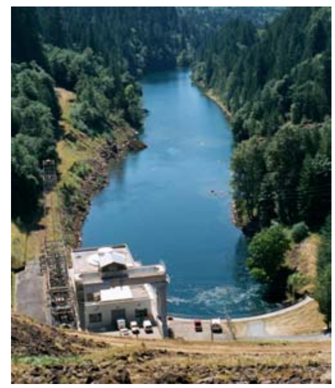
APPENDIX D: LEWIS RIVER HATCHERY REVIEW

JANUARY 14, 2004

Prepared for

PacifiCorp and
Cowlitz PUD



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LEWIS RIVER HATCHERY REVIEW STATEMENT OF WORK

The Lewis River Negotiating Team designated an aquatics sub-group to work on development of a scope of work (SOW) for a Fish Planning Document and a Hatchery Review.
The following are objectives developed by the sub-group for the Lewis River Hatchery Review:

1. Identify methodologies, facilities, and programs to support natural production objectives and provide for sustainable fisheries; and,

2. The product of this review will be a number of alternatives with discussion of the conditions that need to be met in order to support integrated natural and hatchery fish management objectives and the hatchery facilities, operations, and performance needed to meet those conditions.

The following is a final report addressing the identified objectives and associated Tasks as defined below.

Introduction

The Lewis River Hatchery Review will supply a necessary component of the Lewis River Fish Planning Document (FPD), which will be a biological guide for formulating decisions on Project actions to manage anadromous and resident fish resources of the Lewis River basin. The consultant will complete a hatchery review utilizing the Columbia River Artificial Production Review and Evaluation (APRE) results, the Lewis River Hatchery Complex Evaluation report (Tetra Tech 2003), the draft FPD and other appropriate evaluation tools to identify methodologies, facilities, and programs to support natural production objectives and provide sustainable fisheries. The draft FPD identified development of population goals and the hatchery review as the two remaining key work products needed to finalize the FPD.

There are presently three fish facilities on the Lewis River; Lewis River Salmon Hatchery, Merwin Trout and Steelhead Hatchery, and Speelyai Hatchery. PacifiCorp (and Cowlitz PUD for 26% of Speelyai) funds Washington Department of Fish and Wildlife (WDFW) to operate these hatcheries as mitigation for anadromous and resident fish. Lewis River Hatchery provides for a Chinook and coho program, Merwin Hatchery provides steelhead and rainbow trout, and Speelyai provides kokanee and acts as an auxiliary hatchery to the other two. PacifiCorp owns Merwin Hatchery and 74% of Speelyai hatchery (CPUD owns the other 26%). In relicensing discussions, WDFW and others have made known their intention to seek hatchery upgrades and modernization to meet the requirements of a new license.

The Utilities' current mitigation program calls for 800,000 rainbow for Swift, 93,000 kokanee for Merwin, 2.98 million coho fry, 250,000 spring Chinook smolts, 25,000 cutthroat, and 250,000 steelhead smolts. WDFW has altered these requirements to eliminate cutthroat and call for 275,000 steelhead and 1,050,000 Chinook and has submitted a request to FERC to make changes to the current license requirements. In addition, WDFW operates a tiger musky program for stocking into Lake Merwin (specifically Speelyai Bay).

During technical discussions, the need for adult production goals was recognized as essential for development of a fish planning document and to guide development of this hatchery review. A number of methods were evaluated and the following table displays the range of possible adult production goals for the upper Lewis above Merwin Dam.

Appendix Table D- 1. Above Merwin Adult Population Goal Range (Based on Comparison of Four Work Group Methods).

Species	Current Hatchery Production	EDT Potential[1]	EDT Historical[1]	Historical Run Reconstruction
Chum	0	2,800	12,100	6,400[2]
Fall Chinook	Article 49	5,300	8,300	6,800
Spring Chinook	12,800	9,900	15,700	7,000
Coho	71,000	21,800	33,900	78,600
Winter Steelhead	1,250	7,000	7,800	8,000
Summer Steelhead	5,000	500	550	NA
Sea Run Cutthroat	750	3,100	3,400	NA
Totals	90,800	50,400	81,700	106,800

[1]**Average survival rates used**
[2]**Estimate for entire Lewis Basin (approx. 10% above Merwin)**

After much discussion over these possible scenarios, the Negotiating Team sub-group recommended that for the next license period, the hatchery production goal would be 86,000 ocean recruits.

Tasks

The tasks for the Lewis River Hatchery Review were developed by the sub-group and are as follows:

Task 1 – Describe Strategies to Attain Natural Production Goals

Use natural production goals developed by the Population Goals small group to develop species goals and natural production targets[1]. This will be accomplished through the following activities:

[1] The basic formula to follow is simply stated as Production = Natural Production plus Hatchery Production. In other words, the balance of the production goal that cannot be met through natural production will be provided by the Lewis River Hatchery Complex (LRHC).

Activity 1.1 -Artificial Production Strategies

Develop operational and supplementation strategies to meet natural production goals. These strategies may include but are not limited to life history reintroduction strategies, upriver and downriver release strategies, and adult holding. Broodstock criteria will be addressed including broodstock selection, genetic fitness, survival, and overall health of the stocks used for supplementation of natural production. Differences between natural and hatchery broodstock production and selection will be addressed.

Activity 1.2

Identify alternative strategies to those represented in activity 1.1 and describe the potential tradeoffs between strategies. Identify critical uncertainties to strategies that should be measured through monitoring and evaluation of passage of juveniles and adults through the hydro system.

Task 2 – Describe Strategies to Attain Total Production Goals (Including Harvest and Natural Production Goals).

The objective of this task is to develop strategies for achieving harvest augmentation goals established by either the Population Goals small group or by the Lewis River Negotiating Team. Hatchery harvest augmentation is intended to support adult fish harvest objectives including resident and anadromous fish species while not compromising natural production objectives. The decision has not been finalized. Therefore this task will be modified or incomplete if consensus is not reached on harvest goals.

Activity 2.1
Evaluate the relationship between total production, including harvest and natural production objectives, to ensure that natural production objectives are met while providing for harvest opportunities. Compare strategies and associated facilities and operations to address compatibilities and conflicts between harvest augmentation focused actions and natural production focused actions. Broodstock and juvenile rearing strategies will be explored to identify methods to effectively achieve both natural and harvest management objectives.

Activity 2.2
Display harvest potential associated with production goals for anadromous fish. Develop strategies to meet objectives for harvest including adult abundance goals and survival goals. Develop juvenile release and marking strategies to meet harvest objectives

Activity 2.3
Develop strategies to provide resident fish for harvest in the Lewis basin reservoirs consistent with natural production goals.

Task 3 – Determine Attributes of Hatchery Facilities Needed to Achieve Natural Production and Harvest Augmentation Goals.

Identify the hatchery facilities needed to achieve natural production and harvest augmentation goals using the evaluation methods established in the Lewis River Fish Planning Document. This will be a strategic, rather than engineering, description of facility capabilities needed.

Activity 3.1

Recommend facilities that provide the best operation practices for broodstock collection, fish transport, incubation, rearing, juvenile collection, sorting and marking/tagging, smolt release, etc. Assess the adequacy of existing facilities to meet these operational needs.

Activity 3.2

Recommend facilities needed to address water source and disease control, and emergency facilities to avoid fish loss. Address the adequacy of existing facilities to meet these operational needs.

Activity 3.4

Recommend facilities to meet monitoring and evaluation needs to measure performance associated with integrated natural and sustainable fisheries management objectives.

Task 4 – Describe Operating Strategies for the Fish Facilities that will Achieve Natural Production and Harvest Augmentation Goals

This task will provide a synthesis of findings from the first three tasks that relate to hatchery operations. A description of best operating strategies to meet production and harvest goals will be summarized.

Activity 4.1

Develop strategies for selecting broodstock and collecting returning adults, rearing juveniles, and releasing juveniles to meet natural production and harvest augmentation goals. Use recommendations from tasks 1, 2, and 3 to summarize strategies for a full operations plan which addresses natural and harvest objectives.

Task 5 – Describe the Information and Procedures Needed to Enable Adaptive Management

Prepare a section for the aquatic adaptive management plan that includes hatchery performance measures to be tracked in monitoring and evaluating biological impacts. Recommend activities in response to new knowledge for adjusting operations and performance.

Activity 5.1

Identify critical uncertainties that need to be evaluated. This list will be focused on uncertainties associated with strategies intended to achieve natural production and harvest augmentation objectives.

Activity 5.2
Identify performance measures to assess critical uncertainties and track progress, including but not limited to adult production from hatchery releases, reintroduction efforts, and existing natural populations.

Activity 5.3
Design initial monitoring and evaluation approaches to collect data that assess performance measures.

Activity 5.4
Recommend a process to evaluate results and to adapt facilities, operations, and strategies needed to continually meet or seek attainment of adult production goals for the Lewis River.

LEWIS RIVER HATCHERY REVIEW

Executive Summary

The Lewis River Hatchery Review Document is focused on providing information and recommendations to the Negotiating Group to assist in decisions regarding an integrated natural and hatchery fish management program. The information in this report provides a framework for implementing an integrated hatchery and natural program to support natural production objectives and provide for sustainable fisheries. This report also provides the framework for development of an Adaptive Management Plan. The fish planning issues considered in this document include:

Fish Planning Issues to Consider

1. Species production goals
    a. Adult production
    b. Juvenile production
2. Hatchery facility investments
3. Harvest objectives
4. Stocks choices for reintroduction of salmon and steelhead into the upper Lewis
5. Number of species for initial supplementation
6. Life history stage for supplementation
7. Number of fish and duration of supplementation
8. Acclimation or direct release of smolts into the upper Lewis
9. Release of reintroduced fish into the lower Lewis
    a. Direct or stress relief
    b. Area of release
10. Adaptive Management Plan for integrated programs

The species production goals address hatchery production goals for spring Chinook, coho, and steelhead to support the total adult production goal, reintroduction in the upper Lewis, and harvest. Juvenile production options were assessed in terms of numbers of juveniles needed to meet the adult production objectives, within a reasonable risk assumption.

The hatchery facilities are presented in terms of current use and operational issues which affect fish production. The facility issues address future needs to meet the integrated natural production and harvest objectives.

Harvest is presented in terms of the expected harvest of Lewis River adult fish produced from Lewis River hatchery facilities, in marine and freshwater fisheries, under three adult production options. Objectives for anadromous and resident fish harvest are recommended.

The initial reintroduction program will focus activities only above Swift Dam because tributaries of Swift Reservoir appear to have once supported substantial historic spawning and appeared to have had the greatest production potential of the three reservoirs based on EDT and PopCycle Models (Norman and Cramer 2003). The

recommended reintroduction strategy relies on two life stages; adults and smolts. Adults would be release for one generation and smolts for 2 generations.

The number of smolts and adults to be supplemented is recommended for each species. Recommendations are aligned with EDT estimates of juvenile capacity in the habitat upstream of Swift Reservoir and the maximum number of adults supplemented is aligned with EDT and PopCycle estimates of the equilibrium spawning number projected with current habitat and expected passage conditions.

A production distribution matrix is recommended for use in management of returning broodstock to the Lewis facilities. The matrix guides distribution of smolt and adults between the base hatchery harvest program and the supplementation program.

A high priority should be placed on a Monitoring and Evaluation (M&E) program to measure the success and failures of the Swift reintroduction program. The M&E findings will inform decision concerning reintroduction may be carried into Yale and Merwin reservoirs.

This report discusses acclimation vs. direct release (which is most important for spring Chinook) and discusses alternatives including testing, remote sites options, and the Swift power canal site. Access logistics may be a determining factor in the acclimation issue.

We discuss the benefits of stress relief ponds for survival and how it also provides a mechanism to measure mortality. Release locations in the lower river may be dependent on location of a stress relief pond, but must be sensitive to impacts on the existing wild fall Chinook population.

As of January, 2004 the status of these issues is as follows:

Conceptual Agreements

- Total production goal of 86,000 adult fish (ocean recruits- accounting includes harvest and escapement)
- Target production: of 86,000 adult fish (ocean recruits) includes:
    - 12,800 spring Chinook
    - 60,000 coho
    - 13,200 steelhead (combined winters and summers)
- Minimum hatchery production (hatchery floor): 18,000 adult fish (ocean recruits) when natural production reaches 86,000 adult fish (ocean recruits)
- Hatchery production decreased on a fish for fish exchange (1:1) for every adult fish (ocean recruits) above 20,000 produced naturally upstream of Merwin Dam
- Spring Chinook harvest objectives:
    - Selective fisheries for hatchery fish unless natural fish considered harvestable
    - Maintain harvest opportunity in ocean, Columbia River, and Lewis basin fisheries
    - Establish criteria and timeframe for upper Lewis watershed harvest
- Coho harvest objectives:
    - Selective fisheries for hatchery fish unless natural fish considered harvestable

- Maintain harvest opportunity in ocean, Columbia River, and Lewis basin fisheries
- Establish criteria and timeframe for upper Lewis watershed harvest

- Steelhead harvest objectives
  - Selective fisheries for hatchery fish unless natural fish considered harvestable
  - Maintain Columbia River and Lewis basin harvest opportunities
  - Establish criteria and timeframe for upper Lewis watershed harvest
- Fall Chinook harvest objectives:
  - Directed harvest on wild fish in years when escapement goal is met
  - Maintain ocean, Columbia River, and Lewis basin harvest opportunity
- Kokanee harvest objectives:
  - Support harvest opportunity for hatchery kokanee in Merwin Reservoir
  - Support harvest opportunity for natural kokanee in Yale Reservoir
- Rainbow trout harvest objective:
  - Support hatchery trout harvest opportunity in Swift Reservoir
- Preferred stocks for supplementation:
  - Lewis Hatchery early (type s) coho
  - Lewis Hatchery spring Chinook (with Cowlitz stock contingency)
  - Lewis wild winter steelhead (with Kalama Hatchery winter steelhead contingency)
- Initiate supplementation with spring Chinook, coho, and winter steelhead at the same time
- Use adult and smolt life stages for supplementation
- Aquatics Technical Committee develops an Adaptive Management Plan with guidance from the Fish Planning and Hatchery Review documents
- Facility Actions

  <u>Lewis River Hatchery</u>
  - Adult pond modifications
  - Adult crowder and sorter
  - Rearing pond raceways
  - Downstream water intake repair

  <u>Merwin Hatchery</u>
  - Ozone treatment upgrade
  - Rearing pond flow increase
  - Adult holding pond skylights or move adults to outside ponds
  - Two additional fish hauling trucks designed with supplementation capabilities
  - Merwin Trap automated system, modernization and maintenance (part of passage design)

  <u>Speelyai Hatchery</u>
  - Raceway and pond maintenance
  - Rearing pond 14 raceways
  - Water intake structure repair
  - Adult pond remodel
  - Adult kokanee trap-as part of the water intake structure

- Incubation area expansion
- Pollution abatement pond-addressed with water intake repair and loading

<u>Other</u>

- Stress relief ponds constructed in the lower Lewis River (part of passage, location to be determined)
- Adult fish short term handling area at Merwin Dam (part of passage)
- Swift Dam area smolt holding and sorting facility-part of collector system (part of passage)
- Facility improvements should minimize egg and fish transfer

A few issues remain unresolved. A Supplementation Plan will address many of these issues:

- The number of smolts and adults by species to be supplemented
- The duration of a supplementation program. Must be directly linked to natural production
- Allocation of smolts and adults between the hatchery and supplementation programs
- Consistency of supplementation strategies with NOAA fisheries policy and Lower Columbia Fish Recovery Plan objectives.

