ALASKA CHINOOK SALMON KNOWLEDGE GAPS AND NEEDS

Chinook salmon are critically important to subsistence, commercial, and sport users across many diverse fisheries in Alaska. Recent Alaska-wide downturns in productivity and abundance of Chinook salmon stocks have created social and economic hardships across many communities in rural and urban areas of Alaska. There is a significant need for the Alaska Department of Fish and Game (ADF&G) to better characterize and understand the changing productivity and abundance of Chinook salmon stocks across Alaska and to identify actions that could be taken to lessen the social and economic hardships being experienced by Alaskans that utilize and depend upon this important natural resource.

To that end, this document was developed by a team of fisheries scientists in an effort to: (1) identify existing knowledge gaps, (2) identify activities that could be undertaken to narrow those knowledge gaps, and (3) identify the range of potential costs of activities needed to narrow those knowledge gaps.

This information represents initial efforts by ADF&G to build a collaborative research plan aimed at better understanding the causes for Chinook salmon declines in Alaska. The ultimate goal of this knowledge gap analysis and the forthcoming research plan is to improve Chinook salmon stock assessment programs across Alaska so that management can provide better opportunities to harvest these fish sustainably, even during times of low productivity.

Patterns of Chinook salmon productivity and abundance vary over time and among different areas of Alaska. However, recent declines in productivity and inshore harvests are widespread in Alaska. Average annual catches of Chinook salmon in Alaska fisheries during the 12-year period of 1994–2005 and the 6-year period of 2006–2011 have decreased as follows: subsistence – 164,000 to 152,000 fish, about a 7% reduction; commercial – 760,000 to 463,000 fish, about a 40% reduction; and sport – 176,000 to 155,000 fish, about a 12% reduction.

Chinook salmon are also taken as bycatch in groundfish fisheries off Alaska. Chinook salmon bycatch in Bering Sea and Aleutian Island (BSAI) federal groundfish fisheries peaked in 2007 at nearly 130,000 fish. The North Pacific Fishery Management Council (council) began developing a new bycatch management program for the Bering Sea/Aleutian (BSAI) pollock fishery in 2008, implemented in 2011. Average annual bycatch in BSAI groundfish fisheries during 2008–2011 has been approximately 19,000 Chinook salmon. In the Gulf of Alaska (GOA), Chinook salmon bycatch in the groundfish fisheries peaked in 2010 at nearly 55,000 fish. The council adopted a hard cap for the GOA pollock fishery of 25,000 fish in 2011.

Because Chinook salmon stocks that spawn in different areas of Alaska have differing migratory patterns and contributions to fisheries, an effort to comprehensively understand Alaska Chinook salmon productivity and abundance trends must include a variety of geographically distinct stocks. Comparison of productivity and abundance trends across stocks experiencing different freshwater and marine environments will assist in identification of causal mechanisms acting at local or much broader geographic scales.

In Alaska, there are hundreds of individual Chinook salmon stocks. Available information for individual stocks ranges from simple knowledge that Chinook salmon spawn in a certain water body to detailed information including spawning abundance, inshore harvests, smolt production, and freshwater and marine survival statistics. The research team recommends that ADF&G establish a suite of Chinook

salmon indicator, or principal stocks, and implement a minimum stock assessment program for each stock as described herein.

Establishing a suite of indicator stocks will provide an ongoing statewide index of Chinook salmon productivity and abundance trends across a diversity of drainage types and size, representing a wide range of ecological and genetic attributes from Southeast Alaska to Arctic waters. The research team settled on a suite of twelve Chinook salmon indicator stocks: Unuk, Stikine, Taku, Chilkat, Copper, Susitna, Kenai, Karluk, Chignik, Nushagak, Kuskokwim, and Yukon. Clearly, some of these stocks represent complex arrays of stock components that may have different limiting factors.

This broad approach may help to identify more focused areas of research within these large drainages. The research team recognized that there are other stocks that could justifiably be included, but tried to strike a compromise that provides broad representative coverage across Alaska, but is not overwhelming in scope and cost.

The research team recommends that a stock assessment program be implemented for each of the twelve Chinook salmon indicator stocks that promote the following features:

1. Ability to estimate annual Chinook salmon escapement for each indicator stock, along with the annual age-sex-size composition.
2. Ability to comprehensively estimate annual total catch of each Chinook salmon indicator stock, along with the age-size composition.
3. Ability to estimate production in adult equivalents for each Chinook salmon indicator stock for each brood year.
4. Ability to estimate the number of smolt produced by brood year for each Chinook salmon indicator stock; from these statistics and data from number 1 above, estimate smolt production per spawner for each Chinook salmon indicator stock for each brood year (freshwater survival).
5. Ability to estimate marine survival for smolt emigrating from each Chinook salmon indicator stock for each brood year.
6. Ability to estimate annual abundance of each stock in the nearshore marine environment for use in forecasting.
7. Ability to update and refine maximum sustained yield estimates for each Chinook salmon indicator stock.
8. Ability to provide forecasts of returns for each indicator stock for improved management capability.
9. Ability to provide adequate local traditional knowledge (LTK) concerning patterns and trends of use for each indicator stock.

The research team reviewed existing stock assessment programs for each of the twelve indicator stocks and identified gaps in knowledge required to achieve the features described above. In some cases, existing inriver assessment programs are adequate to assess total escapement; in other cases, only tributary escapement assessment programs exist, or existing inriver assessments have known biases that require attention. Often, only inshore catch accounting exists and existing assessments of stock contributions to fisheries are based upon assumptions with little corroborating evidence. In some cases, inriver catch accounting is likely biased and improvements are needed.

Without accurate escapement and catch accounting programs by stock, production cannot be estimated, forecasts are inaccurate, escapement goals are inaccurate, and management is biased. All of these factors often result in foregone harvest opportunities with associated social and economic hardships. Significant knowledge gaps in escapement and catch assessment programs for the twelve selected Chinook salmon indicator stocks were identified by the research team, as well as the range of potential costs to address these issues (Table 1).

The review assessed the availability of LTK about each of the 12 indicator stocks. Such knowledge, based upon local observations and experience and generally shared within Alaska communities across generations, can provide detailed insights about salmon stocks, such as historic and current population sizes and ranges, condition, habitats, and run timing. This information informs and compliments stock assessments accomplished through fisheries science. In addition, studies of LTK directly engage fisheries users in cooperative efforts to document and understand stock statuses and trends. While a great deal of traditional knowledge is held by Alaskans, studies to systematically record and communicate this information are lacking for most Chinook salmon stocks in the state.

Long-term monitoring of freshwater and marine survivals is needed to track where, when, and how productivity changes for Alaska Chinook salmon stocks. This represents a logical path towards understanding why these changes are occurring. Annual estimates of freshwater and marine survivals can improve forecasts, assist in development of appropriate spawning goals, and enhance management performance, including providing amounts necessary for subsistence.

Other than for a few Southeast Alaska Chinook salmon stocks, estimates of freshwater and marine survivals do not currently exist for Alaska Chinook salmon stocks. Such estimates are readily available for many Chinook salmon stocks in Canada and the west coast of the U.S., and are crucial to decision makers associated with fishery management in those jurisdictions. The inability to track freshwater and marine survivals for Chinook salmon stocks in Alaska was identified as a major knowledge gap. Stock assessment programs to address this need were identified by the research team.

The research team also discussed the value of information that could be added to our understanding of trends in marine survival estimates by continued or expanded pelagic trawl research cruises in nearshore areas of the Bering Sea and Gulf of Alaska. While these efforts are limited by current capacity to genetically discriminate Western Alaska stock groups of Chinook salmon juveniles (e.g., Nushagak, Kuskokwim, and Lower Yukon), abundance indices from nearshore trawl research cruises may provide insight into juvenile Chinook salmon survival and distribution during the first year of marine life.

Eastern Bering Sea research cruises were initiated in 1999 through the Ocean Carrying Capacity Program at Auke Bay Laboratories (NOAA-ABL) to study early marine distribution, migration, and growth of Bristol Bay juvenile sockeye salmon. This program expanded to include most of the continental shelf areas of the Eastern Bering Sea and included ecosystem information on other salmon species, forage fish, other nekton, plankton, and oceanographic conditions. Bering Sea trawl surveys continued during 2002–2007 as part of the Bering-Aleutian Salmon International Survey (BASIS) and during 2009–2010 as part of the Bering Sea Integrated Ecosystem Research Project (BSIERP).

Research activities under the BASIS program were, in part, designed to address stock-specific migration patterns of juvenile salmon, identify key biological, oceanographic, and climatic factors affecting salmon

growth rates, and provide information to determine whether there is a limit to carrying capacity for salmon in the Bering Sea. Relative abundance of Chinook salmon juveniles in Northern Bering Sea surveys, combined with the ability to genetically discriminate fish originating from the Canadian Yukon, have provided valuable predictive information on future run sizes and migration timing for this stock.

