	BSAI	Natural Resource Consultants Inc.
0321	2003	Alternative hypotheses for the collapse of the Kvichak sockeye salmon	$192,850	closed	Fishes & Invertebrates	BSAI	Bristol Bay Science & Research Institute, Natural Resource Consultants
0327	2003	Early marine ecology of juvenile chum salmon in Kuskokwim Bay, Alaska	$624,025	closed	Fishes & Invertebrates	BSAI	UAF, USGS Alaska Science Center
0504	2005	Analysis of ongoing salmon programs	$99,850	closed	Fishes & Invertebrates	GOA	Consulting Fisheries Scientist
0520	2005	Gulf of Alaska Long-Term Observations	$420,000	closed	Lower Trophic Level Productivity	GOA	UAF
0521	2005	A profiling echosounder for North Pacific monitoring	$100,000	closed	Fishes & Invertebrates	GOA	Institute of Ocean Sciences, DFO
0535	2005	Dietary specialization of Killer Whales	$183,140	closed	Marine Mammals	GOA	AFSC, Northwest Fisheries Science Center, UAF
0536	2005	A continuous plankton recorder survey of the North Pacific and southern Bering Sea	$100,000	closed	Lower Trophic Level Productivity	GOA	DFO, Kintama Research, Sir Alister Hardy Foundation for Ocean Science
0603	2006	Gulf of Alaska Long-Term Observations	$415,925	closed	Lower Trophic Level Productivity	GOA	UAF
0630	2006	Food web linkages: Forage Fish in the Aleutian Archipelago	$163,845	closed	Fishes & Invertebrates	GOA	USF&WS, USGS Alaska Science Center
0642	2006	Forage Fish Prince William Sound Nearshore	$150,000	closed	Fish Habitat	GOA	AFSC
0708	2007	Gulf of Alaska Longterm Observation Program (LTOP)	$249,996	closed	Lower Trophic Level Productivity	GOA	UAF
0731	2007	Temperature data collections on BS groundfish vessels	$147,816	closed	Fishes & Invertebrates	BSAI	AFSC, Marine Conservation Alliance Foundation, PMEL
0805	2008	On-shelf transport of mesozooplankton in subarctic seas	$169,050	closed	Lower Trophic Level Productivity	GOA	UAF
0823	2008	Cultural Models of Copper River Salmon Biology	$99,535	closed	Human Dimensions	GOA	Ahtna Inc., ADF&G, Ecotrust, North Cape Fisheries Consulting, UA
0915	2009	Disease severity in Chinook salmon during marine migration	$99,998	closed	Fishes & Invertebrates	BSAI	Purdue University, UAF
0922	2009	Eyak Lake community monitoring project	$98,949	closed	Lower Trophic Level Productivity	GOA	Prince William Soundkeeper, PWSSC
1008	2010	Salmon bycatch in the BSAI pollock fisheries	$393,449	closed	Fishes & Invertebrates	BSAI	UAF
1009	2010	Chinook Survival	$302,262	closed	Fishes & Invertebrates	BSAI	University of Washington
1019	2010	Assessment of Health Conditions of Subsistence Fish and Shellfish	$49,947	closed	Other Prominent Issues	GOA	Chugach Regional Resources Commission, NOAA
1110	2011	Pink salmon response to climate change	$157,350	closed	Fishes & Invertebrates	GOA	UAS
1111	2011	Over-winter Survival of Bristol Bay Sockeye Salmon at Sea	$219,006	closed	Fishes & Invertebrates	GOA	ADF&G, Natural Resources Consultants, Inc., AFSC
1114	2011	Steller sea lion diet and population trend in the Aleutians	$392,500	closed	Marine Mammals	BSAI	AFSC, SMRU Ltd.
1122	2011	Development of a fish health and composition analyzer	$39,816	closed	Fishes & Invertebrates	GOA	AFSC
1308	2013	Early Marine Ecology of Juvenile Chinook Salmon (Oncorhynchus tshawytscha) on the Yukon Delta, Alaska	$172,903	closed	Fishes & Invertebrates	BSAI	AFSC
1315	2013	Bioeffects Assessment in Bristol Bay	$91,164	closed	Other Prominent Issues	BSAI	NOAA
1319	2013	Benthic impacts of raised groundgear for the Bering Sea pollock fishery	$286,068	closed	Fish Habitat	BSAI	Alaska Pacific University, AFSC
1412	2014	Yukon River Patterns and Trends	$199,949	ended	Human Dimensions	BSAI	ADF&G, Alaska Pacific University
1413	2014	Value of Salmon	$92,695	closed	Human Dimensions	BSAI	Yukon River Drainage Fisheries Association
1414	2014	Copper River Salmon Blitz	$152,753	closed	Fish Habitat	GOA	Copper River Watershed Project
1422	2014	Arctic-Yukon-Kuskokwim (AYK) Chinook salmon egg thiamine exploration	$70,006	closed	Fishes & Invertebrates	BSAI	ADF&G, NOAA, Spearfish Research
1423	2014	Defining critical periods for YK Chinook	$244,350	closed	Fishes & Invertebrates	BSAI	ADF&G, AFSC, University of Washington
1424	2014	Fitness-based habitat models for Chinook salmon	$495,282	closed	Fishes & Invertebrates	BSAI	University of Georgia
1519	2015	Social and ecological resilience in a Gulf of Alaska community	$153,453	closed	Human Dimensions	GOA	ADF&G
1524	2015	Investigating causes of decline of the Klawock Lake sockeye salmon population	$98,622	closed	Community Involvement	GOA	The Nature Conservancy of Alaska
1529	2015	Tracking marine fish with a payload-controlled autonomous underwater vehicle	$194,556	active	Technology Development	GOA	AFSC
1531	2015	Construction of a fish health and body composition analyzer	$49,566	closed	Technology Development	BSAI	Seafood Analytics
1613	2016	Local and traditional knowledge of Alaska coastal ecosystems	$105,713	active	Human Dimensions	GOA	UAF
1619	2016	Relative reproductive success of pink salmon in Prince William Sound	$289,435	active	Cooperative Research with Industry	GOA	ADF&G
1622	2016	ADF&G Data Rescue and Dissemination	$299,128	active	Data Rescue	BSAI	ADF&G
1702	2017	Data and information in salmon stock-recruitment analysis	$96,041	active	Fishes & Invertebrates	GOA	UAF
1710	2017	State-space model of factors affecting coho survival and abundance	$82,195	active	Fishes & Invertebrates	GOA	UAS
1712	2017	Oil spills and Pacific herring population recruitment	$208,346	active	Fishes & Invertebrates	GOA	NOAA Northwest Fisheries Science Center
1719	2017	Policy Choices and Permit Migration in a Limited Entry Permit (LEP) Fishery	$99,355	active	Human Dimensions	GOA	UAF
1724	2017	A sex identification assay for Chinook salmon	$167,335	active	Technology Development	GOA	University of Washington

See Appendix B for abbreviations

Senator SULLIVAN. Good. Thank you, Dr. Baker. Ms. Gillis.

STATEMENT OF KAREN GILLIS, EXECUTIVE DIRECTOR, BERING SEA FISHERMEN'S ASSOCIATION

Ms. GILLIS. Thank you. Good morning, Senator Sullivan. I wanted to thank you for organizing the hearing here in Anchorage and especially during AFN.

The Senator is correct. My name is Karen Gillis. I'm the Executive Director at Bering Sea Fishermen's Association, an organization formed in 1979 with 150 fishermen from across the reaches of Bristol Bay up through Kotzebue Sound.

I will recognize I have staff in the audience: Joe Spaeder, who is my Research Coordinator and has been since the early 2000s; Katie Williams, who is my Sustainable Salmon Initiative Program Director; Chris Stark, who is an offsite Fairbanks Biologist for us. And I see a Board Member of mine, John Lamont. So thank you, John, for being here.

For 40 years we have proven ourselves by relentlessly working to serve the needs of Western Alaska, and indirectly the entire state by creating economic opportunities, such as the Community Development Quota Program; empowering residents and communities through our responsible stewardship policies; and advocating for the application of the best available salmon science and management practices in Alaska.

Our work is proactive, synergistic, complementary to public services, and rooted in collaborative efforts. There are fisheries, such as those in Western Alaska, facing persistent and severe declines. We cannot conserve the abundance and diversity of nature without knowing how natural systems work and how they respond to the many factors that influence them. Putting fish in the hands of the harvesters relies on innovative, cooperative and interdisciplinary research, which cuts across cultural, academic, national and institutional boundaries.

In the Arctic, Yukon and Kuskokwim regions, or AYK, residents depend on the sustainable harvest of wild salmon. In my written testimony submitted to the Committee, we detail the status and threats to sustainability of Western Alaska Chinook salmon stocks.

As a result of the recent declines, harvesters are not able to meet subsistence needs. In fact, the established amounts necessary for subsistence have not been met for the last seven years on both the Yukon and Kuskokwim rivers. Further evidence of this decline is that total estimated returns evaluated by the North Pacific Fisheries Management Council's 3-System Index has fallen below the 250,000-fish threshold, potentially triggering future bycatch reduction measures.

The steep decline in the total number of Chinook salmon is made worse by two additional factors: There is a documented decline in escapement quality, especially in the decreasing size of female spawning salmon, resulting in fewer eggs in the gravel. The other is smaller, currently less productive stocks in this period are more vulnerable to overharvest and extirpation. Regarding data gaps, there is an urgent need for proactive and coordinated research, monitoring and recovery efforts for salmon stocks.

My written testimony identifies a full set of salmon research and monitoring gaps for the AYK. Some of these include understanding the drivers and consequences of shrinking size of Chinook salmon, assessing risks to the most vulnerable Chinook salmon stocks, as well as researching the impact of climate change on salmon and their habitat.

We face two additional hurdles regarding information gaps. First, the defunding—recent defunding and declining funds for long-term state and Federal salmon monitoring projects, as well as private organizations around the state. Second, awards to Alaska under NOAA's Pacific Coastal Salmon Recovery Fund have steeply declined since 2000—lots of things have declined apparently—despite the program's highest priority to address factors limiting the productivity of Pacific salmon either listed under ESA or necessary for Native subsistence fishing.

In response to salmon declines, BSFA, the Association of Village Council Presidents, Tanana Chiefs Conference and Kawerak organized and invited state and Federal agencies to create the AYK Sustainable Salmon Initiative. Established in 2002, our science-based program works collaboratively to identify and address the critical salmon research needs facing the AYK region.

This is a unique and innovative approach. We are a well-established program, allowing us to build on and leverage the research and monitoring activities of our state and Federal partners. We work on a consensus-based decisionmaking process, so every decision that is made under the AYK SSI is approved by the state agents, Federal agents and regional organizations and BSFA. We are working to implement our AYK Chinook Salmon Research Action Plan, which I brought several copies, but can provide more, and hoping it will be uploaded to the website. It was developed by a panel of——

Senator SULLIVAN. We will submit that for the record for the Committee.

Ms. GILLIS. Thank you, Senator.

The plan was developed by a panel of prominent scientists, and our program works to understand the drivers of declines and returns throughout the state of the entire salmon life cycle.

Until we better understand the trends and causes of variation of salmon abundance, we don't know how management strategies might be helping or hurting. We don't know if declines are driven by human impacts or shifts in ocean productivity. We don't know if escapement goals are adequate. And we cannot forecast major shifts in salmon abundance.

Drawing on our extensive experience, we recommend establishing more funding mechanisms, particularly for the Sustainable Salmon Initiative and collaborative efforts like that, also fully funding state and Federal agencies to do their part of this job. We recommend reinvesting in monitoring programs, as BSFA's worked with the Department of Interior since 1994 to fund.

I'm grateful for today's opportunity. I really look forward to working with you to rebuild and maintain the health of Alaska's salmon fisheries. And I'm excited for the questions.

[The prepared statement of Ms. Gillis follows:]

PREPARED STATEMENT OF KAREN GILLIS, EXECUTIVE DIRECTOR, BERING SEA FISHERMEN'S ASSOCIATION

Thank you, Chairman Thune, Senator Sullivan, and Members of the Committee, for organizing today's field hearing. My name is Karen Gillis. I am the Executive Director of Bering Sea Fishermen's Association (BSFA). I am honored to be here today to extend your awareness of the health of Alaska's salmon fisheries and share our opinions on the capability, or lack thereof, as it pertains to the current data and information necessary for maintaining healthy and sustainable salmon stocks in Alaska.

Ultimately, I recommend establishing a funding mechanism for the Arctic-Yukon-Kuskokwim Sustainable Salmon Initiative which provides a Native, state and Federal science-based partnership undertaking collaborative salmon research informing the rebuilding and management of declined western Alaskan salmon stocks. Our collaborative partnership has an extensive track record of applied research and restoration activities as presented herein.

Not A Traditional Fishermen's Association

Bering Sea Fishermen's Association was formed in 1979 with 150 fishermen from over 30 villages in western Alaska ranging from Bristol Bay to Kotzebue Sound. These fishermen united to become more involved in new fisheries that were developing directly off their coastline, and to build an organization that was concerned with helping local fishermen gain full economic benefits from Alaska's fisheries.

Commercial companies often fished in Alaska waters with short-sighted aggressiveness. As early as 1899, Alaska Natives appealed to the government to protect the salmon for those who relied on it for food.

For decades, foreign fleets scooped up fish and sailed away, while Alaska's own fishermen had no way to access these fisheries due to the lack of adequate venture capital, infrastructure, and local expertise. BSFA initially set about assessing the viability of developing herring fisheries compatible with the rural Alaskan lifestyle.

We've grown and adapted as necessary in response to the fishery issues of most pressing need, focused on healthy and vibrant fishing communities, we foster greater capacity to access and develop fisheries in the Arctic, Yukon, Kuskokwim, and Bristol Bay (BBAYK) regions of Alaska. Within this area there are 128 communities and just over 120,000 residents.

We are committed to the sustainable management of Alaska's resources and serve as stewards of the extraordinary lifestyle and culture of Alaskans. We serve to *strengthen local communities, improve equitable access to fishery resources, support long-term ecological integrity, and stimulate robust economies.*

BSFA enjoys a long list of successes. We've played a significant role in the development of western Alaskan herring and halibut fisheries, succeeded to establish the Chinook salmon savings areas and other salmon bycatch reduction measures in the Bering Sea, constructed community fish plants and cold storage facilities, worked to eliminate high-seas driftnet interception, and foreign high-seas piracy activity in cooperation with the U.S. Coast Guard. We were the force behind the design and implementation of the Community Development Quota (CDQ) Program with Harold Sparck that launched the six CDQ corporations. We've guided and funded salmon research and monitoring efforts in the BBAYK as well as being an incubator for various fisheries research and coordinating programs and nonprofits some of which include:

- Yukon River Drainage Fisheries Association
  An association of subsistence and commercial fishers with a mission of protecting and promoting all wild fisheries and traditional cultures within the Yukon River drainage.
- Norton Sound Salmon Research and Restoration Program
  A forum to engage in a collaborative, regional and interagency-based approach to developing and implementing a comprehensive and strategic Norton Sound Salmon Research and Restoration Plan.
- Bristol Bay Buy-back Coalition
  A coalition of tribes, regional Alaska organizations and fishing companies formed and succeeded to influence the Federal government to buy back $95M in oil and gas leases sold in October 1988 to offshore oil and gas companies interested in exploring in the North Aleutian Basin Planning Area encompassing Bristol Bay and the southeast Bering Sea.

- Arctic-Yukon-Kuskokwim Tribal Consortium
  Based on a Memorandum of Understanding, the AYKTC consists of the Association of Village Council Presidents, Tanana Chiefs Conference, and Kawerak, Inc. The Consortium utilizes BSFA to manage the Arctic-Yukon-Kuskokwim Tribal Research & Restoration Program to administer Pacific Coastal Salmon Recovery Funds to address a set of critical uncertainties and key factors limiting the productivity of Chinook salmon in the AYK region.
- Arctic-Yukon-Kuskokwim Sustainable Salmon Initiative
  A science-based program working cooperatively to identify and address the critical salmon research needs facing the AYK region. The AYK SSI is the largest example of co-management of research funding within the Pacific Rim and one of the largest experiments in the co-management of fisheries and wildlife research in North America.

Most recently we've launched the Alaska Ocean Cluster Initiative to grow Alaska's vibrant, diversified, and resilient blue economy by encouraging and advancing innovators and entrepreneurs to create sustainable products and services from our vast and renewable ocean resources.

BSFA is a bridging organization, an entity which connects diverse groups for collaboration and learning. Our success lies in our ability to be nimble and willing to take on difficult issues quickly with efficient outcomes; both financially and timely. We build trust and achieve conflict resolution and we value supporting local organizations, creating linkages, increasing local influence on policy, and disseminating new visions and organizational innovations. Bridging organizations are central players in an emerging "multisectoral" development paradigm that is less subject to the flaws of the still-dominant market-led and state-led paradigms. Evidence from different natural resource management settings shows that bridging organizations can add value to governing processes by reducing the transaction costs of management.

BSFA acts as a platform for communication among residents and the wide-range of agencies that oversee and manage fisheries in western Alaska. More importantly, BSFA supports the capacity of residents to actively engage in the management and development of their own fisheries. BSFA does not "represent" the interests of our communities, we "serve" their interests by engaging and supporting residents to bring the ideas and needs of western Alaska to state, Federal and international forums.

BSFA & Freshwater Salmon Monitoring

Among all the animals that serve as a source of food for humans, salmon are iconic. Their wide-ranging habit of migrating from freshwater to the ocean and back are indicators of ecological health. They play invaluable ecological, social, and cultural roles in Alaska and around the globe.

Salmon are highly valued culturally simply for their existence, socially as a source of food, and economically as a source of wealth through fisheries and tourism.

The well-being of humans and salmon are intimately linked in coastal communities. Indigenous peoples, resource managers, fishers, processors, businesses, and governments have demonstrated a need to understand what drives the variation we see in salmon abundance now and into a future with climate change.

Salmon abundance fluctuates on intra-annual to decadal scales and the causes of this variation have not yet found convincing explanations in any ocean.

In the summer of 1993, western Alaska experienced a failure in the chum salmon run on a scale never before seen. While some chum returns—particularly northern Norton Sound—had already been depressed, the region-wide poor returns led to sweeping subsistence and commercial fishery restrictions, closures, and lack of adequate spawning escapements to most river systems throughout the AYK region of Alaska. One aspect that became apparent in the face of these disastrous returns was a need to increase monitoring of the salmon returns to improve fishery management. This may not be as important when runs are healthy, but when poor runs dominate, fishery managers must exercise even greater caution when faced with inadequate information.

Beginning in 1994, BSFA received funds from the Department of Interior for research and monitoring of salmon returns in the AYK region. After working with fishery managers to create cooperative efforts between state, federal, and local entities, BSFA passed-through over 80 percent of this funding to rural communities and regional Native organizations and created the most extensive collection of cooperative monitoring projects ever seen in Alaska. Western Alaskan residents were, for the first time, directly involved in gathering information to better understand and

help manage their fisheries, and the fishery managers now had a greatly expanded set of information upon which to base management decisions.

Federal appropriations for this program continued through 2006 but ended abruptly. Without this information the data available to inform fishery managers has become increasingly limited, continued state budget cuts led to unprecedented levels of uncertainty in day-to-day decisions.

