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McNeil River Chum Salmon Stock Status and Action Plan, 2016

by

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and

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November 2016

Alaska Department of Fish and Game **Divisions of Sport Fish and Commercial Fisheries**

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Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity (negative log of)	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
id est (that is)	i.e.
latitude or longitude	lat or long
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	*e*
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	*E*
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	$\log_2$, etc.
minute (angular)	'
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

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November 2016

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ABSTRACT

In response to guidelines established in the *Policy for Management of Sustainable Fisheries* (SSFP), the Alaska Department of Fish and Game (department) recommended that McNeil River chum salmon (*Oncorhynchus keta*) be designated as a "stock of management concern." A "management concern" is defined as "a concern arising from a chronic inability, despite use of specific management measures, to maintain escapements for salmon stocks within the bounds of the sustainable escapement goal (SEG), biological escapement goal (BEG), optimum escapement goal (OEG), or other specific management objectives for the fishery." Escapement of chum salmon has fallen below the lower end of the existing SEG range for McNeil River in 4 consecutive years (2012-2015), and during 11 of the past 20 years (1997–2016). Since 1994, the department has consistently issued emergency order closures of the McNeil River subdistrict during the chum salmon run to minimize harvest on this stock and increase escapement. These management actions have thus far proven insufficient to consistently achieve the SEG.

Key words: McNeil River, chum salmon, *Oncorhynchus keta*, stock of concern, commercial, fishing, sustainable salmon fisheries policy, Alaska Board of Fisheries, Lower Cook Inlet, Alaska

INTRODUCTION

The *Policy for Management of Sustainable Salmon Fisheries* (SSFP; 5 AAC 39.222) directs the Alaska Department of Fish and Game (department) to provide the Alaska Board of Fisheries (board) with reports on the status of salmon stocks and identify any salmon stocks that present a concern related to yield, management, or conservation during regularly-scheduled board meetings. This action plan provides the department's assessment of McNeil River chum salmon (*Oncorhynchus keta*) as a stock of management concern, summarizes historical assessments of annual run sizes, and describes the existing regulations and emergency order (EO) authority that the department follows to manage McNeil River chum salmon. Options are then presented for potential management actions for the commercial and sport fisheries, and research projects for this chum salmon stock.

In September 2016, the department recommended McNeil River chum salmon to be classified as a stock of management concern at the board meeting for the Lower Cook Inlet (LCI) in November of 2016[1]. This recommendation was based on guidelines established in the SSFP, which states that a "management concern means a concern arising from a chronic inability, despite use of specific management measures, to maintain escapements for a salmon stock within the bounds of the sustainable escapement goal (SEG), biological escapement goal (BEG), optimum escapement goal (OEG), or other specific management objectives for the fishery". Chronic inability is further defined in the SSFP as "the continuing or anticipated inability to meet escapement thresholds over a 4 to 5 year period" based on the generation time of most salmon species. The McNeil River chum stock failed to meet its escapement goal 4 consecutive years (2012-2015) and marginally attained it in 2016.

Two natural conditions unique to McNeil River presumed to contribute to the present status of chum salmon are: 1) a physical obstacle (McNeil Falls) located low in the drainage impedes consistent use of upriver spawning habitats; and 2) a high density of brown bears aggregated at McNeil Falls to feed, essentially creating a biological impediment to upstream migration (Otis and Szarzi 2007). Management of this stock is also affected by a special area designation. McNeil River resides within the boundaries of the *McNeil River State Game Sanctuary*

[1] Unpublished memorandum (RC-3) from Directors S. Kelley and T. Brookover, ADF&G, to Alaska Board of Fisheries, September 22, 2016.

(sanctuary) and is bordered on the north by the *McNeil River State Game Refuge* (refuge; Figure 1). The sanctuary and refuge were created by the Alaska Legislature in 1967 and 1991, respectively, for the following purposes (Schempf and Meehan 2008):

1. The permanent protection of brown bear and other fish and wildlife populations for scientific, aesthetic, and educational purposes;
2. To manage human use and activities in a way that is compatible with that purpose and to maintain and enhance unique bear viewing opportunities in the sanctuary;
3. To provide compatible opportunities for wildlife viewing, fisheries enhancement, fishing, temporary safe anchorage, and other activities in both the sanctuary and refuge, and, in the refuge, for hunting and trapping opportunities if compatible with sanctuary management objectives.

Alaska statutes that specifically pertain to the establishment and management of the McNeil River State Game Refuge and Sanctuary are codified as AS 16.20. The refuge statute first became law in 1991 (§ 2 ch 56 SLA 1991), and was amended in 1995 and 1999 (am § 21 ch 21 SLA 1995; am § 2 ch 59 SLA 1999). The sanctuary statutes were first adopted in 1967 (§ 2 ch 108 SLA 1967), and were amended in 1972, 1991, 1995, and 1999 (am § 15 ch 71 SLA 1972; am § 3 and 4 ch 56 SLA 1991; am § 22 ch 21 SLA 1995; am § 3 ch 59 SLA 1999). The department adopted the *McNeil River State Game Refuge and State Game Sanctuary Management Plan* (plan) in 1996 and revised it in 2008 (Schempf and Meehan 2008).

STOCK ASSESSMENT BACKGROUND

Federal (pre-statehood) and state fishery managers have flown aerial surveys of McNeil River since 1950 to index spawning escapement of chum salmon (Table 1). These surveys are conducted from fixed-wing aircraft. Since 1976, multiple surveys have been flown annually to assess the timing and magnitude of the run. The department uses estimates of average stream life and the area-under-the-curve (AUC) method to estimate a total escapement index from these periodic survey counts (English et al. 1992; Bue et al. 1998). The department developed a run-timing adjustment to expand the total escapement index when aerial surveys were truncated prior to the end of the chum salmon run (Otis and Szarzi 2007).

Until 1994, McNeil River chum salmon were consistently harvested by the LCI purse seine commercial salmon fishery. No commercial harvest of chum salmon has occurred in the McNeil River subdistrict since 1993. Minor sport harvest of this stock also occurs, but is limited to irregular effort by the relatively few members of the public who receive permits to view bears at the sanctuary.

ESCAPEMENT

The current SEG for McNeil River chum salmon is 24,000–48,000 fish. This goal was established in 2007 and first implemented in 2008 (Otis and Szarzi 2007). The average McNeil River chum salmon escapement from 1976–2016 was 25,055 fish (Table 1; Figure 2). The most recent 10-year average (2007–2016) was 18,042 fish, 10% lower than the previous 10-year average (1997–2006: 20,095) and 33% lower than the average for all years (1950–2016: 26,872; Table 1). Despite minimal commercial harvest since 1989, and no commercial harvest since 1993, chum salmon escapements to this system in 4 of the past 6 years (2011–2016) were well below the SEG, averaging 19,200 fish annually. In 7 of the last 10 years (2007–2016), the SEG

in place at the time was not achieved (Figure 2). During a period (1999–2006) when other Kamishak District chum salmon stocks were rebounding from a decade-long period of low productivity, McNeil River generally did not achieve the escapement goal most years (Figure 3; Otis and Szarzi 2007). Although fewer aerial surveys were flown annually prior to 1976, it is apparent from available data that McNeil River experienced high chum salmon runs during the mid-1960s, 1970s, and 1980s (Table 1).

HARVEST

The *Lower Cook Inlet Seine Fishery Management Plan* (5 AAC 21.369) directs the department to manage the commercial fishery seine fleet to target LCI salmon stocks. Hence, LCI staff utilizes strict time and area openings and closures to focus harvest on discrete stocks relatively close to the mouths of rivers and streams these targeted stocks are returning to. Harvest of McNeil River chum salmon occurs primarily in the McNeil River subdistrict (249-50) in Kamishak Bay District. The subdistrict includes the marine waters southwest of a line from McNeil Head to a point of land at 59° 09.50′ North latitude, 154° 12.75′ West longitude (Figure 4; 5 AAC 21.200(e)7). The average annual chum salmon commercial harvest in this subdistrict from 1976–1993, as reported on fish tickets, was 16,700 fish. The commercial fishery targeting the McNeil River stock has been closed annually by EO and no commercial harvest from McNeil River subdistrict has occurred since 1993 (Table 2). Illegal harvest and/or interception of McNeil River chum salmon outside the subdistrict are not considered to be significant factors affecting the current status of this stock.

The Kamishak District commercial seine fishing season is open from June 1 until closed by EO (5 AAC 21.310(5)). Individual subdistricts within the district are opened and closed by EO based on inseason harvest and escapement information. Prior to 1989, McNeil River was a popular chum salmon commercial fishery in Kamishak District. From 1976–1988, the commercial harvest of chum salmon from the McNeil River subdistrict ranged from 0–67,900, with an average harvest of 22,900 fish. Fish were commercially harvested every year during that period, except in 1985. Chum salmon productivity experienced a regionwide downturn beginning around 1989, and although other Kamishak District stocks rebounded in the late 1990s and experienced 10+ years of strong runs, commercial harvest and escapement from McNeil River remained poor (Figure 3).

ESCAPEMENT GOAL EVALUATION

ESCAPEMENT GOAL HISTORY

The *Salmon Escapement Goal Policy*, adopted by the department in 1992, established a formal process for setting escapement goals and required publication of the goals (Fried 1994). However, a series of unpublished escapement goals existed for McNeil River chum salmon prior to the policy being adopted. A goal of 10,000 chum salmon appears to be the first goal used by managers (Bucher et al. 1993). However, based on observations of higher than expected returns being produced by large escapements, managers increased the goal in 1975 and converted it to a range of 20,000–40,000 fish (Bucher et al. 1993). In approximately 1979, managers increased the upper end of the escapement goal range to 50,000 fish; then in 1982, the goal was lowered to 10,000–20,000 fish (Fried 1994). By the time the escapement goal was formally published in 1988, it was increased again to a range of 20,000–40,000 fish (Schroeder and Morrison 1989). Methods and rationales for early goals were not well documented (Fried 1994), but the

20,000-40,000 fish goal enacted in 1988 was reportedly based on a subjective assessment of spawning area and commercial harvests resulting from various levels of escapement (Bucher et al. 1993; Fried 1994). The McNeil River chum salmon SEG was most recently revised in 2007 and a detailed explanation of the rationale for the current goal is provided in Otis and Szarzi (2007).

SPAWNER DATA AND SEG ANALYSIS

During 2000 and 2001, the board adopted two policies that established definitions and guidelines governing the establishment and use of escapement goals: 5 AAC 39.222. *Policy for the Management of Sustainable Salmon Fisheries* (SSFP) and 5 AAC 39.223. *Policy for Statewide Salmon Escapement Goals* (PSSEG). Two key terms defined in section (f)(3) of the SSFP are:

biological escapement goal (BEG): the escapement that provides the greatest potential for maximum sustained yield (MSY), and

sustainable escapement goal (SEG): a level of escapement, indicated by an index or escapement estimate, that is known to provide for sustained yield over a 5- to 10-year period, used in situations where a BEG cannot be estimated or managed for.