Eventually we must ask how information from large-scale marine surveys and monitoring efforts will address whether we can increase the numbers of Chinook salmon returning to Alaska rivers. Data from the large-scale marine surveys are utilized in models that connect climate to fish productivity. Examples of these include the FEAST Model, developed in cooperation with the North Pacific Research Board, to predict Bering Sea walleye pollock recruitment under a climate change scenario. The models are appealing because they integrate various parts of the marine ecosystem and can incorporate human and environmental drivers in a single framework. Data (i.e., physical and biological oceanography, fish diet, energetic status, size, growth, and distribution) from research surveys are used to parameterize the models.

In turn, these models can then be used to address questions regarding salmon production. For example, bio/physical data from BASIS can be utilized in models to ask if Chinook salmon returns to Western Alaska would increase if we increase/decrease escapement goals. Similarly, if we increase hatchery production of Chinook salmon, will they survive the Bering Sea environment? Will they compete with other populations of salmon? To investigate the utility of these trawl research cruises to meaningfully inform integrated ecosystem models for salmon management in Alaska, we have included a modeling effort for Western Alaska Chinook salmon as one of our goals cutting across Chinook salmon stocks and fisheries. Demonstration of utility for these stocks may inform applications to others.

The research team also believes that it is important to acquire as much stock-specific information as possible from Chinook salmon harvested as bycatch in groundfish fisheries in the Gulf of Alaska (GOA) and Eastern Bering Sea (EBS). While age, size, coded wire tag (CWT), and genetic tissue sampling already occurs or is planned to occur in these fisheries, increasing resolution of these data to a specific geographic harvest location (i.e., to the individual haul) in applicable groundfish sectors would allow for improved mapping of stock-specific ocean distribution and migratory timing, as well as the potential for improved Chinook salmon bycatch avoidance measures. Biological data collection in these fisheries will likely have to increase to achieve this level of spatial resolution. Moreover, this effort will require partnerships between state, federal, and industry researchers to properly manage the confidentiality and data-sharing issues that will arise in acquiring this information.

The remainder of this document provides informative tables concerning the 12 selected indicator stocks, Alaskan fisheries, activities needed to address identified knowledge gaps associated with each stock and each fishery, and descriptive information concerning each of the 12 selected indicator stocks. Table 1 includes a range of potential costs by type of activity, including annual ongoing and one-time costs that either involves purchase of equipment needed to implement the program or activities that can be accomplished within 3–5 years.

Many of the activities identified to fill knowledge gaps can be implemented directly by the ADF&G, while others could best be implemented by contract to a federal agency, consultant, or other partner. It is important to note that implementation of these activities for some instances will immediately fill a knowledge gap (e.g., a new assessment of inriver run or escapement where there was none previously). In

other instances, it will take four to five or more years to begin to fill a gap in our knowledge (e.g., trends in marine and freshwater survivals where there were none previously). The ultimate strength of the indicator stock approach lies in the ability to keep stock assessment programs going for long periods of time to discern and understand changes in productivity and abundance.

Table 1.–Range of potential costs by type of activity to address Chinook salmon knowledge gaps (thousands of dollars).

Type of Activity	Range of Potential Costs
Across Stocks/Fisheries – see Table 2	$6,000–$8,500
Stock Specific – see Table 3	$6,000–$8,500
Fishery Specific – see Table 4	$1,000–$1,500
Total	$13,000–$18,500

Table 2.–Recommended activities to fill knowledge gaps that cut across Chinook salmon stocks and fisheries.

Activity	Explanation
CWT Lab	Implementation of additional CWT activities across Alaska will lead to greatly increased workload at the CWT lab and additional fiscal resources will be required for the CWT lab to handle the added workload.
Scale Reading Support	Many more scales from both adult and juvenile Chinook salmon will be collected. These scales will need to be read to determine age and samples will require archiving.
Genetic Baseline Development	Additional collections of Chinook salmon are needed to improve the Alaska Chinook salmon genetic baseline, which is required for stock identification purposes.
Genetic Marker Development	The inability to distinguish lower river spawning populations of Bristol Bay, Kuskokwim, and Yukon Chinook salmon from each other is a major knowledge gap; additional genetic marker development is necessary to improve identification ability.
Biometric Support	An additional biometrician will be required to support the program as identified
Publication Support	Additional staff members are needed to ensure timely reporting of results of this program.
Evaluation of Existing Subsistence Harvest Monitoring Programs	Improved subsistence harvest data are needed for some of the 12 indicator stocks in cases where subsistence harvests represent a significant portion of the annual harvest. There is also a need to conduct pilot projects to provide inseason assessments of harvest.
Analysis of Subsistence Harvest Patterns and Trends	Analysis of existing time series harvest data would provide insights into factors shaping subsistence harvests.
Local and Traditional Knowledge of Chinook Salmon Stocks	Additional local and traditional knowledge is needed for some of the 12 indicator stocks.
Nearshore Marine Trawl Research Cruises	As a companion to stock-specific estimates of marine survival, 3 years of trawl research cruises to study trends in nearshore marine abundance and distribution of juvenile Chinook salmon in the northern and southern Bering Sea, and Gulf of Alaska
Modeling effort for Western Alaska Chinook salmon	Use of data from research surveys to parameterize models for addressing questions regarding salmon production.

Table 3.–Stock-specific activities recommended to fill knowledge gaps in Chinook salmon escapement and smolt assessments (CWT-tagging means coded-wire-tagging).

Chinook Stock	Escapement Assessment	Smolt Assessment
Unuk	Mark-recapture with age-sex-size	CWT-tagging of smolt with recaptures in fishery and escapement
Stikine	Mark-recapture with age-sex-size	CWT-tagging of smolt with recaptures in fishery and escapement
Taku	Mark-recapture with age-sex-size	CWT-tagging of smolt with recaptures in fishery and escapement
Chilkat	Mark-recapture with age-sex-size	CWT-tagging of smolt with recaptures in fishery and escapement
Copper	Mark-recapture with age-sex-size	CWT-tagging of smolt with recaptures in fishery and escapement
Susitna	Age-specific genetic mark-recapture (downriver wheels; Deshka weir, plus another weir)	CWT-tagging of smolt with recaptures at Deshka weir, other weir, and fishery.
Kenai	Sonar with age-sex-size	CWT-tagging of smolt with recaptures in fishery and escapement; mixed-stock analysis (early versus late runs)
Karluk	Weir lease and age-sex-size sampling	CWT-tagging of smolt (Karluk and hatchery releases) with recaptures in fishery and escapement
Chignik	Age-sex-size sampling	CWT-tagging and PIT-tagging of smolt with recaptures in fishery and escapement
Nushagak	Mark-Recapture with age-sex-size	CWT-tagging of smolt with recaptures in fishery and escapement
Kuskokwim	Mark-Recapture at weirs with age-sex-size	CWT-tagging of smolt with recaptures in fishery and escapement
Yukon	Telemetry or genetic-based run reconstruction	Work with Whitehorse Hatchery data to estimate marine survival

Table 4.–Average catches and fishery-specific activities recommended to fill knowledge gaps in catch assessment.