BSFA & Marine Research

BSFA has been a long-time supporter of understanding the variability of marine ecology of Pacific salmon as it relates to their sustainability. We have fostered, funded and partnered with state, Federal and regional organizations to investigate the ecological mechanisms regulating marine distribution and production of salmon populations, climate change impacts, retrospective analysis of key populations as indicators of conditions in North Pacific marine ecosystems, and implications of stock identification and model development for salmon management. Our Western Alaska Marine Salmon Studies (WAMSS) program maintains a strong relationship with the NOAA Fisheries, University of Alaska Fairbanks College of Fisheries and Ocean Sciences and the North Pacific Anadromous Fish Commission (NPAFC) to improve the understanding of the marine-life history state of salmon in the Bering Sea.

While WAMSS is suspended due to a lack of funding, international efforts to re-engage in high-seas research is underway. On October 11, 2018 the NPFAC announced the International Year of the Salmon, a five-year initiative which includes a high-seas expedition to the central Gulf of Alaska.

Given the pace of change and the degree of uncertainty we need to effectively use the capacity of these multi-agency efforts to be efficient in our sharing of what we know, conducting research to address known gaps in our understanding, and to stand ready to effectively address surprises when they emerge.

Despite the investments, our ability to understand the relationship of salmon to our actions and the changing environment remains a challenge. Fishery managers continue to pursue a balance between commercial and subsistence fishing objectives while remaining mindful of Alaska's treaty obligations to Canada. Advocating for sustainable fisheries management practices and stewardship of Alaska's resources means BSFA will never tire of tracking decisions and activities that might threaten Alaska's fisheries, the resources upon which we depend, and the people who make up the history of this great land.

Community-Based Salmon Harvest Monitoring on the Kuskokwim River

Data to inform Kuskokwim River salmon fishery management is very limited. Because subsistence harvests are not assessed until after the season, information on run timing, strength, and composition from the upper three quarters of the drainage is extremely limited to inform in-season management decisions. At the same time, communities have shown strong interest in participating in a community-based salmon monitoring program.

As a result of the 2012 Federal Fisheries Disaster Declaration and at the request of the Association of Village Council Presidents, BSFA developed a work-plan for an integrated set of community-based monitoring projects to address three objectives:

1. Inform an operative in-season fisheries management model with relevant additional data from across the watershed.
2. Build fisheries research capacity in community level organizations in the watershed.
3. Improve data transparency and ownership in the management decision process.

The Community-Based Salmon Harvest Monitoring program is designed to support the management of salmon throughout the watershed. This project involves harvest monitors in participating villages being selected, trained and mentored to collect data for in-season assessment, and to provide public outreach regarding the goals of management and assessment.

Data or sample collection varied by river location and management data needs but includes:

- Near real-time harvest reporting
- Drift gillnet catch per unit effort (CPUE) of Chinook salmon and other species to index run timing and strength
- Age, sex and length (ASL) data necessary to assess escapement quality
- Catch ratio of chum and sockeye to Chinook salmon

- Temperature monitoring in selected tributaries to assess thermal stress on Chinook salmon and other salmon species
- Other information that informs management of the fisheries

This data collection program bolsters engagement with fisheries management as well as builds fisheries research capacity within local institutions.

A central goal of the project is to provide fisheries research expertise to work with regional partner organizations to:

- Build capacity and train community-based monitors and harvest reporters.
- Assist with project design, start-up and implementation.
- Assist with data collection, reporting and in-season trouble shooting.
- Assist with communicating fisheries management decisions to community partners.

The project partners with a set of regional organizations across the watershed such as the Kuskokwim River Inter-Tribal Fish Commission, U.S. Fish & Wildlife Service (USFWS), Alaska Department of Fish & Game (ADFG), the Association of Village Council Presidents and other partner organizations.

In addition, several subprojects were funded as collaborative efforts to facilitate existing data collection efforts and fill data gaps, particularly in light of declining agency budgets and the need to provide data to support conservative fisheries management as Kuskokwim River Chinook salmon stocks recover.

All projects maximized the hire and training of local residents in the data collection and reporting process, with a goal of maximizing community fisheries capacity-building throughout the projects.

Voices from the Region

Several years ago, a lengthy effort was undertaken to assess regional perceptions and observations, on the Yukon River, recording respondent's ideas for how to best manage salmon in difficult times (*Brown, C.L. and A. Godduhn, editors. 2015. Socio-economic effects of declining salmon runs on the Yukon River. Alaska Department of Fish and Game, Division of Subsistence Technical Paper No. 398, Fairbanks.*).

The following bullets are derived from this research and are sentiments I've heard in all regions of Alaska:

- Eliminate Non-Essential Use [a reference to bycatch in the commercial pollock fishery in the Bering Sea]
- Eliminate All Use [a preferred alternative to risking the permanent loss of Chinook salmon from the Yukon River]
- Increase an Ecological Approach to Salmon Research Management [a call for a more holistic approach to research and management that includes all stages of salmon life cycles and all habitats occupied during those various life stages]
- Continue Public Outreach Programs and the Development of Communication Networks [an appreciation of collaboration to improve mutual knowledge by both explaining scientific methods and findings, and by listening to local concerns and observations]
- Make Subsistence Fishing More Efficient [short subsistence windows are inefficient]
- Continue to Improve Research Methods for Accurate Run Enumeration and Assessments [concerns regarding the accuracy of sonar-based assessments of salmon run strength and timing]
- Protect Subsistence Practices of Sharing, Barter, and Customary Trade [researchers, managers, policymakers, and the public need to recognize customary trade as a complicated continuum of exchange practices and attend to this complication in policy development]
- Continue to Research the Effects of Gear [mixed comments but general concerns about what the most effective gear is for reducing effects on genetic composition and drop-out rates]
- Economic Mitigation of Salmon Disaster Effects [options and ideas were proposed to mitigate the economic effects of the Chinook salmon disaster]

The take-away from this research is that residents are willing to examine every possible avenue for addressing the declines of salmon, up to and including restricting themselves to protect our salmon resources; this has literally been put into practice in some areas when fishery managers announced fishing openers and residents stood down in protest because they knew there weren't enough fish in the river (Unalakleet River, 2000).

It would be naïve to pretend that illegal fishing doesn't happen in the BBAYK. It happens and may continue to happen while anger and resentment exists as they do. It is a reaction from individuals seeing their way of life disregarded, their voices not heard, and questions not answered. It is a sign of desperation, deep suspicion, and insecurity. When people experience scarcity and are being managed by government, they, out of frustration, are sometimes inclined to do things that are often not in the long-term interest of sustaining resources.

Stock Status & Threats to Sustainability of Western Alaska Stocks

High subsistence dependence on salmon by Alaska Native Tribes combined with low incomes. In the AYK Region, there are over 30,000 Alaska Natives from Athabascan, Inupiat, and Yup'ik cultural groups occupying 90 villages and three regional centers (Bethel, Fairbanks and Nome). The health and well-being of this region depends intensely on the annual harvests of wild salmon.

In virtually all of these communities, salmon constitute the largest category of wild foods harvest, *providing about 167 lbs. of salmon per person annually in rural Alaska* (*Fall, J.A. 2014. Subsistence in Alaska: a year 2012 update. Alaska Department of Fish and Game Division of Subsistence: Anchorage. http://www.adfg.alaska.gov/static/home/subsistence/pdfs/subsistence_update_2012.pdf*). Due to many cultural, nutritional, and logistical factors (such as favorable drying conditions during early summer), Chinook salmon remain the most important salmon species to many communities in the AYK watersheds.

The continued steep decline of AYK region Chinook salmon stocks has resulted in a failure to meet core subsistence needs, and in some years, a failure to meet both key escapement goals as and subsistence needs. Chinook salmon stocks necessary for native subsistence fisheries have steeply declined, resulting in significantly reduced, or in some years, no subsistence harvests. Disastrous declines in Chinook salmon returns to western Alaska rivers within the AYK region beginning in the early 2000s resulted in the closure of commercial harvest of Chinook salmon for over a decade, numerous restrictions to subsistence fisheries, and a series of state and Federal disaster declarations. AYK Chinook salmon populations are suffering a multi-year period of very low productivity and abundance.

Table 1. List of precipitous salmon population declines that have spurred multiple Federal disaster declarations and the designations by State of Alaska as stocks of concern. A "Stock of Concern" designation under the State of Alaska's "Policy for the Management of Sustainable Salmon Fisheries," by the Alaska Board of Fisheries is a *very important gauge of the conservation risks facing these populations.*

Watershed	Year	Declaration Source	Declaration Type
Kuskokwim Region	1997	Federal	Commercial Fishery Failure
Kuskokwim River Watershed	1997	State of Alaska	Economic Fish Disaster
Yukon River Watershed	1997	State of Alaska	Economic Fish Disaster
Kuskokwim River Watershed	1998	State of Alaska	Economic Fish Disaster
Yukon River Watershed	1998	State of Alaska	Economic Fish Disaster
Yukon, Kuskokwim & Norton Sound	2000	Federal	Fisheries Disaster
Kuskokwim River Watershed	2000	State of Alaska	Economic Fish Disaster
Yukon River Watershed	2000	State of Alaska	Economic Fish Disaster
Norton Sound Watershed	2000	State of Alaska	Economic Fish Disaster
Kuskokwim River Watershed	2001	State of Alaska	Economic Fish Disaster
Yukon River Watershed	2001	State of Alaska	Economic Fish Disaster
Norton Sound Watershed	2001	State of Alaska	Economic Fish Disaster
Kuskokwim River Watershed	2002	State of Alaska	Economic Fish Disaster
Yukon River Watershed	2002	State of Alaska	Economic Fish Disaster
Norton Sound Watershed	2002	State of Alaska	Economic Fish Disaster
Yukon River Watershed	2008	Federal	Commercial Fishery Failure
Yukon River Watershed	2009	Federal	Commercial Fishery Failure
Yukon River Watershed	2010	Federal	Commercial Fishery Failure
Kuskokwim Region	2011	Federal	Commercial Fishery Failure
Yukon River Watershed	2011	Federal	Commercial Fishery Failure
Kuskokwim Region	2012	Federal	Commercial Fishery Failure
Yukon River Watershed	2012	Federal	Commercial Fishery Failure

As I discuss below there are multiple dimensions of the Chinook salmon decline. Specifically, the decline in the total number of returning adult salmon is exacerbated by two additional factors:

(1) declining escapement quality, especially the shrinking size of female spawning salmon which results in fewer potential eggs in the gravel; and
(2) smaller, currently less productive stocks in this period of decline are more vulnerable (Figure 1).

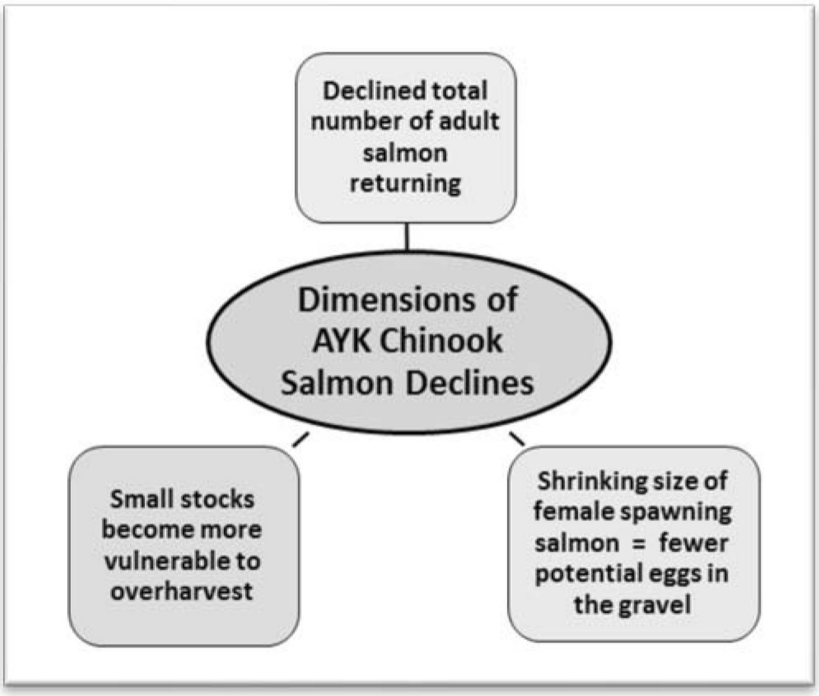


Figure 1: Multiple dimensions of the AYK Region Chinook Salmon declines

Yukon River Chinook Salmon Declines

During 1961 to 1997, the Yukon River Chinook salmon populations sustained an average combined subsistence and commercial harvest level of approximately 155,000 fish per year (Figure 2). The Alaska Board of Fisheries established in regulation the "amounts reasonably necessary for subsistence" (ANS) for Yukon River Chinook salmon as the range of 45,500–66,704 fish. Due to the recent declines and management actions striving to meet critical escapement needs, the *ANS has not been met since 2010.* The 2014 subsistence harvests of Chinook salmon were drastically curtailed to meet escapement goals, and rebuild the stocks, resulting in the *lowest subsistence harvest on record.*

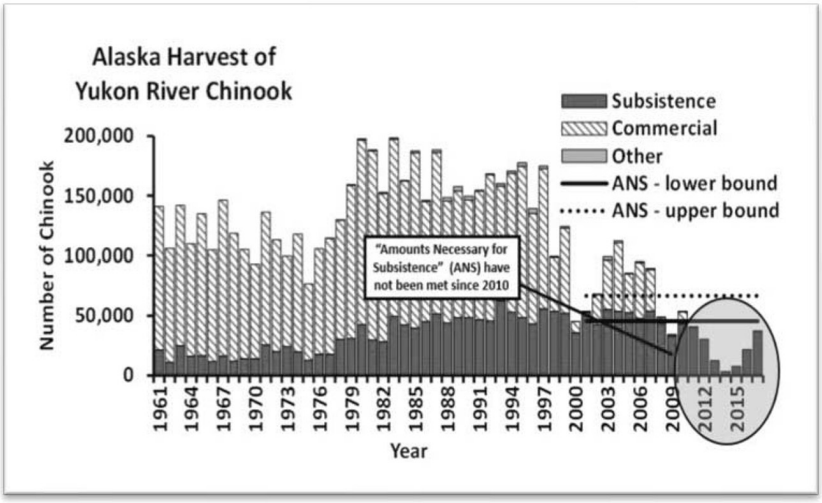


Figure 2. Alaska harvest of Chinook salmon, Yukon River, 1961–2017. *Source:* Yukon River Joint Technical Committee 2017.

Kuskokwim River Chinook Salmon Declines

From 1985 to 2010, the Kuskokwim River supported the largest subsistence fishery for Chinook salmon in the world. Due to the recent declines, subsistence harvests have fallen well below the amount reasonably necessary for subsistence for each of the last eight years (Figure 3). The 2014 Chinook salmon subsistence harvest of 11,000 fish was the lowest on record and 56,000 short of the minimum of what is necessary for subsistence. Estimated Chinook salmon harvests in 2018, will be less than 45 percent of the minimum amount necessary for subsistence in the Kuskokwim River Watershed.

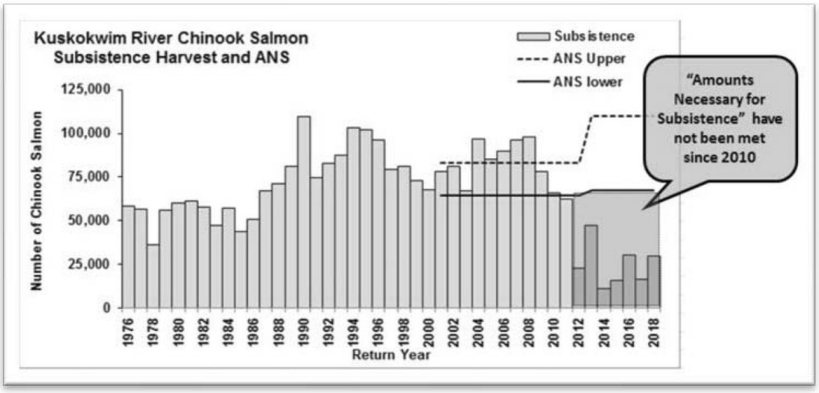


Figure 3. Kuskokwim River Chinook salmon subsistence harvests 1976–2018. *Source:* ADFG, Kuskokwim Region Data.

Norton Sound Chinook Salmon Declines

In the southern Norton Sound region, Chinook salmon *subsistence harvests have decreased by more than 60 percent* for the two watersheds which support important native subsistence fisheries, the Shaktoolik and Unalakleet rivers. Figure 4 presents the combined harvests from these watersheds, showing the steep decline and elimination of commercial harvests (1993–2000), followed by the steep sustained decline in subsistence harvests (2002–2011). This trend continues to the present.

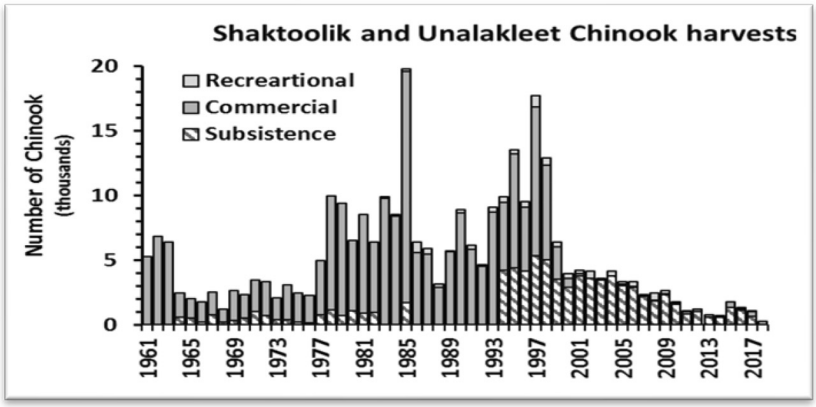


Figure 4. Norton Sound Subdistrict 5 (Shaktoolik River) and Subdistrict 6 (Unalakleet River) combined commercial and subsistence Chinook salmon harvests, 1961–2017. *Source:* ADFG, personal communication.

A key Federal fisheries management metric demonstrating the collective magnitude and duration of the Chinook decline in the AYK region is the North Pacific Fisheries Management Council's "Three-System Index." This index, based on the sum of estimated total returns of Chinook Salmon to the Upper Yukon, Kuskokwim, and Unalakleet rivers, was established by the North Pacific Fishery Management Council (Council) as a measure to reduce Bering Sea pollock fishery impacts after years of dramatically increasing bycatch of Chinook salmon.

A threshold of 250,000 Chinook salmon for the three-system index was implemented by the Council in 2016, meaning that if the total Chinook salmon returns in a year fall below the threshold—indicating declined and therefore more vulnerable Chinook salmon populations—more restrictive bycatch measures would be adopted for the next year's pollock fishery with the intent of reducing pollock fishery impacts on Chinook salmon rearing in the marine environment.

Using the May 2018 revised Kuskokwim River run reconstruction model, ADF&G presented revised total run estimates to the NPFMC indicating that the 3 System Index was less than the 250,000 fish threshold in each of the last three years (Figure 5)(*K. Howard, ADF&G, Memo to the NPFMC: "Updated Relationship of 3 System Inriver Total Run Index and Total Western Alaska AEQ", May 15, 2018*).