The SEG was intended for use in situations where the department lacks sufficient data to use spawner-recruit analyses (e.g., Ricker 1975) to estimate MSY and set a BEG. SEGs are also more appropriate for stocks monitored by methods that produce a relative abundance index with no quantifiable measurement error (e.g., aerial and/or ground survey) rather than an absolute abundance estimate (e.g., weir count, sonar count, mark-recapture, remote video count), because the lack of accurate and precise measures of spawner abundance can have a profound effect on assessing stock-recruit relationships and lead to over-exploitation (Walters and Ludwig 1981).

Adoption of the SSFP and PSSEG necessitated the development of a formal approach for estimating SEG ranges for data-limited stocks. In 2001, the department's Salmon Escapement Goal Interdivisional Review Team (team) developed a method that came to be known as the Percentile Approach. The basis of this approach is a relatively simple algorithm that uses a stock's escapement contrast and estimated exploitation rate to determine which of 4 tiers of percentiles should be used to develop the SEG for that stock based on observed escapements that have been shown to be sustainable (Bue and Hasbrouck[2]). The Percentile Approach was used to develop SEGs for all LCI chum, pink (*O. gorbuscha*) and sockeye (*O. nerka*) salmon stocks at the 2001 LCI board meeting (Otis 2001). The McNeil River chum salmon SEG range was set at 13,750–23,750 and was based on the 25th and 75th percentiles of observed escapements from 1976–2001. This was the range of years where consistent aerial survey methods were used to calculate an annual AUC escapement index from periodic survey counts made throughout the run.

In 2007, following the completion of a stream-life study directed at improving the ability to estimate spawning escapement using the AUC method (Peirce et al. 2011), the department increased the escapement goal range to 24,000–48,000 (Otis and Szarzi 2007). The rationale for this change centered on the understanding that higher escapements were needed to mitigate high levels of inriver predation on prespawning fish by bears, and to encourage more consistent use

[2] Bue, B. G. and J. J. Hasbrouck. *Unpublished*. Escapement goal review of salmon stocks of Upper Cook Inlet. Alaska Department of Fish and Game, Report to the Board of Fisheries, November 2001 (and February 2002), Anchorage.

and production from high-quality spawning habitats available above McNeil Falls. At the time this higher goal was implemented, staff pointed out in their oral report to the board: “In an effort to encourage more consistent seeding of upriver spawning areas, we will restore the higher escapement goal that was in place prior to the change made in 2001. It’s important to note that we won’t have the ability to manage for this higher goal until the run recovers on its own and that until then, we may have a series of years where we fail to meet our new goal. Our approach is proactive - it’s a forward-thinking attempt to see if we can maintain the system at a higher level of productivity once the run recovers” (LCI staff oral report to the board in 2007 regarding LCI escapement goals, RC-4).

ESCAPEMENT GOAL RECOMMENDATION

The department reviewed this escapement goal in 2016 and recommended no change at this time (Otis et al. 2016).

STOCK OF CONCERN RECOMMENDATION

Escapement of chum salmon has fallen below the lower end of the existing SEG range for McNeil River in 4 consecutive years (2012–2015), and during 11 of the past 20 years (1997-2016; Otis et al. 2016). Since 1994, the department has consistently issued EO closures of the McNeil River subdistrict during the chum salmon return to minimize harvest of this stock and increase escapement (Table 3). However, those management actions have proven to be insufficient to consistently achieve the SEG, particularly since the goal was raised in 2007. Therefore, in September 2016, the department recommended McNeil River chum salmon be classified a stock of management concern at the November 2016 LCI board meeting.

OUTLOOK

The department does not develop a formal preseason forecast for McNeil River chum salmon. However, based on parent year run strength and recent escapements, the 2016 run was considered to have a relatively low chance of achieving the SEG. The vast majority of chum salmon returning to McNeil River are 4 and 5 years old so the parent years contributing most to the 2016 return are 2011 and 2012. The escapement index in 2011 was relatively strong (30,977), but the index was weak (10,388) in 2012. Four-year-olds from the 2011 brood year returned to McNeil River in 2015, a year with fair escapement (20,500), but not enough to meet the low end of the SEG. Thus, it was considered likely that 2016 would continue the recent trend of McNeil chum salmon escapement falling short of the goal. However, the preliminary 2016 McNeil River chum salmon escapement index of 26,262 fish did achieve the SEG range (Table 1). It is interesting to note that the above-falls peak count in 2011 (4,211 fish) was relatively high and likely contributed to the higher than expected run in 2016.

HABITAT ASSESSMENT

McNeil River is a remote, pristine watershed on the west side of Lower Cook Inlet. The drainage falls within the boundaries of the McNeil River State Game Sanctuary, a designation that affords additional regulatory protections to fish and wildlife resources in the area (Schempf and Meehan 2008). Land development activities negatively affecting fish habitat in the McNeil River drainage have been virtually non-existent and there are no known upcoming development projects that would have significant negative habitat impacts on this watershed.

Fish habitat assessment of McNeil River includes fish research activities and aquatic habitat assessment focused on better understanding factors affecting chum salmon productivity. In 2003, the department conducted a float trip to assess select habitat characteristics in the lower 19 km of McNeil River. Staff documented viable chum salmon spawning habitat throughout most of the drainage, with the highest quality and most abundant spawning areas occurring in two braided sections of the upper river (Figure 5; unpublished data on file with Lower Cook Inlet Research Group, contact Ted Otis, ADF&G Division of Commercial Fisheries, Homer).

McNeil River is a unique system in that it is effectively bisected into two distinct stream reaches by a series of large, step falls created by a fault line through a bedrock section of the river less than 2.0 km upstream from the ocean (Figure 5). McNeil Falls represent a difficult obstacle for the upstream migration of chum salmon, making them relatively easy prey for the high density of brown bears that annually frequent the area (Peirce et al 2013). Approximately 10 kilometers of spawning habitat exists upstream of McNeil Falls, including two heavily braided sections with abundant upwelling sites that chum salmon favor (Geist et al. 2002; Maclean 2003). In contrast, less than 2.0 km of river are available to chum salmon downstream of McNeil Falls, not all of which is suitable for spawning (Figure 6).

Historically, aerial surveys have documented chum salmon spawning throughout much of the lower 20 km of McNeil River. However, the average number of above-falls spawners during the most recent period of higher productivity (1977–1988) is more than twice the long-term average (Table 1). Unfortunately, escapement was not stratified by stream reach during the earliest observed period of high productivity at McNeil River (1957–1964), so we don't know if high above-falls escapements contributed to that cycle of productivity. Currently, most chum salmon spawning in McNeil River takes place in the relatively limited spawning habitat available below McNeil Falls (Figure 6). In order for McNeil River to realize its productive capacity for chum salmon, it's reasonable to assume that abundant, high-quality spawning habitats upstream of McNeil Falls need to be consistently reseeded by spawners.

FISHERIES MANAGEMENT OVERVIEW AND BACKGROUND

COMMERCIAL FISHERIES

Commercial harvest of chum salmon bound for the McNeil River occurs primarily in the McNeil River subdistrict (249-50), but may also occur in the Kamishak (249-45) and Douglas River (249-40) subdistricts to the south, and the Paint River subdistrict (249-52) to the north (Figure 4). The current regulatory management plan relevant to commercial salmon fishing in Kamishak District is:

5 AAC 21.369: *Lower Cook Inlet Seine Fishery Management Plan*.

Additional guidance specific to this stock is provided in the *McNeil River Chum Salmon Fishery Management Plan* and the *Mikfik Creek – McNeil Lagoon Salmon Fishery Management Plan* approved by the Commissioner in 1988 (Bucher et al. 1993).

The Kamishak District commercial seine fishing season is open from June 1 until closed by EO (5 AAC 21.310(5)). Individual subdistricts within the district are opened and closed by EO based on inseason harvest and escapement information. Prior to 1989, McNeil River was one of the more popular chum salmon commercial fisheries in Kamishak District. From 1976–1988, the

commercial harvest of chum salmon from the McNeil River subdistrict ranged from 0–67,900, with an average harvest of 22,900 fish (Table 2). Fish were commercially harvested every year during that period, except in 1985. Chum salmon productivity experienced a regionwide downturn beginning around 1989. Although other Kamishak District stocks rebounded in the late 1990s and experienced 10+ years of strong returns, escapement at McNeil River remained poor despite consistent annual commercial fishery closures of the McNeil River subdistrict during the chum salmon run (Figure 3). Virtually no commercial harvest of chum salmon has occurred in the McNeil River subdistrict since 1993 (Table 2).

Commercial harvest was not recorded to the subdistrict level prior to 1969, but historic reports indicate the average annual chum salmon harvest for the entire Kamishak District was 7,300 fish (range 0–38,000) during 1951–1959 (Simpson 1960) and 23,200 fish (range 3,200–49,500) during 1960–1968 (Stewart and Flagg 1969).

Regulatory History for McNeil River and Mikfik Creek Fisheries

The *Mikfik Creek – McNeil Lagoon Salmon Fishery Management Plan* (Mikfik Plan) was approved by the department Commissioner in 1988 and the *McNeil River Chum Salmon Fishery Management Plan* (McNeil Plan) was subsequently adopted in 1993 (Bucher et al. 1993). Both plans formally recognized the need to provide adequate fish for consumption by bears while also attempting to provide opportunity for commercial fisherman to harvest fish that were surplus to the escapement goals for Mikfik Lake sockeye and McNeil River chum salmon. The Mikfik Plan states:

> "Management of the sockeye salmon return to Mikfik Creek will be carried out to allow adequate escapement and to provide fish for bear consumption throughout the course of the run. In an attempt to fully utilize this run, commercial fisherman will have the opportunity to harvest large surpluses of sockeye occurring in the lagoon."

Similarly, the stated goal of the McNeil Plan is to:

> "…maintain a healthy chum salmon population returning to McNeil River in sufficient numbers to provide fish for bear consumption within the sanctuary as well as providing for the established commercial purse seine fishery in Lower Cook Inlet. Simply put, the goal of this plan is to manage the chum salmon runs to McNeil River for maximum sustained yield."

To minimize potentially negative interactions between commercial fishing operations, bears, and the bear viewing program at the sanctuary, the Mikfik Plan provides the following guidelines for managing the commercial fishery targeting the Mikfik Lake sockeye run:

The commercial fishery will take place outside the lagoon to the maximum extent possible. Fishing outside the lagoon will be carried out as follows:

(a) Standard fishing periods (two 48-hour periods per week) will begin June 1;

(b) Fishing time will be adjusted by EO depending on the run strength and escapement into Mikfik Creek;

(c) The inside marker defining the boundary for legal fishing will be located at the end of the spit;

(d) Vessels will be allowed to anchor inside the spit as in the past.

If the run is large enough to exceed the escapement goal and a significant surplus of fish is confirmed inside McNeil Lagoon, the lagoon may be opened to commercial fishing under the following guidelines:

(a) Openings in the lagoon will occur for a 2-hour period starting 1 hour before high tide and ending 1 hour after high tide;

(b) Nets must be fished from the boat and may not be fished from the beach;

(c) Fisherman will remain in their boats as much as possible while fishing.