Introduction

There are presently three fish facilities on the Lewis River known as the Lewis River Hatchery Complex; Lewis River Salmon Hatchery, Merwin Trout and Steelhead Hatchery, and Speelyai Hatchery. The Lewis River Salmon Hatchery provides for a Chinook and coho program, Merwin Trout and Steelhead Hatchery provides steelhead and rainbow trout, and Speelyai provides kokanee and acts as an auxiliary hatchery to the other two. PacifiCorp and Cowlitz PUD jointly own and fund Speelyai Hatchery. PacifiCorp owns and funds the Merwin Hatchery and funds the Lewis River Hatchery, which is owned by the WDFW. In relicensing discussions, WDFW and others have made known their intention to seek hatchery upgrades and modernization to meet the requirements of the new licenses.

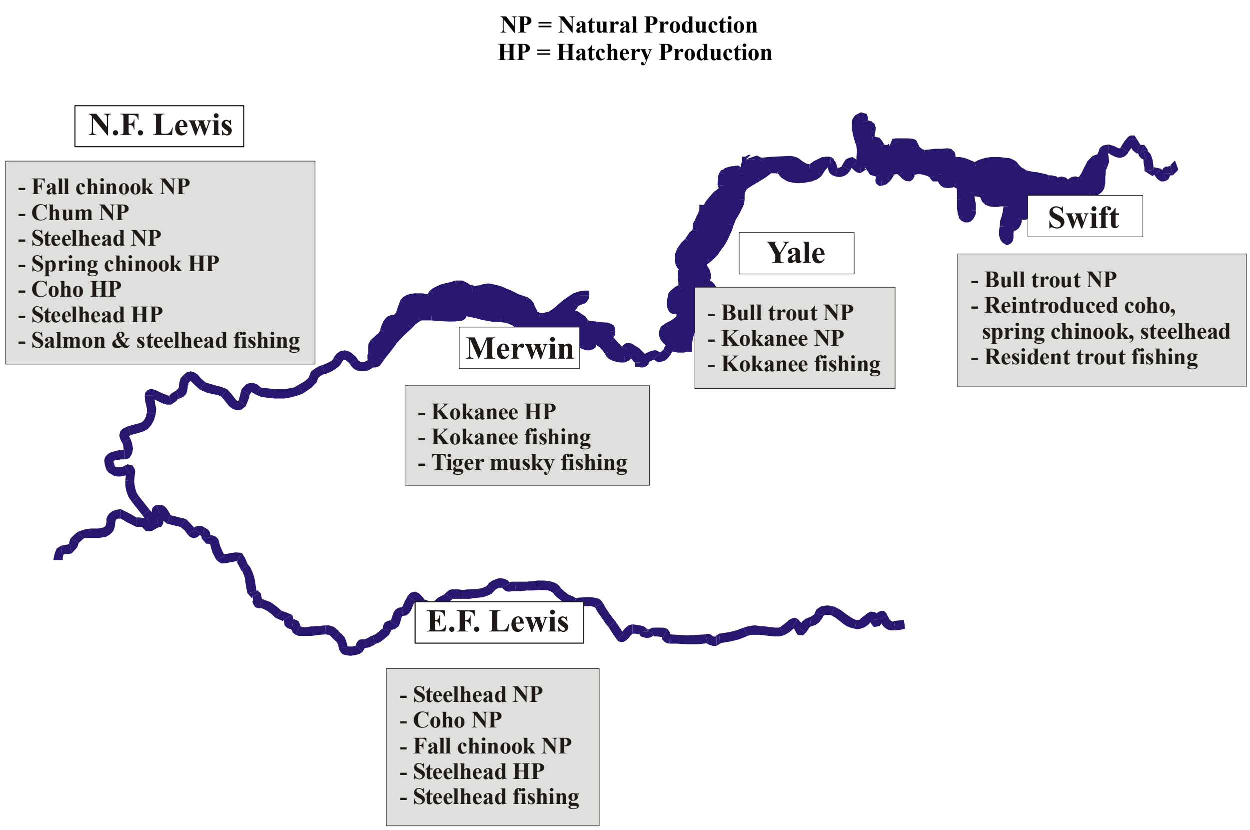
A Lewis River Hatchery Complex evaluation was conducted by Tetra Tech/KCM Inc. (2003). The report represents fish production from the three hatcheries in terms of original license requirements, fish production modifications, and WDFW program goals as defined in a 2001 Lewis River Hatchery complex annual report. In addition, WDFW operates a tiger musky program for stocking into Lake Merwin (specifically Speelyai Bay).

In pursuit of a FERC relicensing agreement for the Lewis River Projects (Merwin, Yale and Swift), this document was created to detail goals, objectives, strategies, and facilities necessary to enable adult harvest/return goals; achieve hatchery production program goals and allow the reintroduction of spring Chinook, coho, and winter steelhead into the upper North Fork Lewis River.

Fish Management Focus by Area

- Initial license period salmonid reintroduction effort in Swift Reservoir with expected future reintroduction in Yale and Merwin reservoirs.
- Merwin Dam License Articles 49, 50, and 51 and subsequent agreements between PacifiCorp and WDFW established the provisions for wild fall Chinook enhancement and hatchery production of salmon, and steelhead.
- Resident fish hatchery programs in Merwin and Swift reservoirs.

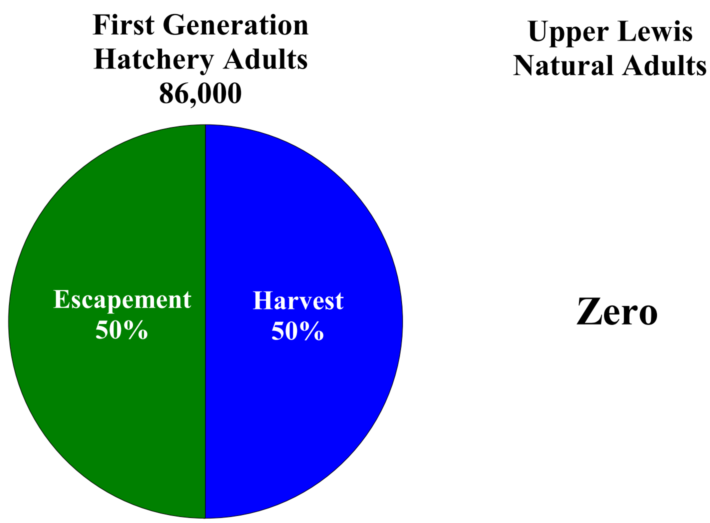
Lewis Basin Fish management can be represented in five geographical areas and displayed as follows:



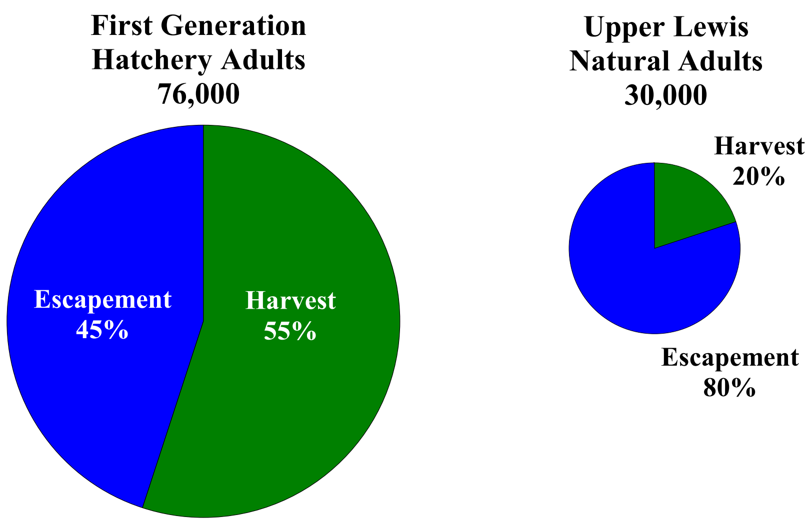
Appendix Figure D- 1. Lewis Basin hatchery and wild fish management by geographical area.

I. OPTIONS FOR ADULT PRODUCTION GOALS BY SPECIES

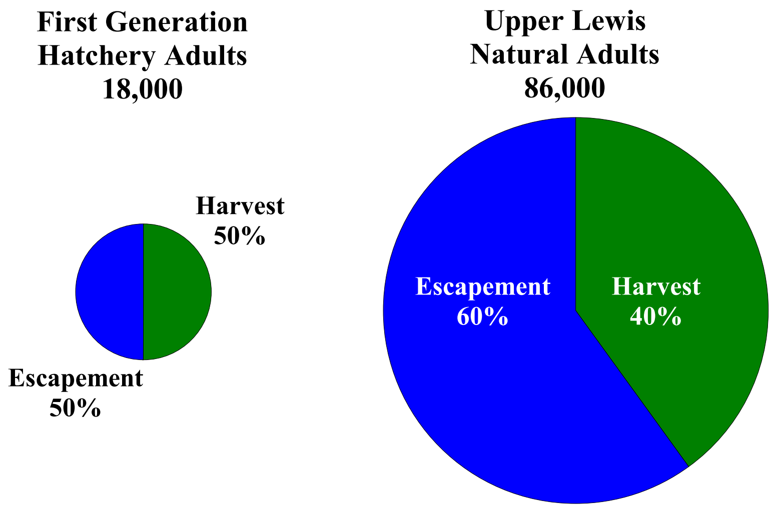
The Negotiating Team sub-group recommended an 86,000 adult production goal to represent pre-dam abundance of wild, native, anadromous fish production in the habitat upstream of Merwin Dam. The adult fish target is total ocean recruits and includes fish harvested and fish that return to freshwater areas to spawn. The Negotiating Team sub-group also recommended a natural production trigger of 20,000 adults upstream of Merwin Dam, which would need to be met before the hatchery goal was reduced from 86,000 adults. The hatchery goal would be reduced proportionally to natural production when natural returns exceed 20,000 adults. For example, if natural production of salmon and steelhead upstream of Merwin Dam were 30,000 adults, the Hatchery goal would be adjusted to 76,000 adults. Appendix Figure D- 2 illustrates hatchery and natural adult production at the beginning of the integrated program, and Appendix Figure D- 3 illustrates a future scenario in which the natural production has exceeded 20,000 adults.



Appendix Figure D- 2. Hatchery and natural production at the beginning of the integrated program.



Appendix Figure D- 3. Hatchery and natural production in the future.



Appendix Figure D- 4. Hatchery and natural after established natural populations.

The Negotiating Team sub-group also supported a hatchery "floor" of 18,000 adults to remain when natural production meets or exceeds 86,000 adults. Appendix Figure D- 4 illustrates a future scenario where natural production has met the 86,000 adult production goal.

The 86,000 adult production goal was based on past abundance estimates which included six populations; winter steelhead, summer steelhead , fall Chinook, spring Chinook, chum, and sea-run cutthroat populations upstream of Merwin Dam. The hatchery production of adult salmonids is attained through propagation of spring Chinook, coho, and steelhead only, with chum, fall Chinook, and sea run cutthroat managed for natural production only. Species-specific targets should be established to accomplish 86,000 adult production from hatchery produced smolts, which includes only spring Chinook, steelhead, and coho reared at the Lewis River hatchery facilities and released below Merwin Dam. As natural production increases, this number will shift toward reduced hatchery production. An ARG sub-group developed three species adult goal options for the Negotiating Team to consider (Appendix Table D- 2).

Appendix Table D- 2. Adult species goal options for Lewis River management

Species	Option 1	Option 2	Option 3	Aquatics Group Estimate Above Merwin[1/]
Spring Chinook	12,800	11,350	12,800	11,350
Coho	65,200	66,625	60,000	50,200
Steelhead	8,000	8,025	13,200	8,025
Others[2/]				16,420
Total	**86,000**	**86,000**	**86,000**	**85,995**

1/Species-specific mid-point population estimates provided to the Negotiating Group for aggregate goal development.

2/ Fall Chinook, chum, and sea-run cutthroat.

Option 1 – Current license goal for spring Chinook and steelhead, balance with coho

This option maintains the current license spring Chinook production target in response to the importance of spring Chinook to fisheries and to buffer a spring Chinook reintroduction effort.

Option 2 – Pre-project (mid-point) population estimate for spring Chinook and steelhead, balance remainder of 86,000 goal with coho

Steelhead program goal is similar to current license, spring Chinook is reduced from current license and coho is reduced from current license but greater than the Aquatics sub-group mid-point estimate for pre-project abundance.

Option 3 – Current license goal for spring Chinook, actual production for steelhead, balance remainder of 86,000 with coho

This option matches a future steelhead adult goal at a level similar to the number of adults currently returning to the Lewis, which is greater than current license expected returns. Steelhead production, unlike salmon, has been exceeding expectations. Spring Chinook adults would be maintained at current license expected levels and coho would be reduced from current license expectation, but would be greater than the Aquatics sub-group mid-point estimate for pre-project abundance.

Sub-group Recommendation: The Aquatics sub-group recommended Option 3. This option maintains the current spring Chinook production target in recognition of the importance of adult returns for supplementation and for sport harvest, and recognizes the steelhead program history of exceeding the current adult objective with the current steelhead smolt production level. The coho adult objective of 60,000 adults is 15% below the current license, but is adequate for significant harvest opportunity and for providing fish for supplementation.

II. FUTURE SMOLT PRODUCTION GOAL ASSESSMENT

Current Smolt Production

The current level of hatchery production of juvenile salmonids in the Lewis River Hatchery Complex was evaluated to address the ability to produce 86,000 adult fish from juvenile fish released into the lower Lewis River downstream of Merwin Dam. This evaluation is intended to assist in developing smolt production goals at levels which will provide reasonable assurance of attaining the hatchery adult production goals. These results, along with reintroduction strategies to meet the aggregate natural production objectives, will inform decisions concerning hatchery facility needs with respect to meeting the hatchery and natural production goals.

Appendix Table D- 3 displays current hatchery smolt production levels, expected adult production, and the smolt-to-adult survival rate (SAR) needed to meet the adult expectations.

Appendix Table D- 3. Current Lewis Complex Fish Production

Species	**Production**	**Expected Adult Production**	SAR Needed
Spring Chinook	1,050,000	12,800	1.2%
Coho	1,800,000	71,000	3.9%
Summer Steelhead	175,000	8,000 (Winter and Summer)	2.9%
Winter Steelhead	100,000		
Total Anadromous Fish	**3,125,000 smolts**	**91,800**	
Kokanee	93,000		
Rainbow Trout	800,000		
Total Fish	**4,018,000**		

For comparison purposes, the actual SARs for these species during the 1974-1997 period is displayed in Appendix Table D- 4. Those averages include: spring Chinook – 0.5%, early coho - 1.9%, late coho – 2.0%, winter steelhead – 1.4%, and summer steelhead – 6.8%. Combined winter and summer steelhead survival is 4.8%.

Appendix Table D- 4. Expected adult production based on current juvenile hatchery production and varying levels of smolt to adult survival.