Chinook Fishery	Average catch (1994–2005)	Average catch (2006–2011)	Stock-Specific Catch Assessment
Southeast	Subsistence: 1,000 Commercial: 303,000 Sport: 70,000	Subsistence: 1,000 Commercial: 310,000 Sport: 69,000	Genetics mixed-stock analysis and sampling of troll, sport, and districts 108 and 111 gillnet
Copper River and Prince William Sound	Subsistence: 7,000 Commercial: 50,000 Sport: 10,000	Subsistence: 6,000 Commercial: 21,000 Sport: 9,000	Age-size of commercial catch. CWT recovery of major fisheries at 20% minimum coverage; genetic mixed-stock analysis of major fisheries
Cook Inlet	Subsistence: 1,000 Commercial: 18,000 Sport: 74,000	Subsistence: 1,000 Commercial: 13,000 Sport: 53,000	Comprehensive marine CWT and genetics sampling of Upper subdistrict set gillnet, Kenai Peninsula sport, Tyonek subsistence, Northern District set gillnet, Central District drift gillnet, winter sport fishery in Homer
Kodiak	Subsistence: <1,000 Commercial: 19,000 Sport: 7,000	Subsistence: <1,000 Commercial: 16,000 Sport: 10,000	CWT recovery of major fisheries at 20% minimum coverage; genetic mixed-stock analysis of major fisheries
Chignik/ Alaska Peninsula	Subsistence: <1,000 Commercial: 17,000 Sport: 4,000	Subsistence: <1,000 Commercial: 14,000 Sport: 3,000	CWT recovery of major fisheries at 20% minimum coverage; genetic mixed-stock analysis of major fisheries
Bristol Bay	Subsistence: 16,000 Commercial: 75,000 Sport: 8,000	Subsistence: 14,000 Commercial: 49,000 Sport: 9,000	Improved genetic baseline resolution (listed under Table 2)
Kuskokwim	Subsistence: 81,000 Commercial: 31,000 Sport: 2,000	Subsistence: 79,000 Commercial: 22,000 Sport: 1,000	Improved genetic baseline resolution (listed under Table 2)
Yukon	Subsistence: 51,000 Commercial: 66,000 Sport: 1,000	Subsistence: 46,000 Commercial: 17,000 Sport: 1,000	Improved genetic baseline resolution (listed under Table 2)
Norton Sound Kotzebue	Subsistence: 6,000 Commercial: 5,000 Sport: 1,000	Subsistence: 4,000 Commercial: 1,000 Sport: <1,000	Improved genetic baseline resolution (listed under Table 2)
federal waters bycatch (pollock trawl only)	GOA: 13,000 EBS: 37,000	GOA: 21,000 EBS: 46,000	GOA: Improvement in observer coverage (catch and CWT/genetic catch composition). EBS: Sample for CWT at 20% minimum for catch coverage. Both: Improved geographic and stock-specific resolution of bycatch to the individual haul.
Totals	Subsistence: 164,000 Commercial: 760,000 Sport: 176,000 Federal Waters: 50,000	Subsistence: 152,000 Commercial: 463,000 Sport: 155,000 Federal Waters: 67,000	

Table 5.–Escapement goals, performance in achieving escapement goals, average run strengths, and average harvest rates for selected Chinook salmon indicator stocks. These estimates are based upon existing data that consist, in some cases, of assumed and uncertain escapements and catches.

Chinook Stock	*Current Escapement Goal*	*Escapement Goal Performance (1990–2005)*[a]	*Escapement Goal Performance (2006–2011)*[a]	*Average Annual Run (1990–2005)*	*Average Annual Run (2006–2011)*	*Average Harvest Rate (1990–2005)*[b]	*Average Harvest Rate (2006–2011)*[b]
Unuk	1,800 to 3,800	100%	100%	7,000	7,000	15%	21%
Stikine	14,000 to 28,000	100%	83%	49,000	44,000	21%	50%
Taku	19,000 to 36,000	100%	83%	75,000	48,000	15%	27%
Chilkat	1,750 to 3,500	100%	67%	6,000	4,000	11%	16%
Copper	>24,000	56%	83%	82,000	64,000	68%	45%
Susitna (Deshka)	13,000 to 28,000	88%	67%	33,000	21,000	13%	18%
Kenai	21,800 to 44,700	100%	90%	72,000	67,000	43%	39%
Karluk	3,000 to 6,000	100%	33%	12,000	3,000	24%	13%
Chignik	1,300 to 2,700	100%	100%	6,000	4,000	37%	32%
Nushagak	40,000 to 80,000	100%	100%	156,000	138,000	45%	40%
Kuskokwim	65,000 to 120,000	100%	83%	274,000	214,000	32%	38%
Yukon (Canadian)	42,500 to 55,000	69%	50%	136,000	79,000	47%	32%

[a] *Percent of years during the time frame specified that escapement goal was achieved or exceeded.*

[b] *Note that a comprehensive analysis involving 25 stocks of Chinook salmon from Oregon to the Yukon by Canadian and U.S. scientists has shown that the optimal harvest rate, the rate associated with maximum sustained yield, is on average 63% for Chinook salmon with a "stream type" life history.*

INDICATOR STOCK DESCRIPTIONS AND KNOWLEDGE GAPS

Unuk River

Stock Description

The Unuk River is a heavily glaciated transboundary river that empties into the northeast corner of Behm Canal approximately 85 km east of Ketchikan. The drainage is around 2,500 km^2 and supports a moderate run of about 7,000 large (28 inches and larger) fish annually, typically the fourth largest run of Chinook salmon in Southeast Alaska. Recent exploitation rates have been around 20% and escapements have averaged about 5,500 large fish, annually. Chinook salmon from the Unuk River have a "stream type" life history as nearly all juveniles reside for one year in fresh water before emigrating in the spring as age-1.0 smolt. The current biological escapement goal (BEG) of 1,800 to 3,800 large fish, with a point estimate of 2,764, has been in place since 2009. At present, this stock is considered healthy, and in the past 35 years, estimated escapements have been within or above the escapement goal range each year.

Fishery Description

Recoveries of CWTs suggest that Unuk River Chinook salmon primarily rear within the confines of Southeast Alaska and Northern British Columbia, with a few recoveries from the waters off the Aleutian Islands in the Bering Sea and GOA. Harvest rates outside of Southeast Alaska are unknown because detailed CWT sampling programs do not exist in these waters. On average, for the 1992–2001 broods, harvests have been highest in the Southeast Alaska troll (47%), sport (36%), and net (10%) fisheries, and most of the remainder has been caught in Northern British Columbia. The majority of the harvest occurs in the southern inside area of Southeast Alaska.

Current Stock Assessment

Escapement of large Chinook salmon in the Unuk River is estimated annually using a mark-recapture study that first began in 1997. In addition, standardized observer counts of large Chinook salmon escapement started in 1977. Radio telemetry studies were conducted in 1994 and 2007, and results indicated that observer surveys covered 80% of the spawning area. The mean expansion factor of 4.83 was estimated using 7 years of coupled mark-recapture estimates and peak observer counts. In addition to the adult work, juvenile Unuk River Chinook salmon were first tagged with coded wire beginning with the 1982 to 1986 broods, and more recently, with the 1992 to present broods. Coupled with a marine sport and commercial catch sampling program that began in 1994 in Southeast Alaska, estimates of harvest are available for 1992 to the present brood years.

Gaps in Current Stock Assessment

Harvest estimates from the Gulf of Alaska and Bering Sea are unknown. Currently there are no detailed CWT sampling programs in place in the GOA and Bering Sea to gather the information necessary to accurately assess harvest rates from these waters. The majority of funding has been provided through the Dingell-Johnson Act (D-J) that provides federal funds to the state for the management and restoration of fisheries having a sport fishing connection. Other sources have included the Alaska Sustainable Salmon Fund, which are federal funds from the Pacific Coastal Salmon Recovery Fund (AKSSF), and the Pacific Salmon Commission's (PSC) Chinook Technical Committee's Letter of Agreement (LOA), which are

federal funds allocated to the PSC for abundance-based management of Chinook salmon. Future funding from these sources is considered doubtful.

Recommended Stock Assessment Projects

We have identified the following projects as beneficial to increasing our knowledge of this stock:

- Annual adult mark-recapture and age, sex, and length sampling project.
- Annual juvenile CWT-tagging program.

Stikine River

Stock Description

The Stikine River originates in British Columbia and flows into central Southeast Alaska east of the towns of Petersburg and Wrangell. The anadromous portion of the drainage is around 15,000 km^2 and supports a run of about 44,000 large (28 inches and larger) fish annually, typically the second largest run of Chinook salmon in Southeast Alaska. Recent exploitation rates have been around 50% and escapements have averaged about 22,000 large fish, annually. Chinook salmon from the Stikine River have a "stream type" life history since nearly all juveniles reside for one year in fresh water before emigrating in the spring as age-1.0 smolt. The current BEG of 14,000 to 28,000 large fish with a point estimate of 17,500 has been in place since 2000. At present, this stock is considered healthy, and since 1985, escapements to the Stikine River were within or above the escapement goal range every year except 2009.

Fishery Description

Recoveries of CWTs indicate that Stikine River Chinook salmon mostly rear in the Bering Sea and GOA. Harvest rates outside of Southeast Alaska are unknown because detailed CWT sampling programs do not exist in these waters. In 1976, as part of a coastwide Chinook salmon rebuilding program, springtime commercial gillnet fishing was closed until the third Monday in June in Southeast Alaska. As a result, most Chinook salmon bound for the Stikine River were harvested in the Petersburg and Wrangell marine sport fisheries and incidentally in the District 108 sockeye gillnet fishery. However, with development of the detailed Chinook salmon stock assessment program on the Stikine River, members from the U.S. and Canadian Transboundary River Panel (TBR) of the PSC successfully negotiated new directed Chinook salmon fisheries as part of the Pacific Salmon Treaty (PST) beginning in 2005. These fisheries were only implemented during periods of surplus escapement as determined using preseason forecasts and inseason estimates of total terminal run. Prior to 2005, exploitation rates were around 20%, but since the onset of directed Chinook salmon fishing, exploitation rates on Stikine River Chinook salmon have averaged around 50%. Most harvests occur in the U.S. commercial gillnet and sport fisheries near Petersburg and Wrangell, and inriver in the Canadian gillnet and aboriginal fisheries.