These provisions of the plan are intended to reduce the potential for boats and nets containing fish going dry and getting stranded in the lagoon when the tide goes out, making them accessible to bears.

Past Commercial Fisheries Management Actions

While the Mikfik and McNeil Plans provide general guidance for management of the commercial fisheries targeting these stocks, inseason management actions are implemented through EOs. In accordance with the Mikfik Plan, staff typically opened the McNeil subdistrict to commercial fishing around June 1 to target early returning Mikfik Lake sockeye salmon outside McNeil Lagoon. However, when necessary to protect the weak McNeil River chum stock, staff generally closed the McNeil and Paint River subdistricts to commercial harvest around June 20 (Table 3). In some years, the area management biologist did not specifically close the McNeil River subdistrict due to knowledge that the seine fleet did not plan on fishing that area.

SPORT FISHERIES

The Alaska Statewide Sport Fish Harvest Survey is designed to estimate sport fishing effort and harvest by location (e.g., Romberg 2015). Due to the low number of respondents reporting angling effort in this area, the survey cannot provide accurate, reasonably precise estimates of the sport harvest on McNeil River. Sport fishing effort at McNeil River is very low, in part due to low visitation to the area. Only 10 visitors per day receive permits to view bears at the sanctuary and 3 department staff are assigned to the McNeil Camp. Sanctuary staff estimated that the total sport harvest by staff and visitors in 2013 was 5 sockeye salmon and 1 chum salmon (Griffin and Weiss 2014). This inconsequential sport harvest appears representative of recent years.

Regulatory History for McNeil River Sport Fishery

The general regulations for sport fishing in the West Cook Inlet area apply to McNeil River, with one additional special regulation that prohibits fishing year round within 0.8 km (½ mile) of McNeil River Falls (about 1.2 km upstream from McNeil Lagoon). Outside of this "no fishing" zone, anglers are allowed to harvest 3 chum salmon 16 inches or longer per day, 6 in possession. However, in the interest of visitor safety, sanctuary staff request that sport fishing activities be confined to an area directly in front of camp along the spit that separates McNeil Lagoon from McNeil Cove and that the only fish retained are those that can be consumed that day (Figure 6).

Past Sport Fisheries Management Actions

There are no recent management actions affecting the McNeil River sport fishery. However, the commissioner may, by EO, change bag and possession limits and annual limits, and alter methods and means in sport fisheries (5 AAC 75.003).

SUBSISTENCE AND PERSONAL USE FISHERIES

McNeil River lies within the State of Alaska Joint Board of Fisheries and Game's Anchorage-Matsu–Kenai Peninsula Nonsubsistence Area; therefore, McNeil River chum salmon are not targeted in any state subsistence fisheries. Furthermore, although Katmai National Park and Preserve is located in the vicinity of McNeil River, subsistence fishing is prohibited by federal regulation in all waters of the park. There are no personal use fisheries in the area.

ACTION PLAN MANAGEMENT OPTIONS FOR ADDRESSING STOCK OF CONCERN

ACTION PLAN GOAL

To rebuild and maintain the McNeil River chum salmon run to levels that consistently achieve the current SEG range, provide adequate fish for consumption by bears, and provide surplus chum salmon for commercial and sport fishing opportunities.

Action Plan Alternatives

Most of the potential management actions listed below are allocative and do not necessarily reflect endorsement by the department. Alternatives include options that may not be practical but are intended to be a comprehensive and objective list of actions that should lead to rebuilding chum salmon to levels that consistently meet the current SEG range for McNeil River.

Action #1–Commercial Fisheries

Objective: Reduce commercial harvest of McNeil River chum salmon.

Background: The Kamishak District commercial salmon fishery opens on June 1 (or earlier through EO), and remains open until closed by EO. Harvest of McNeil River chum salmon occurs primarily in the McNeil River subdistrict, but may occur in adjacent subdistricts to the north and south, where McNeil River bound chum salmon enter McNeil Cove from Cook Inlet. Department staff closely monitors commercial fishing effort in Kamishak District and since 1994 has consistently closed the McNeil and Paint River subdistricts by EO when necessary to protect weak chum salmon runs to McNeil River.

Option A.–Status Quo. Department will continue to use EO authority to manage McNeil River Chum Salmon Run

Past commercial fishing EO management actions have focused on closing the McNeil River (249-50) and Paint River (249-52) subdistricts during the McNeil River chum salmon run.

Specific Action to Implement the Objective: Department would continue to use its EO authority to close the McNeil River (249-50) and Paint River (249-52) subdistricts during the McNeil River chum salmon run.

Benefits: Allowing the department to continue to use its EO authority to manage the McNeil River chum salmon run provides flexibility the department needs to meet escapement objectives and respond to changes in productivity in the future. Continuing to reduce harvest will maximize spawning escapement and help aid recovery.

Detriments: The department will continue to issue EOs to close commercial fisheries in the McNeil River and Paint River Districts during the McNeil River chum salmon run. This may

preclude seine permit-holders from having reasonable opportunity to harvest surplus chum salmon. Because commercial harvest is not the only factor limiting spawning escapement at McNeil River, this action may not be a long-term solution to stock/escapement recovery.

Option B.–Close McNeil River and/or Paint River subdistricts by regulation

Past commercial fishing management actions have been by emergency order.

Specific Action to Implement the Objective: The board takes regulatory action to close the McNeil River (249-50) and/or Paint River (249-52) subdistricts during the McNeil River chum salmon run.

Benefits: The department would not have to use its EO authority annually to manage McNeil River chum salmon. Reducing harvest would allow more McNeil River chum salmon to enter the river and help aid recovery.

Detriments: This may reduce the ability to respond to changes in productivity in the future between regular Lower Cook Inlet Board meetings. This may preclude seine permit-holders from having reasonable opportunity to harvest surplus chum salmon. Because commercial harvest is not the only factor limiting spawning escapement at McNeil River, this action may not be a long-term solution to stock/escapement recovery.

Option C.–Close Specific Fishing Areas during the McNeil River Chum Salmon Run

Past commercial fishing EO management actions have focused on closing the McNeil River (249-50) and Paint River (249-52) subdistricts during the McNeil River chum salmon run. However, other subdistricts may also harvest chum salmon bound for McNeil River (e.g., Kamishak [249-45] and Douglas River [249-40] subdistricts to the south).

Specific Action to Implement the Objective: Take board or EO action to further reduce areas open to commercial salmon fishing in Kamishak District during the McNeil River chum salmon run, June 20 to August 6 (e.g., Kamishak [249-45] and Douglas River [249-40] subdistricts to the south).

Benefits: Reducing the areas open to commercial fishing in Kamishak District during the McNeil River chum salmon run may increase chum salmon escapements to McNeil River by an unknown amount.

Detriments: Commercially exploitable chum salmon stocks exist in the Douglas and Big and Little Kamishak rivers. Closing the Douglas and Kamishak subdistricts to commercial harvest during the McNeil River chum salmon run may, in some years, limit the department's ability to manage the Big and Little Kamishak rivers to not exceed their respective escapement goals. In addition, it may preclude seine permit-holders from having reasonable opportunity to harvest surplus chum salmon returning to the Douglas and Big and Little Kamishak rivers. Because commercial harvest is not the only factor limiting spawning escapement at McNeil River, this action may not be a long-term solution to stock/escapement recovery.

Option D.–Close All Commercial Fishing in Kamishak District during the McNeil River Chum Salmon Run

The entire Kamishak District would be closed during the McNeil River chum salmon run from June 20 until August 6.

Specific Action to Implement the Objective: Take board or EO action to close commercial fishing in the Kamishak District from June 20 until August 6.

Benefits: Closing commercial fishing in Kamishak District from June 20 until August 6 may increase chum salmon escapements to McNeil River by an unknown amount.

Detriments: Several commercially exploitable chum and sockeye salmon stocks exist in Kamishak District with run timing that overlaps with McNeil River chum salmon. Closing the Kamishak District to commercial harvest from June 20 until August 6 may limit the department's ability to manage these stocks to not exceed their respective escapement goals. In addition, it would likely preclude seine permit-holders from having reasonable opportunity to harvest surplus chum and sockeye salmon returning to Kamishak District streams. Finally, because commercial harvest is not the only factor limiting escapement at McNeil River, this action may not be a long-term solution to stock/escapement recovery.

Action #2–Habitat Modifications

Objective: Increase chum salmon production and escapement in McNeil River through habitat modification.

Option A.–Modify McNeil Falls to facilitate easier upstream migration

McNeil Falls represents a significant physical obstacle to the upstream migration of chum salmon and likely contributes to the limited use of high-quality spawning habitat available above the falls.

Specific Action to Implement the Objective: Seek required permits (e.g., Fish Habitat Permit, ADF&G Special Area Permit, US Army Corps of Engineers permit) to modify McNeil Falls in a manner that provides easier upstream migration by chum salmon.

Benefits: Modifying McNeil Falls may increase chum salmon escapements to high-quality upriver spawning areas that currently receive limited use, potentially increasing the overall production of chum salmon in McNeil River.

Detriments: Modifying McNeil Falls may make it more difficult for bears to successfully prey on chum salmon, potentially leading bears to forage elsewhere, which would negatively impact the bear viewing program at McNeil River. In addition, if the lack of consistent upriver spawning is not a major factor limiting chum salmon production at McNeil River then this action may not be a long-term solution.

Option B.–Manage the abundance of brown bears at McNeil Falls.

The high density of brown bears at McNeil Falls may be limiting chum salmon production through predation of pre-spawning fish and impeding upstream migration to high-quality spawning areas above the falls.

Specific Action to Implement the Objective: Seek permission from the Alaska State Legislature, the Board of Game, and the department's Division of Wildlife Conservation to manage the density of brown bears fishing at McNeil Falls through hazing or other action.

Benefits: Managing the abundance of brown bears at McNeil Falls may increase the number of chum salmon spawning in McNeil River above and below McNeil Falls, potentially increasing natural production and future escapement levels.

Detriments: Managing the abundance of brown bears at McNeil Falls contradicts the purpose of the legislation designating the sanctuary and would directly impact the quality of the associated bear viewing program run by the department. In addition, if predation by bears and hindering of migration to upriver spawning areas are not major factors limiting chum salmon production at McNeil River, this action may not be a long-term solution.

Action #3–Natural Recovery

Objective: Allow the McNeil River chum salmon stock to recover naturally.

Background: The current era of low chum salmon production at McNeil River appears to be a natural cycle that has likely occurred repeatedly over geologic time (see Otis and Szarzi 2007).

Option A.–No action.

No action is needed to allow the McNeil River bear/salmon dynamic to play out naturally. This option would likely result in periods of high chum salmon runs during eras when upriver spawning areas are consistently used, followed by periods of low escapements when the obstacle of McNeil Falls and associated bear predation confines production to limited spawning areas below McNeil Falls.

Specific Action to Implement the Objective: No action.