Species	Spring Chinook	Early (S) Coho[a]	Late (N) Coho[a]	Winter Steelhead	Summer Steelhead	Total Steelhead
Current Juvenile Hatchery Production[b]	1,050,000	934,200	865,800	100,000	175,000	275,000
Year	Smolt to Adult Survival Rate[c]					
1974					0.031	
1975				0.005	0.06	
1976		0.0222		0.024	0.054	
1977				0.005	0.04	
1978				0.013	0.181	
1979				0.015	0.16	
1980		0.006		0.008	0.096	
1981		0.002		0.006	0.029	
1982		0.066		0.017	0.049	
1983				0.015	0.08	
1984				0.03	0.124	
1985		0.052		0.012	0.08	
1986		0.0449	0.0833	0.016	0.062	
1987		0.0138		0.02	0.078	
1988	0.0204	0.0552	0.0665	0.013	0.061	
1989	0.0046	0.0102	0.0174	0.018	0.049	
1990	0.0064		0.0077	0.024	0.137	
1991	0.0003	0.0032	0.0059	0.012	0.062	
1992	0.0022	0.0026	0.002	0.004	0.036	
1993	0.001	0.0085	0.0041	0.005	0.016	
1994	0.0022	0.0049	0.0077	0.02	0.045	
1995		0.0074	0.0058		0.019	
1996		0.005	0.0071		0.007	
1997		0.0066	0.0128			
Range of Survival Rates						
Minimum	0.0003	0.002	0.002	0.004	0.007	NA
Average[d]	0.0053	0.019	0.020	0.014	0.068	NA
Maximum	0.0204	0.066	0.0833	0.030	0.181	NA
Expected Adult Production[e]						
Low	315	1,868	1,732	400	1,225	1,625
Average	5,565	18,129	17,340	1,410	11,839	13,249
High	21,420	61,657	72,121	3,000	31,675	34,675
Population Goal[f]	11,350	34,576	32,044	7,500	525	8,025

[a] Early and late stock coho hatchery production and population goals were separated based on the proportion of early and late stock in the total WDFW hatchery program goals.
[b] Current hatchery production is based on actual 2002 juvenile release data.
[c] SAR for spring Chinook and coho were obtained from CWT data on Lewis River stocks. Kalama summer steelhead SARs were used as a surrogate for Lewis River summer steelhead. Winter steelhead SARs were based on Eagle Creek NFH (1989-91) and Oak Springs Hatchery (1993-95) winter steelhead.
[d] Average SARs are based on the years of available data.
[e] Adult production refers to pre-harvest ocean abundance.
[f] Recommended Lewis River population goals above Merwin.

Future Smolt Production

We projected future adult production for the new license period under recent Lewis survival (low), earlier period survival (high), and a mid-point between the low and high (Appendix Table D- 5). This is consistent with the range of marine survival projections used by the Aquatics Technical Work group for EDT modeling of historic populations above Merwin Dam. A mid-point marine survival rate was used by the Work Group to represent potential production upstream of Merwin Dam. These results were used in part to develop the 86,000 adult hatchery production goal recommendation.

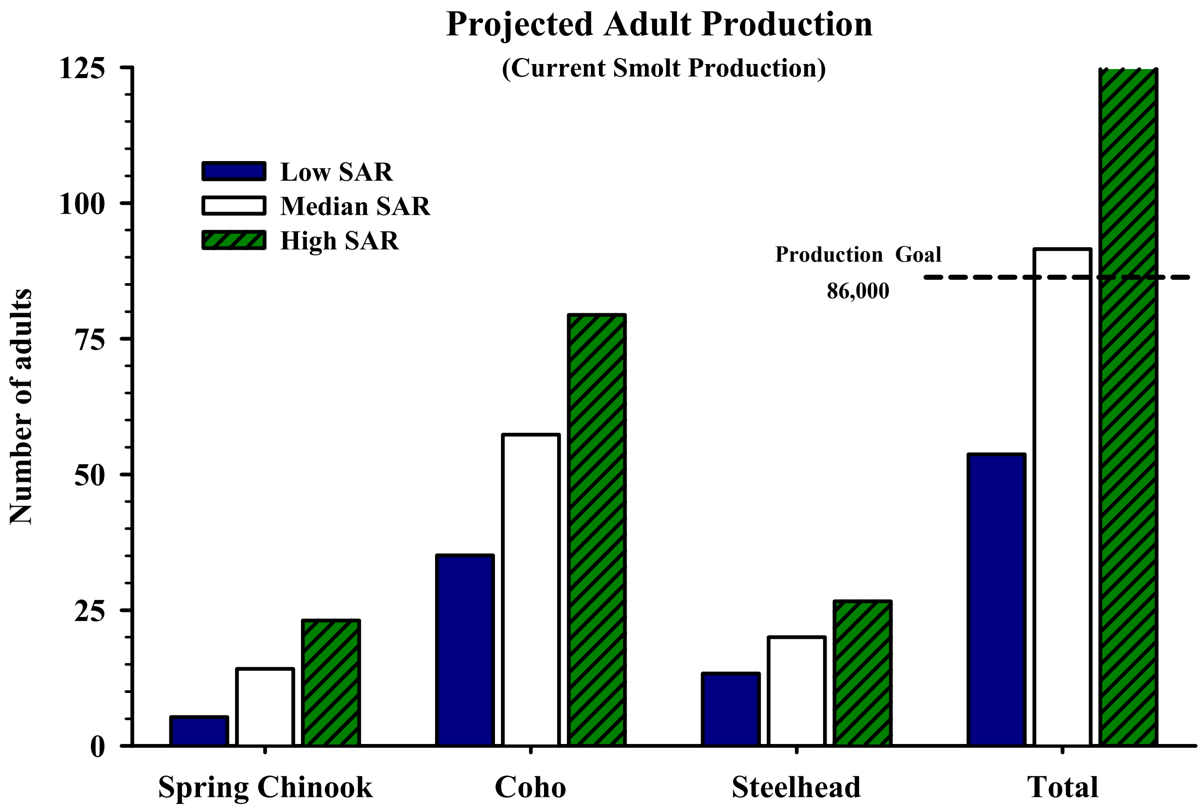
The low (recent period) survival estimates do not include the most recent three years (2001-2003) when marine survival of most Columbia basin populations increased significantly. The high survival estimates represent the survival rate from the pre-1977 period. These survival rates are representative of hatchery survival which is approximately 50 percent of wild survival estimates (Norman and Rawding 2003). These survival estimates should be viewed as reflecting potential average survival over multiple years during the new license period. To simplify this assessment, we used adult species goal option 3 for the adult species targets. The assessment would not change significantly if other adult goal options were used.

Appendix Table D- 5. Lewis potential future smolt to adult survival rates

	Hatchery Fish Survival		
Species	**Low**[1/]	**High**[2/]	**Median**[3/]
Spring Chinook	0.5%	2.2%	1.3%
Coho	2.0%	4.4%	3.2%
Winter Steelhead	1.4%	2.8%	2.1%
Summer Steelhead	6.8%	13.6%	10.2%

[1/] *Average survival for Lewis River hatchery production, surrogate stock survival used for winter steelhead.*
[2/] *a. Spring Chinook – 1980-1987 brood vs. 1989-1995 brood for Cowlitz adjusted for Lewis*
b. Coho – OPI 1960-1977 vs. 1978-1995 survival
c. Steelhead – Early period twice recent period based on salmon information
[3/] *Mid-point between high and low survival.*

The 86,000 hatchery adult production goal (with option 3 species goals) would not be met with current smolt production levels if a low period (average for current license) marine survival was sustained during the new license period. Moreover, a return of 106,000 adults (ocean abundance), including 20,000 naturally produced above Merwin Dam, would not be met due to lack of hatchery fish for supplementation and poor survival conditions (Appendix Figure D- 5).



Appendix Figure D- 5. Projected adult spring Chinook, coho, and steelhead return under low, median, and high marine survival assumptions.

It may be reasonable, however, to assume an improvement (on average) in marine survival over the next 25 years compared to the past 25 year period. However, over a 50-year license period it is possible there could be a swing from a low to high period and perhaps back to a low period. It is certain there will be significant marine survival fluctuations between years.

In the most recent three years (2001-2003), Columbia River salmon returns have reflected substantial improvement in marine survival. Lewis River coho production has increased significantly during those years consistent with other Columbia River coho stocks. Lewis River spring Chinook survival also improved in recent years, but not to the degree of Lewis coho, and not as well as the survival improvement experienced by other spring Chinook stocks, like Willamette and upper Columbia spring Chinook. In fact Lewis spring Chinook survival has remained below 1.0% during the improved marine survival conditions of the past 3 years.

It is not known if the improved marine survival conditions reflected in the past 3 years will continue on average during the first 10-20 years of the license period.

The smolt production level for the initial license period should reflect a reasonable opportunity to reach the total adult goal given a reasonable smolt-to-adult survival assumption. Adjustments can be considered after several years of actual adult production data based on a run reconstruction accounting method discussed later in this review. Adjustments should be made based on survival trends over a number of years and not in reaction to annual survival variability.

Since there is substantial uncertainty in projecting marine survival over the course of the license period, and there is a wide range in the number of smolts and facility needs associated with this uncertainty, we believe the smolt production decision is best viewed as a risk level choice in terms of meeting the production goal and future demands of the reintroduction program. The smolt production level choice should also be viewed as a starting point based on expectations for the full license period, but subject to adjustments based on performance monitoring during the course of the license. In other words, take the best shot at a balanced risk option now; recognizing this choice will be revisited several years into the license.

Appendix Table D- 6 displays the criteria for assigning a risk level for each species, depending on the SAR needed to achieve the adult production goal under various smolt production level options. The risk criteria were based on the percentage of increase from the lower period survival, which was the survival rate experienced during the majority of the current license years.

The lower survival expectations are matched with a low risk assumption, because more smolts would be needed to meet the adult production goal. Conversely a higher SAR survival expectation would result in reduced smolts reared and would increase risk of meeting the adult production goal.

Appendix Table D- 6. Smolt production risk criteria

	Risk Level		
Species	**Low**	**Medium**	**High**
Spring Chinook	<0.75% SAR	<1.0% SAR	>1.0% SAR
Coho	<3.0% SAR	<4.0% SAR	>4.0% SAR
Steelhead	<7.3% SAR	<9.8% SAR	>9.8% SAR

Comparison of Juvenile Production Scenarios

In order to illustrate the differences in production goal risk, supplementation ability, and facility needs associated with the various juvenile production levels, we summarized three scenarios in the following tables. The scenarios include: 1) current smolt production, 2) reduced smolt reduction to match a high survival expectation, and 3) increased smolt reduction to balance production goal risks. Resident fish numbers are held at current numbers in all scenarios.

Scenario 1 (current production)- results in a medium to high risk of not meeting total adult production, a high risk for spring Chinook, medium-high for coho, and low for steelhead. There is fair ability to meet supplementation needs, but poor for Chinook and only fair for coho due to limited space and limits on available fish. The facility needs would include maintenance and modernization to meet base operations demands as well as addressing efficiency, safety, improved survival associated with rearing practices, and supplementation/reintroduction demands.

Appendix Table D- 7. Scenario 1 – current production.

Species (SAR to meet goal)	Juveniles	Adult Production Goal Risk
Spring Chinook (1.2%)	1,050,000	High
Coho (3.3%)	1,800,000	Med-high
Steelhead (4.8%)	275,000	Very low
Total Anadromous	**3,125,000**	**Med-high**
Resident Fish		
Kokanee	93,000	Low
Trout	800,000	Low
Total Fish	**4,018,000**	

Scenario 2(reduced production)-results in a high risk in meeting the total adult production goal and a very high risk in meeting the adult spring chinook production goal. The overall ability for supplementation is poor due to lack of available fish, however it may be good for steelhead if late returning unique winter stock could be collected in sufficient numbers. There would be space available for rearing this unique steelhead stock. Facility needs would include maintenance only, with space available for stress relief and other demands associated with a reintroduction effort. There would also be space available to increase the resident fish program.

Appendix Table D- 8. Scenario 2 – reduced production.

Species (SAR to meet goal)	Juveniles	Adult Production Goal Risk
Spring Chinook (2.2%)	582,000	Very high
Coho (4.4%)	1,364,000	High
Steelhead (9.7%)	136,500	Med-high
Total Anadromous	**2,082,500**	**High**
Resident Fish		
Kokanee	≥93,000	Low
Trout	≥800,000	Low
Total Fish	**2,975,500**	

Scenario 3-(increased production to balance risks)-results in a medium risk in meeting total adult production, a medium-high risk for spring Chinook, low-medium risk for coho, and very low for steelhead. The overall supplementation ability is good, but fair for spring Chinook due to limits in available fish in some years. Facility needs would include maintenance, modernization, and moderate expansion, most notably increased space for spring Chinook for hatchery and/or supplementation rearing options. If spring Chinook survival benefits can be realized by rearing portions of production in Swift power canal or Swift Reservoir then the production risks would be further reduced.

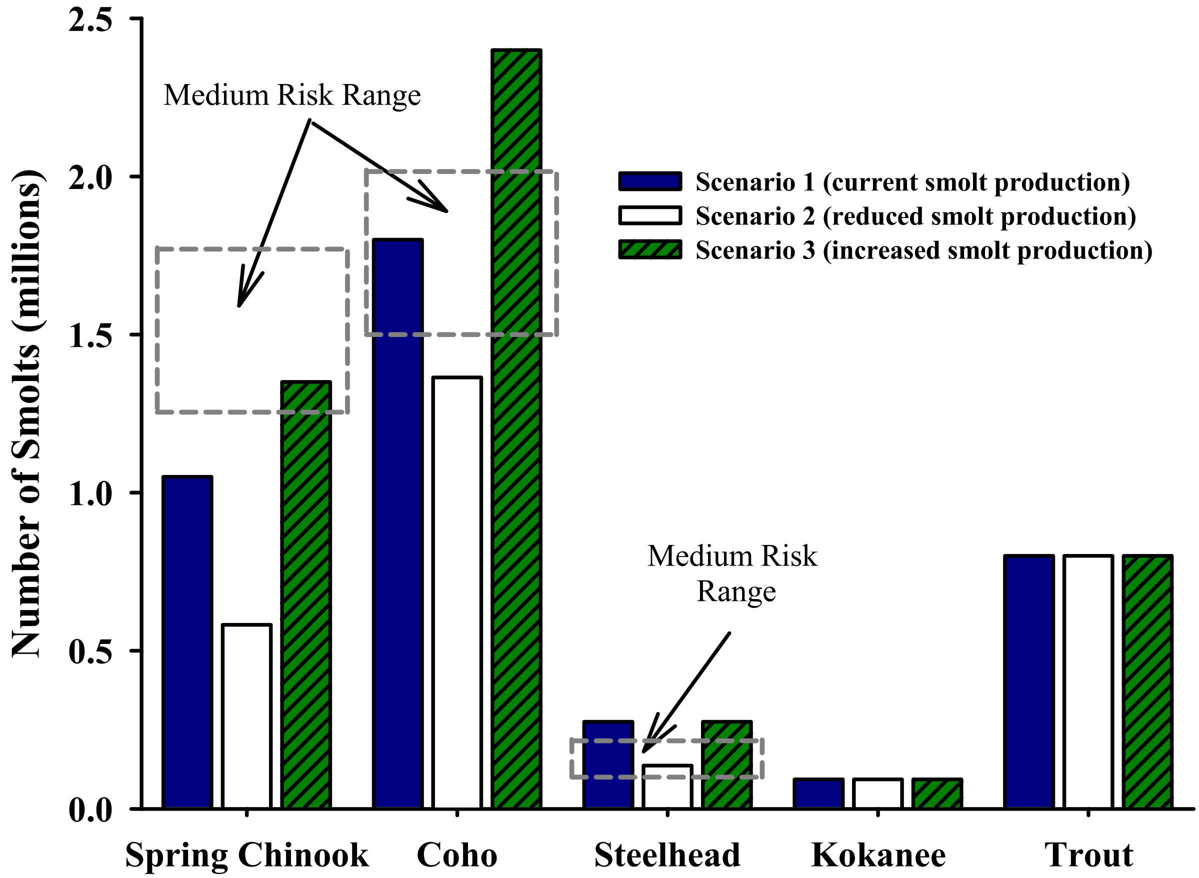
Appendix Table D- 9. Scenario 3 – increased production.

