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An Evaluation of the Solomon Gulch Hatchery for Consistency with Statewide Policies and Prescribed Management Practices

by

Mark Stopha

May 2013

Alaska Department of Fish and Game **Division of Commercial Fisheries**

Symbols and Abbreviations

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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

REGIONAL INFORMATION REPORT NO. 5J13-04

AN EVALUATION OF THE SOLOMON GULCH SALMON HATCHERY FOR CONSISTENCY WITH STATEWIDE POLICIES AND PRESCRIBED MANAGEMENT PRACTICES

by
Mark Stopha
Alaska Department of Fish and Game, Division of Commercial Fisheries, Juneau

Alaska Department of Fish and Game
Division of Commercial Fisheries
333 Raspberry Road, Anchorage, AK 99518

May 2013

The Regional Information Report Series was established in 1987 and was redefined in 2006 to meet the Division of Commercial Fisheries regional need for publishing and archiving information such as project operational plans, area management plans, budgetary information, staff comments and opinions to Board of Fisheries proposals, interim or preliminary data and grant agency reports, special meeting or minor workshop results and other regional information not generally reported elsewhere. Reports in this series may contain raw data and preliminary results. Reports in this series receive varying degrees of regional, biometric and editorial review; information in this series may be subsequently finalized and published in a different department reporting series or in the formal literature. Please contact the author or the Division of Commercial Fisheries if in doubt of the level of review or preliminary nature of the data reported. Regional Information Reports are available through the Alaska State Library and on the Internet at http://www.adfg.alaska.gov/sf/publications/

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Mark Stopha,
Alaska Department of Fish and Game, Division of Commercial Fisheries,
1255 W. 8th St. P. O. Box 115526, Juneau, AK 99811-5526, USA

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ABSTRACT

The salmon hatchery program in Alaska is governed by policies, plans, and regulations that emphasize protection of wild salmon stocks. A rotational series of hatchery evaluations will examine each hatchery for consistency with those policies and prescribed management practices. The evaluation includes a review of hatchery management plans and permits, an assessment of each hatchery program's consistency with statewide policies, and recommendations to address any deficiencies found. Management plans and permits were examined to determine whether they were current, consistent with each other, and accurately described hatchery operations.

This report reviews the Solomon Gulch Hatchery operated by the Valdez Fisheries Development Association. The Solomon Gulch Hatchery produces pink salmon and coho salmon for the commercial and sport fisheries near Valdez, Alaska. The initial broodstock for the hatchery originated from several river and streams near the hatchery. Estimated pink salmon returns averaged 13 million fish from 2006 to 2011. Coho salmon returns during the same period averaged 173,000 fish annually.

Few serious outbreaks of disease were reported over the facility's history, and state hatchery inspectors report the facility was regularly upgraded to maintain fish health. Escapement goals have been established and monitored by the Alaska Department of Fish and Game for wild pink and chum salmon stocks returning to drainages near the hatchery for several decades. From 1990 to 2010, the lower escapement goal to these systems was met in most years.

The basic management plan for the facility should be updated for permit amendments and changes in operations that occurred since the original plan was issued. Spawning escapements to the Lowe and Robe Rivers, two of the historically largest wild coho salmon-producing systems near the hatchery, should be monitored regularly.

Key words: Solomon Gulch Hatchery, hatchery evaluation, hatchery, Valdez Fisheries Development Association

INTRODUCTION

Alaska's constitution mandates that fish are harvested sustainably under Article 8, section 4: "Fish, forests, wildlife, grasslands, and all other replenishable resources belonging to the state shall be utilized, developed and maintained on the sustained yield principle, subject to preferences among beneficial uses."

Due in part to historically low salmon harvests, Article 8, section 15 of Alaska's Constitution was amended in 1972 to provide tools for restoring and maintaining the state's fishing economy: "No exclusive right or special privilege of fishery shall be created or authorized in the natural waters of the State. This section does not restrict the power of the State to limit entry into any fishery for purposes of resource conservation, to prevent economic distress among fishermen and those dependent upon them for a livelihood and to promote the efficient development of aquaculture in the State." Alaska's salmon hatchery program was developed under this mandate and designed to supplement—not replace—sustainable wild stock production.

Alaska's modern salmon fisheries enhancement program began in 1971 when the Alaska Legislature established the Division of Fisheries Rehabilitation Enhancement and Development (FRED) within the Alaska Department of Fish and Game (ADF&G; FRED Division 1976). In 1974, the Alaska Legislature expanded the program, authorizing private nonprofit (PNP) corporations to operate salmon hatcheries: "It is the intent of this Act to authorize the private ownership of salmon hatcheries by qualified nonprofit corporations for the purpose of contributing, by artificial means, to the rehabilitation of the state's depleted and depressed salmon fishery. The program shall be operated without adversely affecting natural stocks of fish in the state and under a policy of management which allows reasonable segregation of returning hatchery-reared salmon from naturally occurring stocks." (Alaska Legislature 1974).

Salmon fishery restoration efforts came in response to statewide annual salmon harvests of 30 million fish, among the lowest catches since 1900 (Figure 1). The FRED Division and PNPs engaged in a variety of activities to increase salmon production. New hatcheries were built to raise salmon, fish ladders were constructed to provide adult salmon access to previously nonutilized spawning and rearing areas, lakes with waterfall outlets too high for adult salmon to ascend were stocked with salmon fry, log jams were removed in streams to enable returning adults to reach spawning areas, and nursery lakes were fertilized to increase juvenile salmon growth (FRED 1975). A combination of favorable environmental conditions, limited fishing effort, abundance-based harvest management, habitat improvement, and hatchery production gradually boosted salmon catches, with recent commercial salmon harvests (2002–2011) averaging 170 million fish per year (Vercessi 2012).

In Alaska, the purpose of salmon hatcheries is to supplement wild stock production for public benefit. Hatcheries are efficient in improving survival from the egg to fry or smolt stage. In natural production, survival of eggs to fry or smolt is highly variable. Estimates for pink salmon survival in two Southeast Alaska creeks ranged from less than 1% to 22%, with average survivals from 4% to 9% (Groot and Margolis 1991). Under hatchery conditions, egg to fry survival is usually 80% or higher.

Alaska hatcheries do not grow fish to adulthood, but incubate fertilized eggs and release resulting progeny. Juvenile salmon imprint on the release site and return to the release location as mature adults. Per state policy, hatcheries generally use stocks taken from close proximity to the hatchery so that any straying of hatchery returns will have similar genetic makeup as the stocks from nearby streams. Alaska hatcheries do not selectively breed. Large numbers of broodstock are used for gamete collection to maintain genetic diversity, without regard to size or other characteristic. In this document, *wild* fish refer to fish that are the progeny of parents that naturally spawned in watersheds and intertidal areas. *Hatchery* fish are fish reared in a hatchery to a juvenile stage and released. *Farmed* fish are fish reared in captivity to market size for sale. Fish farming of salmon is not legal in Alaska; it is prohibited under Alaska Statue 16.40.210.

Hatchery production is limited by freshwater capacity and freshwater rearing space. Soon after emergence, all pink and chum salmon fry can be transferred from fresh water to salt water. Most Chinook, sockeye, and coho salmon, on the other hand, must spend a year or more in fresh water before fry develop to the smolt stage and can tolerate salt water. These species require a higher volume of fresh water, a holding area for freshwater rearing, and feeding. They also have a higher risk of disease mortality due to the extended rearing phase. There are economic tradeoffs between the costs of production versus the value of fish at harvest. Although Chinook, sockeye, and coho salmon garner higher prices per pound as adults, chum and pink salmon are more economical to rear in the hatchery setting and generally provide a higher economic return.

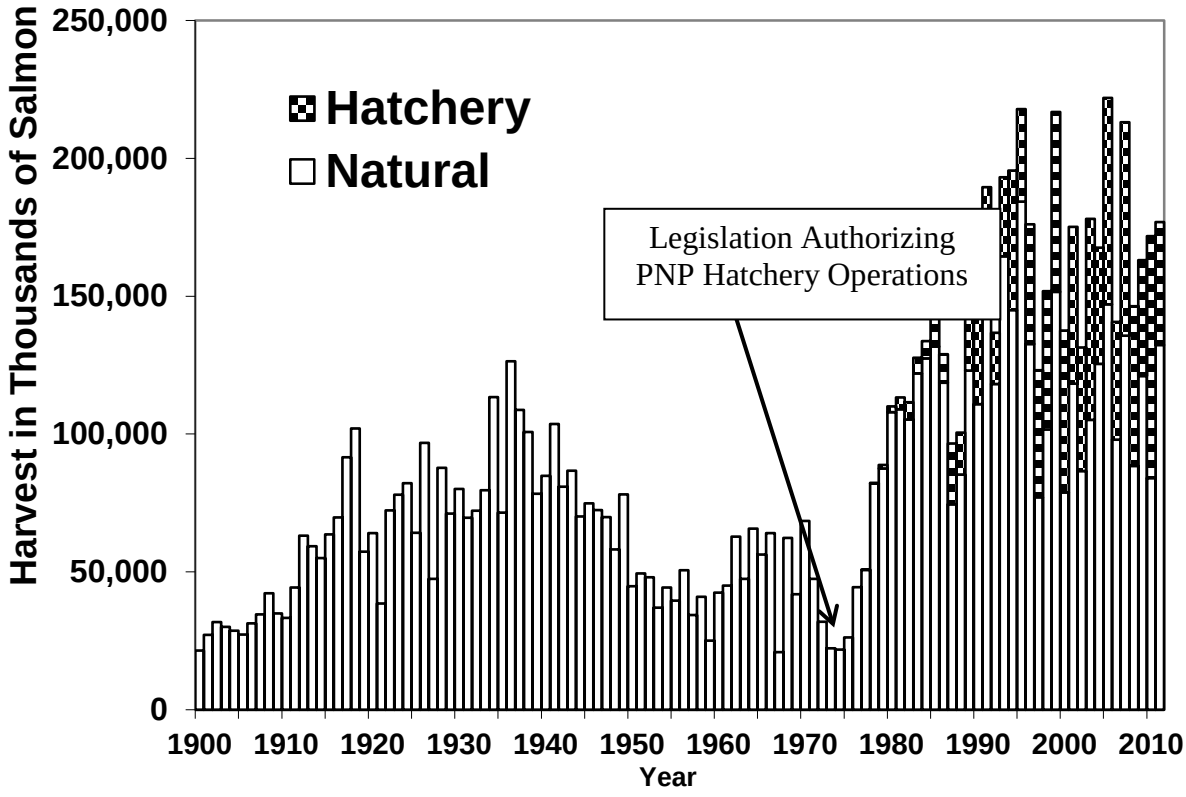

Figure 1.–Commercial salmon harvest in Alaska, 1900–2011.

Pink salmon, which have the shortest life cycle of Pacific salmon (two years), provide a quick return on investment and provide the bulk of Alaska hatchery production. From 2002 to 2011, pink salmon accounted for an average 71% of Alaska hatchery salmon returns by number, followed by chum salmon (21%), sockeye salmon (5%), coho salmon (2%) and Chinook salmon (<1%) (Farrington 2003, 2004; White 2005–2011; Vercessi 2012).

The salmon marketplace has changed substantially since the hatchery program began. As the first adult salmon were returning to newly built hatcheries in 1980, Alaska accounted for nearly half of the world salmon supply, and larger harvests in Alaska generally meant lower prices to fishermen. Some believed the increasing hatchery production in some parts of the state was depressing salmon prices in others (Knapp et al. 2007). By 1996, rapidly expanding farmed salmon production surpassed the wild salmon harvest for the first time (Knapp et al. 2007) and wild salmon prices declined precipitously as farmed salmon flooded the marketplace in the U.S., Europe, and Japan. Alaska responded to the competition by improving fish quality at harvest and implementing intensive marketing efforts to differentiate Alaska salmon from farmed salmon. Infrastructure upgrades increased processing capacity, and innovation provided virtually full utilization of all salmon, including hatchery broodstock carcasses which were previously discarded. By 2004, these efforts paid off through increasing demand and prices.

Today, Alaska typically accounts for just 12% to 15% of the global supply (ASMI 2011). Alaska's diminished influence on world salmon production means that Alaska's harvest volume

has little effect on world salmon prices. Prices paid to fishermen have generally increased over the past decade despite large fluctuations in harvest volume (ADF&G 2012). The exvessel value of hatchery harvest increased from $46 million in 2002 to $136 million in 2011.[1] First wholesale value also showed an increasing trend, with the value of hatchery fish increasing from $160 million in 2002 to $314 million in 2011.[2] Pink and chum salmon, on average, accounted for over 75% of the annual hatchery exvessel and first wholesale values from 2002 to 2011.

Over the past decade (2002–2011), hatcheries contributed an average 35% of the total Alaska salmon harvest, in numbers of fish (Farrington 2003, 2004; White 2005–2011, Vercessi 2012). With world markets currently supporting a trend of increasing prices for salmon, interest in increasing hatchery production by Alaska fishermen, processors, support industries, and coastal communities has increased as well. In 2010, Alaska salmon processors encouraged hatchery operators to expand pink salmon production to meet heightened demand (Industry Working Group, 2010).

Alaska's wild salmon populations are sustainably managed to ensure adequate numbers of adults spawn, and the wild harvest is arguably at its maximum, given fluctuations due to environmental variability and imperfect management precision. Regulatory actions, such as reductions of salmon bycatch in other fisheries or adopting fishing methods that would allow more precise management of escapement, could increase the harvest, but have obvious allocation implications to the current fisheries structure. Hatchery production will remain the primary opportunity to substantially increase the harvest in the near term.

Part of the reason for the rise in price of Alaska salmon was a message of sustainable fisheries management to a growing audience of discriminating buyers. ADF&G applied to the Marine Stewardship Council (MSC) for certification as a sustainably managed fishery. In 2000, the MSC certified the salmon fisheries managed by ADF&G as sustainably managed, and the state's salmon fisheries remained the only MSC certified salmon fishery in the world for nearly a decade. Salmon fisheries elsewhere (Annette Islands Indian Reserve salmon, British Columbia pink and sockeye salmon, and Iturup Island, Russia, pink and chum salmon) were later certified for much smaller geographic areas, and in some cases, only for specific salmon species (MSC 2012). Alaska's certification was MSC's broadest and most complex, covering all five salmon species harvested by all fishing gear types in all parts of the state. Achievement of statewide certification was a reflection of the state's commitment to abundance-based fisheries management and constitutional mandate to sustain wild salmon populations.

MSC certified fisheries are reviewed every five years. When Alaska salmon fisheries were recertified in 2007 (Chaffee et al. 2007), a condition of certification was to "Establish and implement a mechanism for periodic formal evaluations of each hatchery program for consistency with statewide policies and prescribed management practices. This would include a specific evaluation of each program relative to related policies and management practices." (Knapman et al. 2009).

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[1] Exvessel value for hatchery harvest is the total harvest value paid by fish buyers to fishermen for all salmon from http://www.adfg.alaska.gov/index.cfm?adfg=commercialbyfisherysalmon.salmoncatch (accessed 02/04/2012), multiplied by the hatchery percent of the commercial harvest in Farrington 2003, 2004; White 2005– 2011, and Vercessi 2012.

[2] First wholesale value is the price paid to primary processors for processed fish from ADF&G Commercial Operators' Annual Reports multiplied by the hatchery percent of the commercial harvest.

The Alaska Seafood Marketing Institute changed to a new sustainable fishery certification under the Food and Agriculture Organization in 2011. The hatchery evaluations started under the MSC certification continued as an important systematic assessment of Alaska salmon fishery enhancement and its relation to wild stock production at a time of heightened interest for increased hatchery production and potential impacts on wild salmon production. ADF&G established a rotational schedule to review PNP hatchery programs. Hatchery reviews were completed for the Kodiak Region in 2011 (Musslewhite 2011a, 2011b) and for the Cook Inlet region in 2013 (Stopha and Musslewhite (2012), Stopha (2012a, 2012b, 2013). This report for the Solomon Gulch Hatchery (SGH) is the first evaluation for the Prince William Sound (PWS) region. Following completion of reviews for hatcheries in PWS, hatchery reviews for Southeast Alaska will follow.

OVERVIEW OF POLICIES

Numerous Alaska mandates and policies for hatchery operations were specifically developed to minimize potential adverse effects to wild stocks. The design and development of the hatchery program is described in detail in McGee (2004): "The success of the hatchery program in having minimal impact on wild stocks can be attributed to the development of state statutes, policies, procedures, and plans that require hatcheries to be located away from significant wild stocks, and constant vigilance on the part of ADF&G and hatchery operators to improve the program through ongoing analysis of hatchery performance." Through a comprehensive permitting and planning process, hatchery operations are subject to continual review by a number of ADF&G fishery managers, geneticists, and pathologists.