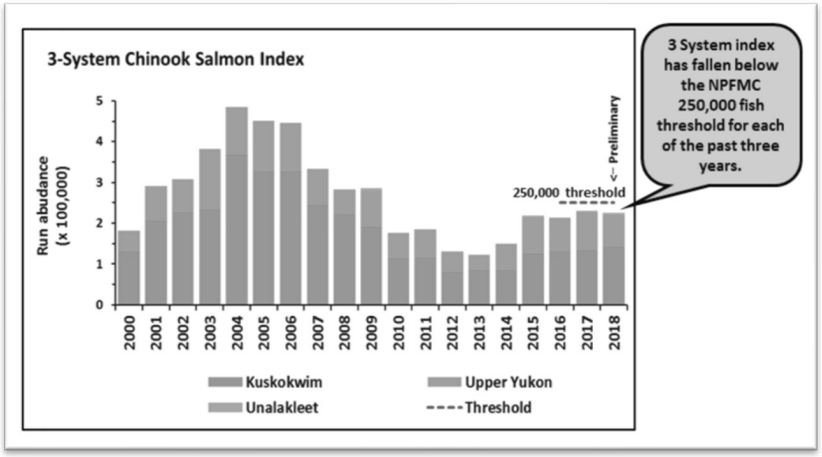


Figure 5: North Pacific Fisheries Management Council's "Three-System Index" based on the revised estimated total returns of Chinook Salmon to from the Kuskokwim River plus the Canadian Yukon and Unalakleet Rivers in relation to the Council's established threshold of 250,000 salmon. Source: (*K. Howard, ADF&G, Memo to the NPFMC: "Updated Relationship of 3 System Inriver Total Run Index and Total Western Alaska AEQ", May 15, 2018; Liller, Z. W., H. Hamazaki, G. Decossas, W. Bechtol, M. Catalano, and N. J. Smith. 2018. Kuskokwim River Chinook salmon run reconstruction model revision—executive summary. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A.18–04, Anchorage*).

Threats to salmon biodiversity: Declines now pose significant documented risks to small populations and potential loss of stock diversity/biocomplexity. Chinook salmon stocks in the AYK region are composed of over 100 discrete spawning populations, many with unique phenotypes and life histories. These aggregate populations—salmon biocomplexity—play an important role in buffering interannual variability of the overall stock complex and provide resilience in the face of environmental change (*Hilborn, R., Quinn, T.P., Schindler, D.E., and Rogers, D.E. 2003. Biocomplexity and fisheries sustainability. Proc. Natl. Acad. Sci. U.S.A. 100(11): 6564–6568. doi:10.1073/pnas.1037274100. PMID:12743372.; Schindler, D.E., Hilborn, R., Chasco, B., Boatright, C.P., Quinn, T.P., Rogers, L.A., and Webster, M.S. 2010. Population diversity and the portfolio effect in an exploited species. Nature 465:609–613.*).

This diversity in populations produces a stabilizing effect where less productive populations are compensated by the most productive populations, thereby stabilizing annual returns to the river (*Schindler et al., 2010*). AYK Chinook salmon stocks still retain much of this diversity that stabilizes annual returns (*Griffiths, J.R., D.E. Schindler, J.B.Armstrong, M.D. Scheuerell, D.C.Whited, R.A. Clark, R. Hilborn, C.A. Holt, S.T. Lindley, J.A. Stanford, and E.C. Volk. 2014. Performance of salmon fishery portfolios across western North America. Journal of Applied Ecology doi: 10.1111/1365–2664.12341*).

However, the challenges to management and conservation of population diversity is that in these large complex watersheds, highly productive populations are harvested together with low productivity or low abundance stocks, which are at risk of unsustainable exploitation or even extinction when part of such mixed-population fisheries. Loss of unproductive or small populations will erode the resilience of the overall system because these components of the population complex can become the productive or dominant producers in the future, under different prevailing environmental conditions (*Hilborn et al., 2003*).

Sustained productivity of salmon has been shown to be possible only if genetic diversity and population structure are maintained (*NRC (National Research Council). 1996. Upstream: salmon and society in the Pacific Northwest. National Academy Press, Washington, D.C.; Hilborn et al.,* 2003). However, the effective population size of some small, currently less productive stocks in the Yukon, Kuskokwim, and Unalakleet River watersheds may be approaching a threshold of concern for long term loss of genetic diversity (*Olsen, J.B., Miller, S.J., Harper, K., and Wenburg, J.K. 2005. Effective population size of Chinook salmon in Yukon and Kuskokwim River tributaries. Arctic Yukon Kuskokwim Sustainable Salmon Initiative Final Report.*

Anchorage, Alaska. http://www.aykssi.org/project/effective-population-size-of-chinook-salmon-in-yukon-and-kuskokwim-river-tributaries/) found that discrete populations may be at risk for long term loss of genetic diversity as populations fall below an "effective population size" (Ne) of ~500. Figure 6 illustrates the drainage-wide pattern of long term decline of monitored Chinook salmon populations.

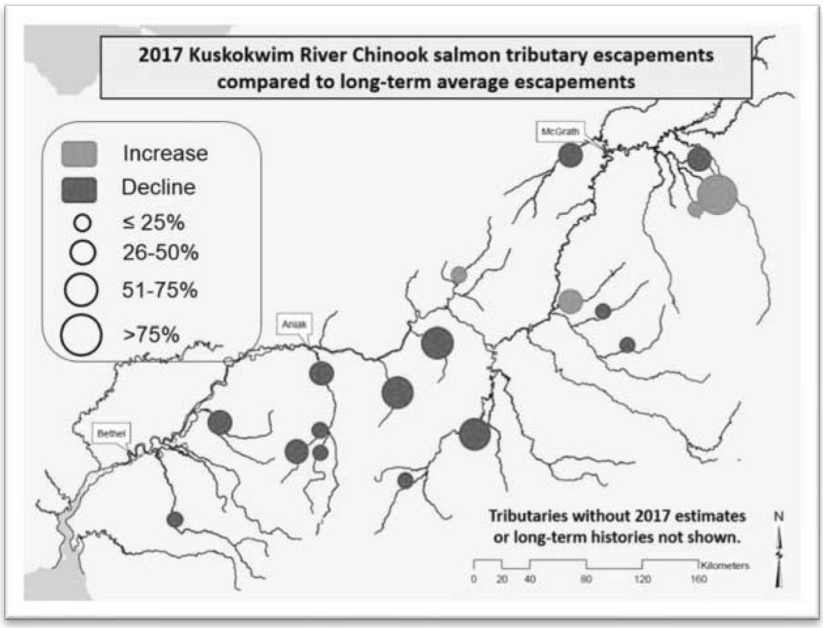


Figure 6. Kuskokwim Watershed with 2017 Kuskokwim River Chinook monitored salmon tributary escapements compared to long-term average escapements, illustrating the magnitude and widespread pattern of decline facing small or currently less productive stocks. This comparison shows that that 77 percent of the monitored tributaries remain declined compared to long-term average escapements, with 15 percent of the tributaries showing declines of greater than 50 percent. *Source:* ADFG, Commercial Fisheries Division.

Some monitored Chinook salmon spawning populations have steeply declined to near or potentially below the "minimum viable population size" applicable to many salmon populations. These potentially vulnerable including three Kuskokwim River Tributaries (Tuluksak, Tatlawiksuk, and Takotna Rivers). The ADFG counted a total of *94 Chinook salmon* at the Takotna River weir monitoring site in 2013, down from a high of 721 in 2001.

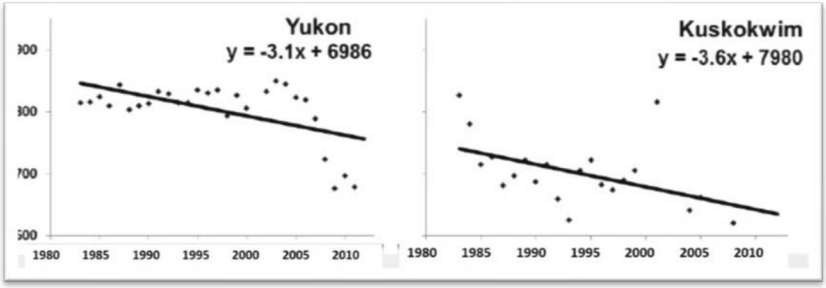


Figure 7: Linear regression of Chinook salmon mean annual length (mm) by year for the Yukon and Kuskokwim Rivers. (*Lewis B, Grant WS, Brenner RE, Hamazaki T (2015) Changes in Size and Age of Chinook Salmon Oncorhynchus tshawytscha Returning to Alaska. PLoS ONE 10(6): e0130184. doi:10.1371/journal.pone.0130184. pmid:26090990*)

Declining size of AYK Region Chinook salmon

The size-at-age of older Yukon and Kuskokwim River Chinook salmon has declined and the mean age of returning fish has declined since the early 1970s (*Lewis B, Grant WS, Brenner RE, Hamazaki T (2015) Changes in Size and Age of Chinook Salmon Oncorhynchus tshawytscha Returning to Alaska. PLoS ONE 10(6): e0130184. doi:10.1371/journal.pone.0130184. pmid:26090990*). Overall, a decreasing proportion of older fish and smaller sizes at a given age (Figure 7) have led to a reduction in the average size of returning females. This decline in the average size results in a reduction in the average number of eggs per spawning female, because fecundity increases with female body size.

Critical AYK Region Salmon Research & Monitoring Data Gaps

The need for an integrated marine and freshwater research and monitoring to better understand the causes of Chinook salmon declines.

For most salmon populations the freshwater stages sustain over half of the total egg-to-adult mortality. Adult, embryonic, and juvenile stages are all vulnerable to changes in freshwater environmental conditions. Specifically, we need to better understand how changes in the suitability or productivity of freshwater habitat and changing ocean conditions (physical and biological) in the Bering Sea has caused reduced survival of Chinook salmon and contributed to the decline of AYK stocks.

The need to better understand the drivers and consequences of declining size of Western Alaska Chinook salmon

By directing research to understand the factors that altered the size, sex ratio, and composition of life history types in ways that have contributed to recent declines of AYK Chinook salmon. The large old female salmon that provided much of the reproductive potential of western Alaskan stocks are disappearing.

Key information gaps related to declining salmon size include:

- How has size- and age-at-maturity of returning adults changed among stocks, and drainage areas (Yukon and Kuskokwim rivers) and has this occurred synchronously with stocks elsewhere such as in Bristol Bay populations and coastwide?
- What is the relationship between size- and age-at-maturity of returning adults in stocks fished by gear selective for small fish versus gear selective for large fish?
- Which explanation, genetic selection or changes in environmental parameters (*e.g.,* ocean conditions), better accounts for the observed changes in size- and age-at-maturity of returning adults in stocks? What is the relative contribution of anthropogenic and environmental variables as causal mechanisms for changes in size- and age-at-maturity?
- Are fewer eggs being deposited than in the past because the size- and age-at-maturity of returning adults in stocks has changed? What is the relative role of different variables affecting fecundity and egg deposition? Do stock-recruit relationships change if they are expressed in units of eggs rather than as aggregate spawning population numbers?
- How should management strategies change to accommodate the changes in reproductive potential of Chinook salmon? Which data are needed to monitor further changes, and which management strategies will be most robust to the inevitable uncertainties of the causes of the decline. Such analyses should be done by independent scientists outside the management agencies to ensure an objective assessment of the problem at hand.

The need to assess and proactively address risks to the most vulnerable Chinook Salmon stocks in the AYK region

We need applied research, monitoring and recovery actions for salmon stocks that address declined stocks to ensure that they *do not become listed on the Federal Endangered Species Act (ESA).*

Considering the very large information gaps combined with steep declines there is an urgent need to address data gaps related to those salmon populations facing declining Viable Salmonid Population parameters that could potentially lead to ESA listing of stocks which are of greatest importance to subsistence fisheries. Each of the major western Alaska rivers support dozens of individual spawning stocks that, in aggregate, make up the runs to the Yukon, Kuskokwim, Nushagak and other large rivers. This collection of populations within each river provides stability to the overall runs but is also critical for producing fish for isolated villages throughout the watersheds.

Recovering and managing at-risk stocks requires an understanding of the genetic and demographic thresholds for population viability as well as the best approaches to risk management. Key information gaps for sustainable salmon management include:

1. Assessing the population viability of smaller currently less productive stocks in the region including assessing risk of overharvest and extinction;
2. Developing approaches to reduce these threats through the implementation of rebuilding actions and risk averse harvest strategies.

Addressing this information gap is critically important for a number of reasons:

- *Proactive measures to conserve small viable stocks are less costly and more effective* than later measures to address stocks at the brink of extinction.
- The AYK region Chinook salmon stocks overall are in a period of low productivity, driving some less productive stocks to new lows.
- Majority of harvest occurs in mixed stock fisheries where the productivity of strong stocks can mask proportionally greater impacts to weak or small stocks.
- Some stocks which are weak producers under one climate regime may emerge as major producers under another regime, highlighting the importance of conserving salmon biocomplexity for long term resilience (*Hilborn et al., 2003*).
- Although small stocks contribute to biodiversity and are most at risk from habitat change, these stocks represent as small proportion of the stocks receiving annual monitoring.
- The focus of management (due to funding shortages) has shifted from tributary escapement goals to a single drainage-wide escapement goal creating greater potential for weak stocks to be overharvested or extirpated without timely detection. A critical information gap is in understanding the consequences of management assuming that each river is a homogeneous collection of fish, when in fact, it is a collection of biologically diverse populations.

Research and monitoring to assess the impact of climate change on salmon and salmon habitat

Western Alaska is one of the fastest warming regions on Earth and recent trajectories of change are predicted to continue for at least the next century. With climate warming comes a loss of snowpack, increased winter flooding, increased erosion, and increased intensities of summer droughts and heat waves. All of these climate-induced changes threaten the productivity and suitability of salmon habitat in western Alaska rivers. Climate change will also alter the productivity of the nearshore ocean and the Bering Sea. In aggregate, changing climate will fundamentally change the nature of salmon habitat in western Alaska and produce changes in population abundance and productivity. New science and monitoring is required to understand the mechanisms and consequences of climate change on salmon and their habitat, and to successfully management these fish in a warmer future.

Particularly pressing science and information needs include:

- Monitoring of river flows and thermal regimes to understand how these change in response to changing air temperature and precipitation patterns. Currently there is almost no dedicated environmental monitoring throughout any of the major rivers in western Alaska
- Monitoring for temperature-mediated disease outbreaks that affect both juvenile fish during rearing and adult fish during migration and spawning
- Monitoring of physical and biological conditions in the nearshore ocean to understand how climate change is affecting early marine survival of salmon smolts
- Assessment of changes in migration timing of adults and smolts in response to changing environmental changes. What is the magnitude of these changes? How are changes in migration best monitored? How should in-season management of salmon adapt to changing migration timing?
- Quantifying the effects of changing climate on stock productivity and, therefore, management reference points for sustaining production from major rivers.
- Evaluation of alternative management strategies for providing the most robust approaches for managing fishery resources in a future with persistent and inevitable uncertainties about climate effects on fish populations.

Loss of key monitoring projects creates additional critical data gaps

For example, a number of critical long-term monitoring projects on the Kuskokwim River—over 60 percent of the high-quality salmon counting projects—have no secure funding from either state and Federal agencies for 2019 forward (Figure 8).

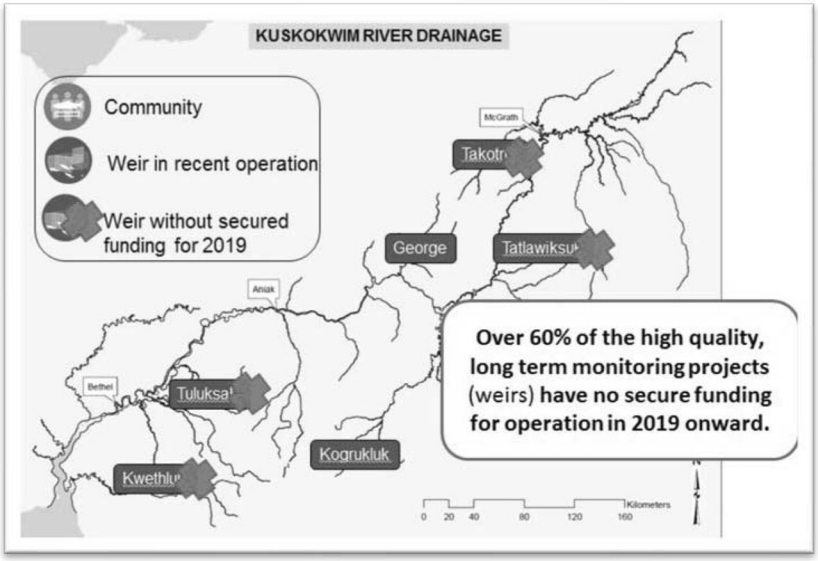


Figure 8: Map of Kuskokwim River salmon monitoring projects using weirs to count returning adult salmon showing long-term projects with & without funding for 2019 onward.

In rivers such as those in western Alaska, which are vast, complex and remote, there will always be substantial uncertainties about the status of the stocks, the causes of population changes, and the consequences of different management actions for achieving the multiple objectives of different stakeholders. It should be required that population models and agency management strategies are periodically and independently reviewed as it is not common practice for management agencies to perform thorough evaluations of how robust their management actions are to these uncertainties. Ongoing climate change will only add to uncertainties about the effectiveness of different management strategies for sustaining populations and allowing a safe level of harvest.

Addressing key information needs in the region is made more challenging by the steep decline in funding awards to Alaska state and tribes from an existing NOAA/NMFS program which has the potential to assist.

PROBLEM: Significant decline in funding to Alaska over the past decade under NOAA's Pacific Coastal Salmon Recovery Fund (PCSRF) Program

- The Pacific Coastal Salmon Recovery Fund (PCSRF) was established by Congress in 2000 to address and reverse the declines of Pacific salmon and steelhead by supporting conservation and recovery efforts in California, Oregon, Washington, Idaho, and Alaska.
- The priority of the program is to *fund projects and activities* that are "necessary for conservation of salmon and steelhead populations that are listed as threatened or endangered, or identified by a State as at-risk to be so-listed, *for maintaining populations necessary for* exercise of tribal treaty fishing rights or *native subsistence fishing,* or for conservation of Pacific coastal salmon and steelhead habitat." (emphasis added)

NOAA's PCSRF recipients in Alaska consist of:

- State of Alaska's Sustainable Salmon Fund

- Arctic-Yukon-Kuskokwim Tribal Consortium (consisting of the tribes represented by the Tanana Chief Conference, Association of Village Council Presidents and Kawerak Inc.)

Despite relative stability in congressional funding levels, the share of the funding allocated to Alaska's PCSRF recipients by NOAA administrators has *dropped from 25 percent of the total in 2007 to ~7 percent in 2016 & 2017 since the competitive grants program began in 2007.* (Figure 9)

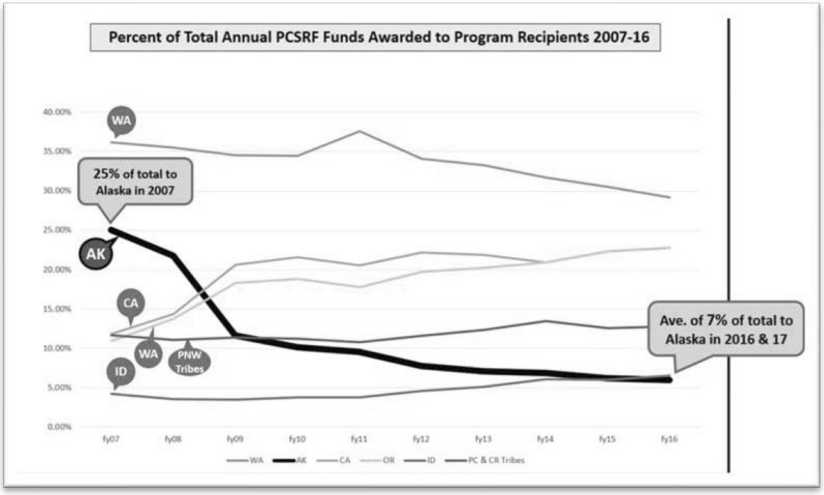


Figure 9: A clear trend of precipitously declined funding to Alaska over the past decade.