Species (SAR to meet goal)	Juveniles	Adult Production Goal Risk
Spring Chinook (0.95%)	1,350,000	Med-high
Coho (2.5%)	2,400,000	Low
Steelhead (4.8%)	275,000	Very low
Total Anadromous	**4,025,000**	**Medium**
Resident Fish		
Kokanee	93,000	Low
Trout	800,000	Low
Total Fish	**4,918,000**	

Appendix Figure D- 6 illustrates the risk associated with the three smolt production scenarios by species. Note that Scenario 3 reaches the very low end of the median risk box for spring Chinook, but moves outside of median risk to low risk for coho. A coho production level that is low risk may provide more assurance of meeting a total adult goal of 86,000.

This option, which produces 2.4 million coho smolts, assumes a compensatory need in some years when spring Chinook survival is below 0.95%.

An alternative option for coho would be a production level of 2.0 million which is in the upper end of the medium risk box. Under this alternative, the overall adult production goal risk remains at medium.



Appendix Figure D- 6. Smolt production levels in Scenarios 1, 2, and 3 displayed with medium risk range.

Adult Production Goal Monitoring

The Lewis River adult production goal for spring Chinook, coho, and steelhead includes total adults produced prior to harvest. This is referred to as ocean adult abundance. Monitoring would include total accounting of adults including ocean, Columbia River, and Lewis harvest, as well as escapement to the hatcheries and spawning grounds.

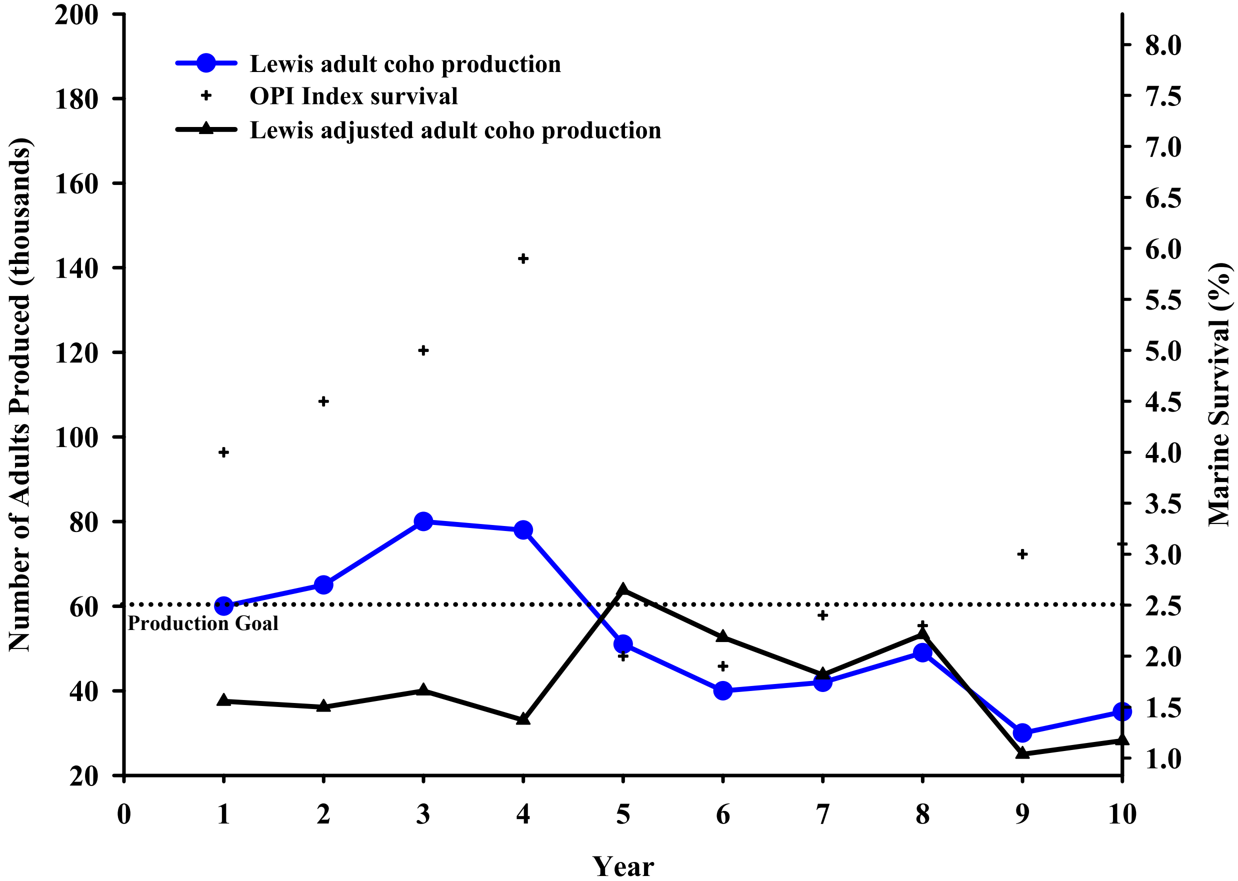
When conducting periodic reviews of the Lewis River artificial production program, the bottom-line measure of success is whether juvenile production and operational strategies are appropriate to meet the adult production goals. There are numerous potential reasons why the population goals may or may not be met. These reasons can be specific to Lewis basin hatchery operations, or can be shared regional factors (e.g. variable and unpredictable marine survival).

When evaluating the success of the hatchery production program to achieve the adult population goals, a relative index concept may be considered. The relative index concept allows decision-makers to evaluate whether the success or failure of the Lewis River adult production is driven by factors within the hatchery program or is highly influenced by extremely high or low marine survival. Appendix Figure D- 7 illustrates how future Lewis River adult coho production could be evaluated using a regional index survival method based on the average survival of aggregate Columbia River and Oregon coastal (Oregon Production Index) coho survival. If the regional index survival is greater than needed to meet the Lewis production goal (2.5% in this example), then the Lewis returns are adjusted downward proportionally to show Lewis production independent of the boost from the exceptional marine survival. However, if the regional index survival is less than 2.5%, the Lewis returns are adjusted upwards so the returns are not unfairly evaluated as a result of poor survival conditions in the ocean.

The key to a reliable regional index adjustment method is in selecting appropriate indicator stocks that would share oceanic and estuary conditions with Lewis stock, and stocks in which programs are in place to accurately monitor survival. When assessing the value of this approach for monitoring Lewis production, spring Chinook, coho, and steelhead should be considered separately, as an appropriate index may be available for one species, but not all species.

Another option is to evaluate Lewis adult production independent of a marine survival index. This method simplifies the accounting process but may not enable full understanding of the reasons for production variations. This method makes it difficult to assess Lewis hatchery production on its own merits, but may be appropriate if it is difficult to find a reliable regional index option.

Adult production performance should be evaluated after a comprehensive review of returns from several generations in order to evaluate a production trend. Short-term evaluations should not be conducted in order to avoid adjustment decisions based on reactions to annual swings in marine survival. The example displayed in Appendix Figure D- 7 represents a hypothetical data set, which could be assessed after 10 years of adult returns.



Appendix Figure D- 7. Hypothetical example of Lewis River adult coho production, OPI Index survival, and adjusted adult production.

Note: Adjustment made based on regional index (OPI) survival relative to 2.5% SAR, which is the survival rate needed to produce 60,000 adult coho from a smolt release of 2,400,000

III. LEWIS RIVER COMPLEX FACILITY NEEDS OVERVIEW

The primary questions to consider relative to hatchery facility needs for the new license period are:

1. What hatchery facility improvements are necessary to address base program operational needs?
2. What hatchery facility needs are necessary to improve production, efficiency, and safety?
3. What additional hatchery facilities are necessary to meet objectives associated with the integrated natural and hatchery programs?
4. Are there fish redistribution options that can be considered to address production capacity issues?

The following changes/modifications to the Lewis River Complex have been suggested by WDFW.

Lewis River Hatchery

Adult Pond 15

a. *Install automated crowder and sorter*- Reduce handling of wild and broodstock fish and reduce human resources.
b. *Divide into four raceways and fish work areas*-Enable separation of adult fish and provide area to handle, tag, and distribute.

Rearing ponds 13, 14, 16

a. *Divide into two raceways*- Provide flexibility for alternative rearing strategies including stock separation, density options, and flow variation- spring Chinook advantage in particular.

Downstream Intake

a. *Refurbish intake system*- Poor condition of pump, screens, and steel pipes. High risk of failure. Provides 20% of water supply.

Alternative rearing pond.

a. *Johnson Creek area*- PacifiCorp owned property. Could provide additional juvenile spring Chinook rearing and provide stress relief options for smolts transported from Swift Reservoir. Could also be used to establish a natures rearing strategy.
b. *Downstream option*- Below wild fall Chinook rearing area.

Speelyai Hatchery

Water supply

a. *Alternative supply*- Current summer water supply may not be adequate for current loads. Summer flows are low and water quality reduced due to upstream development.
b. *Intake structure*- Currently a stop log structure and not stable- no concrete.

Pollution abatement pond- Modified to meet increased production.

Adult pond rebuild- Remodel with adult fertilization work area.

Expand incubation area- Address multiple species capacity needs.

Rearing pond 14 modification- Divide into two raceways to provide rearing flexibility for spring Chinook.

Raceway rehab-Concrete walls are leaking water between raceways, increasing disease risks.

Kokanee

a. *Trapping*- Current collection is conducted by trapping, seining, electrofishing, and transporting adults
b. *Holding*- A small adult holding pond with volunteer access may improve Kokanee broodstock survival and relieve space problems in multiple species adult holding pond.

Merwin Hatchery and Trap

Alternative water source- Ground water incubation source for incubation temperature.

Adult holding- Steelhead not maturing in covered holding area and survival is poor. Survival and maturation better in uncovered smolt release ponds.

Ozone system- Reliability concerns. Is not always able to treat entire water supply.

Rearing ponds water flow

a. *Build head from upstream raceway pond*- Losing significant flow because of low head. Improving flow efficiency could increase rearing capacity and/or survival.
b. *Modify inflow structures in rearing ponds*- To provide proper flow patterns within ponds and improve rearing environment.

Merwin Dam adult trap

a. *Adult collection area* -Increased attraction water, address pump screens and structural issues.
b. *Fish removal*- Automated system that does not require humans to manually capture fish in the trap.
c. *Adult separation*- Need to efficiently separate fish on site. Holding area near dam.
d. *Fish hauling tank trucks*- Two additional trucks needed to replace one borrowed truck and to address expanded fish hauling needs.

Above Swift Dam

Net pen rearing in reservoir or power canal

a. *For additional rearing*- Test potential survival benefits and fish for collection efficiency test at Swift, plus increase production of spring Chinook.
b. *Use as alternative rearing for rainbow trout*- Free space at Speelyai for spring Chinook.

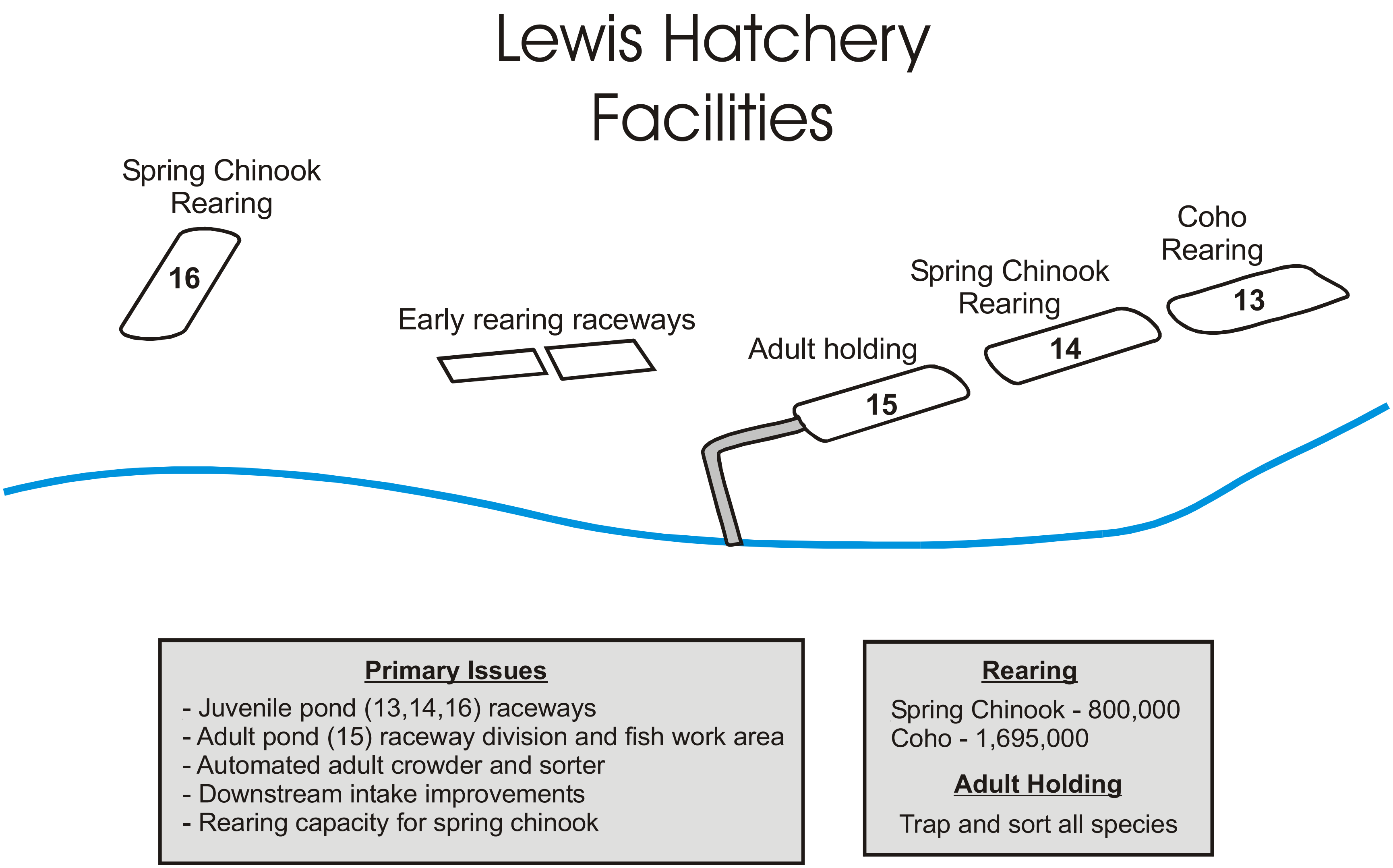
Remote acclimation sites

a. *Temporary acclimation facilities*-Promote homing to key habitats
b. *One acclimation site in key tributary*- Test acclimated versus pen reared and/or direct release.