A variety of policies guide the permitting of salmon fishery enhancement projects. They include *Genetic Policy* (Davis et al. 1985), *Regulation Changes, Policies, and Guidelines for Fish and Shellfish Health and Disease Control* (Meyers 2010), and various fisheries management policies, such as the Sustainable Salmon Fisheries Policy (5 AAC 39.222). These policies are used by ADF&G staff to assess hatchery operations for genetic, health, and fishery management issues in the permitting process.

The State of Alaska ADF&G *Genetic Policy* (Davis et al. 1985; Davis and Burkett 1989) sets out restrictions and guidelines for stock transport, protection of wild stocks, and maintenance of genetic variance. Policy guidelines include banning importation of salmonids from outside the state for enhancement (except transboundary rivers); restricting transportation of stocks between the major geographic areas in the state (Southeast, Kodiak Island, Prince William Sound, Cook Inlet, Bristol Bay, Arctic-Yukon-Kuskokwim, and Interior); requiring the use of broodstock with appropriate phenotypic characteristics; maintaining genetic diversity by use of large populations of broodstock collected across the entire run; limiting the number of hatchery stocks derived from a single donor stock; and protection of wild stocks from possible harmful interactions with introduced stocks.

The *Genetic Policy* also recommends the identification and protection of *significant and unique* wild stocks: "Stocks cannot be introduced to sites where the introduced stock may have significant interaction or impact on significant or unique wild stocks." Davis and Burkett (1989) suggest that regional planning teams (RPTs) are an appropriate body to designate those stocks. In addition, the *Genetic Policy* recommends the designation of watersheds to serve as wild stock sanctuaries to preserve genetic variability. "These sanctuaries will be areas in which no enhancement activity is permitted except gamete removal for broodstock development."

Salmon fishery enhancement efforts are guided by comprehensive salmon plans for each region (AS 16.10.375). These plans are developed by the RPTs, which are composed of six members: three from ADF&G and three appointed by the regional aquaculture association Board of Directors (5 AAC 40.310). According to McGee (2004), "Regional comprehensive planning in Alaska progresses in stages. Phase I sets the long-term goals, objectives, and strategies for the region. Phase II identifies potential projects and establishes criteria for evaluating the enhancement and rehabilitation potentials for the salmon resources in the region. In some regions, a Phase III in planning has been instituted to incorporate Alaska Board of Fisheries approved allocation and fisheries management plans with hatchery production plans."

The *Alaska Fish Health and Disease Control Policy* (5 AAC 41.080) is designed to protect fish health and prevent spread of infectious disease in fish and shellfish. The policy and associated guidelines are discussed in *Regulation Changes, Policies, and Guidelines for Fish and Shellfish Health and Disease Control* (Meyers 2010). It includes regulations and guidelines for fish transports, broodstock screening, disease histories, and transfers between hatcheries. The *Alaska Sockeye Salmon Culture Manual* (McDaniel et al. 1994) also specifies practices and guidelines specific to the culture of sockeye salmon. As with the *Genetic Policy*, these regulations and guidelines are used by the principal pathologist and ADF&G geneticist to review hatchery plans and permits.

The *Alaska Policy for the Management of Sustainable Salmon Fisheries* (5 AAC 39.222) mandates protection of wild salmon stocks in the management of salmon fisheries. Other applicable policies include the *Policy for the Management of Mixed-Stock Salmon Fisheries* (5 AAC 39.220), the *Salmon Escapement Goal Policy* (5 AAC 39.223), and local fishery management plans (5 AAC 39.200). These regulations require biologists to consider the interactions of wild and hatchery salmon stocks when reviewing hatchery management plans and permits.

The guidance provided by these policies is sometimes very specific, and sometimes less so. For example, the *Alaska Fish Health and Disease Control Policy* mandates the use of an iodine solution on salmon eggs transported between watersheds—a prescribed practice that requires little interpretation. In contrast, several policies prioritize the protection of wild stocks from the potential effects of fisheries enhancement projects without specifying or mandating how to assess those effects. These less specific policies provide principles and priorities, but not specific direction, for decision making. In addition, although several *Genetic Policy* guidelines relate to hatchery stock effects on significant wild stocks, to date, significant stocks have only been designated in the Cook Inlet Region (Cook Inlet Regional Planning Team 2007).

A key principle of Alaska policy is to protect wild salmon stocks. The initial rotation of these reports will assess the consistency of individual hatcheries with state policies by (1) confirming that permits have been properly reviewed using applicable policies, and (2) identifying information relevant to each program's consistency with state policies. Future reports may assess regional effects of hatcheries on wild stocks and fishery management.

OVERVIEW OF HATCHERY PERMITS AND PLANS

The FRED Division built and operated several hatcheries across the state in the 1970s and gradually transferred operations of most facilities to PNP corporations. Regional aquaculture associations (RAAs), whose membership is comprised of commercial salmon fishing permit

holders, operate most of the PNP hatcheries in Kodiak, Cook Inlet, Prince William Sound, and Southeast Alaska. Each RAA's board of directors establish goals for enhanced production, oversee business operations of the hatcheries, and work with ADF&G staff to comply with state permitting and planning regulations. RAA members may vote to impose a salmon enhancement tax on exvessel sale of salmon in their region to finance hatchery operations. Independent PNP corporations, not affiliated with a RAA, also operate hatcheries in several areas of the state, and cannot impose a salmon enhancement tax. Both the RAAs and independent PNP hatchery organizations may harvest salmon returning to their hatcheries or release sites to pay for operations. These salmon are referred to as the *cost-recovery* harvest. Several organizations also have tourist and educational programs that contribute to the financial support of their programs.

Public participation is an integral part of the PNP hatchery system. Hearings are held before a hatchery is permitted for operation. RPTs hold public meetings to define desired production goals by species, area, and time in comprehensive salmon plans (5 AAC 40.300). RPTs review applications for new hatcheries to determine compatibility with the comprehensive salmon plan and also make recommendations to the ADF&G commissioner regarding changes to existing hatchery operations, new hatchery production, and new hatchery facilities. Municipal, commercial, sport, and subsistence fishing representatives commonly hold seats on both RAA and independent PNP hatchery organization boards, providing broad public oversight of operations.

Alaska PNP hatcheries operate under four documents required in statue and regulation: hatchery permit with basic management plan (BMP), annual management plan (AMP), fish transport permit (FTP), and annual report (Figure 2). The hatchery permit authorizes operation of the hatchery, specifies the maximum number of eggs of each species that a facility can incubate, specifies the authorized release locations, and may identify stocks used for broodstock (AS 16.10.400, 5 AAC 40.120). The BMP is an addendum to the hatchery permit and outlines the general operations of the hatchery. The BMP may describe the facility design, operational protocols, hatchery practices, broodstock development schedule, donor stocks, harvest management, release sites, and consideration of wild stock management (5 AAC 40.820). The BMP functions as part of the hatchery permit and the two documents should be revised together if the permit is altered. The permit and BMP are not transferrable. Permits remain in effect unless revoked or withdrawn.

Hatchery permits/BMPs may be amended through a permit alteration request (PAR). Requested changes are reviewed by the RPT and ADF&G staff and a recommendation is sent to the commissioner for consideration. If approved, the permit is amended to include the alteration. Reference to a *permit* or *hatchery permit* in this document also includes approved PARs to the hatchery permit unless otherwise noted.

The AMP outlines operations for the current year and is in effect until superseded by the following year's AMP. It should "organize and guide the hatchery's operations, for each calendar year, regarding production goals, broodstock development, and harvest management of hatchery returns." (5 AAC 40.840). Typically, AMPs include the upcoming year's egg-take goals, fry or smolt releases, expected adult returns, harvest management plans, FTPs required or in place, and fish culture techniques. The AMP must be consistent with the hatchery permit and BMP.

An FTP is required for egg collections, transports, and releases (5 AAC 41.001–41.100). The FTP authorizes the specific activities described in the hatchery permit/BMP and AMP, including broodstock sources, gamete collections, and release sites. FTP applications are reviewed by the ADF&G fish pathologist, fish geneticist, regional resource development biologist, Division of Commercial Fisheries regional supervisor, Division of Sport Fish regional supervisor, and deputy director of the Division of Commercial Fisheries before final consideration by the ADF&G commissioner. An FTP is issued for a fixed time period and includes both the specifics of the planned operation and any conditions added by ADF&G.

Each hatchery is required to submit an annual report documenting egg collections, juvenile releases, current year returns and contributions to fisheries, and projected returns for the following year. Information for all hatcheries is compiled into an annual ADF&G report (e.g., Vercessi 2012) to the Alaska Legislature (AS 16.05.092).

The administration of hatchery permitting, planning, and reporting requires regular communication between ADF&G staff and hatchery operators. The serial documentation from hatchery permit/BMP to AMP to FTP to annual report necessarily spans generations of hatchery and ADF&G personnel, providing an important history of each hatchery's species cultured, stock lineages, releases, returns, and pathology.

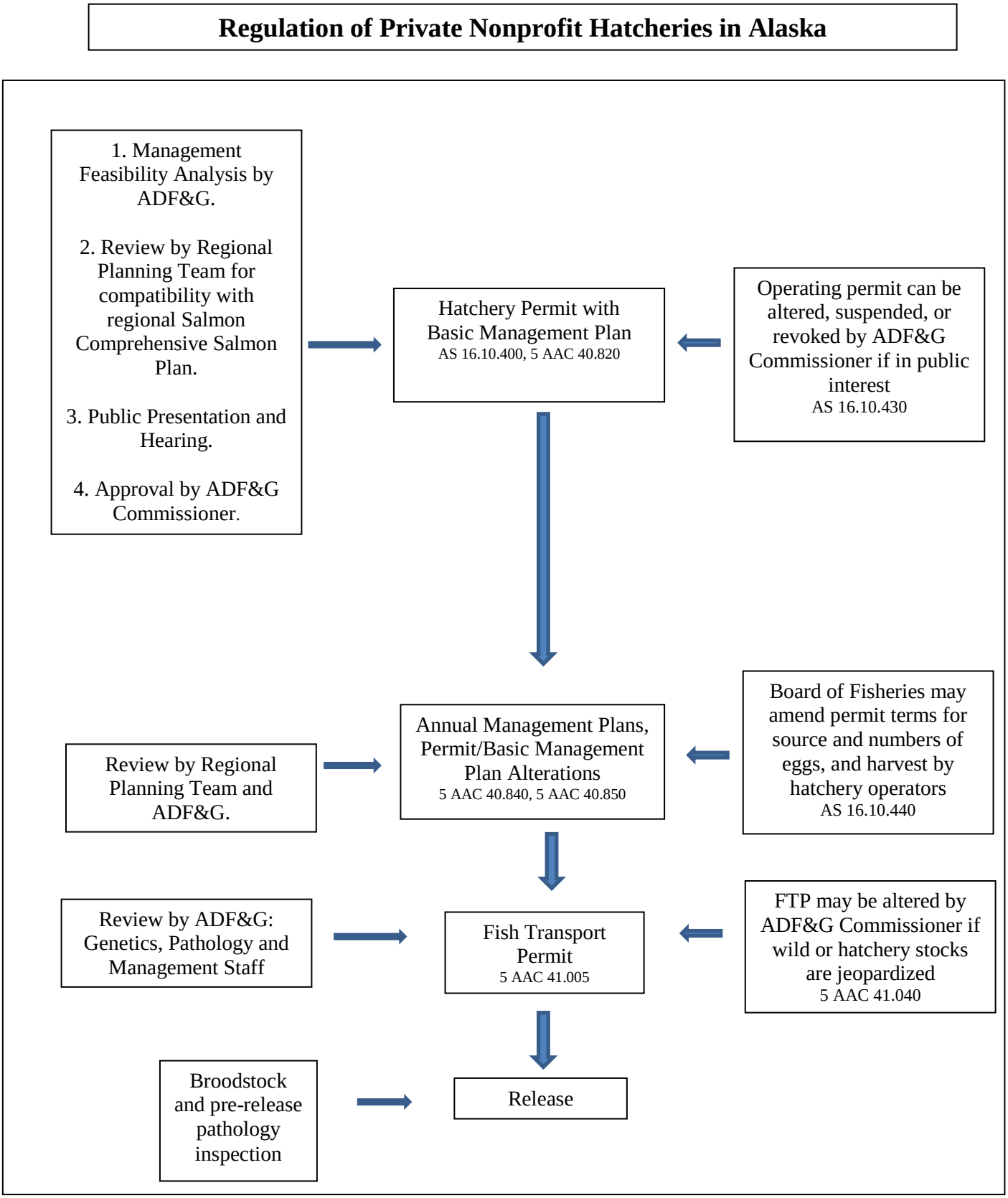

Figure 2.–Diagram of Alaska hatchery permitting process.

SOLOMON GULCH HATCHERY OVERVIEW

The Valdez Fisheries Development Association (VFDA) was established in 1978 by local fishermen concerned about the decline of commercial fishing opportunities near Valdez, Alaska (McDowell Group 2002). The City of Valdez provided a grant of $3,000 to VFDA for organization of a PNP hatchery corporation.[3]

Prior to applying for their permit, VFDA conducted small-scale salmon culture research involving egg collections, incubation, and release of pink and chum salmon under scientific/educational permits issued in the late 1970s and 1980 at the Crooked Creek Hatchery,[4] which was a few miles from the present-day Solomon Gulch Hatchery (SGH) in Valdez. A major objective of the Crooked Creek project was to develop donor stocks for SGH (Prince William Sound Regional Fisheries Planning Team, 1983).

VFDA submitted a preliminary hatchery application for SGH in March 1980, with a requested capacity of 50 million pink salmon eggs and 18 million chum salmon eggs. VFDA wanted to develop an early pink salmon run that could be harvested prior to mixing with the later coho salmon runs important to the area sport fishery. Pink salmon have a two-year life cycle, with discreet even-year and odd-year returning stocks.

For chum salmon, VFDA wanted to develop a late-returning stock which could be harvested after the bulk of the coho salmon had returned to Port Valdez, again to avoid conflict with the established coho salmon sport fishery.

The PWS RPT reviewed the preliminary application as required under 5 AAC 40.170. The RPT recommended that commercial harvest of hatchery fish minimize incidental harvest of wild coho salmon. The RPT also recommended choosing early-run pink salmon and late-run chum salmon stocks to minimize interception of wild stocks of resident pink, coho, and chum salmon. The RPT cautioned that there was also a danger that the Robe Lake sockeye salmon stock could be overharvested during commercial harvests for hatchery pink and chum salmon.[5]

ADF&G fishery biologists reviewing the application were concerned about several aspects of the hatchery. Some were concerned that the hatchery site would not provide adequate separation of wild and hatchery stocks for discreet harvest of hatchery returns and asked for marking of releases to estimate hatchery contribution in the harvest. Others warned that wild coho salmon stocks might be overharvested in fisheries targeting hatchery returns. Some wanted hatchery production increased in stages for evaluation of the return.[6] Technical concerns included the sediment load in the glacier water source for the hatchery that could be detrimental to egg incubation and rearing of hatchlings.[7]

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[3] Unpublished testimony of Jason Wells, VFDA, at public hearing for the Solomon Gulch Hatchery obtained from Sam Rabung, Division of Commercial Fisheries PNP Hatchery Coordinator, Juneau.

[4] Note that the short-lived Crooked Creek Hatchery in Valdez should not be confused with the larger Crooked Creek Hatchery operated on the Kenai Peninsula near Kasilof, Alaska. Both hatcheries are now closed.

[5] Ron Smith, Fish Biologist, PNP Program, FRED Division, to Robert Roys, Director, FRED Division. April 28, 1981 memorandum.

[6] Bob Wilbur, Aquaculture Harvest Coordinator, Division of Commercial Fisheries, ADF&G, to Jerry Madden, Salmon Rehabilitation and Enhancement Coordinator, FRED Division, ADF&G. August 28, 1980 memorandum.

[7] Ken Leon, Principal Biologist, ADF&G, FRED Division, to Patty Schlicting, Project Assistant, PNP Program, ADF&G, FREDDivision, regarding Solomon Gulch PNP. May 23, 1980 memorandum.

VFDA submitted a final application in December 1980. The application added coho salmon production to enhance the coho salmon sport fishery near Valdez. VFDA planned that sales of hatchery pink and chum salmon would provide the necessary revenue to fund both the pink and chum salmon programs targeted by the PWS commercial seine and gillnet fisheries, and the coho salmon program targeted by the sport fishery near Valdez.