Benefits: Allowing McNeil River chum salmon and brown bear populations to fluctuate naturally is consistent with the statutory goals associated with the designations of the sanctuary and refuge.

Detriments: Allowing McNeil River chum salmon and brown bear populations to fluctuate naturally would likely result in periods of low chum salmon productivity where the current escapement goal will not be met.

Option B.–Adjust the escapement goal range so the lower end better represents periods of low productivity.

The current escapement goal is intended to maintain higher levels of chum salmon production in McNeil River by encouraging more consistent use of upriver spawning areas. However, during periods of low productivity in McNeil River, this escapement goal may not be consistently achieved. Lowering the goal so it better represents sustainable escapements observed during periods of low productivity would likely result in meeting the goal more frequently.

Specific Action to Implement the Objective: Department recommendation to lower the McNeil River chum salmon escapement goal. Applying the approach described by Clark et al. (2014) would result in a recommended SEG range of 10,700–22,400 (Tier 1; 20th–60th percentiles).

Benefits: Lowering the McNeil River chum salmon escapement goal would likely lead to meeting the goal more frequently. Taking this action would likely preclude the need for designating this as a stock of management concern while waiting for the McNeil River chum stock to recover naturally (Option A under Action #3).

Detriments: Lowering the escapement goal contradicts the department's strategy to boost streamwide production by maintaining higher escapements at McNeil River once the run naturally recovers (Otis and Szarzi 2007). Lowering the escapement goal would perpetuate the current trend of low productivity and low utilization of abundant spawning areas above McNeil Falls.

2016 ALASKA BOARD OF FISHERIES REGULATORY PROPOSALS AFFECTING MCNEIL RIVER

There are no proposals before the board that affect McNeil River chum salmon. Proposal 3 is the only salmon proposal affecting Kamishak District and it defines waters closed to commercial salmon fishing in the vicinity of Akumwarvik Bay (i.e., Kamishak Rivers) and Douglas River.

RESEARCH PLAN

To date there has been considerable research directed at better understanding various aspects of chum salmon life history and productivity in McNeil River. A comprehensive list of past, current, and desired future research is provided below.

PAST RESEARCH PROJECTS

The following research projects have been conducted to gather fisheries-related information on McNeil River:

1. AWL Sampling (1977–2006): Periodic sampling to characterize the age, sex, and size composition of the escapement and/or commercial harvest of McNeil River chum salmon. McNeil River chum salmon range in age from 3 (0.2) to 6 (0.5), with age 4 (0.3) and 5 (0.4) generally predominating (e.g., Otis and Dickson 2003).
2. Habitat Assessment (2003): Measured depth, current velocity, and substrate composition at 1 m intervals along transects located every 500 m from river kilometer (RK) 20.0 (below McNeil Lake) down to where McNeil River enters McNeil Lagoon. Spawning habitat was more abundant and of higher quality above McNeil Falls, especially in two braided sections between RK 10 and 20 where hyporheic upwelling occurred. Very limited spawning habitat was available below McNeil Falls (Otis and Szarzi 2007; unpublished data on file with Lower Cook Inlet Research Group, contact Ted Otis, ADF&G Division of Commercial Fisheries, Homer).
3. Stream-life Study (2005–6): Used mortality-indicating radio tags to estimate the average stream life (SL) of McNeil River chum salmon, a key parameter in the AUC method for estimating escapement from multiple aerial surveys. Higher predation resulted in tagged fish below McNeil Falls having a significantly shorter SL (12.6 d) than those above the falls (21.9 d). Results published in the *North American Journal of Fisheries Management* (Peirce et al. 2011).
4. Spawning Distribution (2005–6): Used radio telemetry to track chum salmon to determine spawning distribution and key spawning areas in McNeil River. On average during 2005–2006, over 90% of the escapement was confined below McNeil Falls, where spawning habitat is limited. Tagged fish that made it above McNeil Falls primarily spawned in two braided sections between rkm 10 and 20, where hyporheic upwelling was documented during a 2003 habitat assessment (ADF&G, unpublished data; Otis and Szarzi 2007).
5. Predation Study (2005–6): Used mortality-indicating radio tags to determine time and location of death for tagged chum salmon. The cause of death and spawning status at time-of-death was assessed to estimate the extent of bear predation on pre-spawning chum salmon and whether it may be affecting chum salmon production. Below McNeil

Falls, predators consumed 99% of tagged fish, killing 59% of them before they spawned. Above McNeil Falls, only 10% of tagged fish were killed prior to spawning. Results were published in the journal *Ursus* (Peirce et al. 2013).

6. Bear Foraging Behavior (2010): Used in-situ observation to investigate foraging strategies of brown bears at McNeil Falls. Results suggested that physical and cognitive skills may be as important as social dominance in determining foraging success among bears. Results published in the *Canadian Journal of Zoology* (Gill and Helfield 2012). This study also laid the groundwork for developing a remote video system at McNeil Falls to estimate bear predation on pre-spawning chum salmon.

7. Baseline Genetic Sampling (2011–12): Collected tissue samples from adult chum salmon spawning in McNeil River to contribute to the genetic baseline for Cook Inlet fish stocks. Once processed, these data will be available for such purposes as determining stock composition of mixed stock commercial harvests (unpublished data on file with Lower Cook Inlet Research Group, contact Ted Otis, ADF&G Division of Commercial Fisheries, Homer).

CURRENT RESEARCH PROJECTS

1. Aerial Survey (1976–present): Multiple aerial surveys conducted annually to estimate run timing and relative abundance using the AUC method (e.g., Hollowell et al. 2016). The peak of the run typically occurs in the second week of July. Historical escapement indices are presented in Table 1.

2. Predation Study (2011–present): Using remote video to monitor bear predation on pre-spawning chum salmon at McNeil Falls. During 2011–2015, we estimated bears killed an average of 10,518 chum salmon per year (range: 6,663–16,494), which equates to 59% of the average annual escapement index (range: 52%–84%; unpublished data on file with Lower Cook Inlet Research Group, contact Ted Otis, ADF&G Division of Commercial Fisheries, Homer).

3. Water Level and Water Temperature Monitoring (2009–present): Using remote data loggers to record hourly water pressure (proxy for water depth) and water temperature data at McNeil Falls. Once a long enough time series is available, we hope to evaluate the effect water level has on the ability of chum salmon to ascend McNeil Falls (unpublished data on file with Lower Cook Inlet Research Group, contact Ted Otis, ADF&G Division of Commercial Fisheries, Homer).

4. Bear Abundance in the Sanctuary (1976–present): Since 1976, McNeil staff has tallied the number of individually recognizable bears (adults, sub-adults, cubs) observed in the sanctuary by staff over the course of the season. These values are used as a measure of bear use and bear viewing quality in the sanctuary. Since 1976, this count has ranged from a low of 58 in 1976 and 1979 to a high of 144 in 1997. The most recent published count was 95 in 2013 (Griffin and Weiss 2014).

5. Bear Abundance at McNeil Falls (1993–present): Since 1993, McNeil staff has used a second method to assess bear use and bear viewing quality at McNeil Falls. At the top of each hour during the peak bear viewing season (July 15–August 5), McNeil staff count the number of bears visible from the viewing pad at McNeil Falls. The seven highest daily peak hourly counts are then averaged to produce the bear abundance index for that year. This index is

used to monitor trends in bear use and the quality of the bear viewing experience at McNeil Falls. Since 1993, this index has ranged from a low of 22 in 2005 to a high of 61 in 2011. The most recent published count was 50 in 2013 (Griffin and Weiss 2014).

DESIRED FUTURE RESEARCH PROJECTS

1. Improved Escapement Monitoring: Aerial survey is an efficient method for acquiring run timing and relative abundance indices, but it does not provide accurate, precise absolute abundance estimates (Otis and Hollowell 2016). In order to conduct a rigorous stock-recruit analysis to estimate the level of escapement needed in McNeil River to maximize production, we need to estimate the number of spawning fish more accurately and precisely than aerial survey allows. McNeil River is a challenging place to conduct a traditional escapement census project (e.g., weir or sonar). However, it may be possible that sonar or underwater video could be used to improve escapement monitoring of McNeil River chum salmon.
2. Spawning Success by Stream Reach: Currently, the vast majority of escapement and spawning is confined to ~1.0 km of McNeil River below McNeil Falls while ~10.0 km of high quality spawning habitat above the falls is not used to capacity. Also, chum salmon spawning in the intertidal reach below the falls are frequently interrupted by foraging bears and over half are killed before completing spawning. A study designed to measure the relative contribution each of these spawning areas makes to streamwide production would be useful in evaluating how important upriver escapement is to the overall productivity of the McNeil chum salmon population. This study would also investigate whether fish spawning above and below McNeil Falls are genetically distinct or if they all derive from the same population.
3. Genetic Sampling of Commercial Harvest: Currently, chum salmon are commercially harvested intermittently in the Douglas and Kamishak River subdistricts to the south of McNeil River. Particularly when harvest occurs after mid-July, it is assumed to be composed of the Douglas and Kamishak River stocks being targeted, but it's possible some interception of McNeil River chum salmon occurs there, or even farther south in the Kodiak Management area. Likewise, harvest of McNeil River chum salmon could occur in the Paint River subdistrict north of McNeil River, particularly in the future if the Paint River fish ladder is successful and strong runs of Paint River pink and chum salmon leads to frequent fishing effort in this area. Chum salmon have already been documented naturally pioneering Paint River via the ladder and in 2014 Cook Inlet Aquaculture began planting pink salmon fry to establish a run in Paint River. Genetic sampling of Kamishak, Douglas, and Paint River subdistrict harvests would be advisable to confirm that McNeil River chum salmon are not being intercepted.

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TABLES AND FIGURES

Table 1.–Annual above-falls peak count, stream-wide escapement index, commercial harvest, and total run of chum salmon to McNeil River, 1950–2016, with average values by decade.

Year	No. of Surveys	Above-Falls Peak Count[a]	Streamwide Esc. Index[b]	Commercial Harvest[c]	Total Run[d]
1950	1	-	3,185		3,185
1951	1	-	2,400		2,400
1952	0				
1953	0				
1954	0				
1955	0				
1956	1	-	6,647		6,647
1957	1	-	39,819		39,819
1958	12	-	55,293		55,293
1959	2	-	29,959		29,959
1960	2	-	23,224		23,224
1961	2	1,500	33,587		33,587
1962	3	-	62,863		62,863
1963	3	-	181,389		181,389
1964	1	-	129,259		129,259
1965	0				
1966	2	-	1,792		1,792
1967	2	-	12,257		12,257
1968	0				
1969	1	-	578	4,435	5,013
1970	3	-	1,835	1,907	3,742
1971	4	1,500	6,272	0	6,272
1972	4	-	1,158	2,262	3,420
1973	4	10,000	16,703	0	16,703
1974	5	500	1,673	2,016	3,689
1975	2	250	2,043	0	2,043
1976	5	6,500	9,513	16,891	26,404
1977	6	8,350	35,774	38,463	74,237
1978	5	6,000	109,058	4,926	113,984
1979	6	-	10,500	6,473	16,973
1980	7	600	9,997	6,308	16,305
1981	8	2,600	44,623	11,559	56,182
1982	10	6,100	36,624	32,582	69,206
1983	10	13,100	56,326	67,851	124,177
1984	9	5,825	26,598	12,027	38,625
1985	8	1,525	10,500	33	10,533
1986	10	2,000	31,909	12,906	44,815
1987	14	6,075	40,510	32,007	72,517
1988	15	6,000	59,753	55,686	115,439

-continued-

Table 1.–Page 2 of 2.