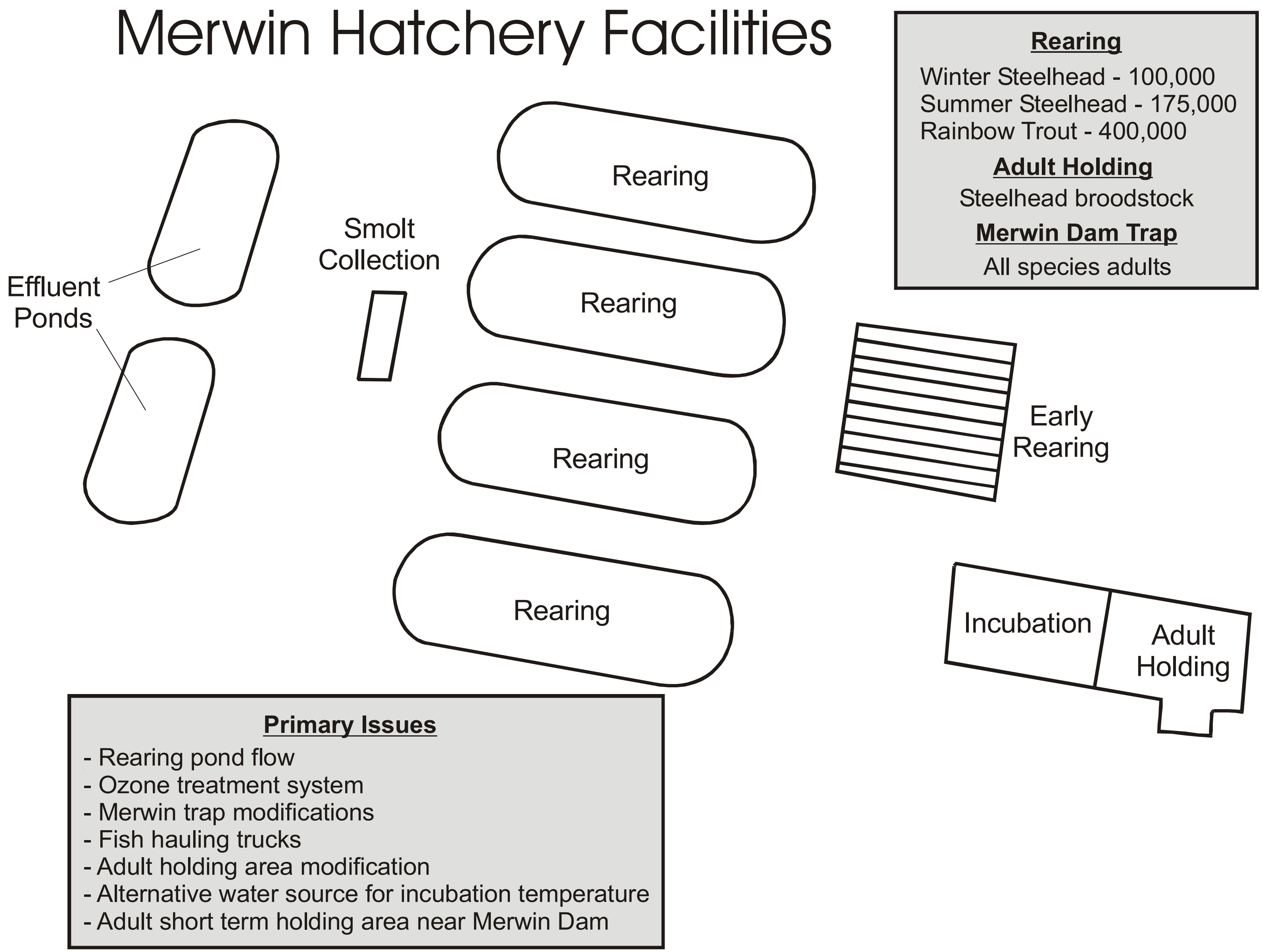
Temporary holding and sorting facility near Swift Dam.

Hatchery Facilities Displayed

The following schematics (Appendix Figure D- 8-Appendix Figure D- 10) illustrate the three hatchery facilities in the Lewis basin, with current juvenile rearing production, adult holding operations, and primary facility issues.

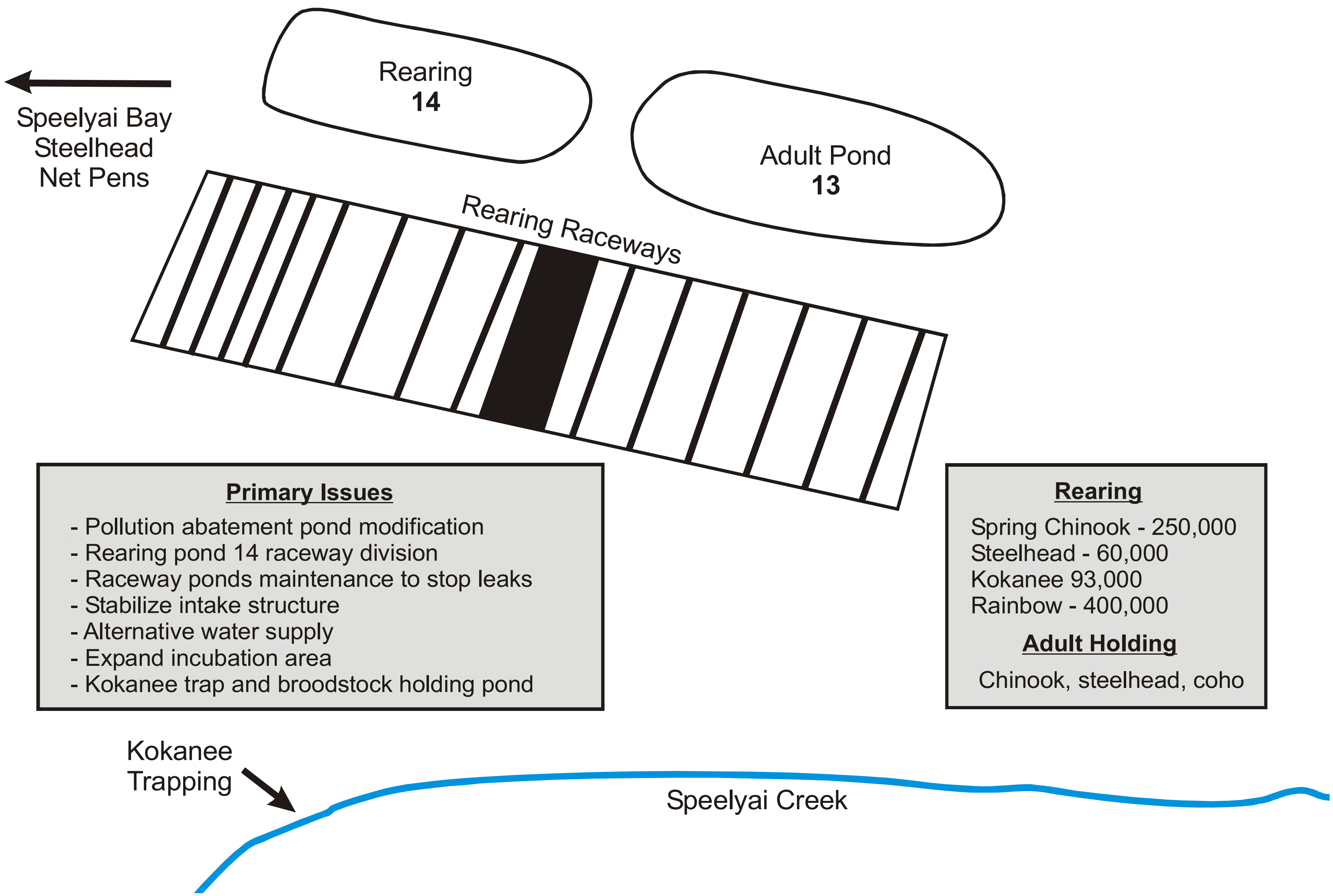


Appendix Figure D- 8. Lewis Hatchery facilities.



Appendix Figure D- 9. Merwin Hatchery facilities.

Speelyai Hatchery Facilities



Appendix Figure D- 10. Speelyai Hatchery facilities.

Appendix Table D- 10, 11 and 12 summarize the hatchery facility issues and provide a short statement explaining the importance of the issues relative to fish production operations.

Appendix Table D- 10. Lewis River Hatchery

Issue	Why
• Adult pond modification	- Adult handling
• Rearing	- Juvenile rearing versatility
• Downstream intake	- Risk of failure
• Automated adult crowder and sorter	- Improve survival of reintroduced fish
• Alternative rearing/stress relief ponds	- Downstream options

Appendix Table D- 11. Merwin River Hatchery

Issue	Why
• Ozone treatment system	- Reliability
• Rearing ponds flow	- Improve flow conditions
• Additional fish hauling trucks	- Replacement and expanded needs
• Merwin Dam Trap modernization/maintenance	- Adult collection efficiency
• Alternative incubation water source	- Temperature control
• Modify adult holding area	- Improve maturation
• Merwin Dam Trap automated system	- Reduce handling
• Adult short-term holding/sorting area near Merwin Dam Trap	- Separate on site

Appendix Table D- 12. Merwin River Hatchery

Issue	Why
• Pollution abatement	- Meet standards
• Rearing pond 14 raceways	- Juvenile rearing versatility
• Raceway pond maintenance	- Structural breakdown/leaks
• Water intake structure	- Log structure not stable
• Alternative water supply	- Improve summer flows
• Remodel adult pond	- Adult fertilization area
• Expand incubation area	- Multiple species capacity
• Build adult kokanee trap	- Volunteer entry
• Construct adult kokanee holding ponds	- Broodstock survival

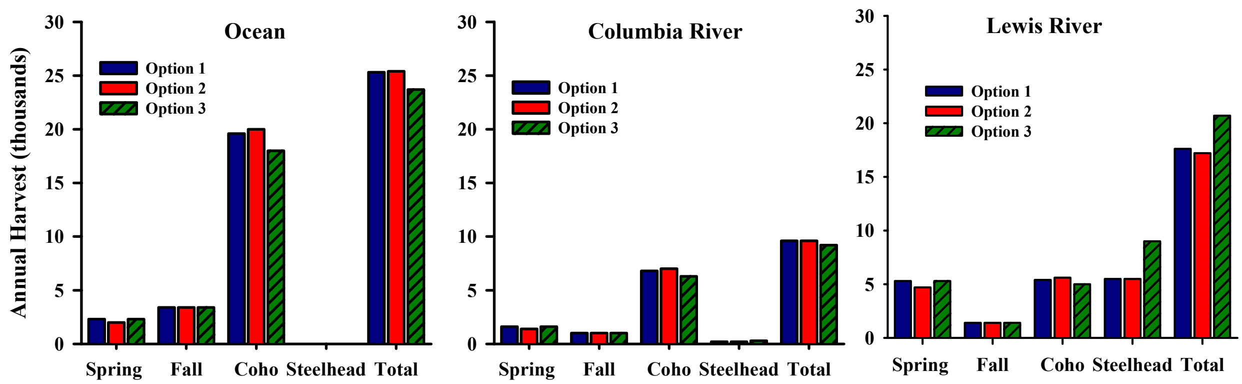
Facility Issues Effecting Production Levels

When considering options to expand the smolt production to meet integrated hatchery and supplementation objectives, it is important to recognize those hatchery facility issues which can affect the numbers of smolts that can be reared in a particular program. The following list displays the issues which effect smolt production capacity:

- Rearing pond raceways
- Rearing flows
- Size of fish at release
- Additional rearing sites
- Stress relief ponds
- Remote acclimation facilities
- Rearing/acclimation facility in Swift Reservoir
- Rearing/acclimation facility in Swift Power Canal

IV. LEWIS RIVER HARVEST OBJECTIVES

The following (Appendix Figure D- 11) displays projected future harvest of spring Chinook, coho, and steelhead produced from the Lewis River Hatchery and fall Chinook produced naturally in the North Lewis River. The harvest projections are connected to 86,000 adults produced from smolts released downstream of Merwin Dam and from an average Lewis River wild fall Chinook return of 11,000 adults. This figure compares the ocean, Columbia River, and Lewis basin harvest under the three species adult production goal options. This analysis does not include potential future harvest of reintroduced adult fish. It is assumed that reintroduced fish would not be immediately harvestable, but may become harvestable in the future if reintroduction efforts are successful in first establishing viable populations and then progressing to sustained healthy and harvestable populations. It is expected that criteria for harvest of natural populations reestablished in the upper Lewis will be folded into the lower Columbia River Recovery Plan process and part of future Fishery Management and Evaluation Plans submitted by WDFW to NOAA Fisheries.



Appendix Figure D- 11. Annual harvest of spring Chinook, fall Chinook, coho, and steelhead in the Ocean, Columbia River mainstem, and Lewis River under Options 1, 2, and 3.

The following (Appendix Table D- 13) displays past harvest distribution of Lewis River salmon and steelhead produced from the hatchery program. These estimates are derived from coded-wire-tag recovery information from the current license period for salmon and, therefore, generally reflect low survival years. Steelhead harvest is based on freshwater harvest rate estimates derived for the WDFW Fishery Management and Evaluation Plan.

Distribution of Hatchery Fish

Appendix Table D- 13. Estimated Lewis Hatchery salmon and steelhead distribution based on CWT recovery information.

	Spring Chinook		Early Coho (Type S)		Late Coho (Type N)		Winter Steelhead		Summer Steelhead	
Location	Recovery Rate	Estimated Harvest	Recovery Rate	Estimated Harvest	Recovery Rate	Estimated Harvest	Recovery Rate	Estimated Harvest	Recovery Rate	Estimated Harvest
Alaska	0.0613	341	0.0005	9	0	0				
Canada	0.0574	319	0	0	0.0009	16				
Oregon	0.0077	43	0.0311	552	0.053	918				
California	0	0	0	0	0	0				
WA Coastal Sport	0.0091	51	0.0786	1,395	0.118	2,043				
WA Comm/Treaty Coastal	0.0158	88	0.0067	119	0.011	190				
Total Ocean	***0.1513***	***842***	***0.1169***	***2,075***	***0.1829***	***3,167***	***0.005***	***7***	***0.005***	***6***
Columbia Estuary Sport	0.012	67	0.0131	233	0.0029	50				
Lower Columbia Sport	0.0043	24	0.0067	119	0.0016	28				
Columbia Commercial	0.0057	32	0.0111	197	0.2297	3,977				
Total Columbia River	***0.022***	***122***	***0.0309***	***548***	***0.2342***	***4,055***	***0.02***	***28***	***0.05***	***595***
Terminal Sport	0.3715	2,067	0.1	1,775	0.1	1,732				
Total Terminal	***0.3715***	***2,067***	***0.1***	***1,775***	***0.1***	***1,732***	***0.5***	***700***	***0.6***	***7,140***
Total Harvest	***0.5448***	***3,032***	***0.2478***	***4,398***	***0.5171***	***8,954***	***0.525***	***735***	***0.655***	***7,795***
Hatchery	0.3748	2,086	0.7522	13,351	0.4829	8,362		665		4,106
Spawning Ground Escapement	0.0804	447	0	0	0	0		0		0
Total Run		**5,565**		**17,749**		**17,316**		**1,400**		**11,901**

Based on average harvest rates derived from recent year CWT recoveries with estimated numbers harvested assuming recent year survival.

Harvest Objectives and Species Goal Options

Harvest objectives can play an important role in determining species-specific production goals. Considerations may include; total ocean and freshwater harvest, harvest within the Lewis basin, different types of harvest opportunities between species, and consideration for year round harvest opportunities.

Under all three adult goal options, coho produce the most harvest in terms of total fish. The majority of coho harvest occurs outside the Lewis basin, predominately in the ocean. Coho fishing in the Lewis River occurs August-November. Steelhead harvest occurs almost entirely in the Lewis River with fishing opportunity occurring primarily from December through August. More than one-half of the spring Chinook harvest typically occurs in the Lewis River, with the remaining harvest split between ocean and Columbia River fisheries. Spring Chinook harvest in the Lewis primarily occurs April-June.

The three options produce similar total harvest numbers, with Option 3 expected to produce slightly more harvest than Options 1 or 2. The main differences between options is the number of each species harvested and the number of fish harvested within the Lewis basin compared to ocean and Columbia River fisheries. Options 1 and 3 produce the highest spring Chinook harvest, Option 2 the highest coho harvest, and Option 3 the highest steelhead harvest. Option 3 produces the most total harvest in the Lewis basin because coho production is exchanged for steelhead and spring Chinook, which are predominately harvested in the Lewis basin.

All options include current level production of resident kokanee and trout for sport fishery opportunity in Merwin, Yale, and Swift reservoirs.