Egg-take requests in the final application were for 50 million pink, 18 million chum, and 1 million coho salmon eggs. Pink salmon were to be early-returning fish to avoid overlapping with the peak of wild pink salmon returns. Chum salmon stocks were to be late-returning fish to avoid overlapping with the major part of the coho salmon return.

A public hearing on the final proposal was held in Valdez in March 1981. From the records on file, all public testimony supported approval of the hatchery. Based on the public support of the hatchery and the ADF&G review of the hatchery application, the commissioner approved the final hatchery permit in June 1981. The permit allowed a combined total incubation of 69 million pink, chum, and coho salmon eggs each year.

The BMP indicated that the final production goals for each of the three species would be established following "an evaluation period where timing, migration patterns, impacts of harvest on wild stocks, and user group benefits will be assessed." The evaluation period would continue for at least seven years. During this period, the BMP provided for egg takes[8] of 50 million pink salmon, 6 million chum salmon, and 1 million coho salmon. In addition to the stocks listed in the permit and BMP, the BMP established criteria for other stocks to be used. The criteria included using early-run pink salmon stocks, late-run chum salmon stocks, and using donor stocks within 50 water miles from the hatchery, when possible. Fishery management would be based on wild stock run strength to Valdez Arm streams. Initial chum salmon releases were limited to 6 million fish in order to assess the harvest of coho salmon in commercial fisheries targeting chum salmon. A portion of all pink, chum, and coho salmon releases were to be marked.

For pink salmon, Siwash Creek was designated as the approved donor stock for odd-year egg takes and Gregorioff Creek, Gorge Creek, and Indian River approved for even-year egg takes. Crooked Creek was the approved source for chum salmon and Corbin Creek (a tributary of the Robe River system) for coho salmon. All approved systems are located in Valdez Arm in the vicinity of the hatchery (Figure 3).

VFDA built SGH near Valdez in 1982 (Figure 3). The hatchery uses discharge water from the Solomon Gulch Hydroelectric Plant, which is supplied by the Solomon Gulch Reservoir. During the early years of salmon returns, VFDA hatchery managers and ADF&G personnel determined migration corridors, consistency of return timing, and degree of separation of wild and hatchery pink salmon in the SGH special harvest area (SHA), which are the waters of the Port of Valdez near the hatchery where VFDA and ADF&G manage broodstock and cost-recovery to the hatchery.

PARs were approved from 1984 to 1991 that incrementally increased permitted pink salmon production from 50 million to 230 million eggs (Appendix A). Coho salmon production was increased from 1 million to 2 million eggs in 1986. Chum salmon production was originally permitted at 18 million eggs, and chum salmon eggs were collected from 1982 until 1994.

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[8] The term egg take or *egg collection* refers to the collection of female gametes (eggs) and subsequent fertilization with male gametes (sperm) from broodstock.

Extended commercial fishing time during several years of that period for strong pink salmon returns to the Eastern District caught significant numbers of chum salmon as bycatch, and as a result, SGH was not able to meet brood stock needs (unpublished 1995 Annual Management Plan, Solomon Gulch Hatchery, Valdez Fisheries Development Association, Inc. obtained from Sam Rabung, ADF&G PNP Coordinator, Juneau). In 1995, VFDA discontinued the chum salmon program because of difficulty in consistently meeting egg-take goals, and in 1999, VFDA relinquished their permitted chum salmon capacity through an approved PAR.

Figure 3. –Solomon Gulch Hatchery location and donor stream location for original hatchery broodstock.

Beginning in the early 1980s, representative numbers of pink, chum, and coho salmon hatchery releases were marked with coded wire tags and recovered in the harvest through a sampling program. In 1997, all pink salmon were otolith thermal marked, with all coho salmon otolith thermal marked beginning in 2000. The SGH pink salmon contribution to the commercial harvest is estimated by sampling the commercial catch. The SGH coho salmon harvest in the Eastern District commercial fishery is estimated by subtracting the average coho salmon catch before hatchery production from the total harvest in the current year (Jeremy Botz, ADF&G Prince William Sound Commercial Fisheries Manager, personal communication). Neither coho nor pink salmon are sampled in the sport fisheries.

Eggs were collected for the hatchery from adult salmon returning to local watersheds during the initial years of the hatchery. By 1989, all broodstock were taken only at the hatchery (Appendix B). Pink and coho salmon are released by the hatchery today. Chum salmon were released from 1982 until 1995 (Appendix C).

From 1991 to 1993, Chinook salmon fingerlings of Cook Inlet origin stocks were incubated and hatched at Wally Noerenberg Hatchery in PWS, reared in freshwater raceways at SGH, and released at 6.5 Mile Creek near Valdez. Currently, the ADF&G Division of Sport Fish releases Cook Inlet origin Chinook salmon smolt reared in the ADF&G Sport Fish Hatchery in Anchorage near Valdez under a statewide Division of Sport Fish stocking plan.

SGH contributes substantial numbers of fish to the sport harvest in Valdez Arm and to the common property commercial harvest[9] in the Eastern District of PWS (Figure 4). Total estimated pink salmon returns of SGH fish averaged about 14 million fish per year from 2007 to 2011. Coho salmon returns averaged about 145,000 during the same period. Chum salmon returns to SGH were reported from 1985 to 1999, with the largest return of 442,000 fish in 1996. No Chinook salmon returns were reported in any year (Appendix D).

The common property commercial harvest of SGH pink salmon averaged 11 million fish from 2007–2011. The commercial SGH coho salmon catch averaged about 49,000 fish over the same period (Appendix E).

The Valdez Arm area provides the largest pink salmon sport fishery in the state, and the coho salmon fishery is among the largest in the state (Jennings 2011a). According to ADF&G estimates, the annual coho salmon sport harvest in Valdez Arm from 2006 to 2010 averaged about 52,000 fish, with the pink salmon annual average harvest about 19,000 fish during the same period (Appendix F).[10]

[9] Commercial harvests are intended for sale in the market place. Hatcheries harvest a portion of their returns to sell in the market place to pay for operations, as well as fish collected for broodstock. These harvests are collectively referred to as the hatchery harvest. Harvest by the commercial fishing fleet for sale by individual commercial fishing permit holders is called the common property commercial harvest.

[10] Sport harvest numbers in VFDA annual reports (Appendix E) generally exceed those estimates from the ADF&G statewide harvest survey (Appendix F). VFDA sport harvest numbers are based on recent averages and estimates from local observations (Ken Morgan, VFDA project manager, personal communication), whereas the ADF&G harvest figures are based on responses to an annual mail-out survey to anglers.

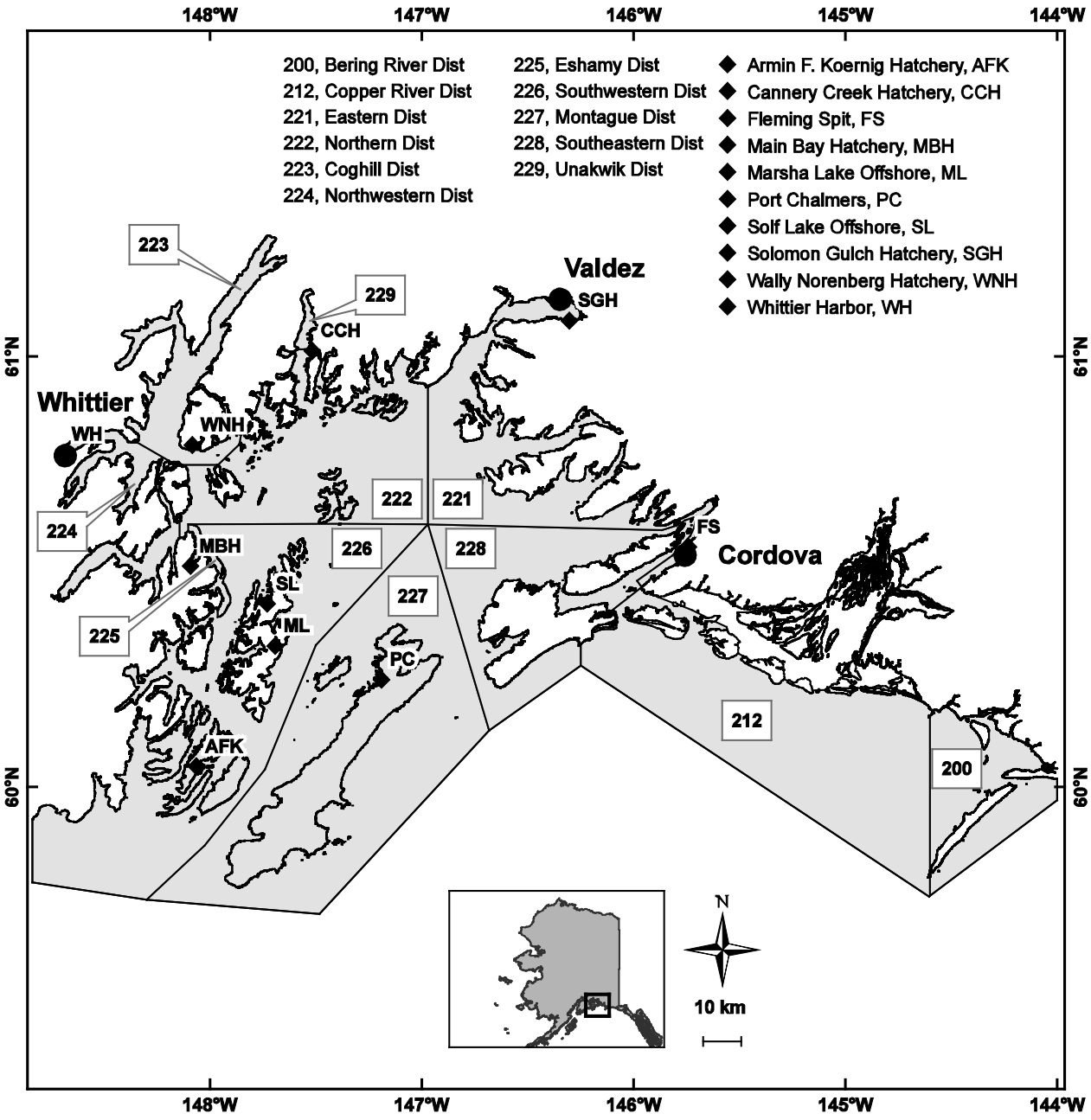

Figure 4.–Commercial fishing districts and hatchery locations in Prince William Sound.

PROGRAM EVALUATIONS

HATCHERY PERMITS AND OPERATING PLANS

Hatchery permit, BMP, AMP, and FTP documents for Solomon Gulch Hatchery were reviewed to determine that they met the following guidelines:

- They are current.
- They are consistent with each other.
- They are an accurate description of actual hatchery practices.

Two FTPs were issued for annual pink salmon egg takes of 50 million eggs at SGH: one for odd year returns (82A-1041) and one for even year returns (83A-1051). FTP 83A-1051 had an expiration date that read "perpetual", instead of a defined date. FTP 82A-0041 had an expiration date of 1988. When the hatchery expanded production through approved PARs over the following decade, only the odd year FTP was updated for the increases. The even year FTP was not updated, likely because there was no expiration date to signal a review of the FTP. The oversight was discovered in 1997, and FTP 83A-1051 was amended to match both the egg-take level and 10-year term of FTP 84A-1041 (Appendix G).

SGH exceeded the pink salmon egg-take levels of its hatchery permit in several years beginning in 1993, with a maximum overage of about 4%. The overages were addressed after the eyed-egg stage, when dead and excess eggs were removed to reduce the egg number to the permitted capacity. The author found no documented concern by ADF&G for these overages.

Coho salmon egg-takes also regularly exceeded the permitted maximum by about 15% (Appendix H). In 2010, ADF&G staff issued a letter to VFDA regarding the egg take overage.[11]

In 2012, SGH coho salmon returns appeared weak and SGH was issued FTP 12A-0123 to collect gametes from Corbin Creek if returns to the hatchery did not meet egg-take requirements. The FTP permit application, under the section *Native Stocks present, their status, and effects of the proposed action on them*, read: “The native coho salmon stock appears to be healthy and abundant, with 1,000 to 10,000 adults returning to the stream annually. This season’s estimates indicate a minimum of 5,000 fish returning.”

Although hatchery personnel opportunistically contact sport fishermen or walk the Robe Lake system to get a general idea of coho salmon abundance (Ken Morgan, VFDA project manager, personal communication), the last surveys of the Robe River/Corbin Creek drainage were done in 1984, according to ADF&G records. It appears the above language regarding adult returns to Corbin Creek were copied over from the earlier FTP, and reviewers made no comment on this section of the FTP application.

The SGH BMP has not been updated for approved permit PARs and other changes in operations. The operational document for SGH has been the AMP, which has included any changes to SGH operations.

[11] Memo from Sam Rabung, PNP Coordinator, ADF&G to Ken Morgan, Operations Manager, VFDA. Sept. 29, 2010, VFDA regarding egg take number. Unpublished document obtained from Sam Rabung, ADF&G PNP Hatchery Coordinator, Juneau.

COMPREHENSIVE SALMON ENHANCEMENT PLAN

The PWS Comprehensive Salmon Enhancement Plans (CSEP) Phase I was approved in 1983 and served to assemble relevant information regarding the development and protection of salmon resources in PWS (Prince William Sound Regional Planning Team 1983). The document assessed the region's commercial, sport, and subsistence fisheries resource needs, identified areas for enhancement and rehabilitation to meet those needs, and set 20-year goals for each fishery.

Three types of commercial fishing gear are permitted in PWS: purse seine, drift gillnet, and set gillnet. SGH is located in the Eastern District commercial fishing area, where only purse seine gear is permitted. The RPT conducted a survey as part of the Phase I CSEP to ask the fishing community about their desires for enhancement. Purse seiners ranked the Eastern District as a preferred area for salmon fishery enhancement, with pink salmon as their preferred species. Sport fishers ranked Valdez as a preferred area to fish in the PWS area, second to the Gulkana River, with Chinook salmon and coho salmon as their preferred species.

The second CSEP was developed in 1986, and called a Phase II plan (Prince William Sound Regional Planning Team 1986). Phase II plans were intended to recommend five-year goals to achieve the 20-year goals in the Phase I plan. For SGH, the Phase II plan recommended increased rearing capacity of the facility from 70 million eggs to its permitted capacity at the time of 136 million eggs. Additional objectives included: increasing chum salmon capacity from 6 to 18 million eggs, maintaining coho salmon capacity at 1 million eggs, and creating a new 300,000-egg Chinook salmon capacity. These production levels were intended to achieve annual average common property harvest goals of SGH hatchery fish of about 4.6 million pink, 337,000 chum, 23,000 coho and 7,600 Chinook salmon. These goals were met for pink and coho salmon (Appendix E). Goals were not met for chum salmon, and a Chinook salmon production program was not developed at SGH.

The third phase of the region's CSEP was developed in 1994 (Prince William Sound-Copper River Regional Planning Team 1994). The purpose of the Phase III plan was to "achieve optimum production of wild and enhanced salmon stocks on a sustained yield basis through an integrated program of research, management, and application of salmon enhancement technology, for the benefit of all user groups." The plan recommended remote release of early SGH pink salmon outside of Port Valdez to improve product quality and reduce exploitation on wild stocks. A remote release program was implemented for a few years in the early 1990s and discontinued.

At the time of the Phase III plan, SGH had permitted egg capacities for 230 million pink, 18 million chum, 2 million coho and 300,000 Chinook salmon. The Phase III plan recommended an increase in chum salmon production only—from 18 million to 36 million eggs—as a means of contribution to overall production goals of the plan. Chum salmon production was discontinued at SGH, however, with the last egg take in 1994, and removed from the SGH permit by approved PAR in 1999.

The Phase III plan also recommended five biological and economic criteria for hatchery programs in PWS. Two recommendations—that growth rates of juvenile salmon during the early marine period be density independent over the long term, and that abundance of juvenile salmon predators be independent of juvenile salmon abundance over the long term—are not addressed here because these parameters would likely be effected by more than one hatchery.

These issues may be addressed in future enhancement evaluations that address issues on a regional scale. Two recommendations—that straying remain below 2% of the wild-stock escapement over the long term and that wild stock escapement goals must be achieved over the long term—can be assigned to an individual hatchery and are addressed in this document.

Straying has been monitored sporadically in PWS since at least the mid-1990s (Sharr et al. 1996). Recent sampling from 2008 to 2010 (Brenner et al. 2012) in eight streams in the Eastern District showed an average of 2% or less hatchery fish in three streams, between 3% and 10% in two streams, and between 11% and 15% in two streams. The eighth stream, Siwash Creek, averaged over 90% hatchery fish in the samples, which is not necessarily unexpected as this stream is near the hatchery and a natal broodstock for the hatchery.