The PCSRF is almost exclusively focused on investing on ESA listed stocks. Clearly there is an imminent need for a program which proactively addresses salmon declines in advance of any potential or actual ESA listings.

AYK SSI: A Successful, Unique, Collaborative Solution

Salmon runs of the Arctic-Yukon-Kuskokwim (AYK) region have been critical to the survival of the people and wildlife for thousands of years. Over eighty communities in the region depend heavily on the harvest of salmon, which forms the foundation of their subsistence diet and their cultural identity. However, dramatic declines in salmon runs across the AYK region over the past two decades have led to restrictions on subsistence fishing and closure of many commercial fisheries. As a result, harvest restrictions have created tremendous hardships for the communities in a region with the highest subsistence dependence on salmon in the state, coupled with some of the lowest incomes in the state.

In response to these declines, BSFA and regional Native organizations invited state and Federal agencies to create the Arctic-Yukon-Kuskokwim Sustainable Salmon Initiative (AYK SSI), a proactive science-based program working cooperatively to identify and address the critical salmon research needs facing the AYK region.

Created via a Memorandum of Understanding in 2002, this innovative partnership includes BSFA, the AYK Tribal Consortium consisting of the Association of Village Council Presidents (AVCP), Tanana Chiefs Conference (TCC) and Kawerak, Inc., as well as ADF&G, National Oceanic and Atmospheric Administration (NOAA) Fisheries, and the USFWS.

The AYK SSI is governed by an eight-member Steering Committee (SC) and advised by a six-member Scientific Technical Committee (STC). Current roster of committee members:

Steering Committee	Scientific Technical Committee
Alaska Department of Fish and Game John Linderman, Commercial Fisheries Division Lisa Olsen, Division of Subsistence	**Christian Zimmerman, Ph.D., Chair** United States Geological Survey Alaska Science Center
Association of Village Council Presidents Jennifer Hooper	**Chuck Krueger, Ph.D., Vice-Chair** Michigan State University Center for Systems Integration and Sustainability
Bering Sea Fishermen's Association Karen Gillis, Chair	**Milo Adkison, Ph.D.** University of Alaska Fairbanks School of Fisheries and Ocean Sciences
Kawerak, Inc. Rose Atuk-Fosdick	**Caroline Brown, Ph.D.** Alaska Department of Fish and Game Division of Subsistence
NOAA Fisheries, Auke Bay Laboratories Peter Hagen	**Andrew Munro** Alaska Department of Fish and Game Commercial Fisheries Division
Tanana Chiefs Conference Gale K. Vick	**Daniel Schindler, Ph.D.** University of Washington School of Aquatic and Fishery Sciences
United States Fish & Wildlife Service Aaron Martin, Vice-Chair	

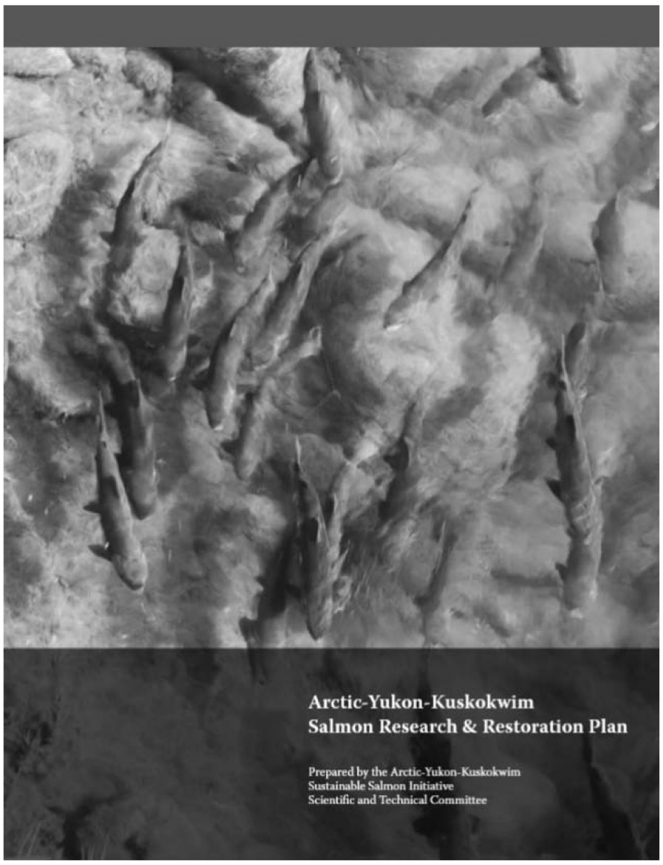
The AYK SSI is truly unique for Alaska and different from other approaches in several important ways.

AYK SSI provides a cooperative forum for addressing research needs

The uniqueness of our program has been recognized as, potentially, the largest example of co-management of research funding addressing salmon within the Pacific Rim and is one of the largest successful experiments in the co-management of fisheries and wildlife research in North America.

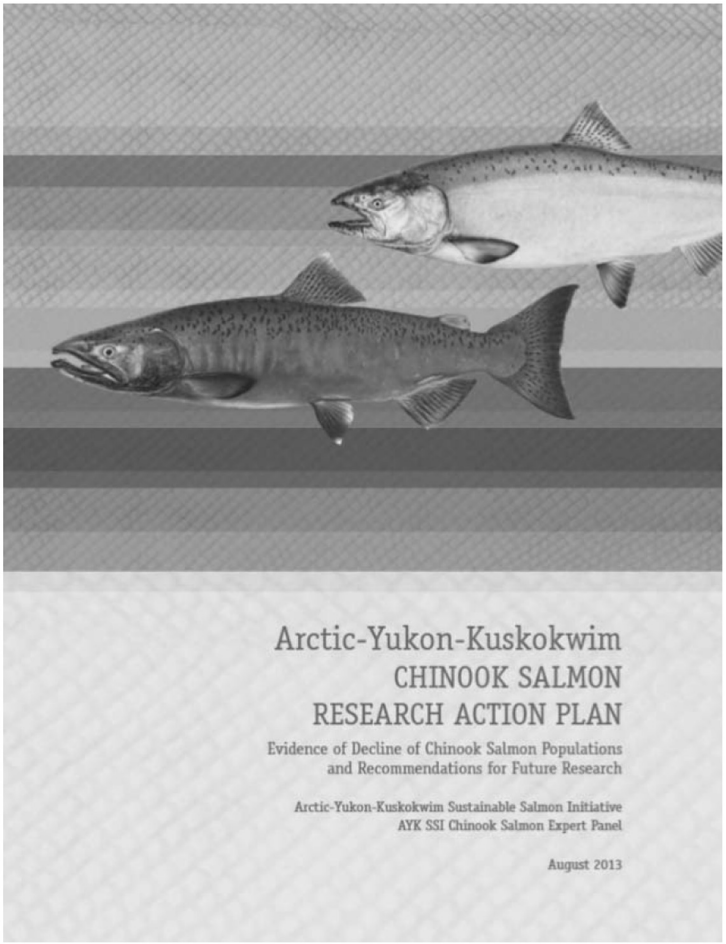
AYK SSI provides coordination and avoids duplication of effort

Projects funded through the AYK SSI address high priority hypotheses and critical uncertainties drawn from our *AYK SSI Salmon Research & Restoration Plan* (RRP). The aim of this long-range, strategic science plan is to identify the conceptual frameworks, research themes and research priorities needed to guide research funded through the AYK SSI. Development of the RRP helps to ensure that available funds are spent wisely and avoids duplication. The RRP draws on the best available science to identify effective ways to investigate and understand the complexity of marine and freshwater ecosystems which support these salmon stocks; identifies significant knowledge gaps, and establishes research and monitoring priorities that complement other relevant programs in the region without duplication of effort. In doing so, the RRP provides a science-based roadmap guiding the AYK SSI's current and future proposal solicitations and ensures that available funds target the highest priority issues and questions. *(Arctic-Yukon-Kuskokwim Sustainable Salmon Initiative (AYK SSI). 2006. Arctic-Yukon-Kuskokwim Salmon Research and Restoration Plan. Bering Sea Fishermen's Association, Anchorage, AK.)*



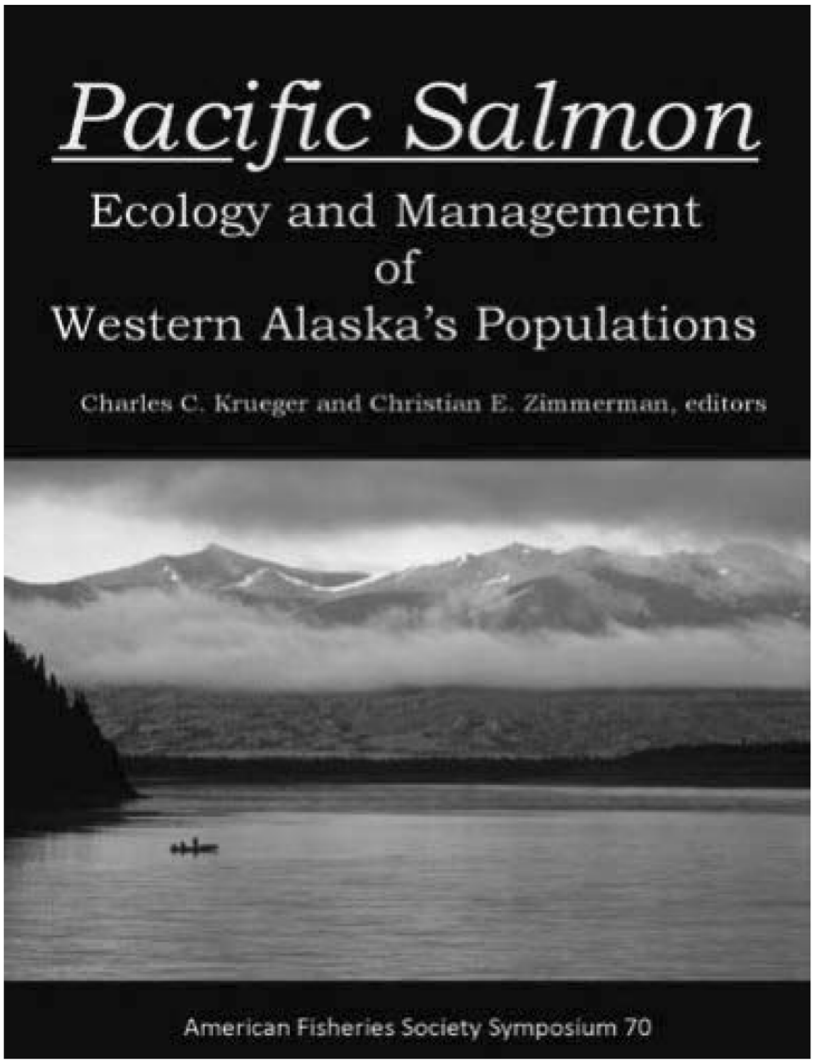
AYK SSI completes implementation-ready AYK CHINOOK SALMON RESEARCH ACTION PLAN to guide research in a coordinated, collaborative way

In 2013, responding to the disastrous decline of Chinook salmon in the AYK region, the specially appointed AYK SSI Chinook Salmon Expert Panel released its research blueprint for addressing failing Western Alaska salmon populations entitled: *"Arctic-Yukon-Kuskokwim Chinook Salmon Action Plan:* Evidence of Decline of Chinook Salmon Populations and Recommendations for Future Research." Our expert panel members included scientists from two divisions within the Alaska Department of Fish and Game, NOAA Fisheries, U.S. Geological Survey, U.S. Forest Service and several universities. For each of the possible drivers of decline, the Chinook Salmon Action Plan provides a description, discussion of the biological plausibility, a summary of the evidence available, and a set of research themes and questions to guide future research. *(Schindler, D.E., Krueger, C., P. Bisson, M. Bradford, B. Clark, J. Conitz, K. Howard, M. Jones, J. Murphy, K. Myers, M. Scheuerell, E. Volk, and J. Winton. 2013. Arctic-Yukon-Kuskokwim Chinook Salmon Research Action Plan: Evidence of Decline of Chinook Salmon Populations and Recommendations for Future Research. Prepared for the AYK Sustainable Salmon Initiative Anchorage, AK). v + 70 pp. Available at https://www.aykssi.org/aykssi-chinook-salmon-research-action-plan-2013/)*



AYK SSI develops a state-of-the-art assessment of salmon stocks and management practices for the AYK region

Pacific Salmon: Ecology and Management of Western Alaska's Populations is a timely book, sponsored by the AYK SSI and published by the American Fisheries Society. It covers the freshwater, estuarine, and marine ecology and management of salmon and is the first-ever comprehensive appraisal of the region's salmon resources. Containing 61 chapters, the book assesses the ecological processes that cause changes in salmon populations; describes the effects of varying salmon runs on rural communities; reviews state, Federal and international management of salmon fisheries in the region; and examines emerging themes at the nexus of salmon ecology and management in the AYK region.



The book includes special sections on the economic, social, and cultural significance of salmon, and on governance associated with salmon management. Reviews of several other fisheries such as those in Washington and Oregon, provide lessons learned elsewhere conclude with recommendations for future research to promote a better understanding of the region's fisheries. *(Krueger, C. C., and C. E. Zimmer-*

man, editors. 2009. Pacific salmon: ecology and management of western Alaska's populations. American Fisheries Society Symposium 70, Bethesda, Maryland.)

The AYK SSI has created an important legacy of improved salmon science and conservation in an otherwise data-poor region with limited scientific capacity. Information from our high priority monitoring and applied research projects has contributed to:

- ✓ An improved understanding by management agencies of the complex relationships between salmon and their freshwater, nearshore and marine environments; and
- ✓ Improved management and recovery of declined salmon populations to better provide sustainable harvest opportunities for subsistence uses.

Our research addresses the full salmon life cycle; integrated marine and freshwater research

Gravel to gravel research focus, the AYK SSI has made important contributions by maintaining its focus on identifying and addressing drivers of decline throughout the entire salmon lifecycle. The AYK SSI is the only program in this large region focused on applied research, conservation, and restoration activities that span the freshwater—estuarine—marine habitats that salmon use throughout their life cycle.

Capacity-Building is a major goal of the AYK SSI's funded research

Our approach to conducting research includes an integrated program to expand the capacity of Native and rural organizations to participate in and lead the salmon research we fund. Principal investigators and their organizations are highly encouraged to demonstrate the ability to create and/or maintain effective relationships with local communities/organizations and a commitment to capacity-building.

We recommend establishing a funding mechanism for the AYK SSI which provides a Native, state and Federal science-based partnership undertaking collaborative salmon research informing the rebuilding and management of declined stocks. Our collaborative partnership has an extensive track record of applied research and restoration activities.

I'm grateful for the opportunity to address you and I look forward to working with you to rebuild and maintain healthy and sustainable western Alaskan salmon stocks.

Senator SULLIVAN. Great. Thank you, Ms. Gillis. Ms. Hoffman.

STATEMENT OF KATRINA HOFFMAN, M.S., PRESIDENT AND CEO, PRINCE WILLIAM SOUND SCIENCE CENTER

Ms. HOFFMAN. Good morning, Senator. My name is Katrina Hoffman. I'm the President and CEO of the Prince William Sound Science Center, which is based in Cordova, Alaska.

Environmental conditions define many aspects of salmon life history, and therefore it's important to measure those conditions in order to evaluate how they drive salmon populations and salmon productivity. Ocean productivity is key to fisheries productivity.

Prince William Sound is home to a salmon industry that's typically worth about 15 million dollars per year in ex-vessel value. It's also the nursery to several hundred million salmon smolts that enter each year from the streams and hatcheries around this periphery.

The environment that salmon smolts encounter is critical to their life history as they proceed to the Gulf of Alaska. We know that environment is changing. The North Pacific in general warming at about a fifth of a degree per decade, and we see that signal repeated in Prince William Sound.

At the same time, the glaciers and ice sheets that surround the Sound are melting and the ocean near those glaciers and glacially influenced rivers are cooling and becoming fresher, and in some

cases more acidic. We don't have a good understanding of what this will do to the marine ecosystem, including salmon populations and productivity. Changes in ocean chemistry, such as ocean acidification, may even influence the ability of salmon to home to their natal streams.

From approximately 2014 to 2016, we did see the North Pacific experience a marine heat wave that you have heard referred to as "the blob." We saw plankton that are more common in Oregon and California becoming present in Alaskan waters, toxin-producing algae blooms up here, and there was a huge die-off of marine birds in Prince William Sound.

We later saw what may be the cascading effects of that blob in our fisheries. As Commissioner Cotten mentioned, the precipitous decline of Pacific cod populations, the 2016 pink salmon run crash, and this year some salmon fisheries in Alaska, including the Copper River fishery, experienced low returns of sockeye salmon, which resulted in restricted fishing opportunity for our communities.

Recently, some of our scientists participated in a two-year working group on ocean and climate effects on salmon. In reviewing available data, they detected effects of ocean temperature and pink salmon numbers on productivity of sockeye salmon populations in the Gulf of Alaska. Their analysis suggests that sockeye exposed to warm coastal waters like the blob in their first year in the ocean were more likely to suffer from competition with other salmon species.

The team also documented slower growth rates of several populations of sockeye salmon in the Gulf of Alaska during years influenced by the blob. In 2016 we conducted a pilot study to examine at-sea foraging strategies of natural-origin and hatchery-origin pink salmon that returned to Prince William Sound. We did this using staple isotopes, which is a way of evaluating their food web interactions.

Food web interactions are important. They can shape salmon body size, overall quality and survival and spawning success. This topic is a major knowledge gap, and it would be valuable to examine in future studies, including high and low run years for pink salmon, as well as sockeye and chum salmon that return to the same regions.

We are also collaborating on a study that looks at the number of days that adult pink salmon are alive and spawning in streams. This is with collaborators at UAF. Stream life is thought to be positively correlated to reproductive success. And this study will assess whether there are differences between salmon that are hatchery and natural in origin and whether those differences are important or can be detected in any way.

Sockeye salmon returning to the Copper River are getting smaller. This winter the science center researchers will initiate a pilot study to explore whether there are trade-offs among sockeye salmon that only swim a short distance upriver versus those that migrate a longer distance. In other words, habitat migration distance potentially affect fat stores, pathogen loads and reproductive fitness. Those relationships are not defined.

Stressful environments have been shown in some studies to magnify the impacts of infectious agents on fish populations. This win-

ter our staff will also use molecular techniques to measure whether and to what extent Copper River sockeye possess certain pathogens that could affect their migration success or spawning success. Very little of this type of work has been done with salmon populations anywhere in Alaska.