Lewis Basin Salmon and Steelhead Recreational Fisheries

Spring Chinook, coho, and steelhead fisheries are regulated for selective harvest of adipose fin-clipped hatchery fish and release of unmarked naturally produced fish. Fall Chinook fisheries are focused on natural production and regulations allow retention of unmarked fall Chinook. Seasons, bag limits, and open areas within the Lewis River are modified in some years to assure hatchery and natural spawning escapement goals are attained.

Harvest of spring Chinook, fall Chinook and coho in the Lewis River was reduced during the mid to late 1990s due to low adult production; however steelhead harvest was more consistent as expected production levels were met in most years. Since 2000, salmon harvest has improved in response to increased adult production.

Ocean Fisheries

Lewis River Chinook are primarily harvested in Canadian and Alaskan ocean fisheries. Ocean harvest rates decreased during the 1990s to about 26% for wild fall Chinook and 16 percent for spring Chinook. The Chinook ocean harvest reduction was primarily due to low West Coast Chinook abundance in the 1990s and will likely continue as a result of a 1999 abundance based management agreement between the United States and Canada which was negotiated in the Pacific Salmon Treaty forum.

Lewis River coho ocean harvest primarily occurs off the Washington and Oregon coasts, in particular near the mouth of the Columbia River. Lewis coho harvest was significantly reduced in the mid-1990s to about 15%. Ocean coho harvest has increased (to about 30%) since 2000 in response to increased abundance and implementation of selective fishery regulations.

Columbia River Fisheries

Lewis River wild fall Chinook are harvested in lower Columbia River sport fisheries and Columbia River commercial fisheries. Recent year harvest rates averaged about 12%.

Spring Chinook are harvested in Columbia River commercial and sport fisheries. Harvest is selective for hatchery fish and is controlled by limitations on harvest of wild upper Snake, upper Columbia, and Willamette spring Chinook. Current Columbia River harvest of Lewis Hatchery spring Chinook is less than 15%.

Lewis River coho are primarily harvested in the Buoy 10 (Columbia estuary) sport fishery and the Columbia River commercial fishery. Total harvest is limited by Oregon State ESA limitations concerning wild lower Columbia coho. Most of the early coho harvest occurs in the Buoy 10 sport fishery, while most of the late coho harvest occurs in the Columbia River commercial fishery. The combined early and late coho harvest rate in recent years has averaged about 15%.

Harvest Impacts to Reintroduced Fish

Harvest management of wild salmon and steelhead includes management in fishing areas within the Lewis basin in which the Washington Fish and Wildlife Commission has regulatory control. The Columbia River fisheries are jointly managed by Washington and Oregon and the *U.S. v. Oregon* Parties. The Pacific Ocean harvest management includes west coast states, federal, tribal, and international government regulatory control.

Harvest impacts to non-adipose clipped fish reintroduced into the Lewis would be similar to impacts on other lower Columbia wild stocks. These impacts would include some non-selective harvest in the ocean (primarily spring Chinook) and catch and release mortality in ocean and freshwater fisheries. In the Salmon PopCycle modeling we projected harvest impacts of 20% for spring Chinook, 15% for early coho, and 3% for steelhead. These estimates assume reintroduced fish would not be adipose fin-clipped.

In the ocean, spring Chinook fisheries are not currently selective and reintroduced fish would be harvested at the same rate as hatchery fish. Washington and Oregon sport fisheries are selective for adipose fin-clipped coho and most commercial troll fisheries in the areas where Lewis coho reside are also selective for adipose fin-clipped coho. Steelhead reside far off shore and are seldom intercepted in the coastal salmon fisheries.

Resident Fish Fisheries in Reservoirs

Merwin reservoir sport fisheries are primarily focused on kokanee, which are produced at Speelyai Hatchery from broodstock collected in Speelyai Creek. There is limited natural production of kokanee from Canyon, Speelyai, and Rock creeks. Northern pikeminnow are also harvested in Merwin reservoir as well as a few tiger muskies, and landlocked salmon, which are sometimes released into the reservoir.

WDFW fishing regulations allow year round fishing for kokanee, trout, salmon, and other game fish. Target fishing and retention of bull trout is prohibited.

Yale Reservoir fisheries are focused on naturally produced kokanee, which originate almost entirely from Cougar Creek. Hatchery kokanee were supplemented from Speelyai Hatchery in 1999 and 2000, but the program was discontinued in 2001. Northern pikeminnow, rainbow trout, and cutthroat trout are also harvested in Yale Reservoir. WDFW fishing regulations allow year round fishing for kokanee, trout, and other game fish. Target fishing and retention of bull trout is prohibited.

Swift Reservoir sport fisheries are focused on rainbow trout planted from Merwin Hatchery. Native cutthroat and landlocked salmon are also harvested in Swift Reservoir. Options to improve catch may be to increase release size, experiment with other stocks, or to provide catchable sized fish directly to the fishery. Swift Reservoir is open for all game fish beginning in late April through October. Selective gear is required in the area just downstream of Eagle Cliff Bridge to protect bull trout. Target fishing and retention of bull trout is prohibited.

Appendix Table D- 14. Resident fish harvest expectations (current production levels).

Species	Area	Annual Harvest	
		Low	High
Kokanee[1/]	Yale Reservoir	12,000	20,000
Kokanee[1/]	Merwin Reservoir	3,000	8,000
Rainbow Trout[2/]	Swift Reservoir	0.71/hr	0.96/hr

[1/] Based on 1995 creel surveys
[2/] Low based on 1999 survey, high based on 1990 survey

Harvest Objective Considerations

Spring Chinook

- An increase in harvest of Lewis spring Chinook will occur if the adult hatchery production goal is attained and Ocean/Columbia River harvest rate remains similar to the near-term.
- Combined ocean and freshwater annual harvest expectation could range from **8,100-9,200**, depending on the production goal option selected.
- Reduction in lower river hatchery smolt releases associated with the reintroduction program could result in proportional reductions in harvest.
- Regulatory changes associated with protection of introduced fish may also reduce harvest of hatchery fish.
- Consideration for future harvest of natural fish in the lower and upper Lewis is dependent on reintroduction success and wild fish recovery goals.

Fall Chinook

- Lewis River fall Chinook are healthy and able to sustain directed harvest in most years.

- If the 1980-1998 average Lewis River return of about 11,000 wild fall Chinook were to continue, then the combined ocean and freshwater expected harvest would be **5,800** fish.

Coho (early and late stock combined)

- Increase in Lewis sport harvest will occur if adult hatchery production goals are attained and Ocean/Columbia River harvest remains similar to the near-term.
- Combined ocean and freshwater annual expected harvest could range from **23,700-25,400**, depending on the production goal option selected.
- Reduction in lower river hatchery smolt releases associated with the reintroduction effort could result in proportional reductions in harvest until such time that wild harvest is allowed.
- Regulatory changes associated with protection of introduced fish may also reduce future harvest until runs are stable.
- Consideration for future harvest of natural fish in the lower and upper Lewis is dependent upon reintroduction success and wild fish recovery goals.

Steelhead (winter and summer)

- The current steelhead harvest exceeds expectations because steelhead returns are greater than expected under the current smolt production.
- Annual freshwater expected harvest could range from **5,700-9,300 (summer and winters combined)**, depending on the adult production option selected.
- Reduction in lower river hatchery smolt releases associated with the reintroduction program could reduce harvest proportionally.
- Regulatory changes associated with protection of introduced fish may also reduce harvest.
- Consideration for future harvest of natural fish in the lower and upper Lewis is dependent on reintroduction success and wild fish recovery goals.

Kokanee

- Current program is producing **15,000 – 28,000** kokanee harvest.
- Merwin program is dependent on Speelyai hatchery production.
- Yale program is dependent on wild production from Cougar Creek.

Rainbow Trout

- Current catch rate is reduced from historic rates. Options to improve catch rate could be considered, including stock, and release size options or reverting to the previously successful management approach, including use of Goldendale stock.
- Future harvest may be affected by regulatory changes associated with reintroduction and bull trout management measures.

Recommended Harvest Objectives

Spring Chinook

- Selective fisheries for hatchery fish unless natural fish considered harvestable.
- Maintain harvest opportunity in ocean, Columbia River and Lewis basin fisheries.
- Establish criteria and time frame for upper watershed harvest.

Fall Chinook

- Directed harvest on wild fish in years when escapement goal is met.

- Maintain ocean, Columbia River, and Lewis basin fishery opportunity.

Coho

- Selective fisheries for hatchery fish unless natural fish considered harvestable.
- Maintain harvest opportunity in ocean, Columbia River and Lewis basin fisheries.
- Establish criteria and time frame for upper watershed harvest.

Steelhead

- Selective fisheries for hatchery fish unless natural fish considered harvestable.
- Maintain Columbia River and Lewis basin harvest opportunity.
- Establish criteria and time frame for upper watershed harvest.

Kokanee

- Support harvest opportunity for hatchery kokanee in Merwin Reservoir and for natural kokanee in Yale Reservoir.

Rainbow Trout

- Support trout harvest opportunity in Swift Reservoir.
- Strive for pre-1996 angler success. Fish per hour may improve with return to Goldendale stock.

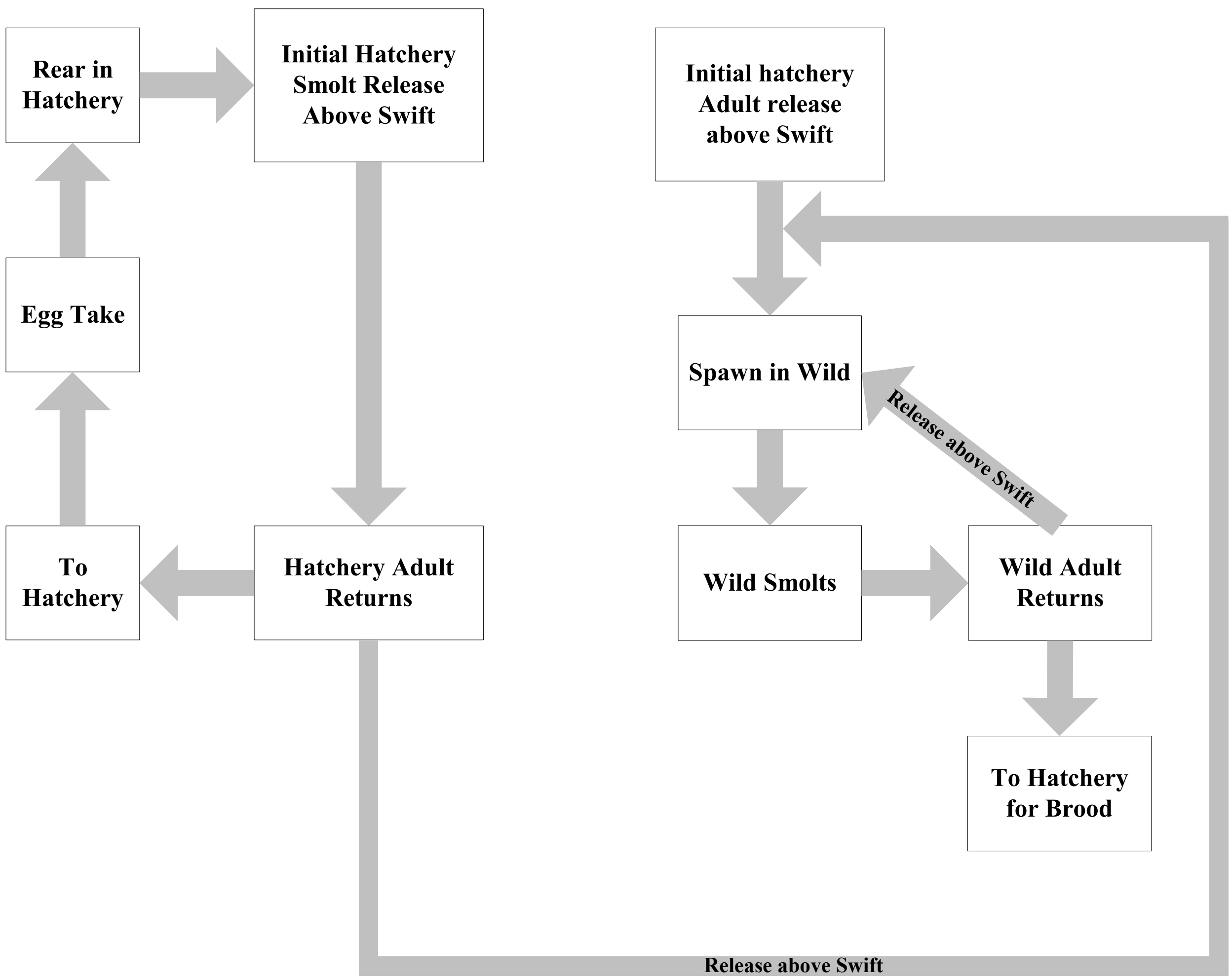
V. SUPPLEMENTATION AND REINTRODUCTION PROGRAM

The initial reintroduction program will focus activities above Swift Dam only. Knowledge and understanding gained from the reintroduction into Swift will be used to determine how the reintroduction program would move into Yale and Merwin reservoirs. The Swift only strategy will be conducted first because tributaries of Swift reservoir appear to support substantial historic spawning area and to have the greatest production potential of the three reservoirs based on EDT and Salmon PopCycle Models (Norman and Cramer 2003). The Swift only strategy will assure hatchery operations and monitoring and evaluation (M&E) program activities are focused and increase the probably of detecting successes and failures. A strategy that initially includes reintroduction into all three reservoirs would triple hatchery and M&E work load likely resulting in logistical errors, and reduced data precision, accuracy, and timely reporting. We are not discounting the importance of reintroducing focal species into the Yale and Merwin reservoirs, but recommend a step-wise approach to assure program success, and to ensure the ability to measure progress and adaptively manage program activities. Once the program has matured, logistical errors will be minimized and reintroduction into Yale and Merwin has a higher probability of succeeding. Yale and Merwin reintroductions strategies should be assessed after 10 years of implementing the Swift only strategy.

The reintroduction strategy relies on two life stages: adults and smolts. Initial releases of adults above Swift Dam will be of returning hatchery adults for a period of one generation. After one generation, the wild returning adults and adults for hatchery smolts will be released above Swift Dam. Smolts will be released for two generations. Initial smolt releases will be from hatchery progeny. During the second generation of hatchery smolt releases, the goal will be to release only smolts from wild returning adults provided sufficient numbers of wild adults return to meet first the adult release above Swift Release minimum release goals and then hatchery needs. Appendix Figure D- 12 provides a schematic reintroduction program. Within two generations, the goal is to have sufficient numbers of wild adults returning to support the reintroduction program and eventually support hatchery needs associated with the harvest program.

Egg and presmolt (fry and fingerlings releases) above Swift Reservoir were considered but, rejected for the following reasons: the primary objective of the reintroduction program is to maximize the number of returning adults for natural spawning. Egg and presmolt releases would have lower survival than smolt releases and therefore was avoided. Eggs reared in hatch-boxes are logistically difficult to operate requiring continued maintenance due to supply line freezing and freshets silting eggs. Presmolt release survival would likely be lower than smolt releases limiting the number of returning adults. Finally, we attempted to minimize program complexity to avoid logistical errors and increase M&E program data power. Egg and presmolts releases would add to the complexity and therefore was counter to established objectives.

A high priority should be placed on the M&E program to measure the successes and failures of the original and reintroduction program. The M&E program will document progress towards achieving performance standards, remove critical uncertainties, and facilitate adaptive management. The Swift only approach will help isolate the factors impeding program success. Limiting activities to one area will allow for greater power interpretation and insure a program that is able to detect and surmount obstacles. Furthermore, any decision to alter program should be based on performance standards and be agreed to prior to program implementation. The adaptive management section of the report provides an adaptive management road map by suggesting performance standards that require M&E program attention.