Current Stock Assessment

Escapement of large Chinook salmon in the Stikine River is estimated annually using a mark-recapture study that first began in 1996. In addition, standardized observer counts of large Chinook salmon escapement started in 1975 and since 1985, counts were made exclusively using a weir operated at the

Little Tahltan River. Radio-telemetry studies were conducted in 1997 and 2005, and results from this, along with the mark-recapture studies, indicated that the weir counts represented about 20% of the total escapement. In addition to the adult work, juvenile Chinook salmon were first tagged with coded wire in the Stikine River 1976, 1979, and 1980 broods and more recently, with the 1998 to present broods. This CWT-tagging program was used to estimate smolt abundance and to also estimate harvests of Stikine-origin Chinook salmon in the commercial and sport fisheries near Wrangell and Petersburg, and in the commercial troll fishery in Southeast Alaska.

Gaps in Current Stock Assessment

Harvest estimates from the GOA and Bering Sea are unknown. Currently, there is no detailed CWT sampling program in the GOA and Bering Sea to gather the information necessary to accurately assess harvest rates from these waters. A genetic stock identification (GSI) program is used annually to distinguish Stikine-origin fish in Chinook salmon catches from the Petersburg and Wrangell marine fisheries, and additional baseline samples from inriver spawning tributaries would strengthen the program and reduce misclassification error. Past funding sources have included various federal and PSC-supported funding sources (e.g., LOA, Northern Fund, and Canada). Future funding from these sources is considered uncertain.

Recommended Stock Assessment Projects

We have identified the following projects as beneficial to increasing our knowledge of this stock:

- Annual juvenile CWT-tagging programs.
- A study of local and traditional knowledge of Chinook salmon stocks.

Taku River

Stock Description

The Taku River originates in British Columbia and flows into Taku Inlet south of Juneau. The drainage is around 17,000 km^2 and supports a run of about 48,000 large fish annually, typically the largest run of Chinook salmon in Southeast Alaska. Recent exploitation rates have been around 27% and escapements have averaged about 35,000 large fish (28 inches and larger), annually. Chinook salmon from the Taku River have a “stream type” life history since nearly all juveniles reside for one year in the fresh water before emigrating in the spring as age-1.0 smolt. The current BEG of 19,000 to 36,000 large fish, with a point estimate of 25,500, has been in place since 2009. At present, this stock is considered healthy, and escapements have been within or above the escapement goal range in 32 of the past 37 years.

Fishery Description

Recoveries of CWTs indicate that Taku River Chinook salmon mostly rear in the Bering Sea and GOA. Harvest rates outside of Southeast Alaska are unknown because detailed CWT sampling programs do not exist in these waters. In 1976, as part of a coastwide Chinook salmon rebuilding program, springtime commercial gillnet fishing was closed until the third Monday in June in Southeast Alaska. As a result, most Chinook salmon bound for the Taku River were harvested in the Juneau marine sport fishery and incidentally in the District 11 sockeye salmon gillnet fishery. However, with development of the detailed

Chinook salmon stock assessment program on the Taku River, members from the U.S. and Canadian TBR of the PSC successfully negotiated new directed Chinook salmon fisheries as part of the PST beginning in 2005. These fisheries have only been implemented during periods of surplus escapement as determined using preseason forecasts and inseason estimates of total terminal run. Prior to 2005, exploitation rates were around 15%, but since the onset of directed Chinook salmon fishing, exploitation rates on Taku River Chinook salmon have been about 27%. Most harvests occur in the U.S. commercial gillnet and sport fisheries near Juneau and inriver in the Canadian gillnet and aboriginal fisheries.

Current Stock Assessment

Escapement of large Chinook salmon in the Taku River is estimated annually using a mark-recapture study that first began in 1989 and 1990, and has taken place annually since 1995. In addition, standardized observer counts of large Chinook salmon escapement started in 1975. Radio-telemetry studies were conducted in 1989 and 1990, and results indicated that observer surveys covered the majority of the major spawning areas. The mean expansion factor of 5.2 was estimated using 5 years of coupled mark-recapture estimates and peak observer counts. In addition to the adult work, juvenile Chinook salmon were first tagged with coded wire in the Taku River beginning with the 1975 to 1979 and 1981 broods, and more recently, with the 1991 to present broods. This CWT-tagging program was used to estimate smolt abundance and to also estimate harvests of Taku-origin Chinook salmon in the commercial and sport fisheries near Juneau, and in the commercial troll fishery in Southeast Alaska.

Gaps in Current Stock Assessment

Harvest estimates from the GOA and Bering Sea are unknown. Currently, there is no detailed CWT sampling program in the GOA and Bering Sea to gather information necessary to accurately assess harvest rates from these waters. A GSI program is used annually to distinguish Taku-origin fish in Chinook salmon catches from the Juneau marine fisheries, and additional baseline samples from inriver spawning tributaries would strengthen the program and reduce misclassification error. The GSI program used for this purpose has been funded with a cadre of soft money funding sources for the past decade. Future funding to support the Southeast Alaska GSI program from these sources is considered uncertain. Past funding sources for the CWT-tagging program have included various federal and PSC-supported funding sources (e.g., LOA, Northern Fund, and Canada). Future funding from these sources is considered uncertain.

Recommended Stock Assessment Projects

We have identified the following projects as beneficial to increasing our knowledge of this stock:

- Annual juvenile CWT-tagging program.

We also recommend the following project to augment needed information for this and other stocks of Chinook salmon harvested in Southeast Alaska:

- GSI of Chinook salmon harvested in Southeast Alaska troll and sport fisheries and in the districts 8 and 11 gillnet fisheries.

Chilkat River

Stock Description

The Chilkat River is a moderate-sized glacial river that empties into upper Lynn Canal near Haines. The drainage is around 2,600 km^2 and supports a moderate run of about 4,000 large fish annually, which is typically the fifth largest run of Chinook salmon in Southeast Alaska. Recent exploitation rates have been around 16% and escapements have averaged just over 3,000 large fish annually. Chinook salmon from the Chilkat River have a "stream type" life history since nearly all juveniles reside for one year in fresh water before emigrating in the spring as age-1.0 smolt. The current BEG is 1,750 to 3,500 large fish (28 inches and larger; point estimate is 2,200 large fish). This goal has been in place since 2003. At present, this stock is considered healthy, and in the past 21 years, estimated escapements have been within or above the escapement goal range each year, with the exception of 2007.

Fishery Description

Recoveries of CWTs suggest that Chilkat River Chinook salmon primarily rear within the confines of Southeast Alaska and Northern British Columbia; however, a few recoveries have been from the waters off the Aleutian Islands in the Bering Sea and GOA. Harvest rates outside of Southeast Alaska are unknown because detailed CWT sampling programs do not exist in these waters. Available CWT information on this stock suggests that exploitation is about 16% for recent years. The majority of the harvest occurs in the northern portion of Southeast Alaska.

Current Stock Assessment

Escapement of large Chinook salmon in the Chilkat River is estimated annually using a mark-recapture study that first began in 1991. From 1975 to 1992, observer counts were conducted on two small tributaries with relatively clear water, yet results from these estimates were inconsistent. Radio-telemetry studies conducted in 1991 and 1992 found that spawning Chinook salmon in these two tributaries represented less than 5% of the total escapement and did not represent trends in abundance; therefore, observer surveys were discontinued. In addition to the adult work, juvenile Chilkat River Chinook salmon were first tagged with coded wire beginning with the 1988 to 1989 broods, and more recently, with the 1997 to present broods. This CWT-tagging program was used to estimate smolt abundance and to also estimate harvests of Chilkat-origin Chinook salmon in the commercial and sport fisheries near Haines and Juneau, and in the commercial troll fishery in Southeast Alaska.

Gaps in Current Stock Assessment

Harvest estimates from the GOA and Bering Sea are unknown. Currently, there is no detailed CWT sampling program in place in the GOA and Bering Sea to gather the information necessary to accurately assess harvest rates from these waters. Past funding sources have included the Northern Fund, AKSSF, and the LOA funds provided to the PSC. Future funding from these sources is considered doubtful.

Recommended Stock Assessment Projects

We have identified the following projects as beneficial to increasing our knowledge of this stock:

- Annual adult mark-recapture and age, sex, and length sampling project.

- Annual juvenile CWT-tagging programs.
- A study of local and traditional knowledge of Chinook salmon stocks. This project addresses data gaps identified by current LTK studies in the Chilkat area.