The RPT recognized in the Phase III plan that the 2% threshold of hatchery straying was not well supported by research, and that more data was needed to improve understanding of interbreeding of hatchery and wild salmon. In 2012, ADF&G awarded the Prince William Sound Science Center a contract for a four year study entitled "Interactions of Wild and Hatchery Pink and Chum Salmon in Prince William Sound and Southeast Alaska" (ADF&G 2013). For Prince William Sound, the project will study the extent and annual variability in straying of pink and chum salmon, and the effects, if any, on productivity of wild pink salmon stocks due to straying of hatchery salmon. These studies will improve our understanding of hatchery and wild stock interactions and provide Alaska-specific scientific guidance for Alaska's hatchery program.

The fifth recommendation of the Phase III plan was that the long-term average cost of hatchery operation, management, and evaluation must remain 50% of the value of hatchery production, and that the RPT will determine how to calculate costs and values of the hatchery program and establish more definitive decision criteria regarding economic benefits. The RPT has not defined these values and costs to date.

Finally, the revised charter for the RPT under the Phase III Plan states that the RPT will update the Comprehensive Salmon Plan at least once a year, and will provide an updated plan to the commissioner each year. Annual reports have not occurred since issuance of the Phase III Plan.

CONSISTENCY WITH POLICY

The policies governing Alaska hatcheries were divided into three categories for this review: genetics, fish health, and fisheries management. The key elements of the policies in each of those categories are summarized in Tables 1 through 3. These templates identifying the key elements of state policies were used to assess compliance of the SGH salmon program with each policy element in Tables 4 through 6.

Table 1.–Key elements of the ADF&G *Genetic Policy*.

I. Stock Transport	
Use of appropriate local stocks	This element addresses Section I of the *Genetic Policy*, covering stock transports. The policy prohibits interstate or inter-regional stock transports, and uses transport distance and appropriate phenotypic characteristics as criteria for judging the acceptability of donor stocks.
II. Protection of wild stocks	
Identification of significant or unique wild stocks	Significant or unique wild stocks must be identified for each region and species as stocks most important to that region. A regional planning group such as the Regional Planning Team should establish criteria for determining significant stocks and recommend such stock designations.
Interaction with or impact on significant wild stocks	Priority is given to protection of significant wild stocks from harmful interactions with introduced stocks. Stocks cannot be introduced to sites where they may impact significant or unique wild stocks.
Use of indigenous stocks in watersheds with significant wild stocks	A watershed with a significant wild stock can only be stocked with progeny from the indigenous stocks. The policy also specifies that no more than one generation of separation from the donor system to stocking of the progeny will be allowed.
Establishment of wild stock sanctuaries	Wild stock sanctuaries should be established on a regional and species basis. No enhancement activities would be allowed, but gamete removal would be permitted. The guidelines and justifications describe the proposed sanctuaries as gene banks of wild type variability.
Straying Impacts	Prevention of detrimental effects of gene flow from hatchery fish straying and interbreeding with wild fish.
III. Maintenance of genetic variance	
Maximum of three hatchery stocks from a single donor stock	A maximum of three hatchery stocks can be derived from a single donor stock. Offsite releases, such as for terminal harvest, should not be restricted by this policy if the release sites are selected so that they do not impact significant wild stocks, wild stock sanctuaries, or other hatchery stocks.
Minimum effective population size	The policy recommends a minimum effective population size of 400. It also recognizes that small population sizes may be unavoidable with Chinook and steelhead.
Use of all segments of donor stock run timing	To ensure all segments of the run have the opportunity to spawn, sliding egg-take scales for donor stock transplants will not allocate more than 90% of any segment of the run for broodstock.
Genetics review of Fishery Transport Permits (5 AAC 41.010 – 41.050)	
Review by geneticist	Each application is reviewed by the geneticist, who then makes a recommendation to either approve or deny the application. The geneticist may also add terms or conditions to the permit to protect wild or enhanced stocks.

Table 2.–Key elements of Alaska policies and regulations pertaining to fish health and disease.

Fish Health and Disease Policy (5 AAC 41.080; amended by Meyers (2010))	
Egg disinfection	Within 48 hours of taking and fertilizing live fish eggs or transporting live fish eggs between watersheds, all eggs must be treated with an iodine solution. This requirement may be waived for large scale pink and chum salmon facilities where such disinfection is not effective or practical.
Hatchery inspections	According to AS 16.10.460, inspection of the hatchery facility by department inspectors shall be permitted by the permit holder at any time the hatchery is operating.
Disease reporting	The occurrence of fish diseases or pathogens listed in 5AAC 41.080(d) must be immediately reported to the ADF&G Fish Pathology Section.
Pathology requirements for Fishery Transport Permits (FTPs) (5 AAC 41.010 – 41.050)	
Disease history	Applications for FTPs require either a complete disease history of the stock or a broodstock inspection and certification if the disease history is not available.
Isolation measures	Applications must list the isolation measures to be used during transport, including a description of containers, water source, depuration measures, and plans for disinfection.
Pathology review of FTPs	Each application is reviewed by the pathologist, who then makes a recommendation to either approve or deny it. The pathologist may also add terms or conditions to the permit to protect fish health. Transports of fish between regions are discouraged.

Table 3.–Key elements of Alaska fisheries management policies and regulations relevant to salmon hatcheries and enhancement.

Sustainable Salmon Fishery Policy (5 AAC 39.222)	
I. Management principles and criteria	
Assessment of wild stock interaction and impacts	As a management principle, the effect of enhanced stocks on wild stocks should be assessed. Wild stocks should be protected from adverse impacts from enhanced stocks.
Use of precautionary approach	Managers should use a conservative approach, taking into account any inherent uncertainty and risks.
Salmon Escapement Goal Policy (5 AAC 39.223)	
Establishment of escapement goals	Management of fisheries is based on scientifically-based escapement goals that result in sustainable harvests.
Mixed Stock Salmon Fishery Policy (5 AAC 39.220)	
Wild stock conservation priority	The conservation of wild stocks consistent with sustained yield is the highest priority in management of mixed-stock fisheries.
Fisheries management review of FTPs (5 AAC 41.010 – 41.050)	
Review by management staff	All proposed FTPs are reviewed by the regional supervisors for the Divisions of Commercial Fisheries and Sport Fish, the deputy director of Commercial Fisheries, and the local Regional Resource Development Biologist before consideration the commissioner of ADF&G. Department staff may recommend approval or denial of the permit, and recommend permit conditions.

Genetics

Wild donor stocks of pink, coho, and chum salmon for SGH were taken from systems near the hatchery (Table 4). Chinook salmon released near the hatchery were from Deshka River and Willow Creek stocks from Cook Inlet. There are no native Chinook salmon stocks of

significance in the Port of Valdez or anywhere in the PWS region, except for the Copper River. Significant stocks or wild stock sanctuaries have not been identified to date by the PWS RPT.

Straying of hatchery fish to wild systems streams in the Eastern District has been documented (Brenner et al. 2012; Joyce and Evans 2000; Sharr et al. 1996; unpublished 1986 VFDA annual report obtained from Sam Rabung, PNP Hatchery Coordinator, ADF&G, Juneau). Sharr et al. (1996) found straying of hatchery stocks to wild systems, wild stocks to other wild systems, and wild stocks to the hatchery. Studies are currently underway to assess genetic effects of hatchery straying in PWS (ADF&G 2013).

Table 4.–The Solomon Gulch Hatchery salmon enhancement program and its consistency with elements of the ADF&G *Genetic Policy*. (See Table 1).

I. Stock Transport	
Use of appropriate local stocks	The pink salmon donor stocks were from Siwash, Vlassoff and Gregorieff Creeks, local streams in Port Valdez and Valdez Arm.
	Coho salmon donor stock was from Corbin Creek, a local stream in Port Valdez.
	Chum salmon donor stock was Crooked Creek, a local stream in Port Valdez.
	Chinook donor stock was from the Deshka River and Willow Creek, both located in Cook Inlet. The state geneticist indicated that since there were no native stocks in the Valdez Arm area, that the stockings were low risk from a genetics perspective.
II. Protection of wild stocks	
Identification of significant or unique wild stocks	Significant or unique stocks were not identified in the comprehensive salmon plans by the RPT.
Interaction with or impact on significant wild stocks	Significant or unique stocks were not identified in the comprehensive salmon plans by the RPT.
Use of indigenous stocks in watersheds with significant wild stocks	Local stocks were used for pink, coho, and chum salmon broodstock.
Establishment of wild stock sanctuaries	No wild stock sanctuaries were identified in the comprehensive salmon plans by the RPT.
Straying Impacts	Streams near SGH were sampled for hatchery straying (e.g., Brenner et al. 2012). Current studies are underway to assess impacts (ADF&G 2013).
III. Maintenance of genetic variance	
Maximum of three hatchery stocks from a single donor stock	The stocks used at SGH are not used elsewhere.
Minimum effective population size of 400	Over 222,000 pink salmon broodstock and 679 coho salmon broodstock were used for the 2011 egg takes according to the 2011 Annual Report submitted by VFDA.
Use of no more than 90% of any run segment of donor stock so all segments of donor stock run can spawn	Escapement goals and guideline removal schedules established by ADF&G in the AMPs of the early years of the hatchery guided the initial wild pink, coho, and chum salmon broodstock takes for SGH.
Genetics review of FTPs (5 AAC 41.010 – 41.050)	
Review by geneticist	The geneticist approved the pink, coho, chum and Chinook salmon FTPs without comment.

Fish health and disease

SGH has had few health issues (Table 5, Appendix I). During the initial start-up of the hatchery, there was some excessive mortality possibly associated with heavy siltation from glacial water or heavy metals. However, filtration cannot effectively be done due to the volume of water needed for incubation. VFDA tried UV filtration upon start up but it was determined that this was not practical and was discontinued in 1991 or 1992. (Mike Wells, Executive Director, VFDA, personal communication).

The hatchery reported a few serious outbreaks of bacterial kidney disease (BKD) over its history and has continually upgraded their operation to maintain fish health. Personnel have been periodically sent to fish health and disease workshops to enhance job skills.

Table 5.–The Solomon Gulch Hatchery salmon enhancement program and its consistency with elements of the Alaska policies on fish health and disease. (See Table 2).

Fish Health and Disease Policy (5AAC 41.080; amended by Meyers 2010)	
Egg disinfection	Due to the large volume of eggs, pink salmon eggs are not disinfected, which is allowed under Alaska regulation (5 AAC 41.080 (b)) in large pink and chum salmon facilities where disease has not been a problem in returning stocks of fish. Coho salmon eggs are disinfected with iodophor.
Hatchery inspections	Hatchery inspections were conducted regularly from 1980 through 2008 (Appendix I).
Disease reporting	ADF&G sent notice for SGH to report hatchery pathogens or diseases to ADF&G in 1983 and requested SGH provide descriptions of substantial moralities in pink salmon eggs in 1984, which they did. Disease reporting was timely after 1984.
Pathology requirements for FTPs (5AAC 41.010)	
Disease history	Tissue and fluid samples from donor stocks were sent to the ADF&G pathologist for analysis when requested.
Isolation measures	Described as required in FTPs and approved.
Pathology review of FTPs	All FTPs for SGH programs were reviewed by the pathologist.

Fisheries management

Commercial Fishery

SGH is located in the Eastern District commercial salmon fishing district of PWS (Figure 4). SGH fish pink salmon donor stocks were selected due to their return timing, which is earlier than most of the wild salmon stocks in the area. SGH returns are managed according to 5 AAC 24.366, The Solomon Gulch Salmon Hatchery Management Plan. The regulation allows ADF&G to manage the waters of Valdez Arm north of Rocky Point (Figure 3) for SGH's broodstock and cost-recovery requirements through early July, after which management is for wild pink and chum salmon stocks returning to the district.

The waters at the head of Port Valdez (Figure 3) normally remain closed to commercial fishing during August and September for protection of wild coho and pink salmon. When harvestable surpluses exist, commercial fishery openings may occur. All SGH pink and coho salmon are otolith thermal-marked. Otoliths are sampled from the commercial pink salmon harvest during the season to assess hatchery and wild stock contributions.

Returns of hatchery pink salmon to PWS dominate the harvest, generally comprising 75% or more of the total pink salmon harvest in the Eastern District (Appendix J). As hatchery returns increased to SGH, fishery managers, hatchery managers, and the fishing industry faced challenges to manage for wild stocks, particularly when hatchery returns began significantly exceeding wild stock returns. The 2005, 2007 and 2008 seasons illustrate the accomplishments and challenges fishery managers and the fishing industry faced in meeting escapement goals and harvesting hatchery salmon in marketable condition.

In 2005, PWS saw the highest pink salmon harvest on record at the time of 60 million fish. Processing capacity could not keep up with supply. When flesh quality was no longer marketable, ADF&G authorized the harvest of pink salmon for salmon roe only, in part to prevent a significant number of hatchery salmon from straying into nearby pink salmon streams (Hollowell et al. 2007). When roe quality was no longer marketable, many pink salmon were not harvested at all, with large numbers of rotting carcasses near Valdez, and an unknown portion straying to area streams. Pink salmon escapement to wild systems exceeded the upper goal in the Eastern District, with escapement within the goal range for chum salmon (Appendix J). Hatchery contribution to the commercial fishery in the Eastern District was about 65% (Hollowell et al. 2007).

Another PWS record harvest of 63.5 million pink salmon was set in 2007. Unlike 2005, a combination of regular fishing and expanded markets for all qualities of salmon resulted in no roe stripping in 2007. According to Lewis et al. (2008), the strategy in the Eastern District was to "keep-up with run entry to prevent a build-up of fish that could deteriorate in quality." Escapement goals for both pink and chum salmon were within the escapement goal range, but the take of 50,000 wild stock pink salmon during SGH cost-recovery operations in 2007 (Lewis et al. 2008) that followed the take of 100,000 wild stock pink salmon in 2006 (Botz et al. 2008) was noted by fishery managers. VFDA began daily sampling to monitor the wild stock component of the cost recovery, and ADF&G and VFDA continue to work together to limit wild stock harvest during the cost-recovery harvest.

In 2008, the PWS pink salmon harvest was about 42 million fish, which was an average harvest for the previous decade. The hatchery component of VFDA and Prince William Sound Aquaculture Corporation (PWSAC)-origin fish comprised 99% of the total commercial harvest in the Eastern District (Appendix J). Managers tried to provide a regular harvest schedule at various locations in PWS so the fishing fleet and processing industry could keep up with the harvest volume when the fish harvested were still in marketable condition. Managers had to balance the economic realities of harvesting and processing a large volume of fish in marketable condition with the biological requirements of the small fraction of the return which were wild stocks. The Eastern District escapement target was not met, reaching only about 45% of the lower goal (Bell et al. 2010).

Coho salmon harvested by the Eastern District commercial fishery are not sampled to estimate the hatchery contribution. VFDA attempts to keep the coho salmon hatchery return on its early

historic run timing to optimize both the sport fishery harvest and the market timing of the commercial harvest (ADF&G 2012).

Sport Fishery

SGH coho and pink salmon returns support some of the largest sport fisheries for these two species in the state. The pink salmon sport harvest is less than 1% of the total return and not likely to be a management concern. The coho salmon sport harvest, however, is substantial, harvesting perhaps half or more of the hatchery return in some years. Although SGH coho salmon are otolith thermal-marked, there is no sampling in the sport harvest to estimate hatchery contribution and harvest rate.

Escapement Goals

Escapement goals have been established for wild pink and chum salmon stocks returning to drainages in the Eastern District for several decades and the goals have changed according to accumulated escapement and biological information (Fair et al. 2012). Over the 29 year period from 1983 to 2011, the lower escapement goal in the Eastern District of PWS was met for pink salmon in 22 years and for chum salmon in 25 years (Appendix J). No formal escapement goals are established for coho salmon stocks in the area.

The harvest of wild pink salmon stocks during cost-recovery operations has been noted (e.g., Botz et al. 2008, Lewis et al. 2008). When compared to the overall hatchery harvest, the wild stock component comprises a small portion of the cost recovery harvest. For example, in 2008, the 76,000 wild fish taken as part of the 4.2 million fish cost-recovery harvest comprised about 2% of the cost-recovery harvest total (Bell et al. 2010). For practical purposes, it could be difficult for fishery managers to detect and measure such a small portion in the harvest during the season. The 76,000 wild fish, however, would comprise 18% of the Eastern District lower escapement goal of 425,000 fish. In years like 2008, when escapement index counts totaled only 194,000 pink salmon in the Eastern District, these fish could have been particularly significant to the escapement.