Appendix Figure D- 12. Reintroduction schematic.

Goals

Create a self-sustaining population of spring Chinook, coho, and winter steelhead above Merwin Dam with the populations dependent on trap and hauling adults between Merwin trap and Swift reservoir and trap and hauling smolts between Swift Dam to below Merwin Dam.

The following issues are addressed in the hatchery reviews to inform decisions regarding the supplementation program and reintroduction effort upstream of Swift Dam. Those issues are:

- Stock selection for supplementation.
- Multiple or single species to initiate reintroduction.
- Life history stages for supplementation.
- How many supplementation fish and for how long?
- Acclimation or direct release of supplemented smolts.
- Release method in lower Lewis.
- Adaptive management strategy.

Stock Selection for Supplementation

Spring Chinook

Spring Chinook historically spawned in the upper Lewis. Native spring Chinook returning to the river were used for initial Lewis Hatchery brood, but did not perform to expectations. Beginning in 1972 other stocks were introduced to rebuild the spring Chinook hatchery program including Cowlitz, Kalama, Carson, and Klickitat stocks. By 1987, the hatchery program was self-sufficient relying on fish returning to the Merwin trap and the hatchery ladder for brood. As a result, the Lewis River spring Chinook hatchery program was influenced by non-indigenous hatchery stocks, but the current hatchery stock is the only known stock to be adapted to the Lewis River and available for the reintroduction program. The Lewis Hatchery fish are genetically similar to Cowlitz Hatchery spring Chinook.

Coho

Coho historically spawned in the headwaters of the Lewis River. The upper Lewis historical returns are believed to be primarily early-timed stock, while late coho primarily returned to the East Fork Lewis and lower Lewis. The early Coho (type s) hatchery program is believed to be linked to native Toutle River stock. The early stock is available at the Lewis River and is likely best suited for the reintroduction program . Early stock was also selected over late stock to provide a lower harvest level (i.e. lower harvest rate for early stock compared to late stock) and allow for late summer early fall adult collection.

Steelhead

Most lower Columbia River winter steelhead hatchery programs in Washington have been developed from Skamania (Washougal River), Beaver Creek (Elochoman), or Chambers Creek (Puget Sound) stocks, except for the 'late' winter steelhead program in the Cowlitz River which has utilized local broodstock. Winter steelhead stocks have been exchanged freely among the lower Columbia River hatcheries. For example, the Beaver Creek stock was developed from Chambers Creek, Tokul Creek, and Cowlitz River stocks while the Skamania stock was developed from Washougal River and Beaver Creek stocks. The Cowlitz 'early' winter steelhead program utilized Chambers Creek, Beaver Creek, and local stocks for broodstock. The current Lewis winter steelhead program was developed from Beaver Creek and Skamania stocks, and is likely not a good choice for reintroduction. However, wild late returning adult winter steelhead have been trapped at Merwin and returned to the lower Lewis. These fish would be the obvious first choice to develop a wild steelhead broodstock in the Lewis. It is however, uncertain if enough wild fish could be trapped at Merwin to support a reintroduction program.

Availability of wild winter steelhead from other Washington tributaries of the lower Columbia for broodstock development is limited. Two wild winter steelhead hatchery programs currently exist on the lower Columbia: Elochoman, Cowlitz, and Kalama river wild winter steelhead. Each program is relatively new; the Elochoman River program began collecting broodstock with the 2000 brood year and Kalama River broodstock collection began with the 1998 brood year. These programs are focused on supporting natural production and harvest within their respective basins.

The Kalama River population is the closest geographically to the Lewis River basin. Also, because of the recent development of a wild winter steelhead hatchery program on the Kalama River, facilities and operations are in place for collecting returning wild adults. Furthermore, the Kalama River winter steelhead population is potentially the healthiest of all lower Columbia populations and therefore would be the most able to withstand withdrawals from the population. Finally, Kalama wild winter steelhead have maintained the 'late' run timing characteristic of lower Columbia wild winter steelhead stocks; this timing would assist in segregating returning adults (and hence, emerging fry) of wild winter steelhead from coho salmon and hatchery winter steelhead populations in the Lewis River. For these reasons, Kalama wild winter steelhead appear to be an appropriate choice as a potential contingency broodstock for the proposed Lewis River wild winter steelhead program if sufficient wild steelhead could not be collected in the Lewis.

Kalama winter steelhead are part of the Lower Columbia ESU, which is listed as threatened under the ESA. Use of Kalama winters for Lewis reintroduction would require endorsement by NOAA Fisheries through the HGMP process and require an Incidental Take Permit. Potential legal complexities associated with future management of production from introduced listed steelhead should be discussed prior to implementation.

Recommended Stock Selection for Reintroduction

Coho

We recommended early Lewis coho for the reintroduction effort.

1. Historical information suggests early coho were predominantly upper Lewis River spawners.
2. Columbia River harvest rates on early stock coho are substantially less than late stock coho.

Spring Chinook

We recommend Lewis hatchery stock spring Chinook for the reintroduction effort.

1. Hatchery program has been self-sufficient since 1987.
2. The original wild stock has been extirpated.

Steelhead

We recommend Lewis wild winter steelhead with a Kalama winter stock contingency plan.

1. Late returning wild fish have been trapped at Merwin Dam in recent years and would be a preferred option for reintroduction broodstock if adequate numbers can be collected.
2. The Kalama River wild winter run has been incorporated into the Kalama Hatchery program and is part of the same ESU as Lewis winter steelhead. This could be a good contingency option if there are not sufficient numbers of late winter run in the Lewis and there is sufficient broodstock at Kalama.
3. The current Lewis River hatchery winter steelhead are derived from a composite of several hatchery origin stocks, including stocks from outside the Columbia River.

Supplementation Strategy by Species

Should the reintroduction program be implemented by supplementing one species at a time or should multiple species be supplemented at once?

Description

Introducing one species at a time would be consistent with a cautious approach to reintroduction. Data could be acquired and uncertainties addressed with one species before attempting others. The addition of one species at a time allows for hatchery operations to adjust to the reintroduction program at a slower pace, which could limit operational complexity and allow time for facilities to prepare for an expanded multiple species supplementation program. The single species approach simplifies the data acquired regarding critical uncertainties (such as collection efficiency) and enables response to obstacles prior to expanding to a multiple species program. If a one species approach were preferred, coho would be the most obvious species to begin the experiment. This is because the most suitable habitat for coho production is in the upper Lewis, hatchery surplus of coho can be expected in most years, pilot studies above Swift Dam determined successful production was possible and that an opportunity to collect juveniles existed. Data from the Cowlitz reintroduction experiment suggest coho smolts may be more catchable than other species (especially spring Chinook).

A multiple species initial strategy would increase the pace of the reintroduction effort and enable species-specific data to be collected early in the experiment. Species-specific data concerning preferred habitats, acclimation needs, residualism, survival, and collection efficiency would be available. Adjustments to strategies and facilities tailored to the needs of individual species could occur during early years of implementation. The multiple species strategy would provide the most comprehensive set of data to be reviewed and considered in the adaptive management plan. Another argument for a multiple species approach is to determine if obstacles for the most difficult species are possible to overcome. Spring Chinook may be the most difficult species to successfully introduce due to a number of circumstances. Spring Chinook have been the most difficult species to propagate in the Lewis hatchery program, they have been the most difficult to successfully collect as juveniles in the Cowlitz reintroduction experiment, they are more likely to need stress relief prior to release, they are the most likely to need acclimation time, and they are the most likely to have limited numbers available at the hatcheries. Therefore, adjustments can be made to accommodate spring Chinook, or if bottlenecks can be overcome for other species and not for spring Chinook, the program could continue with a full understanding of that reality.

Summary

A single species approach would simplify the data and enable significant bottlenecks to be addressed before expanding the program to multiple species. This approach would enable a phased approach for hatcheries operations and facilities. If a single species approach is favored, coho is the suggested species with which to begin with.

A multiple species approach enables the reintroduction experiment to move at a faster pace and, although monitoring and evaluation would be more complex, it would allow for species-specific needs to be recognized and addressed early in the program.

The multiple species approach would also provide the opportunity for utilization of habitats and natural production early in the program, resulting in a “jump start” from the experimental phase to full implementation.

Critical Uncertainties

1. *Information gained from a single species reintroduced could be applicable to the success of other species.*

   This approach would assume common obstacles (like collection efficiency) would need to be resolved before supplementation of other species would be initiated. The first species would act as a surrogate for the others, with success prompting reintroduction of other species.

2. *Benefits of detailed information gained from a multiple species reintroduction strategy will outweigh the complexities added to the M&E program.*

   Shared bottlenecks would likely be adjusted to meet the conditions needed for the weakest link. The objective of this approach would be to gain comprehensive knowledge early and adjust the individual species programs based on this knowledge.

Recommendation: Initiate a multiple species program to maximize knowledge from the onset of the program.

Life History Stages of Supplementation Above Swift Dam

Which life history stages of hatchery origin fish should be released above Swift Dam?

Discussion

Four life stages can be considered for use in the reintroduction program: eggs, pre-smolts, smolts, and adults. Eggs have been successfully incubated in either a hatch-box or in an artificial redd. The advantage of releasing this life stage is the increased chance that resulting fish will imprint to the incubation area and will return as adults to the same site to spawn. Furthermore, the eggs are incubated in a natural temperature regime, which provides for natural selection and may produce more robust fish than those reared on well water in a hatchery. Drawbacks of the hatch-box method are operation of the box is labor intensive, there is chance of mortality associated with frozen intake pipes and it is difficult to mark fish for research purpose. Drawbacks of using artificial redds are high egg mortality, and marking is not possible. Both methods assume the area chosen to incubate eggs contains prime spawning habitat, which may not be a correct assumption.

Pre-smolts are juvenile fish migrating into the Columbia River many months prior to smolting. A number of Columbia River hatcheries programs have conducted both forced and volitional pre-smolt releases with limited success. Pre-smolt releases are currently being re-evaluated as a conservation tool, but conclusive successes were not found in the literature. Pre-smolt releases are primarily conducted for spring Chinook. In a volitional release program, approximately 30% of the fish emigrate in the fall as pre-smolts. Conservationists believe facilitating pre-smolt emigration patterns will strengthen fish populations by encouraging multiple life history strategies in the hatchery, regardless of the poor survival exhibited by pre-smolts. A possible unaccounted benefit of the pre-smolt release program is the reduced density of spring Chinook held in the hatchery until smolting. Lower densities usually result in healthier fish. Analysis has been inconclusive as to whether or not facilitating alternate life history patterns benefits population fitness thereby outweighing the documented low pre-smolt survival (population abundance).

Smolts are the commonly used life stage for reintroduction and supplementation programs. The strongest aspect of a hatchery is the high egg to smolt survival in comparison to the wild. As a result, it takes 10 to 100-fold fewer eggs in a hatchery than in the wild to produce the same number of smolts. However, hatchery smolts are not well adapted for life in the natural environment and therefore experience lower survival from smolt to adult in comparison to wild fish. Nonetheless, hatchery smolts are the standard for release, and supported as such in a large body of literature suggesting smolt releases increase adult returns. The same body of literature indicates that when smolt releases are discontinued in most cases the fish population slowly decreases to a small core population vulnerable to extinction during catastrophic events. Smolt releases are a logical selection for playing a part in the reintroduction program but will probably not result in a healthy self-sustaining population. Primarily because smolt releases increase population abundance but population fitness is low due to releases of maladapted hatchery smolts in natural habitat.

Adult releases may help ameliorate the risk of a perpetual smolt release program and may also out perform egg or pre-smolt release strategies. Hatchery origin adults, released above Swift Dam, will have the opportunity to select spawning areas which theoretically provide higher survival than if human determined spawning sites were selected and redds artificially created. Eggs incubated in natural redds will imprint to the spawning site and will likely return to the same spawning area. Also, naturally spawned eggs will be subjected to natural selection, which will select for fish adapted to the upper river conditions. Finally, resulting pre-smolts and smolts will be able to leave the river volitionally, thereby fostering natural multiple life history strategies. A possible pitfall to the adult releases is that adults may experience significant pre-spawn mortality due to trapping, holding, or transport stress. If pre-spawn mortality is a problem, then adults will contribute little to the reintroduction program. Another issue could be that in years of low hatchery returns fewer adults maybe available for a reintroduction program. Further, years of high precipitation or glacier melt may cause very low survival of adult progeny.

Summary

The combination of a smolt and adult hatchery release program will blend two primary elements needed in a reintroduction program: abundant founding population (smolts), and a mechanism to increase population fitness (natural progeny). Together these two strategies are complementary and safeguard against failure by either life stage due to poor ocean survival and catastrophic losses. Egg and pre-smolt releases may be a desirable strategy to explore once lessons are learned from the adult and smolt release. However, since the adult release would include a majority of the advantages associated with egg and pre-smolt releases, this strategy would be redundant and not necessary unless the adult releases were not performing as anticipated.

Critical Uncertainties

1. *Hatchery smolts and adult progeny will be able to effectively migrate to the vicinity of the emigrant traps and be efficiently collected by the trap.*

   The success of all or any release strategy will hinge largely on effectively trapping and transporting emigrants from above Swift to the lower river. Lack of success in this area could cause this project to fail. As a result, the first research priority would logically be to test the trapping ability of the emigrant trap. Not only for smolts but also for other life stages of all three species using hatchery fish.

2. *Hatchery adults will survive the trap, haul, and release above Swift Dam with low pre-spawn mortality.*

   Of second primary concern is the pre-spawn survival and spawning success of hatchery adults. Thoroughly contemplated studies would track adult distribution, survival and spawning success, with the primary focus placed on pre-spawn survival.

3. *Hatchery adults will find high quality habitat and spawn resulting in adequate egg-to-smolt survival to contribute to adult return goals.*

The egg to smolt survival arising from the released adults should be studied through emigrant trapping, emergent traps, or other methods to determine the survival of the adult progeny in order to determine the success of the adult reintroduction activities within a specified timeframe.

4. *Hatchery smolt and adult progeny will attain SARs adequate to build a wild naturally spawning population above Swift.*

   Even though smolts and natural progeny successfully emigrate and are trapped and hauled to the lower river, this does not guarantee adult returns. Return rates should be compared to the harvest program and index stocks to determine if they are consistent with other basins. If survival is lower than comparative populations then other studies should commence to investigate possible reasons (i.e. disease, post-release mortality, straying, etc.)

Recommendation: Initiate supplementation using both smolts and adult life stages.

Management and Duration of Supplementation

What is the acceptable number of hatchery smolt and adult releases and duration of hatchery releases for the reintroduction program?

Discussion

A multitude of factors play into deciding the number of smolts and adults to be released above Swift Dam. The three most contemplated were receiving habitat, cumulative survival (egg to adult), and hatchery facility operations. The EDT habitat assessment estimated a carrying capacity under current conditions for above Swift Dam to be approximately 2,400 spring Chinook, 12,600 coho, and 2,400 steelhead adults. These estimates assume an average marine survival factor for wild produced smolts. The EDT model does not consider the effect of dam passage or other downstream population limiters such as harvest. The Salmon PopCycle model took the EDT estimates and considered all significant population stressors from egg to returning adults above Swift Dam. The PopCycle model estimated a sustainable adult population above Swift Dam under current habitat conditions at 6,200 coho, 1,200 spring Chinook , and 1,400 steelhead. The reintroduction program was presumed to occur in the near future (over the next 20 years). As a result the effect of habitat improvements was not expected to improve carrying capacity during the initiation of the reintroduction program, because large scale habitat improvement will likely take 30 or more years. In addition, it will likely take a longer period to associate habitat improvements with significant salmonid abundance and fitness enhancements.