Copper River

Stock Description

The Copper River is a glacially dominated system located in Southcentral Alaska and is the second largest river in Alaska in terms of average discharge and fifth largest in terms of drainage area (62,000 km^2). It flows south from the Alaska Range, and Wrangell and Chugach mountains, and empties into the GOA east of Prince William Sound. Copper River Chinook salmon spawn and return to many tributaries of the Copper River, including Chitina, Tonsina, Klutina, Gulkana, and East Fork Chistochina rivers. Freshwater entry of Chinook salmon occurs during late May through mid-July, with 50% of the run typically entering by early June. Annual run size has averaged 74,000 fish since 1980, with a minimum spawning escapement goal of 24,000 fish. Age composition of this stock ranges from 3- to 8-year olds and is dominated by 6-year olds, although 5-year olds can predominate in some years.

Fishery Description

There are subsistence, personal use, commercial, and sport fisheries that harvest Copper River Chinook salmon runs. There is a subsistence gillnet fishery at the mouth of the Copper River; fish wheel and dipnet fisheries in the Copper River between Chitina and the Slana River confluence; and a fish wheel, dip net, and spear fishery in Tanada Creek and on the Copper River adjacent to the village of Batzulnetas. A personal use dip net fishery occurs in the Copper River near the village of Chitina. Harvests in all terminal fisheries average 50,000 fish annually with an annual harvest rate of 63% during 1990–2010. The terminal commercial fishery consists of a drift gillnet fishery at the mouth of the Copper River in the Copper River District of Prince William Sound. The sport fishery is prosecuted in fresh water on several of the many tributaries (e.g., Gulkana and Klutina rivers). Where there is road access to these tributaries, both shore- and boat-based sport fishing occurs. Current escapement performance of Copper River Chinook salmon is good, with the minimum spawning escapement goal exceeded 5 of 6 times during 2006–2011.

Current Stock Assessment

Assessment of run strength of Copper River Chinook salmon is currently conducted with mark-recapture methods using fish wheels deployed at Baird (marking site) and Wood (recapture site) canyons on the lower Copper River. All terminal harvests are either reported directly (subsistence, personal use, and commercial) or estimated by survey (sport). Stock-specific commercial harvest is assumed to occur in the Copper River District statistical area. Total run is estimated by combining terminal harvest in fisheries downstream of the mark-recapture site with inriver runs estimated at the mark-recapture site. Escapement is estimated by subtracting harvests upstream of the mark-recapture site from the inriver run estimated at the mark-recapture site. Age-sex-size composition are currently not collected from the inriver run of this stock, but are estimated from samples taken from the commercial fishery. The current escapement goal is

not based on a brood table, but was developed from reconstructed escapement data and observed fishery yields.

Gaps in Current Stock Assessment

While inriver run is currently estimated with a mark-recapture program, funding for this assessment (USFWS-Office of Subsistence Management) is likely to cease in the near future. Terminal harvests are adequately estimated in total, but estimates of harvest from marine sport, commercial, and subsistence fisheries in Prince William Sound/Copper River are not specific to the Copper River stock. Stock-specific harvests need to be estimated for the major marine fisheries in Prince William Sound/Copper River to more accurately portray harvest rates and production trends. There is no comprehensive estimate of age-sex-size of Copper River Chinook salmon and no way to know if age-sex-size composition data taken from the commercial fishery adequately represents the age composition of the run. There is currently no program to estimate smolt abundance and marine survival rates so that density independent variation in production can be partitioned into freshwater and marine sources.

Recommended Stock Assessment Projects

We have identified the following projects as beneficial to increasing our knowledge of this stock:

- A project to fund estimation of inriver run size of the Copper River stock. This project would include funding to operate fish wheels in the lower Copper River for the mark-recapture experiment and to sample Chinook salmon for age-sex-size. Mark-recapture estimates of abundance will be calculated from the lower-river fish wheels. (This project is currently funded with federal dollars that are likely to be unavailable in the future.)
- A project to estimate smolt abundance of the Copper River stock. This project would include funding to capture and CWT juvenile Chinook salmon for estimation of smolt abundance from subsequent adult returns.
- A project to estimate stock-specific marine harvest of Chinook salmon in Prince William Sound/Copper River fisheries using a combination of GSI and CWT recoveries. This project is needed to estimate contributions of relevant indicator stocks in mixed-stock harvests in Prince William Sound/Copper River. Relevant marine fisheries will be sampled to obtain genetic tissues and to examine the catch for CWTs.
- An analysis of the harvest of Chinook salmon in the subsistence fishery in Copper River District of Prince William Sound, as well as commercial removals of Chinook salmon for personal use, including an LTK component.

Susitna River

Stock Description

The Susitna River is a large (49,000 km^2), glacially influenced drainage that originates in the Alaska Range north of Anchorage. It flows generally south from the Alaska Range for 400 km before entering Cook Inlet west of Anchorage. Susitna River Chinook salmon spawn and return to many of the tributaries of the Susitna River, including Alexander Creek, Chulitna River, Clear Creek, Deshka River, Goose

Creek, Lake Creek, Little Willow Creek, Montana Creek, Peters Creek, Prairie Creek, Sheep Creek, Talachulitna River, and Willow Creek. Freshwater entry of Chinook salmon occurs during late May through mid-July, with 50% of the run typically entering by the middle of June. Annual run size is currently unknown, but is indexed with a weir on the Deshka River and rotary-wing aerial surveys conducted on 12 tributaries of the Susitna River. Run size of the Deshka River component has averaged 35,000 fish per year since 1979, with a spawning escapement goal of 13,000 to 28,000 fish. Based on information from the Deshka River assessment, age composition of this stock ranges from 3- to 7-year olds and is dominated by 5-year olds, although 4- or 6-year olds can predominate in some years.

Fishery Description

There are subsistence, commercial, and sport fisheries that harvest Susitna River Chinook salmon runs. A subsistence set gillnet fishery occurs along the west side Cook Inlet beaches adjacent to the village of Tyonek. The terminal commercial fishery consists of a set gillnet fishery in the Northern District of Upper Cook Inlet (UCI). The terminal sport fishery is prosecuted in fresh water on the many tributaries. On the east side of the Susitna drainage there is road access to these tributaries and shore-based sport fishing predominates. Boat-based sport fishing predominates on the roadless west side tributaries of the Susitna River. Harvests in all terminal fisheries average 29,000 fish annually; harvest rate is unknown, but is thought to be less than 25% annually and averages 14% in the Deshka River since 1990. There is no escapement goal for the Susitna River stock, but there are spawning escapement goals on 13 of the monitored tributaries. Escapement goal performance on the Deshka River has been fair, with the spawning escapement goal achieved in 4 of 6 years during 2006–2011. Three other tributaries of the Susitna River are currently listed as stocks of concern, with Alexander Creek listed as a management concern, and Willow and Goose creeks listed as yield concerns.

Current Stock Assessment

There is currently no overall assessment of run strength of Susitna River Chinook salmon. Run strength is indexed by counts of fish passing through a weir at the Deshka River and from partial counts of fish from rotary-wing aerial surveys conducted on 12 tributaries. All terminal harvests are either reported directly (subsistence and commercial) or estimated by survey (sport). Stock-specific commercial harvest is assumed to occur only in the Northern District of UCI. There is no estimation of total run or escapement. Age-sex-size composition is not estimated for this stock, but is indexed from samples taken at the Deshka River weir. The Deshka River spawning escapement goal was developed from a brood table and stock-recruit analysis, but the remaining tributary spawning escapement goals are based on percentile summaries of observed escapements from partial counts of rotary-wing aerial surveys conducted postseason.

Gaps in Current Stock Assessment

There is no assessment of overall run strength and assessments of run strength at tributaries are largely imprecise indices of abundance. While overall harvest rate of this stock is likely to be low relative to the optimum, it is currently unknown. Terminal harvests are adequately estimated in total, but estimates of harvest from marine subsistence, commercial, and sport fisheries in Cook Inlet are not specific to the Susitna River stock. Stock-specific harvests need to be estimated for all marine fisheries in Cook Inlet to more accurately portray harvest rates and production trends. There is no comprehensive estimate of age-

sex-size of Susitna River Chinook salmon and no way to know if age-sex-size composition data taken at the Deshka weir adequately represents the entire stock. There is currently no program to estimate smolt abundance and marine survival rates so that density-independent variation in production can be partitioned into freshwater and marine sources.