Wild fish harvested during the cost–recovery harvest, however, are not necessarily from Eastern District stocks. The SGH stocks return earlier than most other PWS stocks, and therefore it is not known if these early wild fish were Eastern District stocks, or stocks that traveled through Valdez Arm on their migration elsewhere in PWS. The studies in PWS currently underway (ADF&G 2013) may provide information to identify the origin of the wild stocks in VFDA hatchery harvests, and measure any effects the hatchery harvest may have on wild stock escapements.

Table 6.–The Solomon Gulch Hatchery salmon enhancement program and its consistency with elements of Alaska fisheries management policies and regulations (see Table 3).

Sustainable Salmon Fishery Policy (5 AAC 39.222)	
I. Management principles and criteria	
Assessment of wild stock interaction and impacts	During the 1980s, representative numbers of pink, chum, and coho salmon hatchery releases were marked with coded-wire tags and recovered in the harvest through a sampling program. Pink salmon were otolith marked in 1997, and coho salmon in 2000. Pink salmon are sampled in the commercial catch to assess wild and hatchery stock contributions. Pink salmon wild stocks are assessed annually using aerial surveys and have escapement goals established by commercial fishing district. There is no program to assess hatchery and wild stock contributions to the coho salmon sport or commercial fisheries. Coho salmon escapements are sporadically assessed.
Use of precautionary approach	ADF&G manages the common property commercial harvest of pink salmon in Port Valdez based on wild stock returns after early July. From June through early July, management is based on meeting broodstock and cost-recovery needs of SGH. Initial broodstock collected from wild stocks was contingent on first meeting escapement needs as prescribed by ADF&G. SGH samples the cost-recovery harvest daily to monitor the catch of wild and hatchery pink salmon. Wild coho salmon escapements are occasionally monitored, but no formal assessment program has been established.
Salmon Escapement Goal Policy (5 AAC 39.223)	
Establishment of escapement goals	Escapement goals for chum and pink salmon were established prior to hatchery operations and monitored annually. No coho salmon escapement goals are established for Valdez area systems.
Mixed Stock Salmon Fishery Policy (5 AAC 39.220)	
Wild stock conservation priority	The Board of Fisheries established the Solomon Gulch Salmon Hatchery Management Plan (5 AAC 24.366) in 1987. Through this plan, ADF&G and SGH staffs work together to meet wild stock escapement goals for pink salmon systems in the Eastern District and cost-recovery and broodstock goals for SGH. Escapement goals are established for wild pink and chum salmon stocks in the area, and goals are met in most years. There are no escapement goals for wild coho salmon stocks in the Port of Valdez, and escapements are occasionally monitored.
Fisheries management review of FTPs (5 AAC 41.010 – 41.050)	
Review by management staff	FTPs for SGH programs were reviewed and approved by fisheries management staff.

OTHER REQUIREMENTS

ANNUAL REPORTING AND CARCASS LOGS

All hatcheries are required to submit an annual report to ADF&G that summarizes their production and activities for the year (AS 16.10.470). The annual report must include "information pertaining to species; broodstock source; number, age, weight, and length of spawners; number of eggs taken and fry fingerling produced; and the number, age, weight, and length of adult returns attributable to hatchery releases, on a form to be provided by the department." The completed report is due on December 15. Annual reports were received for all years of operation from SGH.

Much of the data reported in the annual reports is based on gross estimates or incomplete data, and use of the data for narrow inferences should be done with caution and follow-up verification with the hatchery operator. A reviewer of a draft of this report noted that fecundity appeared to decline over time, according to the annual report data. According to Ken Morgan, Solomon Gulch Operations manager, fecundity is reported as a *working fecundity*, meaning only the number eggs that go into the incubators are used to estimate fecundity. Fecundity estimates at the early stages of broodstock development are likely more accurate because nearly all eggs, regardless of quality, were fertilized in an effort to achieve egg-take goals. When the hatchery is at full production with surplus broodstock, less attention is paid to removing all eggs in a skein. In addition, some eggs may fall to the floor and be lost, while other eggs are discarded due to poor quality. As opposed to a *working fecundity* used in the hatchery, an assessment of the number of eggs per female would need to be measured from a sample of complete egg skeins from SGH fish and compared to similar data taken from the donor stocks in the same year to get an accurate assessment of any hatchery domestication effects over time.

Hatchery carcass reporting began in 2008, when PNP hatcheries were required to document the disposal of salmon broodstock carcasses (5 AAC 93.350). If hatchery carcasses are not utilized and disposed of, the hatchery must record the number of males and females used each day, and whether eggs were fertilized, unused, or used for roe sales. A maximum of 10% of the total number of females that are not utilized and disposed of can be used for roe sales; the proceeds from any sales in excess of the 10% maximum must be surrendered to ADF&G. Carcass logs were submitted for SGH in 2008. Logs submissions were not necessary from 2009 through 2011 because all carcasses were fully utilized (ADF&G 2010, ADF&G 2011, ADF&G 2012a).

RECOMMENDATIONS

1. Update the Basic Management Plan to reflect changes to the hatchery permit and operations.

2. Assess run timing of the SGH pink salmon return.

Both fishery management and hatchery management have evolved over the course of production at SGH. As returns to the hatchery began providing more broodstock than needed for egg takes, VFDA and ADF&G staff had to plan for the greater number of fish. Male pink salmon return first to the hatchery, followed by an increasing percentage of females. Cost recovery fishing begins in mid-June in the terminal harvest area in the Port of Valdez, and is intended to crop off the predominately male early-returning fish while they are in good quality condition for sale.

Of course, not all hatchery fish are intercepted in the cost recovery fishery, and adults trickle into the staging area waters in front of the hatchery and into the raceways at SGH. VFDA monitors both the number and sex ratio of pink salmon near the hatchery, and communicates these numbers to ADF&G managers. For logistical efficiency, egg takes do not begin until the number of salmon, their maturation, and the sex ratios are adequate to allow the egg take to begin and continue without delay. These efficiencies are important for later hatchery processes, including otolith thermal marking and hatch timing (Ken Morgan, VFDA Operations Manager, personal communication).

As hatchery efficiency has improved, so has the efficiency of cost-recovery vessels harvesting the early returns, and fewer early fish may reach the hatchery than did in the past (Ken Morgan, VFDA Operations Manager, personal communication). As a result, the first day of egg takes has gradually moved to a later date as hatchery managers wait for the right combination of fish numbers, maturity and sex ratio. The beginning date for pink salmon egg takes has shifted from the second to the third week in July at SGH due to hatchery practices, but not necessarily due to a shift in run timing.

The issue of the later egg take timing was first raised in Simpson (1995). Lewis et al. (2008) noted the importance of maintaining the early-timed pink salmon returns in the SGH broodstock. Smoker et al. (1998) recommended that management preserve variability of return timing to conserve genetic fitness of the population.

Wild stock escapements in the Eastern District were achieved in 16 of 22 years since the first consistent returns of 1.5 million or more pink salmon to SGH in 1990 (Appendix J). The early run timing of the SGH stock has been key to successful fisheries management in the Eastern District. With the early run timing, even in years of low wild-stock abundance, managers can allow harvest of hatchery fish over a relatively large area while closing bays that lead to wild streams to protect early returning wild stocks, because managers know the wild stock run timing peaks several weeks after the SGH return. Should a later egg-take timing shift the run timing of the SGH hatchery return such that it significantly overlaps the wild stock return timing, fishing for hatchery returns could be restricted to a much smaller area for wild stock protection.

3. Periodically assess wild coho salmon escapements to the Lowe River and Robe River (Corbin Creek).

The SGH BMP requires that "The contribution hatchery coho make to existing Valdez Arm sport and commercial catches will be determined." A portion of the releases were coded-wire tagged in the early years of the program. The commercial catch was sampled for coded-wire tagged fish to estimate hatchery contribution from 1988 to 1992, 1995 and 1996. These returns were from releases during the initial years of the program (1986–1990 and 1991–1994), and releases since then have approximately doubled (Appendix C).

Roth and Delaney (1989) estimated 38% of the 8,500 coho salmon harvested in the Valdez Arm sport fishery in 1988 were SGH fish, based on a 1988 creel survey. The harvest since then has increased by about 800%, with the 2007–2011 average harvest of about 67,000 fish (Appendix E). Catches of coho salmon in the commercial fishery are highly variable. Since 1995, the catch ranged from about 1,000 fish in 2009 to over 300,000 in 2000 (Appendix E).

The Valdez area sport fishery has among the highest angler effort and sport harvest of coho salmon in the state (ADF&G 2012b). In 1999, the Alaska Board of Fisheries increased bag limits for coho salmon from three per day to six per day in Valdez Arm because the water body is considered a terminal fishing area of SGH (Hochhalter et al. 2011).

Coho salmon within the Robe and Lowe Rivers are protected in regulation. Freshwater areas of these rivers are closed to salmon fishing, except for a stretch of the Robe River in which fly fishing only is permitted, with a bag limit of one coho salmon per day (5 AAC 55.023).

There is currently no sampling of the commercial harvest or the sport harvest for hatchery contribution of coho salmon. The hatchery contribution for the commercial fishery is calculated by subtracting the average annual coho salmon harvest in the decade prior to hatchery releases (1975–1985) from the total annual catch (Jeremy Botz, ADF&G Prince William Sound Commercial Fisheries Manager, personal communication). For the sport fishery, all coho salmon from the PWS marine water sport fishery are counted as hatchery fish (Botz et al. 2012).

The Lowe and Robe River systems are the two largest coho systems in the Port of Valdez, based on historic escapement counts. Escapements to the Lowe and Robe River systems were monitored from 1971–1984, with annual counts in the thousands of fish. The highest escapement count in the Lowe River was 4,516 coho salmon in 1981, with peak counts in the Robe River system of 9,690 fish in 1971 and 8,573 fish in 1982. Coho salmon systems with smaller escapements have been monitored in recent years, but not the Lowe and Robe River systems (Appendix K). The average annual coho salmon sport harvest was about 5,000 fish in Valdez Arm during the decade prior to the first hatchery returns in 1988, and the Lowe and Robe River systems were likely significant contributors to that catch.

Sustainable exploitation rates for wild stocks are necessarily lower than those for hatchery stocks because of the higher egg-to-juvenile survival rates in the hatchery. In Southeast Alaska, exploitation rates and marine survival of wild stocks in systems of comparable size to the Lowe River and Robe River systems have been estimated annually since 1980 (Skannes et al. 2011). Exploitation rates on SGH coho salmon appear about 40% higher than the average rates on the comparable Southeast Alaska wild stocks, yet the marine survival of the SGH coho salmon are generally lower than the Southeast Alaska wild stocks (Appendix L). No marine survival information was found for the Lowe or Robe River stocks.

Periodic assessments of the Lowe and Robe river coho salmon stocks are necessary to assure sustainable escapements of these wild stocks in the presence of the large hatchery returns and significant harvest of coho salmon in the Valdez area fisheries.

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APPENDICES

Appendix A.–History of Solomon Gulch Hatchery Permit and permit alteration requests, 1982–2008.

Date	Description	Permitted Capacity, in millions of green eggs			
		Pink	Coho	Chum	Chinook
06/25/1981	PNP hatchery permit number 15 issued to VFDA. Hatchery permitted for "No more than 69 million total pink, chum and coho salmon combined may be taken for incubation in any one year." Permit did not specify the permitted number in eggs, but in numbers of fish, yet the BMP clearly defined the maximum limit in number of eggs. Stated eventual egg collection goals by species were 50 million pink salmon eggs, 18 million chum salmon eggs, and 1 million coho salmon eggs. Hatchery donor streams included, for pink salmon, Siwash, Gregorioff and Gorge creeks and Indian River; for chum salmon, Crooked Creek; and for coho salmon, Corbin Creek. BMP required initially tagging a statistically significant portion of releases for stock separation at harvest and tagging of adults in the SHA for later monitoring of escapements to determine the extent of wild fish interception in the SHA. Coho salmon tagging was also required to estimate hatchery contribution to the fisheries.	50	1	18	
08/05/1983	PAR approved to add Crooked Creek as an approved donor source of pink salmon for 1983 only. Permitted collection of up to 2 million eggs. The PAR was requested after VFDA harvested 70,000 pink salmon returning to SGH for sale and later determining broodstock needs had not been met.	50	1	18	
06/26/1984	PAR approved to increase pink salmon egg collection limit to 136 million and all pink salmon eggs must come only from hatchery returns. Increase in production was to be implemented incrementally over 4 years for managers to assess and adjust to a gradual increase in returns. A request for rearing Chinook salmon was not approved pending determination of water quality issues with coho and pink salmon mortalities using the same water source that the proposed Chinook salmon would be reared in.	70	1	18	
09/12/1985	PAR approved to increase production of coho salmon from 300,000 to 600,000 green eggs, based on good egg to smolt survival of 1983 and 1984 brood years. It is unclear why this increase was implemented by permit alteration, since the original hatchery permit and BMP appeared to permit up to incubation of up to 1 million eggs. Today, this change to production levels would have been implemented by FTP and AMP. PAR approval required escapement assessment before collecting wild stock eggs from Corbin Creek.	90	1	18	.050

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Date	Description	Permitted Capacity, in millions of green eggs			
		Pink	Coho	Chum	Chinook
10/20/1986	PAR approved for one year only to permit SGH to incubate up to 1 million coho salmon eggs to the eyed-state for transfer to the Esther Lake Hatchery.	110	2	18	.050
05/20/1987	PAR approved to increase permitted coho salmon capacity from 1 million to 2 million eggs. This PAR approval seems to be inconsistent with the 1985 PAR approval. A PAR to increase Chinook salmon production from 50,000 to 300,000 was denied because the ADF&G commissioner wanted to give the Alaska Board of Fisheries the opportunity to re-examine the allocative question of using cost-recovery funds from commercially-caught pink salmon to support a Chinook salmon program aimed at sport fishers. A PAR to increase the SHA was denied. Sport and commercial fisheries managers and the PWS RPT were opposed to expansion of the SHA because of increased wild-stock interception. The ADF&G commissioner indicated any change in the SHA would need to be approved by the Alaska Board of Fisheries.	136	2	18	.050
03/24/1988	PAR approved to permit release of up to 20 million pink salmon fry from a remote release site in Boulder Bay, Prince William Sound. Boulder Bay is about 20 miles by water from SGH. Permit alteration effective for 3 years to evaluate two years of returns before further approval. Commercial fisheries manager initially opposed to expanding pink production at Boulder Bay, but later reached agreement with VFDA after consulting with VFDA staff and developing a plan to tag releases and limit releases to 3 years in order to evaluate managing the return. The permit alteration did not increase permitted pink salmon egg capacity at SGH, which remained at 136 million.	136	2	18	.050
05/24/1988	PAR approved to increase Chinook salmon capacity from 50,000 to 300,000 eggs. When the City of Valdez provided the funding for the increased production, the worries of using pink salmon cost-recovery funds to support the sport fish project were allayed. VFDA requested 1 million eggs, indicating they would send any excess eggs over 300,000 needed for their project to a PWSAC hatchery, but this provision received objection from ADF&G staff because there could be need, then, to manage for additional broodstock to SGH, even though there was not expressed need for the eggs at the PWSAC hatchery.	136	2	18	.300

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Date	Description	Permitted Capacity, in millions of green eggs			
		Pink	Coho	Chum	Chinook
11/15/1988	PAR approved to increase pinks salmon capacity from 136 million to 156 million eggs. The request was due to an excess 20 million pink salmon eggs being taken from females in the brood freshwater system, which could not be harvested by the common property fishery and would therefore have been wasted. The extra 20 million pink salmon eggs would take advantage of the unused chum salmon incubation space at SGH.	156	2	18	.300
07/03/1989	PAR submitted to release SGH chum salmon at Boulder Bay. PAR denied by ADF&G commissioner on 11/14/1990 due to PWS RPT moratorium on new permits and permit alterations in place at the time.	156	2	18	.300
03/15/1990	PAR approved to increase the remote releases at Boulder Bay, PWS, from 20 million to 50 million pink salmon fry. This permit alteration extended the 1988 permit alteration for another 3 years with the same provisions as the 1988 permit alteration. The permit alteration did not increase permitted pink salmon egg capacity at SGH, which remained at 156 million.	156	2	18	.300
04/27/1990	PAR approved to release up to 20,000 coho salmon smolt from Boulder Bay. Returns were intended to provide an easily accessible run of fish for use by the people of nearby Tatitlek. The permit alteration did not increase permitted coho salmon egg capacity at SGH, which remained at 2 million.	156	2	18	.300
06/05/1990	PAR submitted to increase from 18 to 28 million chum salmon eggs. Up to 6 million fry to be released at SGH and any surplus fry released at Boulder Bay. PAR denied by ADF&G commissioner on 11/14/1990 due to PWS RPT moratorium on new permits and permit alterations in place at the time.	156	2	18	.300
07/04/1990	PAR submitted to release 50 million of SGH pink salmon fry at Cabin Bay on Naked Island. Intent was to reduce commercial harvests in Port Valdez and to spread the fleet. Pink salmon permitted egg capacity would remain at 156 million. (PAR later amended and approved on 05/22/1991- see below).	156	2	18	.300