Year	No. of Surveys	Above-Falls Peak Count[a]	Streamwide Esc. Index[b]	Commercial Harvest[c]	Total Run[d]
1989	9	2,275	48,856	54	48,910
1990	6	300	13,871	138	14,009
1991	6	-	6,751	91	6,842
1992	7	4,200	23,302	2,041	25,343
1993	10	520	19,290	374	19,664
1994	7	500	15,650	0	15,650
1995	8	640	12,072	3	12,075
1996	6	710	24,397	0	24,397
1997	9	1,960	32,175	3	32,178
1998	3	230	19,895	0	19,895
1999	5	970	10,226	0	10,226
2000	9	590	17,736	0	17,736
2001	7	180	16,856	2	16,858
2002	8	375	17,520	0	17,520
2003	7	1,460	30,112	0	30,112
2004	10	4,260	14,613	0	14,613
2005	10	1,510	22,496	0	22,496
2006	7	1,475	19,324	2	19,326
2007	9	1,040	22,312	0	22,312
2008	8	900	10,804	0	10,804
2009	9	890	18,447	0	18,447
2010	11	2,550	13,761	0	13,761
2011	7	4,211	30,977	0	30,977
2012	9	802	10,388	0	10,388
2013	4	552	9,498	0	9,498
2014	9	5,630	17,475	0	17,475
2015	7	2,383	20,494	0	20,494
2016	4	1,670	26,262	0	26,262
1950–2016	6	1,987	26,872	6,480	31,971
1976–2016	8	2,621	25,055	7,327	32,382
2007–2016	8	2,063	18,042	0	18,042
1997–2006	8	1,301	20,095	1	20,096
1987–1996	9	2,122	26,445	9,039	35,485
1977–1986	8	4,610	37,191	19,313	56,504
1957–1976	3	1,125	33,845	3,439	35,374

[a] Peak aerial survey count above McNeil Falls, not consistently recorded prior to 1973.

[b] Based on area-under-the-curve index from multiple aerial surveys, then expanded to account for the date of the last survey flown relative to the end of run timing.

[c] Commercial purse seine harvest from the McNeil River subdistrict; harvest not recorded by subdistrict prior to 1969.

[d] Total Run equals the streamwide escapement index plus the commercial harvest.

Table 2.–Annual escapement (ESC), commercial harvest (CH), and total run (TR) indices in thousands of fish for Kamishak District chum salmon stocks, 1976-2015, and average values by decade.

	Douglas			Kamishak			McNeil			Bruin			Ursus			Cottonwood			Iniskin		
Year	ESC[a]	CH	TR	ESC	CH	TR	ESC	CH	TR	ESC	CH	TR	ESC	CH	TR	ESC	CH	TR	ESC	CH	TR
1976	12.4	7.1	19.5	45.0	10.5	55.5	9.5	16.9	26.4	4.0		4.0	6.0	2.8	8.8	5.0	0.0	5.0	13.5	11.5	25.0
1977	2.8	4.0	6.8	0.0	0.0	0.0	35.8	38.5	74.2	18.0	0.0	18.0	9.3	7.8	17.1	10.0	0.0	10.0	4.4	15.3	19.7
1978	1.1	1.9	3.0	53.0	23.9	76.9	109.1	4.9	114.0	4.0		4.0	9.7	1.9	11.6	12.5	0.0	12.5	11.4	14.9	26.3
1979	2.1	0.7	2.8	30.0	17.8	47.8	10.5	6.5	17.0	15.0	4.0	19.0	5.0	0.5	5.5	2.5	0.0	2.5	4.0	0.2	4.2
1980	5.6	10.0	15.7	23.0	2.8	25.8	10.0	6.3	16.3	15.0	10.6	25.6	8.0	0.3	8.3	4.2	0.0	4.2	9.3	5.4	14.7
1981	1.9	46.7	48.6	17.0	8.6	25.6	44.6	11.6	56.2	10.0	1.7	11.7	10.0	1.5	11.5	9.0	0.0	9.0	9.0	3.5	12.5
1982	1.8	37.1	38.9	43.0	9.2	52.2	36.6	32.6	69.2	10.0	1.3	11.3	9.0	13.5	22.5	7.0	0.0	7.0	12.8	21.6	34.4
1983	0.6	27.2	27.7	50.0	23.9	73.9	56.3	67.9	124.2	5.5	2.6	8.1	7.7	0.0	7.7	8.3	0.0	8.3	12.0	21.4	33.4
1984	0.6	9.2	9.8	31.0	16.2	47.2	26.6	12.0	38.6	8.0	5.9	13.9	7.0	3.7	10.7	6.5	0.0	6.5	9.8	23.0	32.8
1985	0.9	8.0	8.9	10.5	0.1	10.6	10.5	0.0	10.5	2.0		2.0	3.0	0.0	3.0	3.0	0.0	3.0	5.0	0.0	5.0
1986	0.9	11.6	12.5	41.0	0.1	41.1	31.9	12.9	44.8	1.0	5.4	6.4	11.0	22.1	33.1	11.0	0.0	11.0	5.9	8.8	14.7
1987	1.3	23.7	25.0	30.0	24.6	54.6	40.5	32.0	72.5	10.0	0.1	10.1	9.9	17.2	27.1	17.0	0.0	17.0	9.1	9.7	18.8
1988	1.9	34.5	36.4	28.0	57.9	85.9	59.8	55.7	115.4	7.0	2.8	9.8	9.4	20.7	30.1	16.0	33.5	49.5	9.5	5.8	15.3
1989	1.2	0.0	1.2	42.0	0.0	42.0	48.9	0.1	48.9	8.0	4.4	12.4	6.3	3.4	9.7	8.0	0.0	8.0	5.9	0.0	5.9
1990	2.3	0.1	2.4	10.4	0.0	10.4	13.9	0.1	14.0	4.0	1.6	5.6	3.8	0.0	3.8	4.3	0.0	4.3	8.4	0.0	8.4
1991	1.5	3.0	4.5	17.1	0.7	17.8	6.8	0.1	6.8	6.0	2.6	8.6	1.3	0.0	1.3	7.7	1.0	8.7	8.3	0.0	8.3
1992	0.1	12.5	12.6	11.6	1.5	13.1	23.3	2.0	25.3	8.5	0.8	9.3	1.7	2.7	4.4	6.1	0.0	6.1	3.4	0.2	3.6
1993	3.1	0.0	3.1	15.4	0.0	15.4	19.3	0.4	19.7	6.0	0.1	6.1	7.7	0.0	7.7	12.0	0.0	12.0	8.0	0.0	8.0
1994	2.1	0.0	2.1	9.0	0.0	9.0	15.7	0.0	15.7	6.1	0.0	6.1	6.2	0.0	6.2	10.2	0.0	10.2	18.9	0.0	18.9
1995		0.7		0.0	0.0	0.0	12.1	0.0	12.1	6.6	5.6	12.2	11.1	2.2	13.3	15.4	0.0	15.4	22.7	0.0	22.7
1996		0.0		15.5	0.0	15.5	24.4	0.0	24.4	14.9	0.0	14.9	7.6	0.0	7.6	16.1	0.0	16.1	7.8	0.0	7.8
1997		0.0		0.0	0.0	0.0	32.2	0.0	32.2	8.8	0.0	8.8	6.2	0.0	6.2	5.6	0.0	5.6	15.4	0.0	15.4
1998	1.9	0.0	1.9	16.8	0.0	16.8	19.9	0.0	19.9	9.4	0.0	9.4	4.6	0.0	4.6	2.3	0.0	2.3	18.6	0.0	18.6

Table 2.–Page 2 of 2.

	Douglas			Kamishak			McNeil			Bruin			Ursus			Cottonwood			Iniskin		
Year	ESC[a]	CH	TR	ESC	CH	TR	ESC	CH	TR	ESC	CH	TR	ESC	CH	TR	ESC	CH	TR	ESC	CH	TR
1999	2.0	0.0	2.0	20.5	0.0	20.5	10.2	0.0	10.2	10.3	0.0	10.3	21.0	0.0	21.0	12.0	0.0	12.0	23.3	0.0	23.3
2000	3.0	19.9	22.9	72.2	43.7	115.9	17.7	0.0	17.7	13.6	2.4	16.0	41.7	0.0	41.7	24.1	0.0	24.1	23.6	0.0	23.6
2001	0.9	10.3	11.2	63.5	73.0	136.5	16.9	0.0	16.9	21.8	0.0	21.8	37.7	1.5	39.2	15.9	0.0	15.9	13.8	0.0	13.8
2002	0.5	7.0	7.5	33.8	5.1	38.9	17.5	0.0	17.5	9.9	2.0	11.9	17.1	3.4	20.5	42.2	7.8	50.0	28.5	9.3	37.8
2003	1.6	0.0	1.6	38.6	0.0	38.6	30.1	0.0	30.1	13.1	0.1	13.2	30.4	0.0	30.4	72.8	29.7	102.5	18.7	0.0	18.7
2004	1.9	6.7	8.5	103.2	0.0	103.2	14.6	0.0	14.6	15.9	7.0	22.9	16.0	1.8	17.8	16.3	153.2	169.5	22.0	8.7	30.7
2005	0.7	2.8	3.5	37.8	0.0	37.8	22.5	0.0	22.5	21.2	7.0	28.2	12.2	0.0	12.2	17.9	70.9	88.8	16.5	3.2	19.7
2006	2.8	15.2	18.0	101.1	0.0	101.1	19.3	0.0	19.3	7.0	1.9	8.9	15.7	2.3	18.0	13.2	34.7	47.9	15.6	1.5	17.1
2007	0.8	0.0	0.8	30.4	0.0	30.4	22.3	0.0	22.3	3.1	0.1	3.2	20.9	0.0	20.9	12.5	0.0	12.5	5.3	0.0	5.3
2008	2.5	1.7	4.2	25.8	53.5	79.3	10.8	0.0	10.8	17.5	0.1	17.6	6.5	0.0	6.5	11.6	0.0	11.6	20.0	7.3	27.3
2009	0.7	0.0	0.7	19.2	0.0	19.2	18.4	0.0	18.4	10.1	11.9	22.0	12.9	0.0	12.9	19.4	1.5	20.9	30.8	0.0	30.8
2010	0.9	6.9	7.8	18.4	45.6	64.0	13.8	0.0	13.8	6.2	0.0	6.2	11.8	0.0	11.8	15.8	17.9	33.7	19.3	0.0	19.3
2011	3.9	1.7	5.6	24.8	0.0	24.8	31.0	0.0	31.0	3.5	1.2	4.7	10.6	0.0	10.6	4.7	0.3	5.0	16.5	0.0	16.5
2012	5.5	0.0	5.5	42.7	2.4	45.1	10.4	0.0	10.4	16.8	0.0	16.8	2.8	0.0	2.8	4.1	0.0	4.1	3.0	0.0	3.0
2013	17.1	0.7	17.8	10.0	0.0	10.0	9.5	0.0	9.5	8.9	0.0	8.9	10.3	0.0	10.3	5.2	0.0	5.2	5.9	0.0	5.9
2014	6.0	2.3	8.2	20.7	0.4	21.2	17.5	0.0	17.5	3.6	1.8	5.4	5.3	0.0	5.3	7.1	0.0	7.1	13.0	0.0	13.0
2015	15.2	0.0	15.2	21.4	0.0	21.4	20.5	0.0	20.5	11.0	0.0	11.0	14.8	0.0	14.8	17.0	0.0	17.0	7.5	0.0	7.5
Average																					
2006–2015	6.9	2.8	8.4	31.5	10.2	41.6	17.3	0.0	17.3	8.8	1.7	10.5	11.2	0.2	11.4	11.1	5.4	16.5	13.7	0.9	14.6
1996–2005	1.6	4.7	7.4	40.2	12.2	52.4	20.6	0.0	20.6	3.9	1.9	15.8	19.5	0.7	20.1	22.5	26.2	48.7	18.8	2.1	20.9
1986–1995	1.6	8.6	11.1	20.5	8.5	28.9	27.2	10.3	37.5	6.3	2.3	8.7	6.8	6.8	13.7	10.8	3.5	14.2	10.0	2.4	12.5
1976–1985	3.0	15.2	18.2	30.3	11.3	41.5	35.0	19.7	54.7	9.2	2.6	11.8	7.5	3.2	10.7	6.8	0.0	6.8	9.1	11.7	20.8
All Yrs.	3.4	7.8	11.5	30.6	10.5	41.1	25.0	7.5	32.5	9.5	2.1	11.7	11.2	2.7	14.0	12.8	8.8	21.5	12.9	4.3	17.2