With funding from the fishing industry, we provide near realtime data to ADF&G. Our regional seafood development association for the Copper River as well as NOAA have funded us to deploy a pair of imaging sonars in the lower Copper River. We use these sonars to count salmon, and if during the start of the Copper River run, they complement the ADF&G installation several miles upriver. For fish, it's a multi-day run before they hit the ADF&G sonars, and by providing data on salmon escapement that was collected closer to the mouth of the river, the state fisheries managers have the option to use our data along with their own when deciding when to provide fishing opportunities and for how long.

As you know, Copper River salmon is the first major salmon fishery in our state each year that delivers to market. The salmon are very valuable. And each fishing opportunity has the potential to return hundreds of thousands of dollars to over a million dollars to our community alone.

So improving fishing enumeration methods can help maintain sustainable salmon populations while improving economic opportunities for coastal Alaskan communities.

Thank you for the opportunity to testify.

[The prepared statement of Ms. Hoffman follows:]

PREPARED STATEMENT OF KATRINA HOFFMAN, PRESIDENT AND CEO, PRINCE WILLIAM SOUND SCIENCE CENTER AND EXECUTIVE DIRECTOR, PRINCE WILLIAM SOUND OIL SPILL RECOVERY INSTITUTE

Introduction

Good morning Chairman Sullivan, Ranking Member Baldwin, and Members of the Subcommittee. Since our founding in 1989, the Cordova, Alaska-based Prince William Sound Science & Technology Institute (dba Prince William Sound Science Center, and referred to as "the Science Center" or PWSSC) has focused the vast majority of our work on ecosystem research and science education in our heavily spill-affected region. We are the only place-based research and education institute on Prince William Sound, and we now have three decades of experience studying the region. In our first 29 years, the organization has generated more than $90 million in direct expenditures related to our work. We are driven by our vision of communities that maintain socioeconomic resilience among healthy ecosystems.

Cordova remains economically the hardest hit community in the wake of the *Exxon Valdez* Oil Spill. Numerous species have yet to recover from the spill, and environmental conditions, including climate change, are impacting our region—including salmon—in unprecedented and unanticipated ways. To fully understand these changes and to help management agencies and communities adjust appropriately, more long-term research must be conducted in Alaska.

Conclusions from our current research:

- Rapid environmental changes are occurring in Alaska. Unprecedented ocean conditions have characterized the northeast Pacific Ocean in recent years including anomalously warm sea-surface temperatures 2–3 °C above the long-term average, known as the "Warm Blob" or "the Blob".
- We know that Prince William Sound is changing: the North Pacific Ocean in general is warming at about a fifth of a degree per decade, we see that signal in the waters flowing into the Sound from the Gulf of Alaska.
- Glaciers and ice sheets that surround the perimeter of Prince William Sound are melting at rates as high as anywhere else in the world—enough that we see marine waters near those glaciers becoming cooler and fresher as a result of the runoff. This impacts the typical function of the marine ecosystem.

- The recent marine heat wave, colloquially referred to as "the Blob," gives us a hint of what we can expect as the ocean continues to warm. We saw big changes in the surface ocean: productivity was down, nutrients were not used up by living organisms; plankton that are more common off Oregon and California became prevalent in the northern Gulf of Alaska; toxin-producing algae blooms appeared; and there were huge die offs in marine birds and mammals. Recent, unexpected declines in Alaska fisheries, including collapsing Pacific cod populations and historically low returns of salmon in the region, may be cascading effects of the Blob.
- Our research suggests that fish exposed to anomalously warm coastal waters in their first year in the ocean made them more likely to suffer effects from competitive interactions with pink salmon. We have also documented slower growth rate (as measured on scales) of several key populations of sockeye salmon in the Gulf of Alaska during the years influenced by the Blob.
- At-sea food web interactions among natural- and hatchery-origin salmon are important as they can shape salmon body size, overall quality, and survival and spawning success. This topic is a major knowledge gap. We are keen to extend our pilot work with future studies that will examine similar relationships between at-sea foraging and performance correlates, such as body condition, migratory timing, timing of residence in spawning streams, and investment in reproduction, among natural- and hatchery-origin Pink Salmon over multiple years including both high and low run years for Pink Salmon, as well as for Chum and Sockeye Salmon that return to the Prince William Sound region.
- We feel that further study of these issues and reduction of these knowledge gaps is highly relevant to the interests and needs of a variety of salmon stakeholders in the State of Alaska.
- In addition, we believe a new program of research focused on ecosystem shifts, especially those associated with the loss of glacial ice and subsequent ecosystem impacts, including those affecting salmon, is necessary for our region.

Ecosystem Shifts in the Face of Climate Change

Climate change is affecting ecosystems and salmon in Alaska in a variety of ways. One of the most dramatic changes is associated with the loss of glacial ice. The most obvious change is the exposure of new terrain as the glaciers recede. Less obvious, but just as important, are changes in freshwater flow, water temperatures, water chemistry, water clarity, and nutrient supplies downstream of the glaciers. The ecosystems from glaciers to the ocean thus have to adapt to the loss of ice. There is a recolonization of the land by a succession of plants. New lakes, rivers, and streams form that are eventually inhabited by macroinvertebrates and fish, including, potentially, salmon. As glaciers disappear, the source of water shifts from melting ice to snow melt and rain. This leads to altered stream and river flow regimes. The changes in streamflow affect organisms reliant on that water. Changes in freshwater input, minerals, and nutrients carried by the streams or released by glaciers also have impacts on ocean properties and ocean productivity due to changes in ocean chemistry and the physical structure and interactions of different seawater layers.

In the northern Gulf of Alaska region, including Prince William Sound and the Copper River basin, we have glaciers in all stages of loss, and changes in the cryosphere are driving changes in ecosystem function and ocean productivity. For example, the Columbia Glacier is a rapidly retreating tidewater glacier that is exposing miles of new land each decade. We also have hanging glaciers in which the ice is nearly gone, resulting in altered freshwater flow regimes as streams become more influenced by rainfall or rapid melting, flooding, and scouring. The human communities in the region are highly dependent on natural resources, particularly salmon, that must adapt to the changing environment. Changes in ocean chemistry may even influence the ability of salmon to home to their natal streams, and more acid ocean conditions complicate the matter further.

It would be beneficial to support further research focused on these ecosystem shifts, including those associated with the loss of glacial ice. While this is a very large and complex problem, there are many aspects that can be separated that will allow for a series of focused research projects to address the theme in an integrated fashion. Even when focusing on a single species, such as salmon, there is much to learn. The opening of new streams and lakes provide new spawning and rearing habitat. How long does it take for those new habitats to support new fish runs? How does the shift in source of freshwater affect the survival of salmon? Does salmon run timing have to shift with changes in the timing of river outflow cues? There are many unanswered questions. Additional knowledge gained can help humans

continue to utilize the resources in a sustainable manner while adjusting to novel conditions.

Environmental Drivers

The deep waters of the Gulf of Alaska are the northern extent of a huge global conveyor belt that takes about 1,000 years to cycle. This source of seawater, combined with a constant rain of organic material from the surface, results in nutrient-rich waters upwelled to the surface. The nutrients drive the productive marine ecosystems of the Gulf of Alaska region, which in turn drive the many fisheries that are a cornerstone of the Alaska economy. Those deep waters are, however, lacking in one element, iron, a micronutrient that is required by marine producers to take up other nutrients and grow. Iron comes from the weathering of rock, and is present in high concentrations in the freshwater that washes out into the coastal margin of the Gulf of Alaska. In the central Gulf of Alaska, far from shore, iron must be delivered by atmospheric transport of aerosol dust. One potentially large source of aerosol iron from Alaska is glacial flour: the fine, powdery, crushed rock produced by ice grinding on bedrock. Wind storms are able to carry that glacial flour hundreds of miles out into the North Pacific, into the iron-limited region. Such storms are visible in satellite imagery, and in our region, the dust deposited from the Copper River basin into the northern Gulf of Alaska has a measurable effect on ocean productivity. The iron-rich dust provides an injection of nutrients that can support more robust growth of plankton, known as primary productivity. These plankton are the food upon which some salmon prey. There is a delicate interplay between ice, rock, weather, and water that actually supports marine life and salmon fisheries.

We know that the landscapes of our watersheds are changing. Glaciers and ice sheets are shrinking and receding; colonizing plants are moving into those new habitats. Those landscape changes will manifest in the ocean as a change in iron transport, and thus marine productivity. With the initial retreat of glaciers, as we are now seeing, we might expect an initial increase in iron transport as glaciers recede and glacial flour is mobilized. But as those colonizing plants move in, the glacial flour will become bound up in soils, and iron transport will decrease. It is unknown what the impact of this change will be on marine productivity.

Prince William Sound is the nursery to several hundred million salmon smolts that enter it each year from the numerous streams and hatcheries around its periphery. The environment that salmon smolts encounter is critical to their life history as they proceed to the Gulf of Alaska to continue their life cycle. We know that Prince William Sound is changing: the North Pacific in general is warming at about a fifth of a degree per decade. We see that signal in the waters flowing into Prince William Sound from the Gulf of Alaska. At the same time, the glaciers and ice sheets that ring the Sound are melting, at rates as high as anywhere else in the world—enough that we see marine waters near those glacier rivers cooling and becoming fresher. We suspect that this is changing the way the surface oceanography in Prince William Sound works, but don't have a good understanding of what this will do to the marine ecosystem and salmon productivity. Our oceanographic efforts right now are focused on observing Prince William Sound as it changes, using a combination of vessel surveys and automated robotic observations. We are watching how changes in the physical environment are changing the way nutrients move around, how material and energy moves through the food web, and how the major players in the upper trophic levels are responding to these changes.

Observing Marine Ecosystems

We are now able to observe marine ecosystems at unprecedented scales. Every spring, PWSSC deploys a robotic profiling float in the middle of Prince William Sound. It measures temperature, salinity, oxygen, nutrients, and plankton concentrations from a depth of 200 feet to the surface, taking measurements every two inches. The moored profiler does that twice per day. If ocean conditions permit, it will transmit some of that data after every profile. With that profiler we are able to watch the annual cycle of marine productivity in near real time. We see all the nutrients in the surface layer become depleted as the single-celled phytoplankton that drive the base of the marine food web use it up. We are able to watch as different types of zooplankton grazers come and go. Some are important food for species higher up in the food web—the cod, salmon, herring and halibut that consume plankton directly as young fish, not to mention the many other fish, birds and mammals that prey on these plankton consumers. The technology now exists to do this at much larger scales—to monitor the nutrients and productivity that makes up the base of our extraordinarily productive marine ecosystem. Understanding this base of the food web gives us a picture of how much of that productivity will be available to the players higher up in the food web—things like salmon, that in part drive our

region's economy. Tracking every fish in the sea is hard; tracking how much food is available to them is much easier.

The recent marine heat wave, colloquially referred to as "the Blob," gives us a hint of what we can expect as the ocean continues to warm. We saw big changes in the surface ocean: productivity was down, nutrients were not used up; plankton that are more common off Oregon and California became prevalent; toxin-producing algae blooms appeared; there were huge die-offs in marine birds in Prince William Sound. We are now seeing what are likely cascading effects of "the Blob" in our fisheries: Pacific cod populations have collapsed, and there have been historically low returns of salmon in the regions impacted by the Blob.

Salmon Ecology

Via the NCEAS SASAP Working Group (Ocean/Climate effects on salmon), we have detected strong effects of ocean temperature (during 1st year in the ocean) and densities of pink salmon in the ocean on productivity of sockeye populations in the Gulf of Alaska. Further, we found an interaction between these two variables, suggesting that fish exposed to anomalously warm coastal waters in their first year in the ocean made them more likely to suffer effects from competitive interactions with pink salmon. We also documented slower growth rate (as measured on scales) of several key populations of sockeye salmon in the Gulf of Alaska during the years influenced by the Blob.

In addition, we have conducted research via funding we obtained in 2016 through the National Fish and Wildlife Foundation for a one-season pilot study focused on examining the at-sea foraging strategies of natural- and hatchery-origin adult Pink Salmon (Oncorhynchus gorbuscha) returning to the Prince William Sound region of Alaska using stable isotope analysis. This study was an initial effort that extended the work being conducted by the Alaska Hatchery Research Program (AHRP) to begin developing a mechanistic perspective regarding Pink Salmon fitness variation by considering at sea foraging determinants of performance in migration and reproduction. Our results indicate that in 2015, a high run Pink Salmon year, strong relationships existed between muscle δ13C and δ15N stable isotope values and the body size of Pink Salmon, with hatchery-origin Pink Salmon being smaller than natural-origin fish. However, relationships were not evident between marine foraging and body condition (size corrected body weight) of either natural- or hatchery-origin Pink Salmon. On-going analysis is examining relationships between tissue-specific stable isotope values and investment in reproduction such as gonad weight, fecundity and egg size.

Additionally, this pilot study begins to fill a major knowledge gap regarding overlap in at-sea food preferences by natural- and hatchery-origin Pink Salmon as density dependent impacts of ocean ranching practices in Alaska, particularly those occurring at-sea, have not been extensively considered and are not specifically addressed by the AHRP research program. At-sea food web interactions among natural- and hatchery-origin salmon are important as they can shape salmon body size, overall quality, and survival and spawning success. This topic is a major knowledge gap and PWSSC researchers are keen to extend our pilot work with future studies that will examine similar relationships between at-sea foraging and performance correlates, *i.e.,* body condition, migratory timing, timing of residence in spawning streams, and investment in reproduction, among natural- and hatchery-origin Pink Salmon over multiple years including both high and low run years for Pink Salmon, but also similar relationships for sympatric Chum and Sockeye Salmon returning to the PWS region. Salmon food web relationships were recently highlighted as key, needed information. Thus, we feel studies such as ours are highly relevant for filling knowledge gaps that are currently of interest to a variety of salmon stakeholders in the State of Alaska.

Through funding support by Alaska INBRE (Idea Network of Biomedical Research Excellence) at the University of Alaska, PWSSC researchers are currently engaged in a pilot study that is exploring ecological dynamics between reductions in the body size of adult Sockeye Salmon (O. nerka) returning to spawn in the Copper River, Alaska, and energy density, pathogen loads, and reproductive fitness trade-offs among short and long distance Sockeye migrants.

Rapid environmental changes are occurring in Alaska. Unprecedented ocean-climate conditions have characterized the northeast Pacific Ocean in recent years including anomalously warm sea-surface temperatures 2–3 °C above the long-term average. The impacts of ocean acidification are exacerbated in Alaska. In the Gulf of Alaska region, cold water temperatures and significant freshwater input from glacial discharge can influence alkalinity and carbonate ion concentrations in seawater, which has important implications for the structure and function of marine food webs. Stressful environments can magnify the impacts of infectious agents on fish

populations. Recent scientific reviews highlight the increasing concern for understanding how environmental change might alter the severity or distribution of diseases in aquatic animals. It is notable that research focused on infectious agents has not been widely conducted on Alaskan salmon stocks, despite extensive hatchery aquaculture practices and the importance of robust salmon populations to Alaskan livelihoods.

To this end, PWSSC researchers are conducting pilot research that is a first of its kind for the State of Alaska by employing a recently developed, high throughput, molecular microfluidics approach to quantify globally-significant pathogens such as viruses, bacteria, fungal and protozoan parasites in Sockeye salmon of the Copper River. Copper River Sockeye are an economic cornerstone of the commercial salmon fishery in southcentral Alaska and also sustain active subsistence fisheries in the upper reaches of the watershed, some of which are moderately enhanced by the Gulkana hatchery. Since the mid-1990s, there has been a notable long-term decline in the size at age of adult Sockeye returning to the Copper River, with marked declines in body size occurring in recent years (2015–2018). Recent reductions in body size of returning adult Copper River Sockeye has coincided with an unprecedented oceanic heatwave throughout the northeast Pacific Ocean. Body size and energy density of adult Sockeye have been negatively related to warmer sea surface temperatures during the last year of ocean residency, and recent studies have confirmed growth impacts to Sockeye due to density-dependent competition at-sea. Research on salmon in British Columbia, Canada, has already revealed striking relationships between physiological variation and survival during spawning migration by Sockeye of the Fraser River, possibly as a result of viral infection. Thus, our pilot research aims to couple physiological variation in returning Copper River Sockeye, with information on the diversity and loads of pathogens that these fish carry to understand mechanisms contributing to spawning migration success and performance. This initial work on salmon pathogens will lead to important future research to be conducted on all salmon species in Alaska and at various life stages from young emerging in freshwater systems, to adults during their ocean residency and return spawning migration.

Finally, we are looking at reproductive traits in wild and hatchery pink salmon in PWS via a University of Alaska-Fairbanks collaborative study. In two streams in western PWS, we are quantifying stream life (the number of days adult pink salmon are alive and spawning in streams) and determining if there are differences among individuals that differ in their origin (natural- or hatchery-origin). Stream life is thought to be positively related to reproductive fitness. We conducted a pilot project in a single stream in 2017, and executed a full field program in 2018 in two separate streams. Results will be included in a UAF thesis. This work is important in that it may elucidate mechanisms that could explain fitness differences, and thus complements the larger AHRP effort.

Other Work

Salmon Monitoring For Management

The Science Center, in collaboration with the Copper River/Prince William Sound Marketing Association (a Regional Seafood Development Association funded by Area E permit holders) and with recent support from the NOAA Saltonstall-Kennedy program, deploys a pair of imaging sonars in the lower Copper River delta to count salmon during the start of the Copper River run. The sonars complement ADF&G sonars several miles up river and give state fisheries managers near real-time information on salmon escapement that they can use when deciding on the timing and duration of fisheries opportunities. Copper River salmon are the first major salmon fishery to market, and early season fish are exceedingly valuable. Each fishing opportunity generally means several hundred thousand, to over a million dollars added to the local economy alone.

ADF&G AHRP (H–W) Project

PWSSC just completed the 6th year of field sampling under contract to the ADF&G. This work included test fishing at the PWS entrances (Hinchinbrook and Montague) in addition to monitoring in over 30 streams across PWS. The focus of the project was on quantifying the fraction of hatchery-origin pink and chum salmon in the run (entering PWS) and in the spawning populations in streams. This work resulting in the most rigorous assessment to date of the scale and magnitude of straying of hatchery-origin salmon in this ecosystem. The project also involves sampling tissues to assemble DNA-based pedigrees to compare relative reproductive fitness in pink salmon families whose parents differ in origin. This work will provide some insight into whether families composed of hatchery-origin parents are less fit than those completing their entire life cycle in natural habitats. PWSSC have pro-

duced annual reports on this project (posted on the ADF&G website) and we are currently finalizing two manuscripts (on PWS and SE Alaska) that will be reviewed by the AHRP Science Panel and submitted to a scientific journal for peer-review.

Salmon Under Climate Change Impacts

The plumes of meltwater that stream out from tidewater glaciers are a double threat for ocean acidification: They do not contain much calcium or carbon dioxide. Being calcium poor, meltwater tends to be corrosive to calcium in general, and being low in carbon dioxide means that when those water do take up carbon dioxide from the atmosphere, they tend to become even more acidic as the carbon dioxide is converted to carbonic acid. That is bad news for any marine organism with a calcium carbonic shell, because their shell will be dissolved by those acidic waters. Prince William Sound alone has lost many cubic kilometers of ice in the last two decades, and glaciers and ice sheets continue to recede; this problem can be expected to get worse, not better as time passes.