Recommended Stock Assessment Projects

We have identified the following projects as beneficial to increasing our knowledge of this stock:

- A project to estimate inriver run size of the Susitna River stock. This project would include funding to operate fish wheels in the lower Susitna River to sample Chinook salmon for age-sex-size and take genetic tissues for identification of tributary runs, such as the Deshka River (existing weir site) and a yet-to-be determined weir site. Sampling of harvests from inriver sport fisheries will also be conducted to obtain genetic tissues. Mark-recapture estimates of abundance will be calculated from genetic sampling at the lower river fish wheels and inriver sport fishery, combined with counts of fish passing through the two weir sites.
- A project to estimate smolt abundance of the Susitna River stock. This project includes funding to capture and CWT juvenile Chinook salmon for estimation of smolt abundance from subsequent adult returns. This project includes personnel to increase sampling of the inriver sport fishery for CWTs in returning adults.
- A project to comprehensively estimate stock-specific marine harvest of Chinook salmon in Cook Inlet fisheries using a combination of GSI and CWT recoveries. This project is needed to estimate contributions of relevant indicator stocks in mixed-stock harvests in Cook Inlet. Commercial set and drift gillnet fisheries in the Central and Northern Districts of UCI, sport fisheries along the Kenai Peninsula and the Homer winter fishery, and the Tyonek subsistence fishery will be sampled to obtain genetic tissues and to examine the catch for CWTs.
- A study of local and traditional knowledge of Chinook salmon stocks.

Kenai River

Stock Description

The Kenai River is located in the northern Kenai Peninsula of Southcentral Alaska and has two distinct runs of Chinook salmon. Fish entering the river in May and June spawn predominantly in tributaries and fish entering in July and August spawn predominantly in the mainstem of the Kenai River. For management purposes, these two life history patterns are delineated as the early (May–June) and late (July–August) runs. The early run is smaller than the late run and averages 16,000 fish per year, with a spawning escapement goal of 4,000 to 9,000 fish. The late run averages 56,000 fish per year, with a spawning escapement goal of 17,800 to 37,500 fish. Age composition of both of these runs tends to be dominated by 6-year olds.

Fishery Description

There are subsistence, personal use, commercial, and sport fisheries that harvest Kenai River Chinook salmon runs. Small personal use (set gillnet and dip net) and subsistence (hook and line) fisheries harvest

these runs. The commercial fisheries consist of a set gillnet fishery along the beaches of the eastern Kenai Peninsula and a drift gillnet fleet that operates in the Central District of UCI. The sport fishery is prosecuted primarily from boats inriver and in marine waters. The early run is harvested primarily by the sport fishery and is assumed to have no appreciable commercial or personal use fishery harvest. Harvests of early-run fish in the sport and subsistence fisheries average 4,300 fish annually, with the harvest rate averaging 25%. Harvest of late-run fish is split evenly between sport and commercial fisheries, with the remainder taken in small personal use and subsistence harvests. Late-run harvests average 26,300 fish annually, with an average harvest rate of 47%. Management of all fisheries is conducted inseason to achieve the spawning escapement goals for each run. Escapement goal performance is generally good, with escapement goals achieved 90% of the time during 2006–2010, although performance since 2009 is somewhat uncertain due to changes in run assessment methodology.

Current Stock Assessment

Until 2012, assessment of run strength of Kenai River Chinook salmon was conducted with split-beam sonar, which differentiated Chinook salmon from smaller salmon based on distance from shore (smaller salmon are assumed to migrate closer to shore than Chinook salmon) and echo-based characteristics (echo magnitude or echo length) related to fish size. Assessment methodology is currently transitioning to DIDSON imaging sonar, which can estimate fish size more accurately. An inriver test gillnet fishery is conducted adjacent to the sonar site to gather catch rate and species composition data for use in corroboration of sonar passage estimates. Mark-recapture estimates of the inriver run are also calculated using GSI data from the inriver test fishery and passage data at weirs on selected tributaries to the Kenai River. All terminal harvests are either reported directly (subsistence, personal use, and commercial) or estimated by survey (sport). Total runs are estimated by combining terminal harvests in fisheries downstream of the sonar with inriver runs estimated at the sonar. Escapements are estimated by subtracting harvests upstream of the sonar from the inriver runs estimated at the sonar. Age-sex-size compositions are estimated from samples from the commercial and sport fisheries, and from the inriver gillnet test fishery. Brood tables constructed from these data were used to conduct stock-recruit analyses for each run to determine the current escapement goals.

Gaps in Current Stock Assessment

Historical assessment of run strength is known to be biased due to misclassification of smaller and more numerous salmon as Chinook salmon by the split-beam sonar due to imprecision in estimation of echo-based discriminators and the assumption of discrimination based on distance from shore. The newer DIDSON technology, in combination with information on fish size from the inriver test fishery, is thought to provide accurate estimates of species composition based on size of fish. The current sonar site experiences large tide-related fluctuations in water level that make it impractical to sample the entire river cross-section with sonar, and recent experiments have detected substantial numbers of Chinook salmon passing behind the transducers. An alternative sonar site has been identified above tidal influence where nearly the entire cross-section of river can be sampled. Although terminal harvests are adequately estimated in total, estimates of harvest from marine waters are not specific to the Kenai River stock. Stock-specific harvests need to be estimated for marine fisheries, including the sport fishery along the Kenai Peninsula and commercial harvests in Central District of UCI to more accurately portray harvest rates and production trends. Attempts have been made to estimate smolt abundance and marine survival

of the Kenai River stock, but there is currently no program to estimate these quantities so that density independent variation in production can be partitioned into freshwater and marine sources.

Recommended Stock Assessment Projects

We have identified the following projects as beneficial to increasing our knowledge of this stock:

- A 3-year project to move the sonar site and run-strength assessment upstream to a site where the majority of the width of the river can be ensonified. This project was initiated in 2012 with existing capital funding, but requires additional funds for personnel to conduct run-strength assessments at the upstream site, concurrently with the current sonar site for comparison. At the end of the 3-year project, the current site would be abandoned, and the sonar and run-strength assessment moved to the new site. This project includes personnel to increase sampling of the inriver sport fishery for CWTs in returning adults as part of the smolt abundance assessment.
- A project to estimate smolt abundance by run (tributary and mainstem runs) of the Kenai River stock. This project includes funding to capture, CWT, and genetically identify juvenile Chinook salmon for estimation of smolt abundance by run from subsequent adult returns.
- A project to comprehensively estimate stock-specific marine harvest of Chinook salmon in Cook Inlet fisheries using a combination of GSI and CWT recoveries. This project is needed to estimate contributions of relevant indicator stocks in mixed-stock harvests in Cook Inlet. Commercial set and drift gillnet fisheries in the Central and Northern Districts of UCI, sport fisheries along the Kenai Peninsula and the Homer winter fishery, and the Tyonek subsistence fishery will be sampled to obtain genetic tissues and to examine the catch for CWTs. This is the same project as that recommended for the Susitna River stock in Cook Inlet.
- A study of local and traditional knowledge of Chinook salmon stocks.

Karluk River

Stock Description

The Karluk River is located on the southwest end of Kodiak Island and supports 1 of only 2 native stocks of Chinook salmon on the Kodiak Archipelago. From its source at the outlet of Karluk Lake, the Karluk River flows 35.2 km to its terminus at Karluk Lagoon. Freshwater entry of Chinook salmon occurs during late May through mid-July, with 50% of the run typically entering by the middle of June. Spawning occurs during August and September in the Karluk River, with few to no fish spawning in Karluk Lake or any of the inlet streams. Annual run size has averaged 9,000 fish since 1976, with a spawning escapement goal of 3,000 to 6,000 fish. Age composition of this stock ranges from 3- to 7-year olds and is dominated by 6-year olds or occasionally, 5-year olds.

Fishery Description

There are subsistence, commercial, and sport fisheries that harvest Karluk River Chinook salmon. A small subsistence set gillnet fishery at Karluk Lagoon harvests this run. The commercial fishery is a purse seine fleet that primarily targets 2 sockeye salmon runs entering the Karluk River; harvests of Chinook salmon from June 1 through July 15 are thought to be Karluk-origin fish. The sport fishery is prosecuted

primarily in fresh water from fly-in trips that originate either at the outlet of the lake, at an area midway downstream known as the portage, or at Karluk Lagoon. Harvest in all fisheries averages 2,300 fish annually, with an average harvest rate of 23%. Karluk River Chinook salmon are currently a stock of management concern because recent escapement goal performance has been poor. During the 6-year period from 2006 to 2011, the spawning escapement goal was achieved only twice.

Current Stock Assessment

Assessment of run strength of Karluk River Chinook salmon is conducted with a weir located 400 m upstream of Karluk Lagoon. All terminal harvests are either reported directly (subsistence and commercial) or estimated by survey (sport). Stock-specific commercial harvest is assumed to occur from June 1 through July 15 in the Inner and Outer Karluk sections statistical areas. Total run is estimated by combining terminal harvest in fisheries downstream of the weir with inriver runs estimated at the weir. Escapement is estimated by subtracting harvests upstream of the weir from the inriver runs estimated at the weir. Age-sex-size composition data are currently not collected from this stock, but were estimated from samples taken at the weir from 1993–2010. Brood tables constructed from these data were used to conduct stock-recruit analyses to determine the current escapement goal.