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Date	Description	Permitted Capacity, in millions of green eggs			
		Pink	Coho	Chum	Chinook
05/22/1991	PAR approved to increase permitted pink salmon egg capacity from 156 to 230 million. Conditions of approval included VFDA's development and funding of an ADF&G-approved evaluation program to determine inseason hatchery contributions to the PWS fisheries and to acquire necessary permits and agreements for water quantity required at SGH. The 07/04/1990 PAR to release up to 50 million SGH pink salmon fry at Cabin Bay at Naked Island was amended and approved for release of up to 80 million pink salmon fry to be released at Outside Bay at Naked Island.	230	2	18	.300
06/05/1991	PAR submitted 06/05/1990 (above) amended one year later on 06/05/1991 to move release site from Boulder Bay to Naked Island after PWS RPT expressed concerns about Boulder Bay site. The initial 06/05/1990 PAR was denied by ADF&G commissioner on 11/14/1990 due to PWS RPT moratorium on new permits and permit alterations in place at the time. The author found no further correspondence of approval or denial of the amended 06/05/1990 PAR that was amended 06/05/1991.	230	2	18	.300
03/14/1992	PAR submitted on 08/02/1991 approved to move release site of 05/22/1991 approved PAR to move the release site on Naked Island from Outside Bay to Cabin Bay because of inadequate freshwater for imprinting at Outside Bay.	230	2	18	.300
06/10/1993	PAR submitted on 01/13/1993 to release 9 million chum salmon fry at Cabin Bay on Naked Island was denied until a formal agreement between ADF&G and VFDA was reached regarding an evaluation program and how it will be funded.	230	2	18	.300
03/24/1999	PAR submitted on 05/13/1996 to relinquish permitted capacity for chum salmon (18 million green eggs) so that PWSAC could utilize this production at their hatcheries.	230	2	0	.300

Appendix B.–Egg collection numbers and broodstock sources for the Solomon Gulch Hatchery (SGH), 1982–2011.

Year	Salmon Species	Eggs	Stock
1982	Pink	3,900,000	Vlassoff Creek
	Pink	4,500,000	Gregorieff Creek
	Coho	115,000	Corbin Creek (Robe River/Lake)
	Chum	1,900,000	Crooked Creek
1983	Pink	12,900,000	SGH (Siwash Creek)
	Coho	143,000	Corbin Creek (Robe River/Lake)
	Chum	2,100,000	Crooked Creek
1984	Pink	72,700,000	Vlassoff Creek and Gregorieff Creek
	Coho	370,000	Corbin Creek (Robe River/Lake)
	Chum	2,500,000	Crooked Creek
1985	Pink	84,800,000	SGH (Siwash Creek)
	Coho	112,000	SGH
	Chum	2,600,000	Crooked Creek
	Chum	500,000	SGH (Crooked Creek)
1986	Pink	64,100,000	SGH (Vlassoff and Gregorioff)
	Coho	1,300,000	SGH
	Coho	1,400,000	Esther Hatchery
	Chum	2,800,000	Crooked Creek
	Chum	1,300,000	Spring Creek
	Chum	535,000	SGH
1987	Pink	158,900,00	SGH (Siwash Creek)
	Coho	1,600,000	SGH and Corbin Creek (Robe River/Lake)
	Chum	1,700,000	SGH (Crooked Creek)
1988	Pink	154,600,000	SGH
	Coho	1,600,000	SGH
	Chum	1,600,000	SGH
	Chum	1,700,000	Spring Creek
1989	Pink	142,500,000	SGH
	Coho	1,500,000	SGH
	Chum	6,000,000	SGH
1990	Pink	156,500,000	SGH
	Coho	2,800,000	SGH
	Chum	1,100,000	SGH
1991	Pink	199,000,000	SGH
	Coho	2,000,000	SGH
	Chum	3,100,000	SGH
1992	Pink	208,800,000	SGH
	Coho	2,200,000	SGH
	Chum	19,800,000	SGH

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Year	Salmon Species	Eggs	Stock
1993	Pink	231,700,000	SGH
	Coho	2,200,000	SGH
	Chum	7,300,000	SGH
1994	Pink	219,200,000	SGH
	Coho	2,400,000	SGH
	Chum	1,500,000	SGH
1995	Pink	239,900,000	SGH
	Coho	2,800,000	SGH
1996	Pink	208,500,000	SGH
	Coho	2,200,000	SGH
1997	Pink	237,900,000	SGH
	Coho	2,300,000	SGH
1998	Pink	231,900,000	SGH
	Coho	2,200,000	SGH
1999	Pink	238,700,000	SGH
	Coho	2,200,000	SGH
2000	Pink	235,300,000	SGH
	Coho	2,400,000	SGH
2001	Pink	230,000,000	SGH
	Coho	2,400,000	SGH
2002	Pink	236,400,000	SGH
	Coho	2,300,000	SGH
2003	Pink	237,000,000	SGH
	Coho	2,200,000	SGH
2004	Pink	233,800,000	SGH
	Coho	2,100,000	SGH
2005	Pink	239,000,000	SGH
	Coho	2,200,000	SGH
2006	Pink	235,100,000	SGH
	Coho	2,500,000	SGH
2007	Pink	233,000,000	SGH
	Coho	2,300,000	SGH
2008	Pink	230,200,000	SGH
	Coho	2,300,000	SGH
2009	Pink	236,300,000	SGH
	Coho	2,300,000	SGH

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Year	Salmon Species	Eggs	Stock
2010	Pink	236,200,000	SGH
	Coho	2,000,000	SGH
2011	Pink	236,100,000	SGH
	Coho	2,000,000	SGH

Source: Data from annual reports submitted by VFDA (unpublished VFDA Annual Reports, obtained from Sam Rabung, ADF&G PNP Coordinator Juneau).
Note: Numbers rounded.

Appendix C.–Juvenile releases of salmon from SGH, 1982–2012.

Year	Pink Salmon	Coho Salmon	Chum Salmon	Chinook Salmo
1982	7,900,000		400,000	
1983	5,600,000		600,000	
1984	8,400,000		900,000	
1985	51,300,000	94,700	2,100,000	
1986	54,600,000	232,000	2,300,000	
1987	59,700,000	304,000	3,400,000	
1988	130,800,000	822,000	1,600,000	
1989	128,400,000[b]	987,000	2,900,000	
1990	122,200,000[c]	797,000[d]	3,100,000	
1991	131,300,000	994,000[d]	1,600,000	193,000[e]
1992	86,900,000	1,226,000[d]	2,700,000	95,000[e]
1993	141,900,000	462,000	17,700,000	197,000[e]
1994	149,400,000	915,000[d]	6,000,000	
1995	205,400,000	1,325,000[d]	1,400,000	
1996	223,100,000	1,876,000[d]		
1997	188,900,000	1,315,000[d]		
1998	195,200,000	1,748,000[d]		
1999	213,900,000	1,864,000[d]		
2000	195,800,000	1,626,000[d]		
2001	203,900,000	1,519,000[d]		
2002	202,600,000	1,842,000[d]		
2003	206,400,000	1,295,000[d]		
2004	222,500,000	1,442,000[d]		
2005	222,200,000	1,968,000[d]		
2006	216,900,000	1,512,000		
2007	220,400,000	1,974,000		
2008	199,600,000	1,828,000		
2009	226,200,000	1,526,000		
2010	223,100,000	1,915,000[d]		
2011	223,600,000	2,111,000[d]		

Source: Data from annual reports submitted by VFDA (unpublished VFDA Annual Reports, obtained from Sam Rabung, ADF&G PNP Coordinator Juneau).
Note: Fish were released at SGHS unless otherwise noted.
Note: Numbers rounded.
[a] Data from SGH annual reports submitted by VFDA.
[b] 11% of total pink release at Boulder Bay.
[c] 38% of total pink release at Boulder Bay.
[d] Includes about 20,000 coho released at Boulder Bay.
[e] Received Deshka River and Willow Creek stock Chinook from PWSAC in March 1990 as fingerlings and released to 6.5 Mile Creek as smolt.

Appendix D.–Total return of SGH salmon, including commercial and sport harvest, harvest for sale by the hatchery, broodstock, and escapement to adjoining stream.

Year	Pink Salmon	Coho Salmon	Chum Salmon
1983	95,000		
1984	222,000		
1985	566,000	34	450
1986	1,240,000	4,000	6,000
1987	5,745,000	14,000	6,000
1988	1,127,000	16,000	9,000
1989	3,439,000	108,000	35,000
1990	11,019,000	85,000	48,000
1991	6,121,000	55,000	14,000
1992	2,100,000	45,000	25,000
1993	1,732,000	4,000	72,000
1994	13,354,000	44,000	6,000
1995	6,827,000	142,000	28,000
1996	7,476,000	148,000	442,000
1997	7,256,000	96,000	271,000
1998	4,760,000	98,000	32,000
1999	14,924,000	132,000	1,000
2000	12,351,000	473,000	
2001	16,127,000	313,000	
2002	5,265,000	99,000	
2003	17,375,000	203,000	
2004	11,100,000	144,000	
2005	18,100,000	242,000	
2006	9,100,000	295,000	
2007	23,908,000	143,000	
2008	14,854,000	268,000	
2009	1,292,000	83,000	
2010	18,377,000	92,000	
2011	13,357,000	140,000	

Source: Data from annual reports submitted by VFDA (unpublished VFDA Annual Reports, obtained from Sam Rabung, ADF&G PNP Coordinator Juneau).
Note: Numbers rounded.

Appendix E.– Estimated common property commercial and sport harvest portions of the total VFDA salmon return listed in Appendix D.

Year[a]	Pink Salmon		Coho Salmon		Chum Salmon	
	Sport	Commercial	Sport	Commercial	Sport	Commercial
1987	125,000	4,250,000	2,000	4,000		3,000
1988	20,0000	350,000	4,000	4,000		7,000
1989	20,000	2,500,000	20,000	14,000		25,000
1990	50,000	8,600,000	25,000	44,000		46,000
1991	33,000[b]	2,540,000	10,000	4,000	50	8,000
1992	27,000	465,000	11,000	5,000	200	64,000
1993	29,000	500	500	100	200	
1994	60,000	9,640,000	10,000		200	
1995	60,000	3,790,000	25,000	78,000	200	11,000
1996	100,000	4,830,000	25,000	87,000	1,000	340,000
1997	100,000	4,000,000	25,000	48,000	1,000	255,000
1998	100,000	1,220,000	52,000[c]	24,000		
1999	150,000	9,470,000	50,000	67,000		
2000	125,000	7,600,000	104,000[d]	342,000		
2001	125,000	11,460,000	139,000[e]	147,000		
2002	24,000	391,000	44,000	25,000		
2003	30,000	11,870,000	119,000	63,000		
2004	0	7,260,000	105,000	24,000		
2005	25,000	13,710,000	66,000	130,000		
2006	25,000	4,840,000	66,000	210,000		
2007	28,000	19,600,000	71,000	51,000		
2008	30,000	10,240,000	85,000	158,000		
2009	30,000	59,000	60,000	1,000		
2010	30,000	16,100,000	60,000	5,000		
2011	30,000	11,000,000	60,000	32,000		

Source: Data from annual reports submitted by VFDA (unpublished VFDA Annual Reports, obtained from Sam Rabung, ADF&G PNP Coordinator Juneau).
Note: Numbers rounded.
Note: Commercial harvest does not include cost-recovery harvest by VFDA.
[a] No sport or commercial data figures were available from the annual reports until 1987.
[b] Includes 758 subsistence-caught fish.
[c] Includes 1,627 subsistence-caught fish.
[d] Includes 3,800 subsistence-caught fish.
[e] Includes 3,854 subsistence-caught fish.

Appendix F.–Sport fish harvest in Valdez Arm, 1977–2009.

Year	Angler Days Fished	Coho Salmon	Pink Salmon
1977 [a]	19,423	5,277	12,020
1978 [a]	12,687	3,582	7,910
1979 [a]	19,068	6,402	13,217
1980 [a]	18,707	5,545	11,606
1981 [a]	18,716	4,018	11,686
1982 [a]	13,904	4,014	6,634
1983 [a]	15,764	4,710	8,696
1984 [a]	18,620	5,138	9,639
1985 [a]	33,174	5,848	15,223
1986 [a]	19,449	5,749	12,858
1987 [b]	45,745	8,739	25,955
1988 [c]	51,096	10,241	26,776
1989 [c]	48,471	18,134	32,789
1990 [c]	71,230	18,630	46,730
1991 [c]	67,891	10,393 [d]	48,609
1992 [c]	59,450	17,580	28,587
1993 [c]	52,546	12,841	32,478
1994 [c]	54,854	18,633	46,426
1995 [c]	74,681	37,265	41,963
1996 [c]	49,051	42,822	27,965
1997 [c]	46,358	36,311	22,121
1998 [c]	45,617	37,088	31,933
1999 [c]	58,030	36,125	29,407
2000 [e]	70,105	67,563	31,885
2001 [e]	38,769	43,786	23,564
2002 [e]	15,019	6,568 [f]	16,730
2003 [e]	52,595	70,041	25,520
2004 [e]	51,608	49,680	23,019
2005 [g]	48,607	57,944	30,880
2006 [g]	51,436	52,505	16,361
2007 [g]	55,178	59,605	26,238
2008 [g]	46,455	48,451	17,866
2009 [g]	44,005	35,461	16,374
2010 [h]	50,722	62,631	16,170

[a] Data from area fished = Valdez Bay from Mills (1979–1981a, 1981b, 1982–1986).

[b] Data from sum of areas fished = Boat-Valdez Bay + Shoreline-Valdez Bay from Mills (1987).

[c] Angler days fished, pink salmon catch, and 1997–1990 coho catch data from sum of areas fished = Boat-Valdez Bay + Shoreline-Valdez Bay + Shoreline-Valdez from Mills (1988–1994). Howe et al. (1995, 1996, 2001a, 2001b, 2001c, 2001d).

[d] Coho catch data from 1991 to 2010 from Hochhalter et al. (2011).

[e] Angler days fished and pink salmon catch data from sum of areas fished = Boat-Valdez Arm + Shoreline-Valdez Road System+ Shoreline-Remainder of Valdez Arm from Walker et al. (2003), Jennings et al. (2004, 2006a, 2006b, 2007).

[f] The sport fish harvest survey changed slightly in 2002 (Gretchen Jennings, Program Coordinator, Division of Sport Fish, ADF&G, personal communication) and the catch normally attributed to Valdez Arm may have been attributed to another unknown location in the area. The catch in Valdez Arm in 2002 were likely on par with the sport catch in 1997 and 1998, which showed similar estimated total returns reported in the SGH annual reports.

[g] Angler days fished and pink salmon catch data from sum of areas fished = Boat-Valdez Arm + Shoreline-Valdez road system+ Shoreline-Allison Point+ Shoreline-Remainder of Valdez Arm from Jennings et al. (2009a, 2009b, 2010a, 2010b, 2011a).

[h] Angler days fished and pink salmon catch data from sum of areas fished = Valdez Arm-Trip to Valdez-Boat + Allison Point-Shoreline + Remainder of Valdez Arm-Shoreline, (Jennings et al. 2011b).

Appendix G.–Summary of fish transport permits for Solomon Gulch Hatchery.