The productivity in the marine ecosystem of the Gulf of Alaska each year is set up in part by the size and duration of the "spring bloom": an explosion of growth by primary producers that proceeds until all the nutrients in the surface waters are used up. The size of that spring bloom in many ways sets up the amount of production that will make its way into higher trophic levels like fish. A better understanding of the timing and magnitude of that bloom will give us a better idea of the state of the ecosystem, and improve our ability to forecast fisheries productivity.

Conclusion

Rapid environmental changes are occurring in Alaska. Unprecedented ocean conditions have characterized the northeast Pacific Ocean in recent years including anomalously warm sea-surface temperatures 2–3 °C above the long-term average. We know that Prince William Sound is changing: the North Pacific in general is warming at about a fifth of a degree per decade, we see that signal in the waters flowing into the Sound from the GOA. Our research suggests that fish exposed to anomalously warm coastal waters in their first year in the ocean made them more likely to suffer effects from competitive interactions with pink salmon. We also documented slower growth rate (as measured on scales) of several key populations of sockeye salmon in the Gulf of Alaska during the years influenced by the Blob. We feel more studies are highly relevant for filling knowledge gaps that are currently of interest to a variety of salmon stakeholders in the State of Alaska. In addition, we believe a new program of research focused on the ecosystem shifts, especially those associated around the loss of glacial ice and related to salmon, is necessary for our region.

As part of this research, we believe that to truly get a picture of what is happening we need to take in place measurements at different depths—not just remote-sensing. This will allow us to understanding interactions between wild and hatchery salmon—in PWS and GOA and on the spawning grounds. This needs to be broad, and include oceanographers, ecologists, pathologists, geneticists, fishery managers, and hatchery operators. More work on key fitness components (spawning, hatching and early life history, resistance to pathogens, etc.) should be undertaken to help elucidate any differences that might exists between wild, natural-origin, and hatchery-origin salmon in PWS. We must also look at ocean effects on salmon—growth and competitive interactions at sea. NOAA has substantial resources, and groups like PWSSC could collaborate, focusing on linkages between PWS and GOA, for example. In addition, we must look at migratory and reproductive performance of salmon in changing river conditions, including glacially-influenced rivers like the Copper or smaller coastal streams like many in PWS, while also engaging economic studies of salmon management practices, to maintain our regional resilience and presence as a global leader in salmon management.

Thank you.

Senator SULLIVAN. Great. Thank you, Ms. Hoffman. Ms. Peltola.

STATEMENT OF MARY SATTLER PELTOLA, EXECUTIVE DIRECTOR, KUSKOKWIM RIVER INTER-TRIBAL FISH COMMISSION

Ms. PELTOLA. Thank you, Senator Sullivan. My name is Mary Peltola. I'm the Executive Director of the Kuskokwim River Inter-Tribal Fish Commission. The fish commission is a consortium of all

of the 33 federally recognized Alaska Native tribes located along the Kuskokwim River.

In February 2016, the Kusko Fish Commission entered into a Memorandum of Understanding with the U.S. Fish & Wildlife Service to cooperatively manage the Kuskokwim River Chinook salmon stocks and to ensure more self-determined management structure.

The fish commission has four in-season managers who, together with the Federal and state managers, make important in-season decisions about fishing openings and closures. Our in-season managers have fished on the Kuskokwim River for decades and bring a wealth of traditional knowledge to the table. Traditional knowledge is rarely used by managers who favor western scientific models and data sources.

While there is a role for western science and traditional knowledge in co-management, traditional knowledge fills informational gaps that can otherwise confound in-season management decisions. Traditional knowledge also makes adaptive management possible. By integrating traditional knowledge into existing western management regimes, we hope to pioneer a better approach to fisheries co-management.

Traditional knowledge means having a detailed and deep understanding of an ecosystem and using that understanding to help you make informed decisions about where and when to use that ecosystem's resources.

For example, this summer the Kuskokwim River had a later Chinook run. Rather than coming in in late May or early June, Chinook started to come back in mid-June. And we see this trend not only with Chinook salmon, but many other species of salmon, as well as migratory birds. The moose this year were about 2 weeks late in coming down to the banks. We see it with insects and plants, as well.

By the last week of June, Kuskokwim subsistence fishermen had had only two chances to fish and June is usually—has traditionally been unrestricted, and that's when we put up all of our fish. Western science cannot accurately predict run timing or what percentage of the run has passed at a given location.

One of the Kuskokwim River Inter-Tribal Fish Commission's in-season managers, James Nicori, relied on his traditional knowledge to help answer these questions. James predicted that more Chinook were coming because he knew that when catches are successful on the Kuskokwim side of the river in front of his fish camp and unsuccessful on the Kuskokwak Slough side, it is still early in the run.

As of June 22, James had observed fishermen catching on the Kuskokwim side, and skunking on the slough side. To him, this meant that we were not yet halfway through the run.

Federal and state managers were reluctant to accept James' knowledge because no proven or scientific or reliable data supported it. But the fish commission firmly recommended additional opportunity based on this traditional knowledge, and two limited openings were held on June 24 and on June 29. People were able to fish, and the additional chances did not compromise overall escapement goals.

In another example of traditional knowledge, in 2014, I asked my uncle, Phillip Noes, to teach me how to use a set net. He only asked me one question: What do you want to catch? I said sockeye—we call them reds on our river—and I did not want to get any kings, or Chinook. In early June we went to the mouth of the Gweek River, and he showed me exactly how to set the net. Each day when I checked the net, 85 to 95 percent of the fish in it were sockeye, and I only caught one Chinook that summer.

Traditional knowledge is also essential to effectively addressing climate change in the Kuskokwim River region and its effect on our natural resources. Climate change impacts our lands, waters and natural resources. Because of climate change, we cannot harvest enough Chinook to meet our nutritional needs.

Traditional knowledge represents the most significant data set of systemic observations to our ecosystem. Using traditional knowledge to address climate change ensures that our responses have the necessary adaptivity and flexibility.

I urge Congress to support and create additional legislative, administrative and funding opportunities for our tribes to fully co-manage our important resources on an equal footing with our Federal and state partners. The only effective way to co-manage our resources is by fully integrating our traditional knowledge into co-management.

I would also ask you to seriously consider moving the Federal subsistence program out of its current location.

And I really appreciate this opportunity to speak in front of you. Thank you.

[The prepared statement of Ms. Peltola follows:]

PREPARED STATEMENT OF MARY SATTLER PELTOLA, EXECUTIVE DIRECTOR, KUSKOKWIM INTER-TRIBAL FISH COMMISSION

My name is Mary Peltola. I am the Executive Director of the Kuskokwim Inter-Tribal Fish Commission (KRITFC). I am originally from Kwethluk, Alaska, a small Yupik Alaska Native Village located on the Kuskokwim River. I have been fishing with my family on the Kuskokwim in our traditional ways for my entire life. Our fishing—when we fish, where we fish, how we fish—has always been informed and managed by our traditional knowledge. For thousands of years, our traditional knowledge protected our salmon stocks and helped ensure healthy runs and returns. However, despite an agreement with the U.S. Department of Interior (DOI) that provides our tribes with a role in the co-management of traditional subsistence fisheries on the Kuskokwim, our traditional knowledge is continually sidelined and minimized in favor of Western scientific models and data sources championed by Federal and State administrative structures and policy priorities. The failure to acknowledge and fully integrate our traditional knowledge undermines our tribes' efforts to protect our salmon stocks and preserve our traditional ways of life. I will first describe the KRITFC and how it utilizes traditional knowledge in its co-management of Chinook salmon stocks in the Kuskokwim River, and will then recommend how Congress can support and create additional legislative, administrative and funding opportunities for our tribes to fully co-manage important resources in Alaska. I will also recommend how Congress can recognize the value of traditional knowledge and its importance in improving resource management outcomes, including addressing salmon management in the face of climate change.

For about a decade now, our Kuskokwim Chinook salmon stocks have been crashing. The consequences are disastrous. We depend on Chinook salmon for our nutritional, spiritual, and cultural well-being. In May 2015, the KRITFC was formed as a consortium of all of the 33 federally-recognized Alaska Natives tribes located along the Kuskokwim River to address the crisis facing our Chinook salmon. This historical unity of the tribes was driven by our understanding, and insistence, that we must have at least a co-management role if our Chinook salmon stocks and our traditional ways of life were to survive in the face of drastically reduced Chinook re-

turns. Each tribe appoints a Commissioner to the KRITFC which is authorized to make decisions on behalf of that Tribe. The Commissioners, in turn, select seven of their own members to serve on an Executive Council that is responsible for making larger governance and strategy determinations for the KRITFC. The KRITFC, and the Executive Council, strives to achieve consensus in all decisions. The KRITFC also selects four In-Season Managers from four different regions along the Kuskokwim River (Upper, Middle, Lower, and Lowest) who, together with Federal and State managers, participate in making important in-season decisions about fishing openings and closures. In-Season Managers bring a wealth of traditional knowledge to a conversation otherwise dominated by Western scientific principles.

In February 2016, the KRITFC entered into a Memorandum of Understanding (MOU) with the U.S. Fish and Wildlife Service (FWS). The MOU was designed to enable the KRITFC, together with FWS, to cooperatively manage Kuskokwim River Chinook salmon stocks to ensure a stronger, more self-determined management structure, help address conservation issues so that the run could recover, and to avoid the burdensome administrative process. Working with FWS, the KRITFC has consistently and unanimously agreed to voluntary fishing restrictions to protect Kuskokwim River Chinook salmon stocks. The KRITFC also uses its collective traditional knowledge and expertise concerning the Kuskokwim River to develop culturally appropriate conservation management plans.

Since inception, the KRITFC has aspired to integrate traditional knowledge in the development of management plans for the Kuskokwim River, and to jointly implement these management plans with FWS and, when possible, the State of Alaska. It is also the KRITFC's goal that once a management plan is agreed to, and consistent with conservation, our tribes will be clearly empowered to implement and enforce that plan for their rural tribal members. Only when traditional knowledge is fully integrated into management of Chinook salmon stocks, and we are fully able to implement and enforce management plans throughout our tribes, will there be true co-management. Co-management of whaling through the Alaska Eskimo Whaling Commission is clear evidence that fully incorporating Alaska Natives and their knowledge into management of subsistence uses and resources is essential for conservation and to continue the traditional and cultural well-being of Alaska Natives.

However, the KRITFC's ability to achieve its goals for full co-management authority is frustrated under existing Federal and State subsistence management programs. Throughout its 702-mile long course, the Kuskokwim River runs through both Federal and State lands and is subject to the management jurisdictions of both entities. Under the Alaska National Interest in Lands Conservation Act (ANILCA), Federal managers are required to prioritize non-wasteful subsistence uses of fish and wildlife resources, such as Kuskokwim River Chinook salmon, by Alaska's rural residents, including KRITFC's rural tribal members. If conservation concerns require Federal managers to restrict people from hunting or fishing from a certain stock, they must consider a user's customary and direct dependence upon the resource as the mainstay of livelihood, the user's local residency, and the availability of alternative resources before any restrictions are put in place. ANILCA helps to ensure that the people who depend on a resource the most have the best opportunity to harvest that resource.

By contrast, State law prohibits prioritizing subsistence uses of fish and game resources for Alaska's rural residents. Instead, State managers must provide all Alaskans, regardless of whether they live in a rural village where food is costly and scarce or in an urban city where food is plentiful and relatively affordable, with equal access and opportunity to take fish and wildlife resources. Realistically, the State's "all-Alaskans" policy means is that a person who works and lives in Anchorage is provided with the same opportunity to fish for Kuskokwim River Chinook salmon as an elder subsistence user living in Bethel who is unemployed and depends on the nutrition provided by Chinook salmon to make it through the winter without going hungry.

These conflicting management regimes create serious problems that restrict our tribes' subsistence opportunities and impede our ability to fully engage in our traditional subsistence ways of life and to be fully self-determined in our engagement. Despite these obvious conflicts, and despite the fact that Federal management is required to prioritize subsistence opportunities for rural residents, it is the FWS policy to defer to state management of the Kuskokwim River whenever possible. Unless FWS agrees that there is a conservation concern or a threat to subsistence uses, the agency stands aside while the State manages the Federal portion of the Kuskokwim River through State regulations governed by its diluted "all-Alaskans" policy and its bias towards commercial fisheries. This is routinely done over the KRITFC's objection, and to the obvious detriment of rural subsistence users. It is also contrary to the intent of the MOU that KRITFC entered into with the FWS.

Neither Federal nor State management regimes recognize our right as a matter of policy or law to manage our fish and wildlife resources. The fact that we do not reside within reservations is used as an excuse to sideline tribal co-management. And, because we do not have a direct role in either the Federal or State management systems, our traditional knowledge is sidelined and takes a backseat to the empirical data and assumptions informed by the Western science favored by Federal and State managers, despite the fact that we have successfully managed this river with our traditional knowledge for thousands of years.

Since before contact with Russian traders and missionaries, and certainly before statehood, we were stewards of this resource and successfully managed the harvest and conservation of our Kuskokwim River salmon stocks according to our traditional Yupik and Athabascan rules and values. These rules and values are not difficult to understand: provide for children, the sick, and the elderly first. Only catch what you can eat, and share what you cannot. Treat all resources with respect. Co-management is not true co-management without full acknowledgement and integration of our traditional knowledge into the management of our Chinook salmon.

While each KRITFC member tribe has a unique relationship with the Kuskokwim, we are all unified by the vitally important role salmon—in particular, Chinook salmon—plays in our nutritional, cultural, and spiritual well-being. We are further unified by our bounty of traditional knowledge and expertise about effectively managing and protect our Chinook salmon stocks in the face of diminishing returns and the unpredictable effects of climate change. Our traditional knowledge helps us understand who we are and how to act to ensure future success for our children and communities. Traditional knowledge guides our customs, ceremonies, cultural practices, and our individual behaviors to ensure that respect is shown to the land, water, and natural resources upon which our people depend.

While I personally do not think that Western science values traditional knowledge in the same way that it values empirical data, there is increasing interest in and attention being paid to traditional knowledge in the context of resource management. However, many people misunderstand traditional knowledge or are confused by what it means. Traditional knowledge is holistic. The quality and behavior of one species can be used as an indicator of presence and abundance of a completely different species. What one thinks, what one says, and what one does, all has the potential to impact or influence another aspect of one's world. Wasting a resource or treating a resource disrespectfully incurs consequences for the individual, those around them, as well as the resource. In comparison, the western way of knowing is compartmentalized and specialized, some might say narrow. A western scientific observer may study a particular aspect of the world, like salmon run-timing and abundance, take notes, gather data, test hypotheses, confirm or formulate new theories, and develop a predicted salmon run forecast for the next season based on mathematic models.

Some academics understand traditional knowledge as "a living body of knowledge which pertains to explaining and understanding the universe and living and acting within it. It is acquired and utilized by indigenous communities and individuals in and through long-term sociocultural, spiritual and environmental engagement. TK is an integral part of the broader knowledge system of indigenous communities, is transmitted intergenerationally, is practically and widely applicable, and integrates personal experience with oral traditions. It provides perspectives applicable to an array of human and non-human phenomena. It is deeply rooted in history, time, and place, while also being rich, adaptable, and dynamic, all of which keep it relevant and useful in contemporary life. This knowledge is part of, and used in, everyday life, and is inextricably intertwined with peoples' identity, cosmology, values, and way of life. Tradition—and TK—does not change, nor does it equal only 'the past'; in fact, in inherently entails change." [1]

I understand traditional knowing as having a detailed and deep understanding of an ecosystem and using that understanding to help you make informed decisions about where and when to use that ecosystem's resources. For example, in 2014, my mom's younger brother taught me how to use a little set net to fish for red (sockeye) salmon. We went to the mouth of the Gweek River, a small tributary of the Kuskokwim River north of Bethel, where his grandparents had their fish camp. He knew exactly where to put the net to catch 95 percent sockeye (Reds) and avoid Chinook salmon. Many biologists and fisheries managers imagine that gill nets are indiscriminate killers of fish. But if you know where each species tends to swim, if they prefer sandbars, slower currents or deeper depths, gill nets can be a very tar-

[1] Raymond-Yakoubian, Julie, Brendon Raymond-Yakoubian and Catherine Moncrief. 2017. *The incorporation of traditional knowledge into Alaska Federal fisheries management.* Marine Policy 78: 132–142.

geted and discreet gear type. I know this from experience: I only caught one Chinook in the set net that summer.

My friend Charlie Wright, who lives on the Yukon River, told me that on his section of the Yukon, an indicator of the arrival of Chinook salmon is yellow butterflies. When he sees a yellow butterfly, he knows the Chinook salmon are there. He also said the abundance of yellow butterflies reflects the abundance of Chinook salmon. In 2017 when the Chinook salmon came back in real numbers, there were big swarms of butterflies again. These interconnections are inherent to indigenous knowledge systems and represent a very different way of viewing the relationship between human beings and the natural world compared western science.

Traditional knowledge should not need to be "proven" by Western scientific methods and ways of knowing before it is considered in making resource management decisions, but oftentimes, our traditional knowledge is disregarded in favor of western scientific predictions and models. For example, in 2017, the KRITFC and FWS agreed on a conservative harvest of 40,000 Chinook salmon during pre-season negotiations and meetings. This harvest estimate was based upon the State's estimated Chinook returns—estimates based wholly on western science.

However, when the run actually started FWS and the KRITFC disagreed about its size and timing. Western science indicators used by UFWS suggested that the Chinook run was weak, whereas real-time traditional knowledge suggested that the Chinook run was strong but returning in ways—running deeper in the river, and returning later in the summer—for which western science could not account. At the end of the summer, the post-season escapement numbers confirmed that the traditional knowledge advanced by the Commission was correct, and there was a surplus of at least 10,000 Chinook salmon. While the conservation of these fish was important, those 10,000 fish represent lost subsistence opportunity and food security for hundreds of our tribal members. Had our traditional knowledge been fully acknowledged and recognized, we would not have lost important subsistence fishing opportunity.

There is a role for both Western science and traditional knowledge in the co-management of Kuskokwim River Chinook salmon stocks. The KRITFC strives to make all management decisions using the best available data. Oftentimes, that best available data is our traditional knowledge. Traditional knowledge fills informational gaps that can otherwise confound in-season management decisions. By integrating traditional knowledge into existing Western management regimes, the KRITFC hopes to pioneer a more complete, accurate, and holistic approach to fisheries management.

KRITFC's In-Season Managers all value the empirical data that is presented by our State and Federal managing partners in support of their management decisions. However, these tribal managers also recognize the value of traditional knowledge and are skilled at incorporating traditional knowledge into resource management decision-making in order to strengthen the end result. For example, upon receiving a mathematical forecast of the anticipated salmon return, our In-Season Managers will also use other traditional information before advising people on when and how long to fish. These additional considerations include observations about river water levels, snow depth of the previous season, height of grasses, when shoots of green grass emerge, numbers of migrating birds arriving and when they arrive, where people have been catching certain kinds of fish and which stock of fish are presently migrating, the nature of and direction of winds at the river mouth, when cotton flies, when there are storms in Kuskokwim Bay, river water temperatures, water clarity, amount of debris floating downriver, anticipated fishing interests, and fish-drying weather conditions, and the effect that these interconnected observations have on one another insofar as fisheries management is concerned.