Note: ESC = annual escapement; CH = commercial harvest; and TR = total run.

[a] Escapement (ESC) value is the area-under-the-curve (AUC) index for all streams and years except 1976-2004 for Douglas, which is the peak survey count.

Table 3.–Emergency orders (EO) issued since 1994 that affect the commercial harvest of chum salmon in the McNeil River subdistrict of Kamishak Bay.

Year	EO Number	Emergency Order Action
2016	2-F-H-02-16	Closes waters of McNeil River subdistrict to commercial salmon harvest after June 20.
	2-F-H-03-16	Closes the Paint River Special Harvest Area (SHA) to common property salmon harvest on June 20.
2015	2-F-H-06-15	Closes waters of McNeil, Chenik and Paint River to commercial salmon harvest effective Monday, June 22. No chum salmon harvest was reported from Kamishak District (Hollowell et al. 2016).
2014	2-F-H-04-14	Closes waters of McNeil, Chenik and Paint River to commercial salmon harvest effective Friday, June 20. No chum salmon harvest was reported from Kamishak District (Hollowell et al. 2015).
2013	NA	No E.O. closing the McNeil subdistrict, but also no chum salmon harvest reported from Kamishak District (Hollowell et al. 2014).
2012	2-F-H-03-12	Establishes a seven days per week fishing schedule in waters of Kamishak district excluding the McNeil and Paint River subdistricts beginning Friday, June 1. No reported chum harvest (Hollowell et al. 2013).
2011	2-F-H-16-11	Closes waters of McNeil and Paint River subdistricts effective 6:00 a.m. Saturday, June 26. No reported chum salmon harvest (Hollowell et al. 2012).
2010	2-F-H-007-10	Closes waters of McNeil River and Paint River Subdistricts in Kamishak Bay District to commercial salmon seining effective at 6:00 a.m. Saturday, June 26, 2010, until further notice. No reported chum salmon harvest (Hammarstrom and Ford 2011).
2009	2-F-H-007-09	Closes waters of McNeil River and Paint River Subdistricts in the Kamishak Bay District to commercial salmon seining effective at 6:00 a.m. Friday, June 26, 2009, until further notice. No reported chum salmon harvest (Hammarstrom and Ford 2010).
1994–2008	NA	Through EO closures or personal communication with the fleet, area management staff effectively precluded harvest of chum salmon in the McNeil River subdistrict during 1994–2008. Three or fewer chum salmon were harvested in the McNeil River subdistrict in 1995, 1997, 2001, and 2006 while targeting Mikfik Creek sockeye salmon. In all other years during this period, no chum salmon harvest was reported from the McNeil River subdistrict (Hammarstrom and Ford 2010).
Pre-1994	NA	Active commercial fishing targeting McNeil River chum salmon occurred during this period, regulated in season by EO's affecting the McNeil River subdistrict.

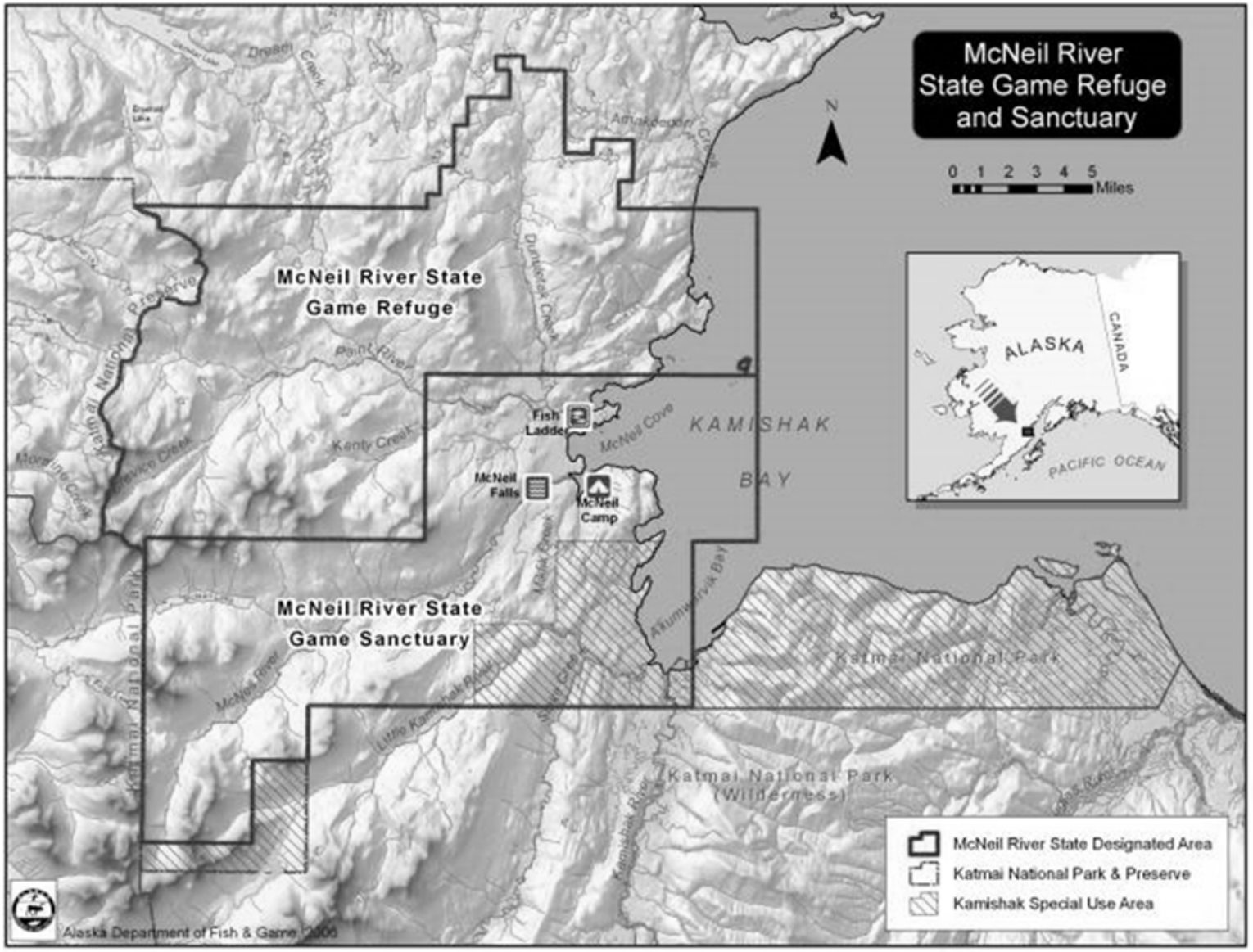

Figure 1.–Map illustrating the location of McNeil River relative to the boundaries of the McNeil River State Game Refuge and Sanctuary, the Paint River Fish Ladder, and McNeil Camp, from which the department operates a bear viewing program.