Gaps in Current Stock Assessment

Age-sex-size composition data are currently not collected from the inriver run or fishery harvests due to budgetary constraints. Although terminal harvests are adequately estimated in total, estimates of harvest from the commercial fishery are not specific to the Karluk River stock. Stock-specific harvests need to be estimated for the commercial fishery to more accurately portray harvest rates and production trends. There is currently no program to estimate smolt abundance and marine survival rates so that density independent variation in production can be partitioned into freshwater and marine sources. While not part of this stock assessment, hatchery releases of Chinook salmon into systems on the east side of Kodiak Island are derived from Karluk River brood source. These hatchery releases need to be marked with CWTs so that they can be correctly identified in mixed-stock fishery samples.

Recommended Stock Assessment Projects

We have identified the following projects as beneficial to increasing our knowledge of this stock:

- A project to estimate age-sex-size composition of the inriver run of the Karluk River stock that would include funding to sample for age-sex-size of all monitored Chinook salmon stocks on Kodiak Island and the Alaska Peninsula. Funding is also needed to lease private land, which would permit access to the weir site near Karluk Lagoon.
- A project to estimate smolt abundance of the Karluk River stock. This project includes funding to capture and CWT juvenile Chinook salmon for estimation of smolt abundance from subsequent adult returns. This project includes the cost associated with CWT-tagging hatchery releases on the east side of Kodiak Island of fish derived from Karluk River brood source.
- A project to comprehensively estimate stock-specific marine harvest of Chinook salmon in Kodiak Archipelago fisheries using a combination of GSI and CWT recoveries. This project is needed to estimate contributions of relevant indicator stocks in mixed-stock harvests around the

Kodiak Archipelago. All commercial salmon fisheries will be sampled to obtain genetic tissues and to examine the catch for CWTs.

Chignik River

Stock Description

The Chignik River is located on the Alaska Peninsula near the village of Chignik and is the largest Chinook salmon-producing system on the southern shore of the Alaska Peninsula. The Chignik River watershed is dominated by Black and Chignik lakes, with the Black and Chignik rivers draining them, respectively. Chignik Chinook salmon exhibit late run timing, with freshwater entry of Chinook salmon occurring during late June through mid-August. Typically, 50% of the run enters the Chignik River by mid-July. Annual run size has averaged 5,500 fish since 1978, with a spawning escapement goal of 1,300 to 2,700 fish. Age composition of this stock ranges from 3- to 7-year olds and is composed of roughly equal proportions of 5- and 6-year olds, with 4-year olds predominating in some years.

Fishery Description

There are subsistence, commercial, and sport fisheries that harvest Chignik River Chinook salmon. A small subsistence fishery in the Chignik River and Lake harvests this run. The commercial fishery is a purse seine fleet that primarily targets 2 sockeye salmon runs entering the Chignik River; incidental harvests of Chinook salmon from the Chignik Lagoon are thought to be Chignik-origin fish. There is a small sport fishery prosecuted in the Chignik River downstream from the weir site. Harvest in all fisheries averages 2,200 fish annually, with an average harvest rate of 37% since 1990. Current escapement performance of Chignik River Chinook salmon is very good, with the spawning escapement goal achieved annually during 2006–2011.

Current Stock Assessment

Assessment of run strength of Chignik River Chinook salmon is conducted with a weir located approximately halfway between Chignik Lagoon and Chignik Lake. All terminal harvests are either reported directly (subsistence and commercial) or estimated by survey (sport). Stock-specific commercial harvest is assumed to occur in the Chignik Lagoon statistical area. Total run is estimated by combining terminal harvests in fisheries downstream of the weir with inriver runs estimated at the weir. Escapements are estimated by subtracting harvests upstream of the weir from the inriver runs estimated at the weir. Age-sex-size composition are currently not collected from this stock, but were estimated from samples taken from sport harvests during 1995–2005. Brood tables constructed from these data were used to conduct stock-recruit analyses to determine the current escapement goal.

Gaps in Current Stock Assessment

Age-sex-size composition data are currently not collected from the inriver run or fishery harvests due to logistical and budgetary constraints. Although terminal harvests are adequately estimated in total, estimates of harvest from the commercial fishery are not specific to the Chignik River stock. Stock-specific harvests need to be estimated for the commercial fishery to more accurately portray harvest rates and production trends. There is currently no program to estimate smolt abundance and marine survival

rates so that density independent variation in production can be partitioned into freshwater and marine sources.

Recommended Stock Assessment Projects

We have identified the following projects as beneficial to increasing our knowledge of this stock:

- A project to estimate age-sex-size composition of the inriver run of the Chignik River stock.
- A project to estimate smolt abundance of the Chignik River stock. This project includes operating funds to capture, and Passive Integrated Transponder (PIT) tag and CWT juvenile Chinook salmon for estimation of smolt abundance from subsequent adult returns. The additional PIT tagging is needed for this assessment to identify individually-tagged salmon in adult returns at this weir site.
- A project to comprehensively estimate stock-specific marine harvest of Chinook salmon in Chignik and South Peninsula fisheries using a combination of GSI and CWT recoveries. This project is needed to estimate contributions of relevant indicator stocks in mixed-stock harvests in the Chignik and South Peninsula management areas. Commercial salmon fisheries will be sampled to obtain genetic tissues and to examine the catch for CWTs.
- Improvements to the existing subsistence harvest monitoring and assessment program.

Nushagak River

Stock Description

The Nushagak River is located in Southwestern Alaska and flows about 390 km from its headwaters to Bristol Bay. The Nushagak Drainage has two main tributaries: the Nuyakuk River, draining Tikchik lakes, which enters from the west; and the Mulchatna River, which flows into the Nushagak River from the east. The Nushagak River is the largest Chinook salmon producer in Bristol Bay, with an average run size of 156,000 fish. Average escapement is 80,500 fish per year, with an escapement goal of 40,000 to 80,000 fish. Chinook salmon subsistence, commercial, and sport fisheries are managed using the *Nushagak-Mulchatna King Salmon Management Plan*, which was adopted into regulation in 1992. The plan was established because of declining run sizes from a peak in the early 1980s. It was modified in the mid to late 1990s because of trends in age composition of spawning escapement (proportion of larger, age 5 to 7, fish were less than desired). The plan establishes an inriver goal of 75,000 fish at the sonar (65,000 escapement, reasonable opportunity for subsistence, and sport guideline harvest level of 5,000 fish greater than 20 inches in length). Commercial openings are scheduled to maintain natural representation of age structure. The early part of the run is comprised mainly of smaller, younger age-classes, whereas older age-classes are more prevalent in the later portion of the run.

Fishery Description

There are subsistence, sport, and commercial fisheries that harvest Nushagak River Chinook salmon. Subsistence harvest in the Nushagak District (set gillnet) requires a permit and averages 13,000 fish annually. The sport fishery in the Nushagak River is primarily catch-and-release, but harvests average 6,000 fish annually. The commercial fishery consists of both set and drift fisheries, with average

commercial harvest in the Nushagak District of 53,000 fish (67,000 total in Bristol Bay). Commercial harvest estimates are considered to be biased low because catches are dominated by sockeye salmon. Management of the fisheries is conducted inseason to achieve the inriver escapement goal established in the *Nushagak-Mulchatna King Salmon Management Plan*. Management performance has been very good, with the escapement goal being met in 4 of the last 10 years and exceeded in the other 6 years.

Current Stock Assessment

Inseason run strength and timing assessment of Nushagak River Chinook salmon is conducted with sonar at Portage Creek, where sonar targets are counted for 10 minutes per hour from two strata for each bank. The sonar project is designed to assess sockeye salmon, and the middle portion of the river is not ensonified, so there is an unknown portion of fish (primarily Chinook salmon) that are not counted. Projects are currently underway to assess this uncounted portion of Chinook salmon using radio telemetry. Estimates of species composition, age, sex, and size distribution are estimated with gillnet test fishing at the sonar site. The Nushagak River spawning escapement goal was developed from a brood table, stock-recruit analysis, and yield analysis.

Gaps in Current Stock Assessment

Assessment of inriver abundance is known to be biased because of the inability to ensonify the entire width of the river. Commercial harvest estimates are probably biased low due to underreporting because sockeye salmon dominate the commercial catch. There is currently no program in place to estimate smolt abundance and marine survival rates of Nushagak River Chinook salmon so that density independent variation in production can be partitioned into freshwater and marine sources.