There are a number of other ways in which the KRITFC uses traditional knowledge to improve management decisions and outcomes on the Kuskokwim River. A few years ago, the Bering Sea Fisherman's Association (BSFA) designed and began implementing a community harvest data monitoring program. This program trains people from local Kuskokwim communities to collect real-time harvest data from subsistence fishermen and women either as they fish, or immediately thereafter, to gauge the size, strength, and timing of Kuskokwim River Chinook salmon runs. Recently, the KRITFC partnered with BSFA to help implement this program. The KRITFC then uses the information reported by BSFA's community monitors to inform its management decisions. The KRITFC firmly believes that the knowledge of our local fishermen and women is one of the best and most accurate sources of in-season information we have. Their individual experiences and observations of fishing conditions are a unique and essential source of traditional knowledge that we rely on heavily during the fishing season.

The KRITFC's use of information collected through the Bethel Test Fishery is another example of how the KRITFC blends empirical data with traditional knowledge to improve management outcomes. Every year, the State of Alaska's Bethel Test Fishery (BTF) helps to monitor the strength and timing of Kuskokwim River Chinook salmon run. The number of Chinook salmon that pass through the BTF each day during the season is used as an indication of the run's health, strength, and timing. As with the data provided by BSFA's harvest monitoring program, data collected by the BTF plays a critical role in the KRITFC's in-season management decisions.

Traditional knowledge is also essential in any study of climate change in the Kuskokwim River region and how climate change is affecting our natural resources. Traditional knowledge represents the most significant data set of systematic observations of our ecosystem. Though the KRITFC lacks the resources to conduct "formal" climate change studies demonstrating how climate change is affecting our subsistence resources, by the measure of the traditional knowledge used and recognized by our elders, it is evident that climate change is making it more challenging to predict weather, river conditions, and fish and wildlife behavior. Our tribal elders are observing changes in weather, temperature, river water levels, returning species, and other indicators of natural resource status, health, changes which all suggest that climate change and the coincident escalation of global temperatures is having a detrimental effect upon our subsistence resources—which, in turn, has a detrimental effect upon our physical, psychological, and spiritual well-being.

As this Subcommittee is aware, climate change has a broad range of impacts upon the lands, waters, and natural resources of Alaska. From milder, drier winters to warmer, wetter summers, these impacts change our physical landscape right before our eyes. These impacts also affect health and strength of the natural resources we depend on, as well as the lives and health of our tribal members. We need secure, dependable funding in order to build our capacity and commit to monitoring the effects of climate change. Additional congressional appropriation is one of the only ways to secure this necessary funding.

It is difficult to know the full extent to which climate change has affected the health and bounty of Kuskokwim River Chinook salmon stocks. But recent years of disastrously low Chinook salmon returns have deeply impacted our emotional, nutritional, economic, social, and spiritual well-being. We are no longer able to harvest enough Chinook salmon to meet our nutritional needs throughout Alaska's long and harsh winters. When our families can barely feed themselves, it then becomes additionally challenging for us to engage in our traditional practices of sharing and trading food resources with our friends and family who cannot otherwise provide for themselves. The Commission believes that the negative effects of climate change have contributed to, and even created, an ongoing scarcity of essential resources, which in turn is causing an ongoing crisis in our tribal communities as we lose our food security and watch one another suffer.

My recommendation to the Subcommittee is simple: support and create additional legislative, administrative and funding opportunities for our tribes to fully co-manage important resources in Alaska. Recognize the value of traditional knowledge and its importance in improving resource management outcomes, including addressing salmon management in the face of climate change. The diluted form of tribal "cooperative management" that the State and FWS seek to foster may serve to protect their perceived roles as the "primary" management authorities. This failed model, however, will not serve either the salmon or subsistence users moving into the future. The only way to fully integrate traditional knowledge, and secure a partnership with the primary salmon harvesters on the Kuskokwim, is to establish, in law, a co-management structure that integrates the KRITFC as an equal with the State and FWS.

Senator SULLIVAN. Great. Thank you. Thanks again to all the witnesses. Again, I think you see the expertise that's aligned here.

So let me ask a very basic question. Well, really two. Hopefully you got to see the first panel. But you know, I didn't get a sense that a lot of them thought there were a lot of data gaps, and I get the sense that you think that there are a lot of data gaps. And that's fine. That's why we are having two panels and getting the views of everybody.

So let me open this up to all the panelists. You know, what would you consider the top data gaps, you know, top two or three that we need to focus on, Federal, state, but mostly Federal here?

And then a second question. Why don't we just start with that question. Then I'll go to the second one. I'll just open it up to any of you.

Yes, Ms. Hoffman.

Ms. HOFFMAN. That's an opportunity to put in a pitch for the value of oceanography because, as you heard the first panel mention the phrase ocean conditions, ocean conditions, and ocean conditions.

Senator SULLIVAN. Right.

Ms. HOFFMAN. The challenge with the ship-based monitoring that they mentioned is that it's very limited temporally and spatially. You go out on a vessel for about a week, maybe more, maybe less, and in that time you collect data. Satellites can collect data on much greater time scales, but it's not very fine in resolution.

So we have in Alaska the opportunity to improve ocean observing systems through both moored and autonomous devices. For example, the Prince William Sound has an autonomous moored profiling robot that's stationed in the central Prince William Sound. It does two runs a day between zero feet and 200 feet of depth, and in that run it collects all kinds of chemical, physical and biological data. It appears at the surface and pings that data to us via a cell tower. We can control it remotely. And——

Senator SULLIVAN. How far out in the ocean can that go, like how many miles off the shoreline?

Ms. HOFFMAN. We have this moored just to the east of Naked Island, but you can moor devices in potentially any location, as well as devices that operate autonomously without any moorings that are transiting the ocean environment.

And although it is expensive to instrument these and they do need to be maintained from time to time, we installed this device in the ocean in March and we remove it sometime between October and December. That allows us to capture the spring bloom, the fall bloom, and to detect the zooplankton that are prey for forage fish and salmon species. And we have been doing this for 6 years in Prince William Sound.

Our colleagues at UAF just got funding from NSF and others to install a similar device on the Seward line that they are in the process of constructing, but as you can hear, there is an opportunity to collect this kind of environmental data in many locations that will be relevant and valuable to fishery managers, both Federal and state.

Senator SULLIVAN. Anyone else on that?

Ms. PELTOLA. In addition to using traditional knowledge, the Kuskokwim River has seen a marked reduction in resources available from mostly the state side. Many weirs are not being operated. We need—we always need—and a marked recapture study had been funded using disaster funds that is now closed.

Bering Sea Fishermen's Association started a community-based harvest monitoring program that does not have funding for next summer, as well as sonar, test fish, aerial surveys; all of those things need additional funding.

Dr. BAKER. Let me just weigh in there, as well. I think I would agree with Milo that I think the habitat is quite good in Alaska, and I think that allows for resilience overall, but understanding individual year or maybe stanzas of years and returns, both in terms of abundance and run timing and so on, there are a lot of issues that are related to ocean conditions.

And so understanding how those ocean conditions—similar to what Katrina was talking about, how that influences different stage-specific survival for different species, looking at whether or not there are some carrying capacity constraints for some of those fish, I think there are several questions along those lines that we'd be really good to get at.

And we had an integrated ecosystem research program in the Gulf of Alaska that was primarily devoted toward looking at groundfish in the first year of survival, which meant looking up in the water column up high. And we collected a lot of—opportunistically we collected a lot of salmon data there. And there were some recognitions that salmon at that life stage are competing to some extent with some of those groundfish. So understanding some of the species interactions in the marine environment, I think, is another area. Danielle might be able to talk more about that, as well.

Senator SULLIVAN. Dr. Adkison.

Dr. ADKISON. Yes. So I wanted to talk about kind of a general lack of knowledge about where salmon go and what they do in the ocean. It's a really hard and really expensive thing to study. One of the biggest improvements we made during my career is these regular NOAA nearshore surveys looking at juvenile salmon. And I think you heard the last panel talk about how they have kind of had to cobble together funding to continue that program every year.

Senator SULLIVAN. So you would say that is a critical gap that we should prioritize funding for?

Dr. ADKISON. I would say so. And I would also like to extend it beyond looking at the—the excellent program looking at juvenile salmon in the nearshore to putting more effort into older salmon further out in the ocean.

Senator SULLIVAN. That's a lot harder to do, though, I take it?

Dr. ADKISON. It is quite a lot harder to do. That study I was talking about that was looking at oceanic predation in salmon sharks, one of our faculty has been putting pop-up satellite tags on Chinook salmon that are older out in—near Dutch Harbor he has been taking them. But it's really expensive. It's hard to get a good sample size. But we really don't know what they are doing out there.

Senator SULLIVAN. Ms. Gillis.

Ms. GILLIS. Thank you. And I concur everything that was said, except I have a couple more points. So——

Senator SULLIVAN. Remember, I asked you to prioritize.

Ms. GILLIS. Right. So my point is the Sustainable Salmon Initiative addressed this directly starting—we have been addressing this since 2002; what are the gaps, what are the priorities. We do have within the science research plan that I provided today seven, but I would say the top three, and as I think about your Federal view on Alaska, freshwater is extremely important, you know, for a lot of reasons.

Bill Templin mentioned the juvenile studies and so did Milo because he's right. We have cobbled together a lot of money. We agree that that's an incredible priority, what the juvenile, you know, life expectancy really is from the point they leave that month until they return.

So we also believe that ocean mortality at any level were—again, Bill said when do those fish die in their life span, and anthropogenic changes to marine ecologic processes. Again, it kind of crosses the board. These are very expensive, all of these. And I don't expect that anyone can afford, even the most efficient spenders of money, but I do think as organizations work more and more together, we really do have an opportunity here to keep things efficient and not duplicate efforts.

Senator SULLIVAN. Let me ask a related question. And you know, we have two panels here. The first one, obviously, was the government, and they need the data. But they make the decisions. They make the management decisions. They, you know, have the authority to do that as state and Federal officials.

A lot of what you guys are doing is not only helping with them, but reinforcing their decisionmaking by providing additional data and expertise. How well do you feel you are able to plug in to them in terms of getting your expertise, your data—Ms. Peltola, I specifically wanted to emphasize and I'm glad your testimony did, the importance of traditional knowledge. I think we have seen examples.

You know, I spoke in my remarks at AFN earlier this morning about what happened with the International Whaling Commission down in Brazil and the subsistence quota that was reauthorized, but I think most Alaskans know the story there that the whaling captains, you know, had much better knowledge about what was happening with the bowhead whale population than all the best western scientists in the world. And it took the western scientists a long time to recognize like, holy cow, these guys have got it right and we have been wrong the whole time. But they finally did, which was good.

So for all of you, are there roadblocks to plug in? It seems like the feds and the state are pretty amenable to getting the data and the expertise that you also bring to the table. But is that the case and are there areas that we can do a better job on that? Really from everybody.

Mary, you want to start?

Ms. PELTOLA. Could you see I was really eager?

Senator SULLIVAN. You are.

Ms. PELTOLA. So we have an MOU. The Kuskokwim Inter-Tribal Fish Commission has an MOU with Fish and Wildlife, as I stated. And under it, the advice given by the in-season managers is urged to be taken with the utmost adherence to that advice. That is not something that we on our river enjoyed with the state. It was advisory and it was very clear—it has been very clear that that's just advice and they don't have to take it. And for many years there was much frustration because of that.

We do feel with the Inter-Tribal Fish Commission that we are in the room where the decisions are happening and have more say in openings and closures.

Senator SULLIVAN. So that's gotten a little better.

Ms. PELTOLA. It is with this Inter-Tribal Fish Commission. I also want to add that with our four in-season managers, they come from four sections of the river. And because they have that—they have been on that river every summer of their life—their parents, grandparents, ancestors—they have a sense of deep time that we don't have in western science. And because they are residents and from there and depend on that species, it has added legitimacy to the management of our river.

And I believe—you know, and we are not the only river that has an Inter-Tribal Fish Commission. There's also one on the Yukon. And I think that with tribal co-management, it adds legitimacy in the eyes of Native people.

Senator SULLIVAN. Others in terms of the plug-in process? Yes. Dr. Adkison.

Dr. ADKISON. Yes. So I just wanted to give a shout out to a program that's really good at bringing state, Federal and private groups together, and that's the fish habitat partnerships that are funded through Fish and Wildlife Service. The groups on the Kenai, the Mat-Su group, the Bristol Bay group, Southeast Alaska group are doing wonderful cooperative work. You know, Mat-Su group is doing a whole bunch of stuff, restoring fish passage and prioritizing that. That's Federal funded, and it's just completely nonconfrontational. We have got the Director of the Bristol Bay group and the former Director of the Kenai group here in the audience.

Senator SULLIVAN. Ms. Gillis.

Ms. GILLIS. I want to echo something Mary said in her testimony and maybe put it into a different light.

Mary mentioned the information about how the run was late this year based on traditional knowledge. She also mentioned that her uncle took her out and taught her, do you want to catch the right fish—if you want to catch a particular fish, this is how you do it. Those are scientists and those are managers. And Mary is right. Traditional ecological knowledge is not respected. As far as, you know, the big decisions, I think it's unwanted, like Mary said.

Bering Sea Fishermen's Association knows that the people in the region have a seat at the table, need a seat at the table. We have been working on it. I mean, really, you know, it's our main priority. And it's not just about us. It's about making sure that there are entities in the region and individuals in the region that have the right information in their hands so that they can talk to the managers at a level that the managers talk to them.

And so it has been a long frustration. I have been with the organization for 26 years with a little blip, even though I didn't actually leave. And I have to say, it's frustrating, and I feel it's deceiving in the public service efforts to say, yes, we'll take your money so that you can fund our research projects, but we don't really want to work with you.

Senator SULLIVAN. Others? Ms. Hoffman.

Ms. HOFFMAN. Thank you, Senator. Every entity has its own mission or mandate. And where I see some of the most excellent integration is when a funder requires it. And that's when they take a proactive lead on requiring partnerships. You have seen this in Gulf Watch Alaska, which was funded by the Exxon Valdez Oil

Spill Trustee Council. You saw this in the Gulf of Alaska Integrated Ecosystem Research Program funded by NPRB.

And there is a sea change in the scientific community in attitudes and approaches on what data is made available publicly and when it is made available publicly.

Senator SULLIVAN. You mean in a positive way?

Ms. HOFFMAN. In a positive way. It's becoming more common.

Senator SULLIVAN. Could you explain a little bit more?

Ms. HOFFMAN. Well, typically, let's say, in a traditional academic environment, a scientist would write a grant. They would get funded by an entity to do their work, and they would hold that data close forever, sometimes until they die. And sometimes they might never publish information based on that data. And that limits the ability of the scientific community to advance its work.

So making data publicly available advances the state of science, and the effort is smoothed when a funder requires that. And you have excellent technological applications, like the Alaska ocean observing system has made a data portal available. And they mine data from publicly available sources, and anyone can use it. And it's a fantastic way of streamlining that integrative effort between the nonagencies and organizations.

Senator SULLIVAN. So you think it's going pretty well?

Ms. HOFFMAN. I'm seeing a positive shift.

Senator SULLIVAN. Good. Dr. Baker, what about you?

Dr. BAKER. I think it's a great question. As an institute, we are kind of in a unique position where we fund academic research. We also fund government—Federal, state and community-related research.

And so one of the programs that we have is a data rescue program. So we worked with the Alaska Department of Fish and Game to take what was essentially a huge archive of written documents, most of which I had gone through in some of my research in grad school. And it was very inaccessible. It was in different offices that different individuals knew about, and as they retired, that information was often lost.

And so we provided a program that allowed them to digitize that and publicize that. And that's something that we do, as Katrina mentioned, for any of the research that we fund, we have an obligation for that project to organize the data, develop metadata, to describe what that data is and then have that go out to a publicly accessible data portal. And I think that's a really important aspect for any kind of funding is to ensure that that research, as Katrina had mentioned, is accessible beyond the group of individuals or scientists or agencies that are working on that.

And I think we have also made some in-roads with making some bridges between institutions. And I actually might ask Danielle to talk a little bit about some of the work she was doing between both the state and the Federal Government on run timing, as well as further outreach to arctic Native communities and some of the work that we were doing there.

STATEMENT OF DANIELLE DICKSON, SENIOR PROGRAM MANAGER, CHIEF OFFICER FOR COLLABORATION AND SYNTHESIS, NORTH PACIFIC RESEARCH BOARD

Ms. DICKSON. Hi. My name is Danielle Dickson. I'm a Senior Program Manager for North Pacific Research Board. I'm also our Chief Officer for Collaboration and Synthesis.

Senator SULLIVAN. Oh, good.

Ms. DICKSON. So I have been working in recent months with NOAA—in part funded by NOAA to help advance an ecological forecasting initiative. And one of three case study projects involves attempting to forecast run timing for salmon in Cook Inlet. So we have——

Senator SULLIVAN. I'm assuming when NOAA funds it, they want to use it.

Ms. DICKSON. Yes.

Senator SULLIVAN. That's good.

Ms. DICKSON. And so I have been very fortunate to work with some very talented individuals in both NOAA and the Alaska Department of Fish and Game to pool their resources and work on building a model.

And we are drawing from some NPRB-funded research, including the data that has been rescued from Fish and Game that Matt just mentioned and looking at how we can make better connections across organizations to really make use of the breadth of data that are available, including data from the marine systems that have been collected by other programs like NPRB's Gulf of Alaska Integrated Ecosystem Research Program and the Seward Line Long-Term Monitoring Program, for example, to try to get at some of that information on ocean conditions that may be important to salmon run timing.

And our Integrated Ecosystem Research Program in the Arctic runs from the northern Bering Sea through the entire Chukchi Sea and a little bit into the western Beaufort Sea. That program in part is looking at what are the drivers of fish distribution and abundance dance in the Chukchi Sea, including specifically pink and chum salmon. And that program includes a very robust piece on social science and looking at what are the drivers of food security for Arctic residents and whether they are more driven by environmental conditions or socioeconomic conditions, for example.

Senator SULLIVAN. Great. Thank you, Danielle. Ms. Gillis, if you want to add to that, but I also wanted to ask you a specific question. In your testimony you mentioned the NOAA grants and funding, we have seen a significant decline. Why do you think that's happening?

Ms. GILLIS. Can I——

Senator SULLIVAN. Yes, please.

Ms. GILLIS.—just do a quick—Matt did mention the data rescue project, which again—well, the Sustainable Salmon Initiative was a partner with the department in rescuing data. And I think the noted point here is that it's taking private funds sometimes to make data accessible, and that's a frustration for us, but I think maybe everyone. And so I just wanted to add that to what Matt and Danielle were saying.

Yes, the Pacific Coastal Salmon Recovery Fund was established in the year 2000 by Congress to address the ESA listed stocks. They have three priorities, but their highest priority and the highest ranking that determines the highest amount of money that you receive now is competitive. Now the process for funds is competitive since 2007. So there were direct appropriations between 2000 and 2006, and since 2007 this program has gone to a competitive process.

And it's—the competition is between Washington, Oregon, Idaho, Alaska, Nevada is in there, but—and California and the tribal organizations in Washington and Alaska and the Lower 48 in those same states.

So we compete against these other states for this funding. In fact, the highest priority—and I said it because it's just—I don't understand the distinction. And even though we have asked—and thank you for sending your letter inquiring to the same exact question.