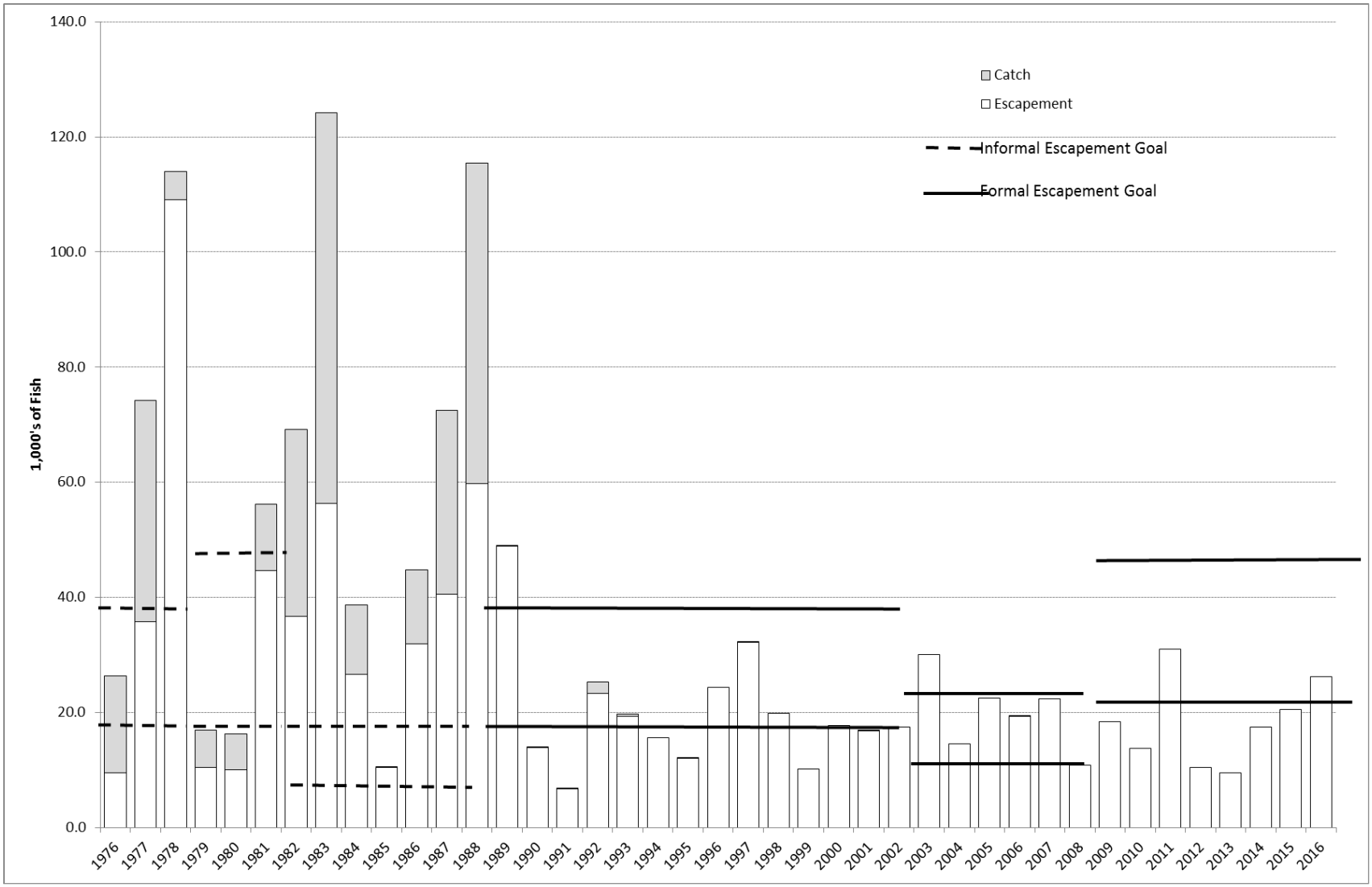

Figure 2.–Histogram of annual catch, escapement, and total run indices (thousands of fish) for McNeil River chum salmon 1976–2016, with lines representing the escapement goal that was in place at the time.

Note: The first formal goal was published in 1988; goals prior to that (dashed lines) were informal goals used for inseason management.

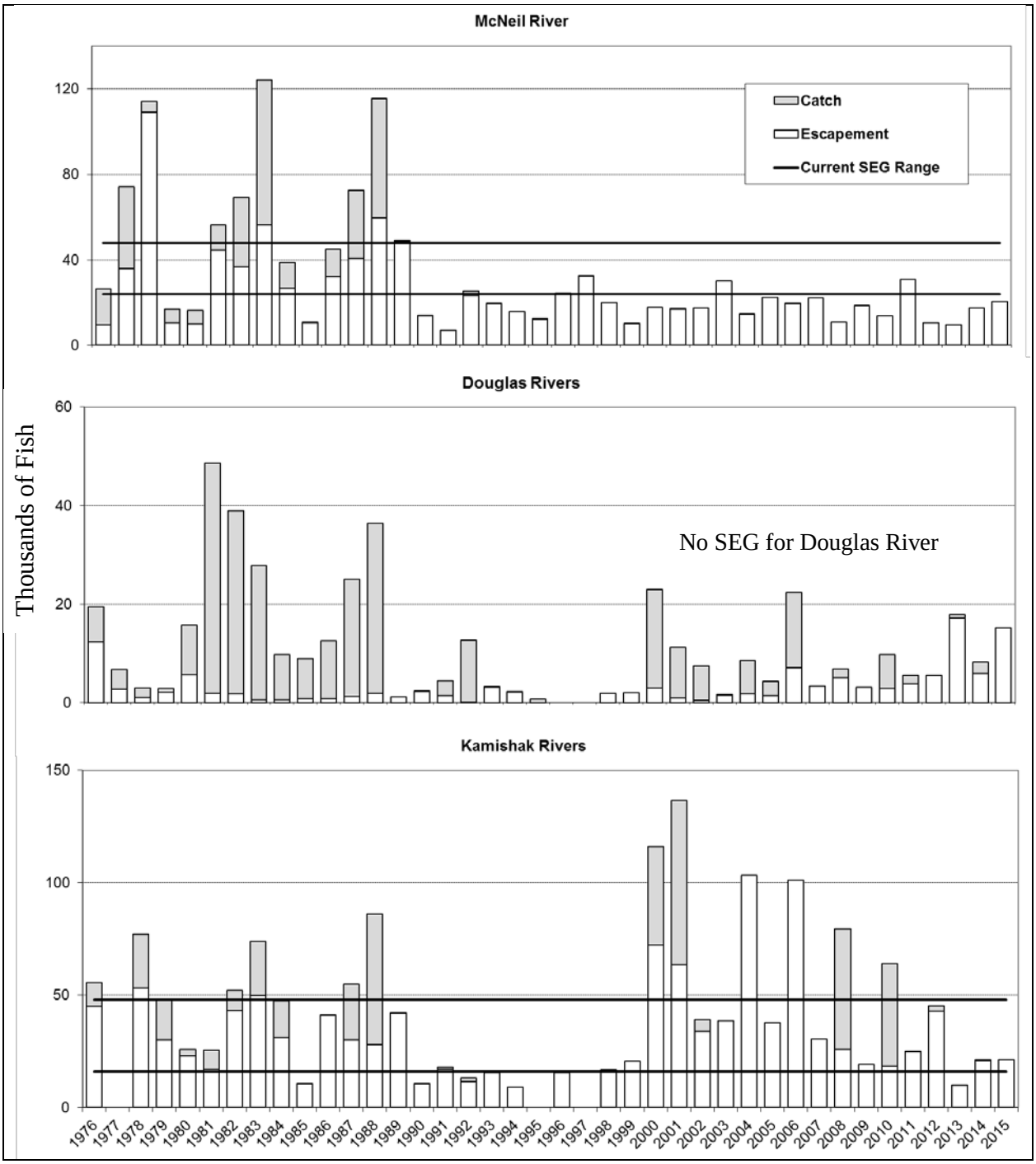

Figure 3.–Kamishak District chum salmon catch and escapement indices, 1976–2015.

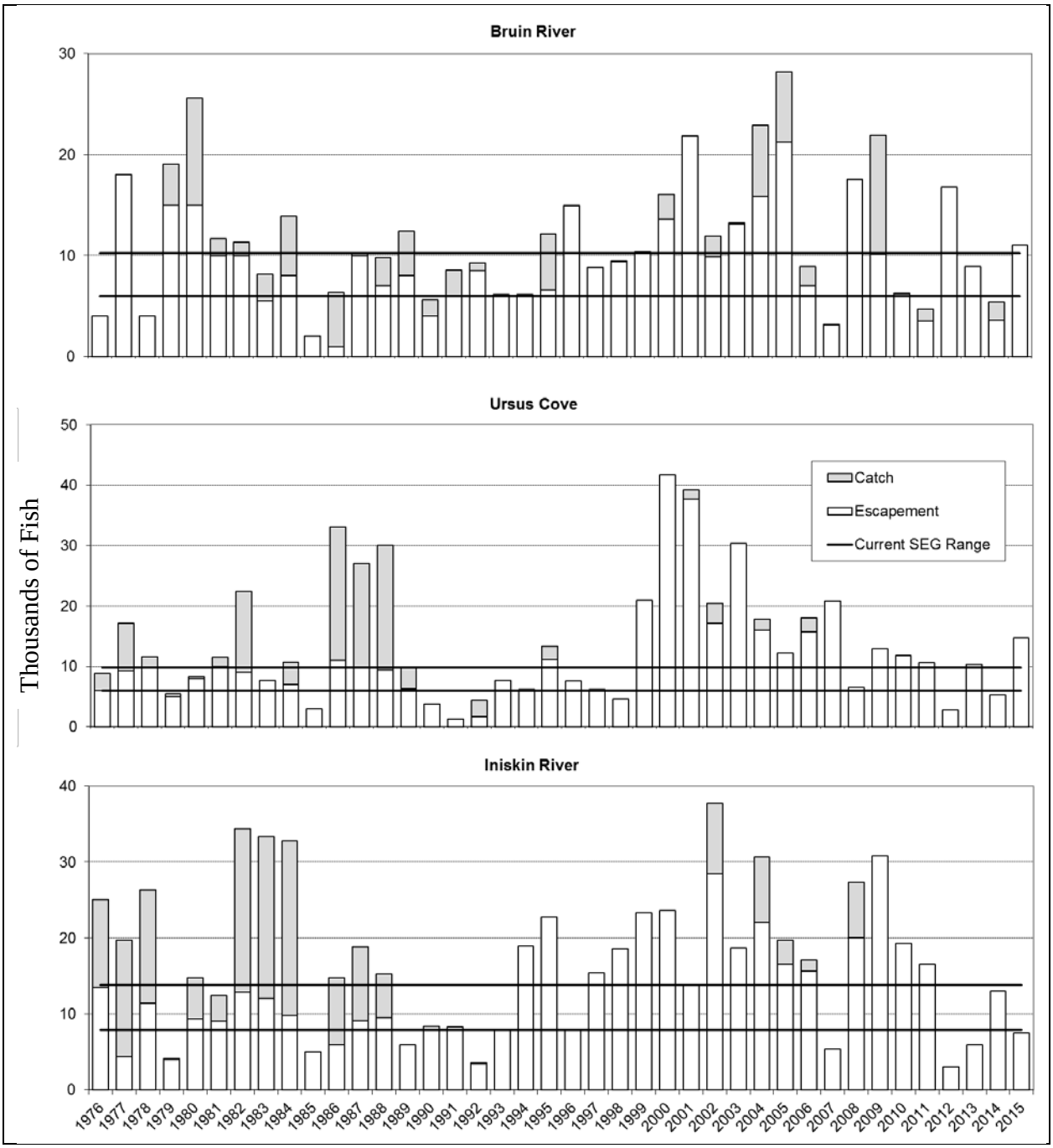

Figure 3.–Page 2 of 2.