Recommended Stock Assessment Projects

We have identified the following projects as beneficial to increasing our knowledge of this stock:

- A project to estimate inriver run size of Nushagak River Chinook salmon using mark-recapture methods. This project will also investigate the use of guided sport charters for tagging of fish.
- A project to estimate smolt abundance of the Nushagak River stock. This project includes funding to capture and CWT juvenile Chinook salmon for estimation of smolt abundance from subsequent adult returns.
- A study of local and traditional knowledge of Chinook salmon stocks.
- Improvements to the existing subsistence harvest monitoring and assessment program.

Kuskokwim River

Stock Description

The Kuskokwim River is the second largest drainage area in Western Alaska, originating on the north and west sides of the Alaska Range mountains and flowing west some 700 miles to Kuskokwim Bay and the Bering Sea. The Kuskokwim River Chinook salmon stock is a complex array of many populations throughout the drainage, representing a total run estimated between 240,000 and 423,000 fish in recent years. There are currently 11 tributary escapement goals based upon weirs or aerial surveys, including

Kogrukluk (5,300–14,000), Kwethluk (6,000–11,000), Tuluksak (1,000–2,100), George (3,100–7,900), Kisaralik (400–1,200), Aniak (1,200–2,300), Salmon (330–1,200), Holitna (970–2,100), Cheeneetnuk (340–1,300), Gagaryah (300–830), and Salmon rivers (470–1,600). Using a recent run reconstruction and stock recruit analysis, a drainagewide escapement goal will be recommended in 2013. Kuskokwim River run strength has been highly variable over the past 2 decades, with strong returns during 2004–2006, and much weaker runs since 2007, with historically low returns during 2010–2011.

Fishery Description

The largest Chinook salmon subsistence fishery in Alaska takes place in the Kuskokwim River, with annual harvests between about 27,000 and 110,000 fish over the last 5 decades. Total harvests during the same time period range from about 59,000 to 164,000 fish. Gear used for subsistence fishing for Chinook salmon is primarily large-mesh drift gillnets. Directed commercial harvests of Chinook salmon ended in 1987, and incidental harvests in the chum and sockeye commercial fisheries have been less than 10,000 fish in the most recent decade. There is a very small sport fishery in various tributaries of the Kuskokwim River. Most tributary escapement goals were met regularly prior to 2008; however, many have fallen short since then. Restrictions to subsistence fishing have been imposed since 2010 in response to low run abundance.

Current Stock Assessment

Inseason run strength and timing is estimated using catch-per-unit-effort (CPUE) from the Bethel test fish project. Age, sex, and size data are currently collected at weir-based escapement projects. Estimates of Chinook salmon harvested in chum and sockeye commercial fisheries are adequate, and subsistence harvest estimates from survey information are generally deemed fairly accurate; however, consistent and systematic samples of subsistence harvest for age, sex, and size are needed.

Gaps in Current Stock Assessment

There is currently no accurate measure of inseason run abundance for Kuskokwim River Chinook salmon, with inseason management reliant upon CPUE data from the Bethel test fish project. Current run reconstructions and stock recruit analyses would benefit from additional mark-recapture studies, particularly during years of low abundance. Consistent sampling for age, sex, and size are necessary at all tributary weir sites, the Bethel test fishery, and the subsistence harvest. There is currently no program to estimate smolt abundance and marine survival rates so that density independent variation in production can be partitioned into freshwater and marine sources.

Recommended Stock Assessment Projects

We have identified the following projects as beneficial to increasing our knowledge of this stock:

- A 3-year mark-recapture project to estimate inriver abundance and collect age, sex and size information. This project will also explore select tributaries in the Kuskokwim River where coded-wire tagging of juvenile Chinook salmon might be conducted.
- An annual project targeted at continuing weir projects and age-sex-length (ASL) collection at weirs.

- An annual project to estimate smolt abundance in the Goodnews River (or other surrogate stock) in Kuskokwim Bay as a surrogate for smolt abundance trends of the Kuskokwim River stock. This project would include funding to capture and CWT juvenile Chinook salmon in the Goodnews River (or other surrogate stock) for estimation of smolt abundance from subsequent adult returns. Funding would also be provided to scan returning Chinook salmon for CWTs at a fish processing facility in Kuskokwim Bay.
- ASL sampling of the subsistence harvest (included in operating funds for ASL data collection at weirs).
- An analysis of subsistence Chinook salmon harvest patterns and trends.
- An evaluation of the existing subsistence harvest monitoring program, including an inseason assessment pilot project.
- A study of local and traditional knowledge of Chinook salmon stocks.

Yukon River

Stock Description

The Yukon River originates in Yukon Territories, Canada, and flows north and west approximately 3,000 km to its mouth in the Bering Sea. Approximately 40% of the Yukon River drainage area lies in Canada. The Yukon River Chinook salmon stock is a complex amalgam of many populations originating in Alaska and Canada. Available data suggests that roughly half of Chinook production in the Yukon originates from the Canadian Yukon, with a drainagewide total run of approximately 100,000–400,000 Chinook salmon in recent years. There are currently 6 escapement goals established for Alaska Yukon River populations including a weir-based escapement goal on the East Fork Andreafsky River (2,100–4,900), peak aerial survey goals on the West Fork Andreafsky River (640–1,600), Anvik River (1,100–1,700), and Nulato River (940–1,900), and tower-based goals on the Chena (2,800–5,700) and Salcha (3,300–6,500) rivers. There is also a sonar-based goal for Chinook salmon crossing the U.S/Canada border of 42,500–55,000 fish, established by agreement between the U.S. and Canada under the auspices of the PST. Yukon River Chinook salmon are currently considered to be in a period of low productivity where escapement goals are not always met and fishery restrictions are common. The Alaska Board of Fisheries has designated Yukon River Chinook salmon a stock of yield concern.

Fishery Description

Yukon Chinook salmon are harvested over a large area throughout the drainage, primarily by subsistence and commercial fishermen. Fisheries are managed within 6 districts in the Alaskan portion of the drainage. Commercial and subsistence fishing employs large mesh gillnets and fish wheels in various parts of the drainage. Total catch for all fisheries over the past fifty years ranges from about 30,000–200,000 Chinook salmon, with an average of 73,000 fish taken in the most recent decade. In Alaska, subsistence fishers typically take between 30,000 and 60,000 Chinook salmon annually. There is very limited sport harvest in tributaries near Fairbanks. Management of fisheries is conducted inseason to achieve escapement goals, based upon test net indices in the lower river and at Pilot Station sonar at river mile 121. Performance in meeting escapement goals has varied between projects, but in recent years, fisheries have been severely restricted in an effort to achieve them.

Current Stock Assessment

Assessment of run strength for Yukon River Chinook salmon is primarily conducted using CPUE from the lower Yukon River test fishery, Hooper Bay/Dall Point offshore test fishery, Mountain Village test fishery, a Rapids fish wheel project, and with Pilot Station sonar passage estimates. Genetic samples taken from the lower Yukon test fishery, Pilot Station test nets, and commercial and subsistence harvests characterize the stock composition of the run, which is typically resolved to the level of lower middle and upper Yukon spawning stocks. Run strength for the Canadian component is assessed at Eagle sonar on the U.S./Canada border. Commercial harvests are reported on fish tickets and subsistence harvest numbers are acquired by postseason survey. Total runs of Yukon River Chinook salmon can be estimated by adding harvest numbers and escapements below Pilot Station sonar to the sonar estimates. Age, sex and size samples are taken from test fish, escapement, and harvest samples. Brood tables exist for Upper Yukon River Chinook salmon (Canada), a stock which is genetically distinct from Alaska stocks.

Gaps in Current Stock Assessment

Run-strength assessment is known to be biased due to difficulties in estimating Chinook salmon abundance at Pilot Station sonar because Chinook salmon are co-migrating with far more abundant summer chum salmon. Commercial harvests are adequately estimated; however, information about timing and effort in subsistence fisheries, which now comprise a substantial or majority of Chinook salmon harvests, is incomplete due to low (15%) response to voluntary returns of harvest calendars in areas not accessible by road. Estimates of escapement are generally good; however, only a small number of systems are monitored with weirs or towers, with the remainder monitored by aerial surveys or not monitored. Current estimates of run strength need to be confirmed independently.

Recommended Stock Assessment Projects

We have identified the following projects as beneficial to increasing our knowledge of this stock:

- A telemetry of genetically-based mark-recapture assessment to estimate inriver run as the basis for annual run reconstruction.
- An examination of existing Whitehorse Hatchery CWT data to estimate marine survival, if possible.
- A study of local and traditional knowledge of Chinook salmon stocks.
- An analysis of subsistence Chinook salmon harvest patterns and trends.
- An evaluation of the existing subsistence harvest monitoring program, including an inseason assessment pilot project.