Their highest priority is to address factors limiting the productivity of Pacific salmon either listed under ESA, which are the Lower 48 states, or necessary for Native subsistence fishing. So if that "or" is in there and they continue to tell us since 2007 that we don't fit their highest priority, then the language is either interpreted incorrectly, which I absolutely believe, or I don't know what Native subsistence fishing is.

Senator SULLIVAN. So you think that that's set up to kind of skew the funding to the Lower 48 states?

Ms. GILLIS. I can tell you that of the 1.2 billion, almost 1.3 billion dollars that the Pacific Coastal Salmon Recovery Fund has awarded, Washington has received $470 million.

Senator SULLIVAN. Geez.

Ms. GILLIS. Alaska has received—when we had direct appropriations and Senator Stevens and a little bit different profile than we do now, it was different. Alaska had a higher priority. When we compete, we fail at every turn against those other states. And we get about five to seven percent of the——

Senator SULLIVAN. But the basis by which you described the allocation prioritization, is that a regulation in NOAA or is that statutory? Do you know?

Ms. GILLIS. Statutory. Statutory.

Senator SULLIVAN. Well, I have one bit of homework to do on this issue. Do you have a comment on that, Ms. Hoffman?

Ms. HOFFMAN. I did. There are Federal funding opportunities, such as the one Ms. Gillis mentioned, that also have a heavy match requirement. For institutions that are entirely soft money funded, such as several at the table, that makes it prohibitive to compete. If you are not an agency with base funding, you absolutely cannot enter the competition.

Second, there are excellent funding opportunities, such as the NOAA Saltonstall-Kennedy fund that Alaska—both ADF&G and my organization and many others have benefited from in fisheries research. I will say to you, though, that the cap on individual projects, the value of the cap, is set at $300,000. And we know that the cost of doing research in Alaskan waters can be astronomically high. You cannot necessarily do a good science project in two or

more years for under $300,000, but you are required to fit within that cap.

So even if the agency has a set amount of funding, such as 10 million dollars available for this funding opportunity in a year, if they were to raise the cap to, say, half a million, scientists could put together better research programs that would be better reviewed and we would have the opportunity to do better work.

Senator SULLIVAN. That's very helpful. And hopefully all of you know we had a bill that was a bill of mine that passed the Senate recently that for the Saltonstall-Kennedy funds makes it much less NOAA controlled and much more kind of our stakeholders in terms of being able to choose where the funds go, I think, which would benefit all of you, all of us. And that recently passed the Senate. We are trying to get that through the House and hopefully get that signed into law.

So let me ask the big $64,000 question from each of you. And it's really one of the big reasons we held this. And I asked the last panel, of course. Strong runs in certain parts of the state, depending on species, historically strong runs, weak king runs pretty much almost everywhere, and all kinds of theories on what is driving that? I do think it is important to look at kind of historical context, which is what I tried to emphasize a little bit in my opening statement and I know Commissioner Cotten talked about, as well.

But a lot of theories on the ocean conditions. And what we talked about on the last panel a little bit, I won't repeat them here, but you guys are experts on it. I would just like your very frank opinion on what you think is going on? And I'm not sure anybody really knows. The last panel indicated that, but might have some more definitive views on that, which I would welcome here. So I really want to get your sense of that. Maybe we could just start down the line here.

Dr. ADKISON. Sure. And I don't know if I'll be much more help. We kind of have an idea when it's happening. The early marine period seems to be the most likely culprit.

Senator SULLIVAN. So you agree with the last panel to some degree on that? They did say that.

Dr. ADKISON. I do, but I'll come back to my kind of the big picture that, you know, these ups and downs are normal. And I think—I'm a scientist. I want to know why it's happening.

Senator SULLIVAN. I don't want to keep interrupting. But what about the size of the kings; is that normal, and are we ever going to get back to, you know, 70-pound Yukon River kings?

Dr. ADKISON. I think so, but I couldn't guarantee it.

Senator SULLIVAN. I think we all hope so, right?

Dr. ADKISON. Yes. You know, I—I think these phenomenon are driven by environmental fluctuations. And you know, I think it's really interesting and important to try to understand them. I think it's even more important, though, to make sure both the salmon and the people that depend on the salmon have the ability to be resilient to these kinds of fluctuations because they are going to keep happening.

Senator SULLIVAN. OK. Dr. Baker.

Dr. BAKER. Yes. I think it's a great question. I think a lot of the most prominent theories have been mentioned already. I agree, I

think it is an early life history survival and sort of a match or mismatch with the environmental conditions in that particular area. I think we talked a little bit about the differences with the Bering Sea and the Gulf of Alaska.

If you are talking about increased temperatures, there is not too much further north you can go in the Gulf of Alaska. You are running up against the continent there. Within the Bering Sea, you have a little bit more flexibility and the Aleutians and sort of adapting to that with your spatial distribution.

And then I think the forage species is also an important aspect. Not all these species are feeding on the same things or at the same—on the same things at the same life stage. So we are looking at what are estuarine conditions, what are some offshore conditions, and are you looking at a piscivorous or a fish-dominated diet or plankton or squid, and there are some significant differences between the species on that, so that might be part of it, as well.

Senator SULLIVAN. Thank you. Ms. Gillis.

Ms. GILLIS. Again, I'll concur in the causes. I think we are getting closer to finding out, you know, what are the big causes.

Talking about things that we can do or things that we can change, because when these normal fluctuations happen, we don't know how to respond right now. So we are taking stabs in the dark, and we are—so maybe 150 years from now we will be in this new down or whenever the next up is going to happen.

So let's be prepared and let's not make these issues divisive, I guess I would say, too. And we are all looking—we all have the same goal. 70-pound Yukon kings, in addition to maybe ocean conditions and other factors, disease—they were targeted. Everybody wanted those. So our impacts are just as real as the science, you know, and the ocean is indicating. So will we get back to them? I don't know, honestly. Because we don't—there is no data. There is no way to know how—whether that will ever happen. Make sure my fingers are crossed because I'm always optimistic.

But anyway, I just wanted to say that they are both right and there are so many more factors and considerations that are driving this panic in us to find out more.

Senator SULLIVAN. Ms. Hoffman.

Ms. HOFFMAN. Thank you, Senator. When ecosystems change, there are what you might call winners and losers. And our colleague, Dr. Sonya Batten, who runs the continuous plankton recorder through the north Pacific, detected during the warm blob years a presence of more pennate diatoms than we are accustomed to seeing. They have a different nutritional content. They are preferentially preyed upon by some organisms versus others.

The challenge for humans in an example such as that is that the cascading effect up through the ecosystem sometimes affects our things that we value. They affect the organisms that our industries and communities need to maintain our economy and ways of life. And those are unpredictable.

Senator SULLIVAN. Ms. Peltola.

Ms. PELTOLA. I really feel that our communities that rely on salmon have been going through the seven stages of grief. And you can see it in meetings. And a lot of that is blame. We spend a lot

of time trying to figure out what the cause of this is. You can't help but wonder if it's that eight-inch commercial gear.

Many scientists have said that the 8-year-old kings, the largest ones, are almost extirpated. They are in the very low single digits of the entire run. And we know that the larger female kings have the best chance—their eggs have the best chance of reproducing. They have, I don't know, 65 percent more eggs or larger. They have a higher survivability rate.

I'm learning through my—this job that ocean pinks eat the same food that Chinook do, which surprised me because they are such different quality of fish. But they eat the same food. And there are studies that show that in the high pink years in the ocean, kings don't grow as much during that year.

I personally wonder if it has something to do with no snowfall. We have had multiple years of almost—you know, very brown tundra. It's really annihilated the ptarmigan and other species. But I wonder if at the headwaters if the river is freezing to the bottom and freezing the eggs when they are incubating.

And we have seen on our river more presence of one-year-old kings, which to me means they don't like the ocean conditions, so they are trying to stay in the river longer. I don't know. These are all my wild guesses.

Senator SULLIVAN. Well, they are important. Well, listen. I want to thank everybody here. The goal here is actually to try to be unifying and try to find answers to questions that we all care about. I think that's a unifying concern here in Alaska. And as I mentioned, data and scientific gaps that can help us get to some of the answers that I think everybody is struggling with. But I'm not sure we solved it, but I think it was a very important discussion and a lot of different views.

So again, I really want to thank the witnesses coming in on a Saturday to be part of this official Senate hearing.

I do want to mention again, we will have a website up where people can submit questions. And the way these hearings work is the hearing record will remain open for two weeks. During this time, myself or other senators may submit questions for the record upon receipt. The witnesses, and I should have told the last panel because they are still on the hook for answers, are requested respectfully to submit their written answers back to the Committee as soon as possible if there are additional questions for the record for all of you.

And again, I want to thank all of you for being here. I want to thank everybody else who attended. And we will continue to focus on this issue. But for now this hearing is adjourned.

[Proceedings adjourned at 1:10 p.m.]

A P P E N D I X

ADDITIONAL TESTIMONY OF SAM COTTEN, COMMISSIONER,
ALASKA DEPARTMENT OF FISH AND GAME

Introduction

Following the hearing that took place at the Dena'ina Civic and Convention Center in Anchorage, Alaska on October 20, 2018, the Alaska Department of Fish and Game (ADF&G) is honored to submit additional testimony to the Subcommittee on Oceans, Atmosphere, Fisheries and the Coast Guard. Senator Sullivan asked exceptionally important questions of the witness panels that led ADF&G to discuss and organize relevant research to address the current state of Alaska's salmon fisheries.

Research Need: The Marine Environment (nearshore and open ocean)

The single largest gap in scientific understanding of Pacific Salmon in the Gulf of Alaska (GOA) surrounds the marine environment, both nearshore (0–5miles offshore) and open ocean. Natural perturbations to the marine ecosystem are believed to have had effects on food availability, body condition, and ultimately on survival of a number of species (Pacific salmon and cod for example) during critical juvenile life history stages. Concerns have also surfaced regarding fisheries enhancement activities (large scale releases of pink and chum salmon) and the capacity of the oceans intrinsic productive capacity to support additional inputs while not impacting wild salmon stocks. The recent events surrounding the GOA, coupled with several fisheries disasters that have been experienced, should be sufficient impetus for justifying the following efforts in an attempt to address the contemporary questions needing resolution.

Background

There are estimates that about one third of all Pacific salmon rear in the GOA in the winter. An international collaborative project known as the *Gulf of Alaska Salmon Expedition* will be the first comprehensive study of the stock abundance, composition, and condition of all species of Pacific salmon in the GOA at the end of their winter residence. This international study of Pacific salmon could be a precedent for future studies to determine mechanisms that regulate Pacific salmon abundance in the ocean and potentially develop additional forecasting tools based on abundance of stocks sampled. This one expedition should be considered a "proof of concept" study based on the past success of Russian trawl surveys that have been used to assess abundance of pink and chum salmon in the Sea of Okhotsk. Surveys of the abundance and condition of Pacific salmon in their first winter-at-sea are a logical extension of early marine survival studies conducted in nearshore marine areas of each North Pacific country. Ultimately, stock-specific abundance estimates will be used to test the hypothesis that brood year strength of salmon is determined by the end of the first-ocean winter.

Current Projects

There are several collaborative projects between the State of Alaska and NOAA Fisheries aimed at understanding early marine ecology of salmon (impact of climate on fitness and survival); information from two of these projects are used to forecast adult returns.

1) Southeast Coastal Monitoring—21 year time series of bio/physical oceanographic measurements, catch of salmon and other associated marine species, and analyses of fish diet and fitness. The location is in the northern regions of southeastern Alaska, inside waters. The annual survey occurs during the last week of June, July, and August (21 days at sea). Data are used to forecast adult returns of pink salmon to Southeast Alaska. We are working on forecast tools for Chinook and chum salmon at this time. Funding for this project is currently provided by the Northern Fund Committee of the Pacific Salmon Commission with potential contributions from pink salmon disaster funds. Most of the funding goes to the State of Alaska for charter costs for the R/V Medeia with some funding directed to con-

tract work at the Alaska Fishery Science Center. Long term funding for this work is not clear since there are no permanent State of Alaska or NOAA budget allocations. *Total survey cost is around $300K to $400K.*

Past projects that could play a central role in understanding early marine ecology of Gulf of Alaska salmon stocks.

The Alaska Fisheries Science Center/Alaska Biological Laboratory conducted bio/physical oceanographic measurements and surface trawl (juvenile salmon and associated marine fish species) along the GOA shelf within the eastern and western regions during 2001 to 2016. These surveys were conducted on chartered fishing vessels (35 days at sea). The data were used to understand ecosystem function, juvenile salmon migration, and fitness for stocks from the Pacific Northwest, Canada, Southeast Alaska, and Prince William Sound regions, as well as collecting information on marine ecology of important age-0 ground fish (*i.e.,* sablefish). *The annual cost of the research was $850K (charter vessel costs = $525K).*

New Project(s) International Year of the Salmon (initial effort)

The international year of the salmon (IYS) is seeking funding to address questions related to shifting distribution/migration pathways, ocean carrying capacity, and competition among stocks of Pacific salmon. A signature project in the GOA (winter 2019) is planned and funding has been secured for this effort. The survey/research costs associated with this project are approximately $1.75 million of which $1 million is for vessel chartering and conducting the survey.

Each of these surveys have had an impact upon our understanding of the GOA/North Pacific ecosystem, however they have not been sufficiently connected nor integrated into a cohesive project that spans nearshore and offshore processes while integrating information from the spring/summer and winter phases of the ecosystem. The current activities being conducted in the nearshore environment coupled with the winter survey results outlined above should be combined into a longer term comprehensive project that addresses the gaps identified but also allows for capturing a wider array of ocean environmental conditions that are likely occurring over multiple year scales. *The cost of these surveys in total is in the order of $3–4 million dollars annually and should be conducted likely every other year for a period of 8–10 years.* Efforts have been made through IYS (North Pacific Anadromous Fish Commission) to solicit interest from Canada, Japan, Korea, and Russia.

Research Need: Human Dimensions of Alaska Salmon Fisheries Management

Salmon are critically important to the food security, well-being, and cultural identity of Alaska's communities and people. Maintaining healthy and sustainable salmon stocks requires an effective fisheries management program that incorporates sound biological and social science. Here, we briefly describe four components of human dimensions research on Alaska's salmon fisheries, identify data gaps, and highlight key principles of this research. We draw upon the findings of the multidisciplinary *State of Alaska's Salmon and People* (SASAP) project, the Alaska Department of Fish and Game's (ADF&G) *Chinook Salmon Stock Assessment and Research Plan* (ADF&G Chinook Salmon Research Team 2013), and the research program of the Division of Subsistence, ADF&G.

- *Harvest monitoring and assessment of subsistence fisheries.* A collaborative review of Alaska's subsistence fisheries harvest monitoring programs concluded that "collection of accurate harvest data is an essential component of any effective resource management program" (Fall and Shanks 2000:B–8). The review developed guiding principles as well as recommendations for effective monitoring programs. Many of these recommendations remain to be implemented. Research needs include:
- There are significant gaps in Alaska's current subsistence salmon harvest monitoring programs: post season harvest surveys in the Kuskokwim Area are not fully funded and do not include all communities; there is no annual program in the Kotzebue District; and there is no program in the Arctic District, where new salmon fisheries are developing as a result of the expanding range for salmon stocks.
- Few current subsistence harvest monitoring programs include subsistence fishers' assessments of the performance of the fishery; for example, if adequate harvests were achieved.
- There is very limited evaluation of the subsistence harvest estimates resulting from current monitoring programs; some programs are limited by in-

complete participation by all users and/or failure to account for all sources of salmon for home use.

- There is increasing interest among managers and users in in-season collection of subsistence salmon harvest data to aid in in-season management and evaluation of management actions, but little critical investigation has taken place to explore how best to implement such efforts to minimize respondent fatigue and coordinate with existing programs.

2. *Patterns and trends in Alaska's subsistence salmon fisheries.* There is presently no coordinated effort to identify and evaluate long-term patterns and trends in Alaska's subsistence salmon and personal use fisheries. Causes of annual and more long-term changes to harvest quantities, species composition, effort, and participation are not well understood, but are likely related to stock status, access issues, social and economic conditions, regulations, or personal factors (see Magdanz *et al.,* 2005). Understanding these factors is especially important in the context of the effects of climate change on salmon stocks and fisheries. Research needs include:

   - A SASAP working group identified social indicators of well-being of Alaska communities as they relate to salmon harvests and uses. There are, however, currently no projects funded to follow through on this. A primary need is projects that select key indicators for tracking and further analysis.
   - One indicator of trends in subsistence fisheries is how harvest levels compare to "the amount reasonably necessary for subsistence" (ANS) which the Alaska Board of Fisheries is required to establish for each salmon stock with customary and traditional subsistence uses. Research is needed to evaluate ANS as a tool for assessing how well subsistence opportunities are being provided in Alaska's management system.
   - Because subsistence salmon harvests occur within the mixed subsistence/cash economy of rural Alaska, research is needed on the interrelationships between commercial and subsistence fisheries in terms of knowledge, access, equipment, and income.

3. *Traditional ecological knowledge (TEK), local traditional knowledge (LTK), and indigenous knowledge (IK) about Alaska salmon.* Although this topic is a component of human dimensions research, there is strong overlap with stock assessments, in-season management, and run forecasting. As noted in ADF&G's Chinook Salmon Stock Assessment and Research Plan (pages 16–17):

   > LTK can provide detailed observations about abundance, distribution, run timing, condition, and habitat, often focused on specific locations and informed by considerable time depth. In addition to empirical information, LTK raises research questions and hypotheses for further investigation and testing. Thus LTK studies seek both to document local knowledge and to involve the holders of this knowledge directly in applying this information to inform scientific inquiries and fisheries management.

Key data gaps, which can be investigated through case study research, relate to:

- How can TEK/LTK be integrated into the management process, both in-season and long-term?
- How can TEK/LTK be effectively and respectfully communicated to managers and the public?
- What are the guidelines for respectfully evaluating the utility of TEK/LTK into salmon management?

4. *Governance systems for Alaska salmon fisheries.* Governance includes the laws, procedures, and organizations that manage and regulate salmon fisheries. Research that evaluates the performance of these systems may identify improvements in terms of public participation, data collection, communication, and understanding. The databases developed by SASAP's Governance Working Group created numerous possibilities for research. These databases organized information related to the content and outcome of proposals submitted to the Alaska Board of Fisheries; board membership; meeting locations; location of advisory committees; and the number of advisory committee meetings by type of committee. Research needs include investigation of:

   - What are the impediments to the public's effective involvement in the regulatory program?
   - What are the most effective ways for ADF&G to support the public process?

- How can management and regulatory decisions (resulting from the board process as well as in-season management) be best communicated to a diverse public?

Although not a topic for research, adequate funding of advisory committees is also an issue for Alaska's salmon management system, especially fiscal support for those committees in rural areas serving multiple remote communities and ADF&G participation in these meetings.

Key Themes: The following are components essential to human dimensions research on Alaska's salmon systems.

- Partnerships between managers and stakeholders: they promote understanding of multiple ways of knowing, encourage sharing of skill sets, and help reach consensus on key findings.
- Local involvement in all phases and types of research, including: identifying researchable topics, preparing proposals, conducting research, and communicating results.
- Communication of findings in multiple formats, for diverse audiences.
- Assessments of study findings: all findings (biological and human dimensions) should be available for review and discussion.
- Avoid duplication of effort to effectively use available funds and prevent multiple, potentially incompatible sets of findings.

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