FTP Number	Issued	Expiration	Summary and reviewer comments.
80-77	1980	1983	Collect up to 2 million eggs from Crooked Creek pink salmon in Port Valdez, incubate eggs at SGH for release at SGH.
80-78	1980	1980	Collect up to 400,000 eggs from Crooked Creek chum salmon in Port Valdez, incubate eggs at Crooked Creek Incubation facility, and release at SGH.
81-3	1981	1981	Collect and incubate up to 10 million eggs from Siwash pink salmon for release at SGH.
81-249	1981	1981	Collect and incubate up to 500,000 eggs from Crooked Creek chum salmon for release at SGH.
82-9	1982	1982	Collect and incubate up to 6 million eggs from Crooked Creek chum salmon for release at SGH.
82A-0010	1982	1982	Collect and incubate up to 100,000 eggs from Crooked Creek chum salmon at SGH for release to Crooked Creek for aquaculture studies by Valdez High School and Prince William Sound Community College students.
82A-0013	1982	1982	Collect and incubate up to 10 million eggs from Vlasoff Creek pink salmon for release at SGH.
82A-0014	1982	1982	Collect and incubate up to 100,000 eggs from Corbin Creek coho salmon for release at SGH.
82A-0015	1982	1982	Collect and incubate up to 10 million eggs from Gregorieff Creek pink salmon for release at SGH.
82A-0029	1982	1982	Collect and incubate up to 10 million eggs from Naomoff Creek pink salmon for release at SGH.
82A-1041	1982	1988	Collect and incubate up to 50 million eggs from Siwash Creek stock pink salmon returning to SGH. This is the odd-year return to the hatchery.
82A-1042	1982	1983	Collect and incubate up to 300,000 eggs from Corbin Creek coho salmon for release at SGH.
82A-1043	1982	1983	Collect and incubate up to 6 million eggs from Crooked Creek chum salmon for release at SGH.
83A-1051	1983	2021	Collect and incubate up to 50 million pink salmon eggs at SGH (Vlassoff and Gregorieff creeks broodstock) for release at SGH and no expiration date (expiration read “perpetutal). FTP renewed in 1997, increased egg take to 230 million, and expiration date of 2006. FTP renewed again in 2006 and 2011. This is the even-year stock return to the hatchery.
83A-1052	1983	1984	Collect and incubate up to 6 million eggs from Crooked Creek chum salmon for release at SGH.
83A-1053	1983	1984	Collect and incubate up to a cumulative of 300,000 eggs from Corbin Creek and SGH coho salmon for release at SGH.

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84A-1040	1984	1996	Collect and incubate up to 300,000 coho salmon eggs from Corbin Creek broodstock for release at SGH. FTP renewed in 1985, and egg take increased to 600,000. FTP renewed in 1986, with egg take increased to 1 million and expiration date of 1996.
84A-1041	1984	2021	Collect and incubate up to 92 million pink salmon eggs from Siwash Creek broodstock for release at SGH. FTP amended in 1986 to extend FTP until 1996 and increase maximum egg take to 110 million. FTP amended in 1992 to increase maximum egg take from 110 to 230 million. FTP extension amendments in 1997, 2006 and 2011. This is the odd-year return to the hatchery.
84A-1042	1984	1996	Collect and incubate up to 6 million eggs from Crooked Creek chum salmon for release at SGH. Amended in 1986 to extend expiration date until 1996.
85A-1048	1985	1985	Collect and incubate up to 2 million eggs from Spring Creek chum salmon for release at SGH.
86A-1006	1986	2000	Collect and incubate up to a cumulative of 18 million eggs from SGH, Crooked Creek and Spring Creek chum salmon for release at SGH.
86A-1007	1986	2020	Collect and incubate up to 2 million Corbin Creek stock coho salmon eggs at SGH for release at SGH and up to 20,000 at Tatitlek Creek in Boulder Bay. FTP amended in 1992, and renewed in 1997, 2006, and 2010.
86A-1021	1986	1996	Collect and incubate up to 6 million eggs from Spring Creek chum salmon for release at SGH.
86A-1054	1986	1987	Collect and incubate up to 50,000 eggs from Willow Creek stock Chinook salmon for release at Anderson Bay in Port Valdez.
88A-1018	1988	1988	Release 20 million pink salmon juveniles from SGH in Bolder Bay. Amended in 1989 to extend until 1989. Amended in 1990 to extend until 1990 and increase release to 50 million. Amended in 1991 to extend until 1991. Amended in 1992 to extend until 1996. Release numbers part of permitted capacity at the time, and not an increase in hatchery capacity.
90A-0017	1990	2015	Transport of up to 20,000 coho salmon smolt from SGH (Corbin Creek stock) to Tatitlek Creek. FTP renewed in 1991, 1997, 2006 and 2010.
90A-0009	1990	2000	Transport 1 million chum salmon fry from SGH for release to Chalmers River. Eggs incubated at Wally Noerenberg Hatchery (WNH) and moved to SGH at the eyed stage.
91A-0159	1991	2001	Transport up to 200,000 Chinook salmon smolts from WNH for release at 6.5 mile creek near SGH.
12A-0123	2012	2017	Allow egg take up to 1.5 million eggs from Corbin Creek coho salmon when hatchery returns do not provide enough eggs. Minimum escapement to Corbin Creek must be met before broodstock may be collected.

Appendix H.–Comparison of permitted and reported egg takes and releases in hatchery permit, basic management plan, annual management plan, fish transport permits, and annual reports for the Solomon Gulch Hatchery salmon projects, 1982–2012.

Year	Species	Basic Management Plan Eggs (millions)	Annual Management Plan Eggs (millions)	Fish Transport Permit			Annual Report Eggs (millions)[a]
				FTP No	Eggs (millions)	Expires	
1981	Pink	Not completed until 1982	10.0	81-3	10	1981	Not available
	Chum		0.500	81-249	0.500	1981	Not available
1982	Pink	50	10.0	82A-0013	10	1982	8.4
				82A-0015	10		
				82-A-0029	10		
	Coho	1	0.100	82A-0014	0.100	1982	0.115
	Chum	18	6.0	82-9	6	1982	1.9
1983	Pink	50	50.0	82A-1041	50	1988	12.9
	Coho	1	0.300	82A-1042	0.300	1983	0.143
	Chum	18	6.0	82A-1043	6	1983	2.1
1984	Pink	70	70.0	83A-1051	50	“perpetual”	66.7
	Coho	1	0.300	83A-1053	0.300	1984	0.300
	Chum	18	6.0	83A-1052	6	1984	2.7
1985	Pink	90	92.0	82A-1041	50	1988	96.9
				84A-1041	92	1985	
	Coho	1	0.300	84A-1040[b]	0.600	1996	0.070
	Chum	18	6.0	84A-1042	6	1985	3.1
				85A-1048	2	1985	
1986	Pink	110	110.0	83A-1051	50	“perpetual”	64.1
	Coho	2	1.0	84A-1040[c]	1	1996	2.8
				86A-1007	1	2000	
	Chum	18	6.0	84A-1042	6	1996	4.1
				86A-1021	6	1996	

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Year	Species	Basic Management Plan Eggs (millions)	Annual Management Plan Eggs (millions)	Fish Transport Permit			Annual Report Eggs (millions)
				FTP No	Eggs (millions)	Expires	
1987	Pink	136	136	82A-1041	50	1988	164.0
				84A-1041[d]	110	1996	
	Coho	2	1.0	84A-1040	1	1996	1.6
				86A-1007	1	2000	
	Chum	18	6.0	84A-1042	6	1996	1.6
				86A-1021	6	1996	
	Chinook			86A-1054	0.050	1987	
1988	Pink	136	136	83A-1051	50	"perpetual"	155.0
				88A-1018[e]	20	1988	
	Coho	2	2	84A-1040	1	1996	1.6
				86A-1007	1	2000	
	Chum	18	18	84A-1042	6	1996	3.3
				86A-1021	6	1996	
	Chinook		0.300				
1989	Pink	156	156	84A-1041	110	1996	142.8
				88A-1018	20	1989	
	Coho	2	2	84A-1040	1	1996	1.5
				86A-1007	1	2000	
	Chum	18	18	84A-1042	6	1996	6.0
				86A-1021	6	1996	
	Chinook		0.300				
1990	Pink	156	156	83A-1051	50	"perpetual"	159.4
				88A-1018[f]	50	1990	
	Coho	2	1.5	84A-1040	1	1996	2.2
				86A-1007	1	2000	
				90A-0017[g]	0.020	2000	
	Chum	18	18	84A-1042	6	1996	1.1
				86A-1021	6	1996	
	Chinook		0.300				

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Year	Species	Basic Management Plan Eggs (millions)	Annual Management Plan Eggs (millions)	Fish Transport Permit			Annual Report Eggs (millions)
				FTP No	Eggs (millions)	Expires	
1991	Pink	230	230	84A-1041	110	1996	203.0
				88A-1018	50	1991	
	Coho	2	2	84A-1040	1	1996	2.0
				86A-1007	1	2000	
				90A-0017	0.020	2000	
	Chum	18	18	84A-1042	6	1996	3.1
				86A-1021	6	1996	
	Chinook			91A-0159 [h]	0.200	2001	
1992	Pink	230	230	83A-1051	50	"perpetual"	208.8
				88A-1018	50	1996	
	Coho	2	2	84A-1040	1	1996	2.2
				86A-1007 [i]	2	2000	
				90A-0017	0.020	2000	
	Chum	18	18	84A-1042	6	1996	19.8
				86A-1021	6	1996	
1993	Pink	230	210	84A-1041 [j]	230	1996	231.7
				88A-1018	50	1996	
	Coho	2	2	84A-1040	1	1996	2.0
				86A-1007	2	2000	
				90A-0017	0.020	2000	
	Chum	18	18	84A-1042	6	1996	3.1
				86A-1021	6	1996	
1994	Pink	230	230	83A-1051	50	"perpetual"	219.2
				88A-1018	50	1996	
	Coho	2	2	84A-1040	1	1996	2.3
				86A-1007	2	2000	
				90A-0017	0.020	2000	
	Chum	18	18	84A-1042	6	1996	1.5
				86A-1021	6	1996	
1995	Pink	230	230	84A-1041	230	1996	239.9
				88A-1018	50	1996	
	Coho	2	2	84A-1040	1	1996	2.8
				86A-1007	2	2000	
				90A-0017	0.020	2000	

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Year	Species	Basic Management Plan Eggs (millions)	Annual Management Plan Eggs (millions)	Fish Transport Permit			Annual Report Eggs (millions)
				FTP No	Eggs (millions)	Expires	
1996	Pink	230	230	83A-1051	50	"perpetual"	208.5
				88A-1018	50	1996	
	Coho	2	2	84A-1040	1	1996	2.2
				86A-1007	2	2000	
				90A-0017	0.020	2000	
1997	Pink	230	230	84A-1041[k]	230	2006	237.9
	Coho	2	2	86A-1007	2	2000	2.3
				90A-0017 [l]	0.020	2006	
1998	Pink	230	230	83A-1051[m]	230	2006	231.9
	Coho	2	2	86A-1007	2	2000	2.2
				90A-0017	0.020	2006	
1999	Pink	230	230	84A-1041	230	2006	238.7
	Coho	2	2	86A-1007	2	2000	2.2
				90A-0017	0.020	2006	
2000	Pink	230	230	83A-1051	230	2006	235.3
	Coho	2	2	86A-1007 [n]	2	2005	2.4
				90A-0017	0.020	2006	
2001	Pink	230	230	84A-1041	230	2006	230.0
	Coho	2	2	86A-1007	2	2005	2.4
				90A-0017	0.020	2006	
2002	Pink	230	230	83A-1051	230	2006	236.4
	Coho	2	2	86A-1007	2	2005	2.3
				90A-0017	0.020	2006	
2003	Pink	230	230	84A-1041	230	2006	237.0
	Coho	2	2	86A-1007	2	2005	2.2
				90A-0017	0.020	2006	
2004	Pink	230	230	83A-1051	230	2006	233.8
	Coho	2	2	86A-1007	2	2005	2.1
				90A-0017	0.020	2006	
2005	Pink	230	230	84A-1041	230	2006	239.0
	Coho	2	2	86A-1007	2	2010	2.2
				90A-0017	0.020	2006	

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Year	Species	Basic Management Plan Eggs (millions)	Annual Management Plan Eggs (millions)	Fish Transport Permit			Annual Report Eggs (millions)
				FTP No	Eggs (millions)	Expires	
2006	Pink	230	230	83A-1051	230	2011	235.1
	Coho	2	2	86A-1007 [o]	2	2010	2.3
				90A-0017 [o]	0.020	2010	
2007	Pink	230	230	84A-1041	230	2011	233.0
	Coho	2	2	86A-1007	2	2010	2.3
				90A-0017	0.020	2010	
2008	Pink	230	230	83A-1051[p]	230	2011	230.2
	Coho	2	2	86A-1007	2	2010	2.3
				90A-0017	0.020	2010	
2009	Pink	230	230	84A-1041	230	2011	236.3
	Coho	2	2	86A-1007	2	2010	2.3
				90A-0017	0.020	2010	
2010	Pink	230	230	83A-1051	230	2011	236.2
	Coho	2	2	86A-1007 [q]	2	2020	2.0
				90A-0017 [r]	0.020	2015	
2011	Pink	230	230	84A-1041 [s]	230	2021	236.1
	Coho	2	2	86A-1007	2	2020	2.0
				90A-0017	0.020	2015	

[a] In the VFDA Annual Reports (unpublished VFDA Annual Reports, obtained from Sam Rabung, ADF&G PNP Coordinator Juneau), the number of eggs collected is estimated by a sample weight expansion to total weight. Beginning in about 1993, the eggs are enumerated a second time by weight after the dead eggs are removed. The pink salmon egg-take numbers from annual reports that are shown on this table are the greater of the estimate before and after dead eggs are picked.

[b] FTP 84A-1040 amended in 1985 to increase permitted egg take from 300,000 to 600,000.

[c] FTP 84A-1040 amended in 1986 to increase permitted egg take from 600,000 to 1 million.

[d] FTP 84A-1041 amended in 1986 to increase permitted egg take from 92 million to 110 million and extend FTP duration until 1996.

[e] FTP 88A-1018 allowed transport of 20 million juvenile pink salmon from SGH for release at Bolder Bay.

[f] FTP 88A-1018 amended in 1990 to increase release of pink salmon at Bolder Bay from 20 million to 50 million.

[g] FTP 90A-0017 allowed transport of up to 20,000 coho salmon smolt from SGH for release site near Tatitlek.

[h] FTP 91A-0159 allowed transport of up to 200,000 Chinook salmon from Wally Noerenberg Hatchery (WNH) to Six-and-a-half-mile Creek in the Port of Valdez. This FTP was issued to WNH.

[i] FTP 86A-1007 amended in 1992 to increase coho salmon permitted egg take from 1 million to 2 million.

[j] FTP 84A-1041 amended in 1992 to increase pink salmon egg capacity from 110 to 230 million.

[k] FTP 84A-1041 extended in 1996 until 2006.

[l] FTP 90A-0017 extended in 1997 until 2006. k. FTP 90A-0017 extended in 1997 until 2006.

[m] FTP was amended in 1997 to increase egg-take limit from 50 million to 230 million and expire in 2006.

[n] FTP 86A-1007 amended to expire in 2005.

[o] FTPs 86A-1007 and 90A-0017 amended to expire in 2010.

[p] FTP 83A-1051 amended to expire in 2011.

[q] FTP 86A-1007 amended to expire in 2020.

[r] FTP 90A-0017 amended to expire in 2015.

[s] FTP 84A-1041 amended to expire in 2021.

Appendix I.–Pathology Inspection Report summaries for Solomon Gulch Hatchery, 1979–2008.

Year	Event	Observations, Issues and Recommendations
1979	Prerelease inspection of Crooked Creek stock chum salmon.	No pathogens or parasites seen in samples.
1980	Hatchery Inspection (Crooked Creek facility)	Recommendations: 1. Disinfection bath to disinfect equipment. 2. Disinfect dip nets, screens, etc. used to collect fish from incubators or holding tanks prior to introduction into another incubator/holding tank. 3. Laboratory setup for preliminary diagnostic examination of sick fish. 4. Chemicals such as iodophore, formalin, MS222, NaCl, Diquat reagents and chemicals for testing water quality be purchased and kept on hand at the hatchery. 5. Purchase equipment for measuring DO, temp, etc.
1981	Corbin Creek coho salmon broodstock screening.	Due to the absence of BKD, the state pathologist indicated this stock may be used a possible brood source.
1981	Gregorioff Creek pink salmon broodstock screening.	Due to the absence of BKD, the state pathologist indicated this stock may be used a possible brood source.
1981	Indian River pink salmon broodstock screening.	Due to the absence of BKD, the state pathologist indicated this stock may be used a possible brood source.
1981	Vlassoff Creek pink salmon broodstock screening.	Due to the presence of BKD, the state pathologist indicated stock was not recommended a possible brood source.
1982	Hatchery Inspection-prerelease inspection of pink salmon.	Recommended release of fish as planned.
1982	Hatchery Inspection of Crooked Creek facility in preparation for chum egg incubation and transfer to new Solomon Gulch facility.	Recommended disinfecting eggs prior to placement of eggs in Solomon Gulch Hatchery.
1982	Naomatt Creek pink salmon broodstock screening.	Due to the absence of BKD, the state pathologist indicated this stock may be used a possible brood source.