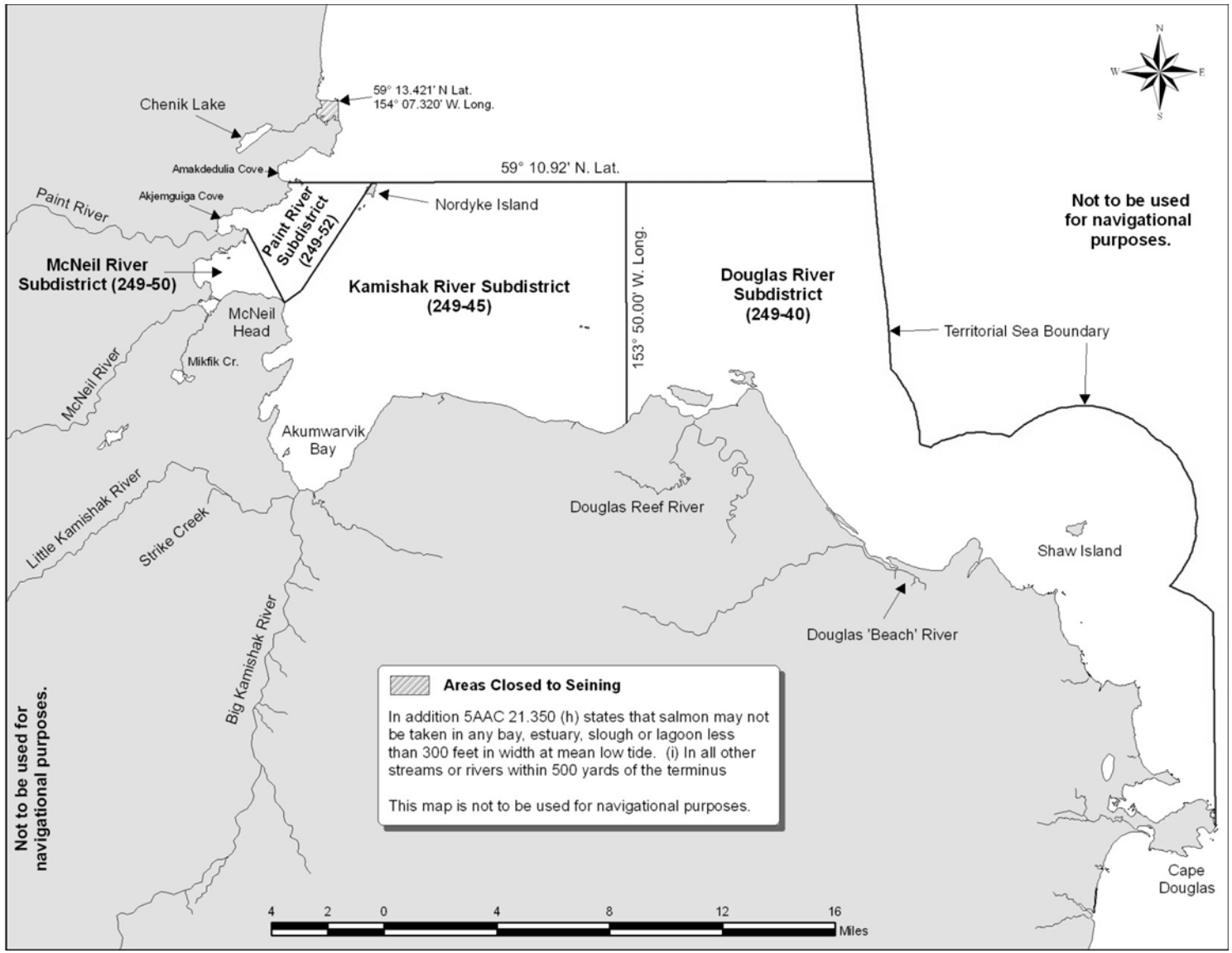

Figure 4.–Kamishak Bay District of Lower Cook Inlet management area showing commercial fishing districts and reporting subdistricts, Chenik Lake to Cape Douglas.

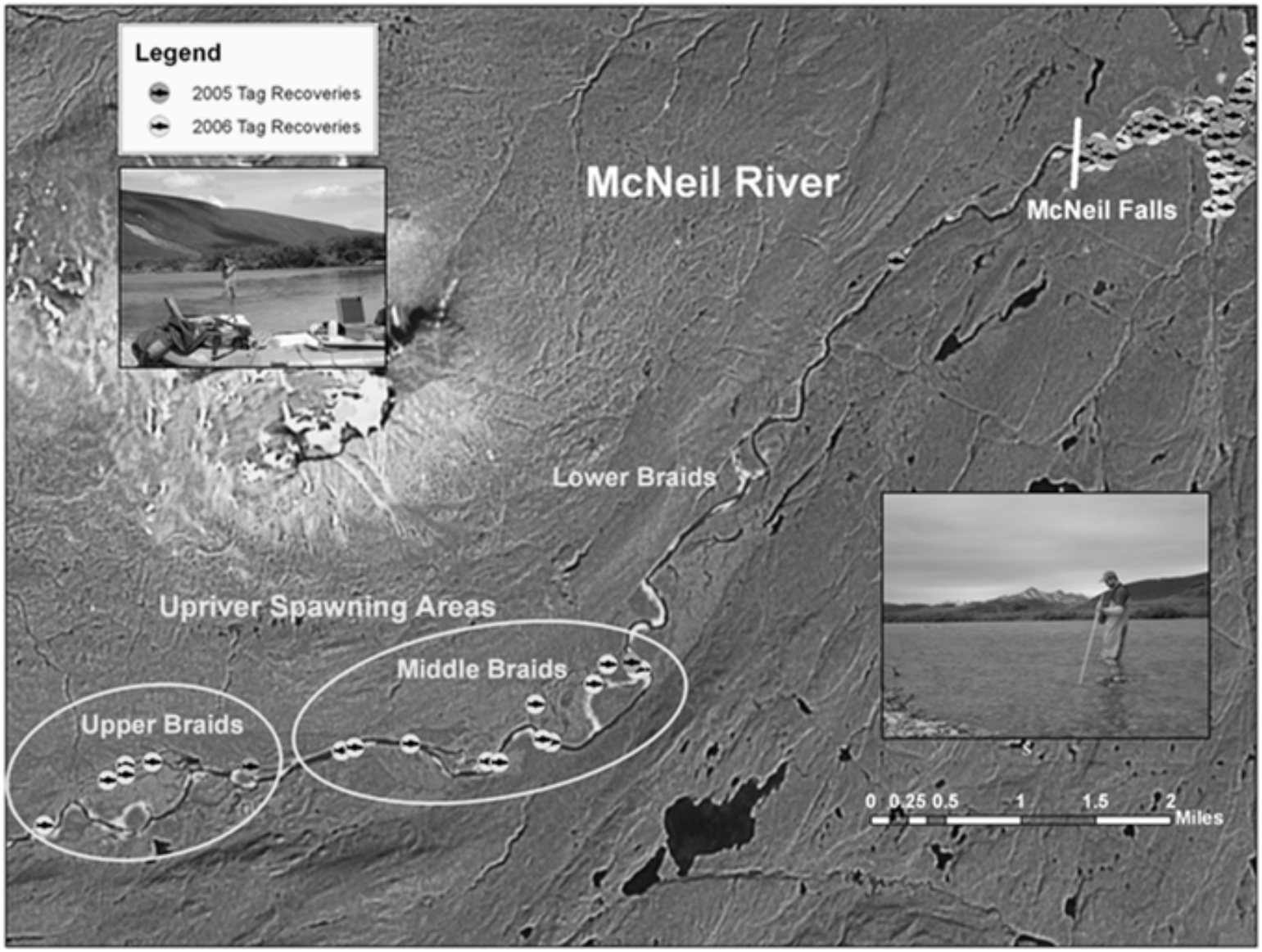

Figure 5.–Satellite image illustrating McNeil River drainage and locations tagged fish were documented below McNeil Falls and at two braided sections of the upper river during radio telemetry study conducted in 2005–2006.

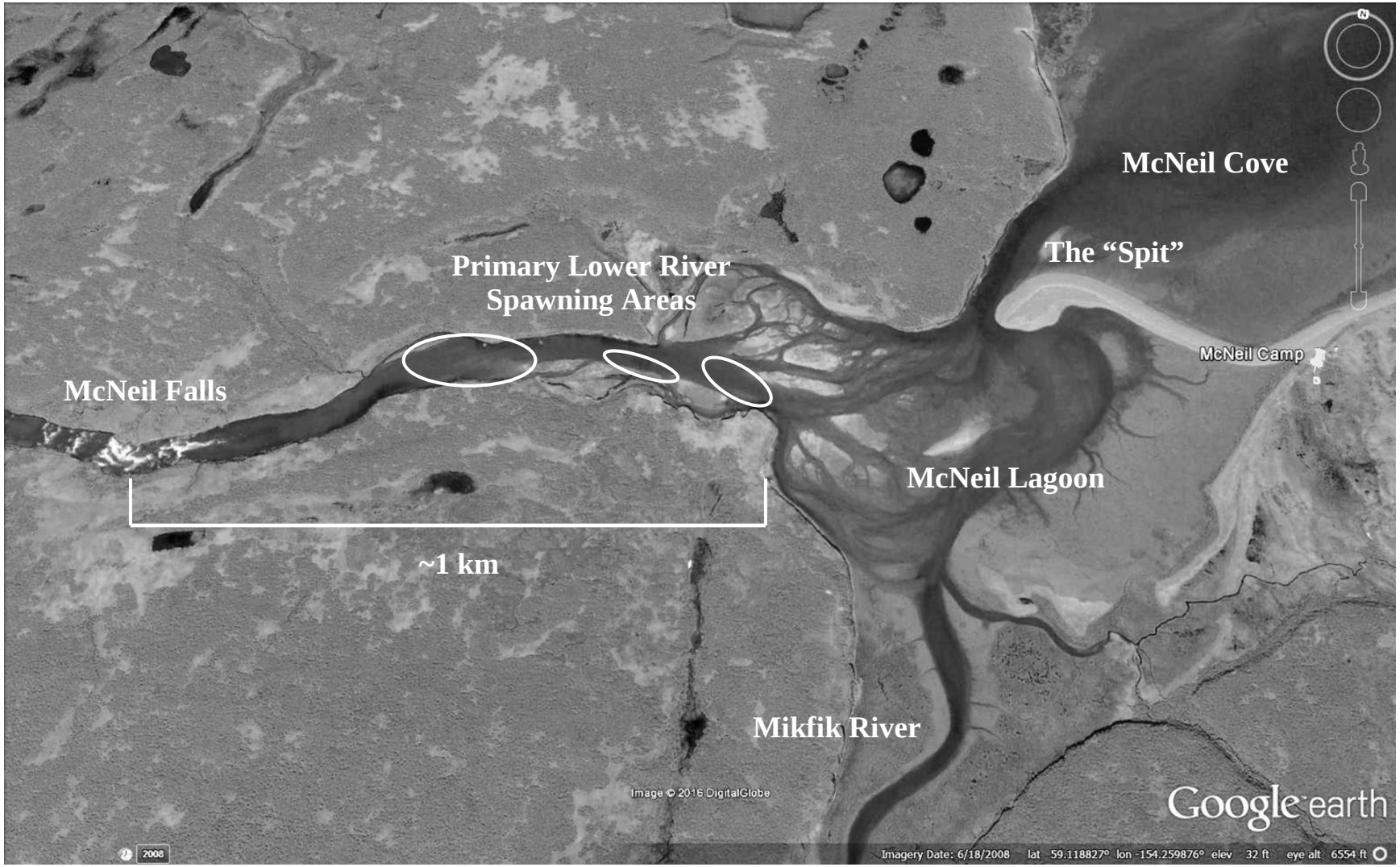

Figure 6.–Satellite image showing features of Lower McNeil River including McNeil Falls, McNeil Lagoon, McNeil Cove, and the limited spawning areas available in this reach, depicted by white ovals.