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Year	Event	Observations, Issues and Recommendations
1982	Hatchery inspection of Crooked Creek facility.	Facility orderly and clean. Recommend foot baths at the new facility, and equipment, boots, etc not be used jointly between Crooked Creek and the Solomon Gulch facility. Disinfect eyed eggs before moving into new hatchery. Fish in good health. Release of pink salmon authorized.
1983	Prerelease inspection of Crooked Creek chum salmon.	Fish in good health. Release authorized.
1983	Reporting of pathogens and diseases.	Notice to report hatchery pathogens or diseases to ADF&G Fish Pathology Section.
1983	Prerelease inspection of Vlassoff/Gregorioff Creek pink salmon.	Fish in good health. Release authorized.
1984	Pink salmon mortality.	ADF&G requested detailed description of substantial mortalities of pink salmon eggs. Report from VFDA indicated no specific causative agent of the mortality.
1984	Hatchery inspection.	Pink salmon – heavy silt on eggs. Recommended vacuuming egg surfaces at intervals. Suggested ways to collect or remove silt through settling. Chum salmon eggs showed less siltation. Coho salmon juveniles showed hyperactivity. Suggested heavy metal involvement could be responsible. Hatchery neat and orderly.
1985	Coho salmon prerelease inspection.	Sporocytophaga detected in a head lesion. Authorization given to release fish.
1985	Broodstock screening of Spring Creek chum salmon.	Due to the absence of BKD, the state pathologist indicated this stock may be used a possible brood source.
1986	Hatchery Inspection.	Hatchery in good working order. Mortalities currently being taken to dump or discarded in bay. Recommended disinfecting mortalities in chlorine or buying them in lime pit as they are a potential source of pathogens.
1987	Hatchery Inspection.	Recommended release of pink, coho and chum salmon. Recommended all eggs disinfected in iodophor. Suggested purchasing independent set of net pens for the coho, which could be located some distance from the chum and pink pens. Ideally, different year classes of coho would not be in the same vicinity to avoid spread of disease and cannibalism, although no cannibalism was seen.

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Year	Event	Observations, Issues and Recommendations
1988	Hatchery inspection.	Coho in one of new pens as recommended in 1987. Recommended iodophor disinfection of coho and Chinook eggs in particular because of extended rearing time. Cover exposed formalin in the laboratory and ventilate the area if possible. Use disinfection station for egg maintenance utensils.
1989	Hatchery Inspection.	Formalin fumes now controlled. Hatchery manager attended short course on fish disease and should allow person to recognize many of the things that can go wrong. Fish culture and disease control at SGH appear will organized and applied, and no recommendations at this time.
1990	Hatchery Inspection.	Fish culture very good at SGH, with competent personnel. Recommended disinfecting all eggs from all sources.
1992	Hatchery Inspection.	Fungus issues in pink and coho salmon. Poor water quality in *super incubators*, resulting in gill lamellar pathology in pink salmon fry. Recommendations included decreasing loading of incubators, increasing water flows, cull moribund coho salmon to reduce BKD infection, install footbaths, use separate utensils for each stock and disinfect between tanks/incubators, place mortalities in chlorine solution prior to disposal, reduce feed levels because of excessive fat in examined fish, and reduce capacity where NOPAD incubators filled to about 12 cm with no more than 300,000 eyed eggs per tray and flows at least 14 gallons per minute.
1992	Mortality notice from SGH to ADF&G.	Heavy pink salmon loss (80 million alevins) attributed to 5 water flow disruptions in October, November and December 1991. Plans to upgrade emergency water supply implemented to be completed in October 1992.
1993	Hatchery Inspection.	Saprolegnia observed on pink salmon fry. Poor eyed egg survival and mortality from Trichodina upon ponding of coho salmon. Hatchery clean and well organized. Recommended cleaning organics off incubators to reduce fouling materials, install degassing equipment if supersaturation becomes a problem, replace *super incubators* with NOPAD incubators.
1994	Hatchery Inspection.	Pink salmon post-hatch mortality from siltation, with Saprolegnia on some fry. Control by cleaning and fungus control and transport to net pens as soon as possible. Install seawater line to control fungus, increase water hardness, pH, and flow to incubators, dilute silt and allow early emerging pink fry to be reared in the outside concrete raceway.
1995	Hatchery Inspection.	Boiler being installed for thermal marking. Electroshocking installed for euthanasia of broodstock. Fish health and fish culture practices appear to be good. Hatchery clean and orderly. Recommend eliminate use of wood for dam boards and other structures in contact with fish rearing water, install seawater pump when finances permit for reasons described in 1994 inspection, and dispose of mortality in deep water if fish are dumped near the hatchery.

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Year	Event	Observations, Issues and Recommendations
1997	Hatchery Inspection.	Some pink salmon mortality due to low DO at low tide in net pens so pink salmon were released. BKD issue with coho salmon. Recommend family track and/or inject broodstock with erythromycin to prevent BKD outbreaks, destroy wooden boards and replace with disinfectable metal or fiberglass grates, continue to monitor for BKD, evaluate placement of net pens for pink salmon as losses were lower in pens with greater separation, and determine whether there are resident salmonids in Solomon Lake to evaluate future strategies for controlling BKD at the hatchery.
2001	Hatchery Inspection.	Some mortality with coho from bacterial coldwater disease, gas bubble disease and Saprolegnia. SGH well organized and clean facility. Routine fish health checks and firm understanding of fish issues at facility. Recommend degassing system in the raceways and replace wooden boards over indoor raceways and replace with disinfectable material.
2004	Hatchery Inspection.	Wood walkways all replaced with aluminum grates. Recommend placing footbaths at all entrances and exits to the coho rearing areas, install seawater line, use separate utensils for each rearing unit, and see if lowering coho egg loading densities improves survival.
2007	Post treatment evaluation of coho salmon infected with Trichodina.	After two formalin treatments, some viable Trichodina remain, and a third treatment is probably warranted.
2007	Hatchery Inspection.	Heavy siltation on influent water due to extensive flood conditions in Valdez. Recommend a full spectrum water quality analysis to assess water supply and provide information as to why pH is low (5), and consider lower coho salmon egg densities to recommended level of 300,000 per incubator SGH loading densities are currently lower than 300,000 per incubator (Mike Wells, VFDA Executive Director, personal communication).
2008	Coho salmon laboratory examination because of continuing low level mortality.	Ongoing problems with Trichodina, Saprolegnia and external fusobacteria. Fish were treated multiple times with formalin and Chromine-T. No Trichodina or fusobacteria observed in samples. Recommended removing fish with obvious gill fungus, and keep raceways as clean as possible to allow recovery from gill damage.
2008	Low level coho salmon mortality.	Gill hyperplasia, gas bubble disease and Trichodina. Recommend continue to screen for Trichodina parasite and treat if they increase in numbers. Gill hyperplasia likely due to previous chemical treatments and should improve if water quality is good. Keep total dissolved gases below 100% saturation.

Appendix J.–Indexed escapement count, escapement goal, commercial harvest, hatchery cost-recovery harvest, and hatchery percentage of the commercial harvest of pink salmon, and the indexed escapement and escapement goal for chum salmon, for the Eastern District of Prince William Sound, 1983–2010.

	Pink salmon					Chum salmon	
Year	Escapement	Escapement Goal	Commercial Harvest (millions)[a]	Hatchery cost-recovery harvest (millions)[b]	Hatchery % of commercial harvest[c]	Escapement	Escapement Goal
1983	450,000	403,750–484,500	2.4	<0.1		146,000	87,000–109,000
1984	1,143,000	400,000–480,000	4.5	<0.1		131,000	87,000–110,000
1985	720,000	400,000–480,000	6.7	0.2		98,000	87,000–110,000
1986	384,000	400,000–480,000	2.5	<0.1		149,000	87,000–110,000
1987	517,000	400,000–480,000	7	1.1		184,000	87,000–110,000
1988	394,000	400,000–480,000	0.5	0.5		259,000	87,000–110,000
1989[d]	357,000	400,000–480,000	3.2	0.7		112,000	87,000–110,000
1990	428,000	427,000–521,000	8	2.1		115,000	84,000–102,000
1991	427,000	380,000–464,000	2.6	3.2		86,000	85,000–104,000
1992[d]	195,000	427,000–521,000	0.5	1.3		49,000	84,000–102,000
1993[d]	315,000	380,000–465,000	0	1.3		50,000	87,000–109,000
1994	614,000	427,000–521,000	11.6	3.2		40,000	87,000–109,000
1995	397,000	380,000–465,000	4.2	2.5		76,000	87,000–109,000
1996	584,000	427,000–521,000	6.1	2.4		138,000	87,000–109,000
1997[d]	346,000	380,000–465,000	4.5	2.4		93,000	87,000–109,000
1998[d]	378,000	427,000–521,000	2.2	3.4		86,000	87,000–109,000
1999	623,000	380,000–465,000	12.3	4.4	76%	243,000	87,000–109,000
2001	437,000	380,000–465,000	16.1	4	70%	199,000	87,000–109,000
2002[d]	226,000	427,000–521,000	0.4	4.4	97%	94,000	87,000–109,000
2003	957,000	355,000–780,000	14.9	4.2	81%	199,000	50,000–130,000
2004	725,000	425,000–930,000	9.5	3.8	76%	109,000	50,000–130,000
2005	1,026,000	355,000–780,000	20.5	3.5	65%	113,000	50,000–130,000

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Year	Pink salmon					Chum salmon	
	Escapement	Escapement Goal	Commercial Harvest (millions)[a]	Hatchery cost-recovery harvest (millions)[b]	Hatchery % of commercial harvest[c]	Escapement	Escapement Goal
2006	249,000[e]	425,000–930,000	5.7	3.9	82%	109,000	50,000
2007	375,000	355,000–780,000	22.1	4	86%	124,000	50,000
2008[d]	194,000	425,000–930,000	11	4.3	99%	75,000	50,000
2009	455,000	355,000–780,000	0.1	0.7	41%	85,000	50,000
2010	491,000	425,000–930,000	18.8	2.2	97%	92,000	50,000
2011	983,000	355,000–780,000	13.3	2.1	86%	197,000	50,000

Source: Escapement (1983–2011), Commercial Harvest (1983–2011) and Hatchery Harvest (1998–2011) from Botz et al. *In prep*.
Source: Hatchery Harvest (1983–1997) from Morstad et al. 1998.
Source: Escapement goal and hatchery percent of commercial harvest for the Eastern District from the annual management report for each year (Randall et al. 1984, 1985, 1986; Brady et al. 1987, 1988, 1990, 1991a, b; Donaldson et al. 1992, 1993, 1995a, b; Morstad et al. 1996–1999; Sharp et al. 2000; Johnson et al. 2002; Gray et al. 2002, 2003; Ashe et al. 2005a, b; Hollowell et al. 2007; Botz et al. 2008, 2010, 2012, *In prep*; Lewis et al. 2008; Bell et al. 2010.
Note: Numbers rounded.
[a] Commercial harvest represents the common property harvest only and does not include fish harvested by the hatchery for cost-recovery and broodstock.
[b] Hatchery harvest represents broodstock and cost-recovery harvest at the hatchery.
[c] Hatchery contribution by district not available in annual management reports prior to 1999.
[d] Escapement goal was not met. Years where escapement was within 10% of the lower escapement goal (1986 and 1988) were counted as meeting escapement.
[e] Although the escapement count was below the lower goal number, Botz et al. (2008) indicated that counts at stream mouths were 85% higher than anticipated, and judged that an adequate number of fish were present in the district to meet escapement goals, but had not yet entered streams to be counted towards the escapement goal.

Appendix K.–Escapement counts of coho salmon in streams near Valdez, 1971–2008.

Year	Lowe River[a]	Robe River/ Corbin Creek	Duck Creek[b]	Indian River[b]	Donaldson Creek[b]	Naomoff Creek[b]	Vlasoff River[b]	Twin Falls Creek[b]	Stellar Creek[b]	Gladhaugh Creek[b]
1971	193	9,690								
1972	211	875								
1973	67	4,000								
1974	78	1,662								
1975	1,506	1,533								
1976	1,310	1,049								
1977	1,363	1,522								
1978	1,643	5,091[c]								
1979	1,536	3,470								
1980	1,329	5,467								
1981	4,516	3,125								
1982	2,296	8,573								
1983	801	2,670								
1984	642[d]	5,257[e]								
1995										
1996							200			
1997							50			
2001							500	500		
2003			10							
2004			400	100			1,000	100	100	
2006							100			
2007				100	50		50	300	20	20
2008					50		55			4

Souce: Data from aircraft, boat and/or on foot counts.

[a] 1975–1984 data from Williams and Potterville (1985); 1971–1983 data from Williams 1976.

[b] Tommy Sheridan, ADF&G division of Commercial Fisheries, Fishery Manager, Cordova, unpublished data.

[d] Flooding caused large area to be unaccountable.

[c] An aerial survey by ADF&G Cordova Office in 1978 reported a count of 600. The higher count in Williams and Pottersville (1985) was used here.

[e] ADF&G peak count in 1984 was 3,666 fish; VFDA peak survey count (from Ken Morgan, VFDA Hatchery Manager, personal communication) was 5,257 and therefore the higher count was used here.

Appendix L.–Historical harvest contributions, thermally marked otolith releases, and total returns of coho salmon to Solomon Gulch Hatchery, with comparison of smolt to adult marine survival rates of Southeast (SEAK) Alaska wild stocks (Berners River, Auke Creek, Hugh Smith Lake) and exploitation rates of Southeast (SEAK) Alaska wild stocks (Berners River, Auke Creek, Hugh Smith Lake and Ford Arm Lake) that are similar in size to the primary wild coho salmon systems (Lowe and Robe rivers) in the Port of Valdez.

Year	SGH Smolt Release	Common Property Catch	Broodstock/ Escapement/ Cost Recovery	Total Return	SGH Marine Survival [a]	SEAK Wild Stocks Marine Survival	SGH Common Property Catch Exploitation Rate [b]	SEAK Wild Stock Weighted Avg. Exploitation Rate [b]
1991	807,153	14,550	40,637	55,187	7%	22%	26%	55%
1992	993,633	22,580	29,427	52,007	5%	26%	43%	60%
1993	1,226,044	12,943	4,001	16,944	1%	17%	76%	65%
1994	461,388	19,633	33,467	53,100	12%	28%	37%	71%
1995	915,087	116,271	37,637	153,908	17%	13%	76%	67%
1996	1,325,316	130,182	35,485	165,667	13%	18%	79%	66%
1997	1,875,823	83,811	23,423	107,234	6%	13%	78%	45%
1998	1,315,183	62,432	22,948	85,380	6%	17%	73%	61%
1999	1,748,486	103,357	15,220	118,577	7%	15%	87%	61%
2000	1,863,528	413,853	26,512	440,365	24%	12%	94%	52%
2001	1,625,599	227,469	27,373	254,842	16%	18%	89%	51%
2002	1,519,328	78,338	29,323	107,661	7%	20%	73%	41%
2003	1,821,889	149,901	21,466	171,367	9%	19%	87%	52%
2004	1,275,145	94,009	12,482	106,491	8%	16%	88%	59%
2005	1,442,274	206,604	32,788	239,392	17%	11%	86%	52%
2006	1,968,366	280,214	18,627	298,841	15%	13%	94%	51%
2007	1,511,592	148,399	21,312	169,711	11%	9%	87%	55%
2008	1,973,604	223,310	25,457	248,767	13%	18%	90%	49%
2009	1,828,100	51,537	21,379	72,916	4%	14%	71%	52%
2010	1,525,927	74,142	46,569	120,711	8%	17%	61%	56%

Source: SGH data Appendix E 5 in Botz et al. (2012). Southeast Alaska data is from Table 29 in Skannes et al. (2012). Marine survival was the average of Berners River, Auke Creek and Hugh Smith Lakes, which have escapements similar to those seen in earlier surveys of the Lowe and Robe systems. Ford Arm Lake was not used in the marine survival calculation because smolt to adult survival information was not available, only pre-smolt to adult survival, so it was not comparable to the other 3 Southeast Alaska systems and SGH, which are smolt to adult survival estimates.

[a] Marine survival rates are not included for Ford Arm Lake because only presmolt to adult survival rates, but not smolt to adult rates, are available.

[b] Exploitation rates were calculated as the combined catches of the sport, commercial, personal use and subsistence fisheries divided by the total return.