A range of smolt and adult release numbers and duration of release was investigated in order to identify a reasonably sized program with a high likelihood of success (Appendix Table D- 15). The modeled release numbers were determined based on typical hatchery programs in the Columbia Basin. Smolt and adult releases were mixed and matched with varying duration and the resulting population response was simulated for 50 years using the PopCycle model.

When the minimum smolt and adult releases for the minimal duration (2 years) (Appendix Table D- 16) was modeled the population did grow and reach carry capacity after 30 or more years. The slow rate of population growth indicated that this release strategy would be subject to failures if catastrophic events occurred and assumed survival rates were too optimistic.

Moderate release number of smolts and adults for a moderate duration (2 to 25 years) (Appendix Table D- 17) indicated a strong population response for the first 10 years exceeding carrying capacity. By the end of 10 years density dependent mortality caused the population to compensate to reach the expected carrying capacity. Moderate releases for a moderate duration appear to allow for the population to have supply fish earlier in the program which would speed adaptation to the upriver environment, provide harvestable surplus within two generation of production, and provide a buffer in case of catastrophic events and lower than assumed survival. Maximum releases for maximum duration (Appendix Table D- 18) acted similar to the moderate release providing an even greater population of adults for a longer period of time.

Appendix Table D- 15. A range of alternative hatchery release numbers and duration used to model resulting population abundance via the PopCycle model.

	Number Released			Duration Years
	Coho	Steelhead	Spring Chinook	
Smolts	0 50,000 100,000 200,000	0 10,000 20,000 40,000	 50,000 100,000 200,000	50 5 2, 5, 10, 25 5
Adults	0 250 500 1,000 2,000	 100 200 400 800	 250 500 1,000 2,000	50 2 2, 5, 10, 25 2 2

Appendix Table D- 16. Low Option

	Smolts		Adults		
Species	Number Released	Duration (years)	Target Number Released	Max. No. Released[1/]	Duration (years)
Coho	100,000	3	250	3,100	2
Steelhead	10,000	5	100	700	2
Spring Chinook	50,000	5	250	600	2

[1/] Based on 50% carrying capacity.

Appendix Table D- 17. Medium Option

	Smolts		Adults		
Species	Number Released	Duration (years)	Target Number Released	Max. No. Released[1/]	Duration (years)
Coho	200,000	6	500	6,200	3
Steelhead	20,000	10	200	1,400	5
Spring Chinook	100,000	10	500	1,200	5

[1/] Maximum number of hatchery adults that might be released above Swift Dam based on expected spawning equilibrium numbers (from PopCycle), if adult surpluses exist.

Appendix Table D- 18. High Option

	Smolts		Adults		
Species	Number Released	Duration (years)	Target Number Released	Max. No. Released[1/]	Duration (years)
Coho	200,000	9	2,000	9,300	6
Steelhead	40,000	15	800	2,100	10
Spring Chinook	200,000	15	1,000	1,800	10

[1/] Based on 150% of carrying capacity.

Summary

The PopCycle model results indicate a medium option approach would have a high probability of successfully reintroducing fish. This approach provides reasonable assurance that there would be fish available from the hatchery program adult returns, and the opportunity to rear fish for supplementation purposes without a major overhaul of the hatchery facilities. A large smolt and adult supplementation program would increase the chance that fish would not be available without compromising the 86,000 adult hatchery production goal and facility space may be more limiting. The minimal approach would likely have fish available consistently and would provide little stress on facilities, however, would probably not provide sufficient numbers to achieve a successful reintroduction program.

The duration of a hatchery supplementation program should be re-visited, depending on outcomes, as part of an adaptive management program. The initial strategy should seek to balance the need for supply-fish early in the program to adapt to environmental conditions and enable production to occur while performance stressors are discovered and corrected. This could be followed by the need to reduce first generation hatchery influence over time to enable natural adaptation traits to be developed and to increase fitness of the species. Based on these considerations, Appendix Table D- 19 outlines the number and duration of releases which we believe represent the greatest likelihood of success.

Appendix Table D- 19. Recommended hatchery supplementation strategy

	Smolts		Adults		
Species	Number Released	Duration (years)	Number Released	Max. No. Released[1]	Duration (years)
Coho	200,000	6	500	6,200	3
Steelhead	20,000	10	200	1,400	5
Spring Chinook	100,000	10	500	1,200	5

[1] Maximum number of hatchery adults released above Swift Dam based on expected spawning equilibrium (Salmon PopCycle), if adult surpluses exist.

Critical Uncertainties

1. *The average survival rates used to model program success are representative of future conditions and large annual swings in survival will not affect the average survival over a long period.*

   There is question as to whether ocean conditions (the single largest survival factor) will become better or worse in the future. Accurate predictions of future ocean survival do not exist and therefore our recommendations are tentative. Additionally, the EDT and PopCycle analyses use average marine survival estimates for wild fish and apply these to fish reintroduced into the upper Lewis. Realistically these fish may experience survival more similar to hatchery production than wild production in the initial years. This would result in lower production then projected for the early years. The program should be designed to adjust the duration and number of smolts and adults released based on comparisons to index stocks and progress towards meeting program goals. Furthermore, other survival factors such as smolt trapping efficiency, adult spawning success, and unforeseen environmental events will likely require changes to the program. If survival is poor in the initial years of the reintroduction experiment due to low marine survival, flooding, or hatchery operational problems resulting in poor first and second generation performance, should the duration of the release program be extended or the experiment determined to be a failure? The M&E program will hopefully isolate the reasons for any unexpected performance.

2. *Hatchery adults and smolts will be available for the reintroduction program without impacting the harvest program.*

   The availability of hatchery smolts and adults will be dependent upon annual marine survival and decisions concerning the number of smolts reared at the hatcheries, and facilities to support hatchery rearing and the supplementation program. There will also be variability in annual marine survival and availability between species in a given year. Consideration should be given to revisit species-specific supplementation numbers in a given year under circumstances where a particular species is not available.

Abundance Based Distribution of Hatchery Returns

The following (Appendix Table D- 20- Appendix Table D- 22) provides a framework for distribution of smolts and adults between the hatchery and supplementation programs. This approach is abundance-based and reflects total smolt production programs (combined hatchery and supplementation) of 1.35 million spring Chinook, 2.0 million coho, and 275,000 steelhead. The adult return triggers reflect broodstock needed to meet smolt production as well as adults used for supplementation. A framework plan (such as this) is needed to enable hatchery personnel to have clear annual operational guidance. The criteria are expected to be adjusted in the future as part of the AMP.

Appendix Table D- 20. Spring Chinook hatchery and supplementation distribution matrix.

Hatchery Adult Return	Hatchery Program Smolts	Supplementation Program Smolts	Supplementation Program Adults
≤ 800[1/]	≤ 1,050,000	0	0
801-875[2/]	1,050,000	Up to 100,000	0
876-1,375[3/]	Up to 1,250,000	100,000	Up to 500
≥1,375[4/]	1,250,000	100,000	Up to 1,200

1/Hatchery minimum program of 1,050,000 smolts, Cowlitz stock contingency for backfill considered to enable supplementation.

2/Hatchery program not increased until 100,000 supplementation smolts and 500 supplementation adults attained.

3/Supplementation adults prioritized after minimum hatchery program and supplementation smolts objectives attained.

4/Hatchery smolt expansion to 1,250,000 prioritized before supplementation adults increased above 500.

Note: Supplementation level adjustments considered based on future natural returns as part of AMP.

Appendix Table D- 21. Early coho hatchery and supplementation distribution matrix.

Hatchery Adult Return	Hatchery Program Smolts	Supplementation Program Smolts	Supplementation Program Adults
≤ 2400[1/]	780,000-880,000	0 - 100,000	0
2,401-3,450[2/]	880,000	200,000	Up to 500
>3,450[3/]	880,000	Up to 200,000	Up to 6,200

1/ Minimum hatchery program of 880,000 early coho smolts unless late hatchery coho program can be increased by 100,000 smolts to assure minimum combined program of 1.8 million smolts.

2/ Once hatchery program and 100,000 supplementation smolts are attained adult coho can be used for supplementation. Once 500 adults supplementation attained, increase smolt supplementation up to 200,000.

3/ Supplementation adults increased above 500 once full hatchery and supplementation smolt objectives met.

Note: Supplementation level adjustments considered based on future natural returns as part of AMP.

Appendix Table D- 22. Winter steelhead hatchery and supplementation distribution matrix.

Hatchery Adult Return[1/]	Hatchery Program Smolts	Late Winter Adults[2/]	Supplementation Smolts	Supplementation Adults
400	1000,000	80	20,000[3/]	0
		>80[4/]	20,000	Up to 1,300

1/ Current Lewis hatchery early winter composite stock.

2/ Late wild winters steelhead trapped at Merwin Dam for broodstock development.

3/ If less than 80 Lewis fish, consider late winter stock from Kalama Hatchery as contingency to backfill supplementation adults.

4/ If less than 150 Lewis fish, consider up to 50 late winter Kalama adults for adult supplementation.

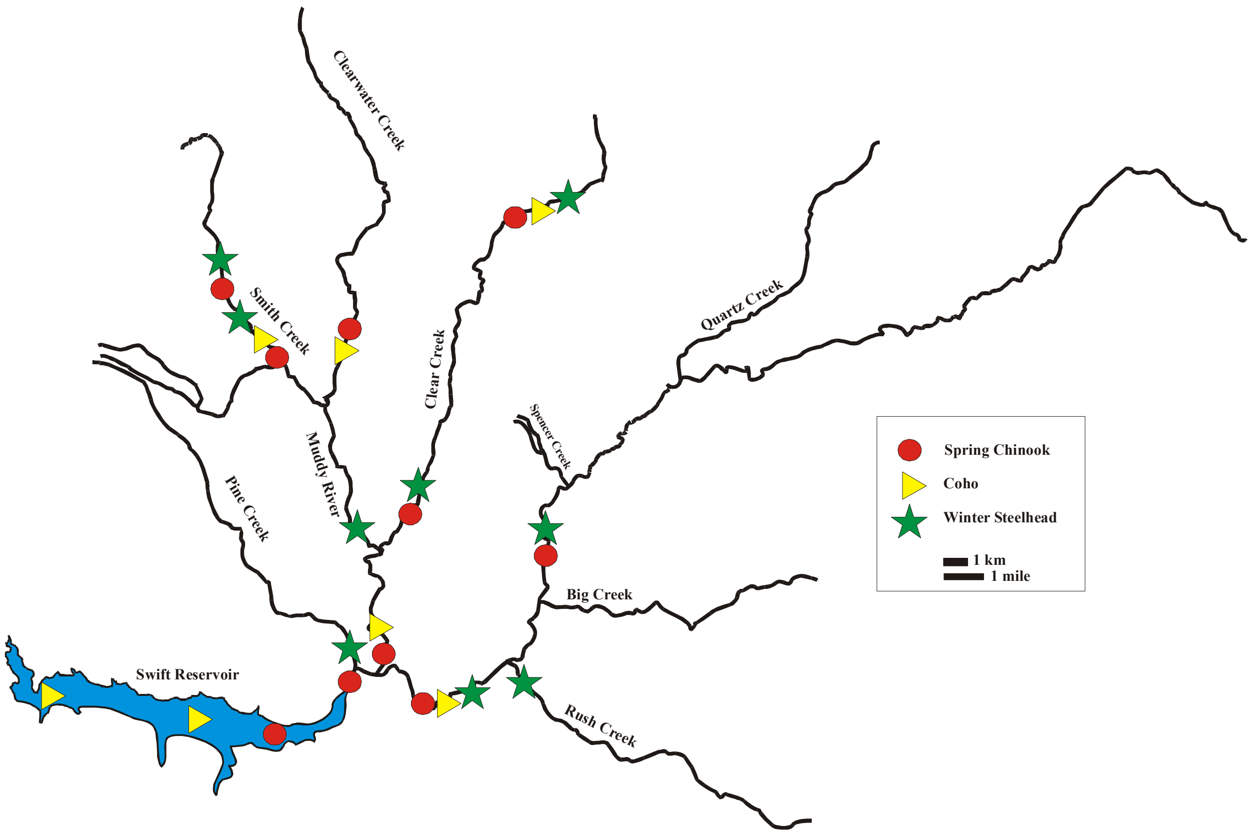
Note: Supplementation level adjustments considered based on future natural returns as part of AMP.

Hatchery Smolt Release Strategies Implemented and Tested

Which hatchery smolt release strategies should be implemented and tested?

Description

Appendix Figure D- 13 displays potential release sites for smolts and adults based on most productive habitat based on the EDT analysis.



Appendix Figure D- 13. Possible adult and smolt release locations. Based on most productive habitat. NOTE: the Swift Reservoir smolt plant areas shown for the Muddy River above Clear Creek, Smith Creek, Clearwater Creek and upper Clear Creek are not accessible by truck.

Two smolt release strategies are considered: acclimation and direct release. Acclimation facilities are typically ponds or temporary raceways adjacent to the stream at a desired return site. Fish are held for 2 days to 3 months and volitionally released as smolts. Direct releases are, as implied, smolts trucked to a release site and released. Five factors play a pivotal role in the selection of a release strategy: 1) what species will be released? 2) is imprinting to the release site needed to insure that adults will return and spawn in the release area for all species? 3) is short-term post release survival an important factor? 4) are adult returns to multiple sites a goal? 5) is limiting the release of residual fish above Swift Dam a goal?

Fish species has the greatest influence on selecting a release strategy. The literature suggests coho and steelhead smolts imprint within two to three days of rearing whereas spring Chinook may need up to 30 days. Consequently, acclimation facilities may be warranted for spring Chinook, but not for coho or steelhead. The survival benefit of acclimation over direct release is disputable. Studies have produced variable results ranging from greater survival of acclimated fish to no difference between acclimated and direct releases. Steelhead appear to gain the lowest level of survival benefits from acclimation, coho gain intermediate survival benefits and spring Chinook experience the greatest survival benefit. The distribution of spring Chinook, coho, and steelhead should be considered. Large releases at few sites concentrate fish (typical of acclimation strategy) and can cause low post-release survival due to high level of competition, vulnerability to concentrated predators, and local catastrophic events (e.g. mud slide). Direct release has the flexibility of releasing fish at multiple sites and may result in augmented survival by reducing competition, predation and the effect of catastrophic events by increasing the distribution of the fish. Finally, acclimation with volitional release is a successful method to remove precocious males from the release population. Fish that do not volitionally move out of the acclimation pond are considered “residuals”. The majority of residual fish are precocious males usually considered an undesirable by-product of hatchery rearing. Acclimation facilities allow the removal of residuals whereas direct releases will not.

Summary

The release strategy most suitable for the reintroduction program is not clear because of conflicting results in the literature. Success or failure of a release strategy appears to be strongly associated with the program goal, fish species, environmental setting and the fine details within the strategy. As a result, it may be prudent to test the benefits of acclimation and direct release. The experiment might test the release site affinity of adults, post release survival of smolts, and residualism rates by comparing acclimated versus directly released fish. Spring Chinook might be the best initial test subject for this experiment. The literature suggests spring Chinook received the greatest benefit from acclimation and therefore the M&E program would likely detect differences in performance between the release strategies. However, logistical problems with appropriate sites and weather conditions precluding access may prove difficult to overcome in implementing an acclimation option. An alternative may be rearing sites in the Swift power canal to assure, at a minimum, adult spring Chinook imprinting to Merwin Dam trap. Adults would then be manually distributed upstream of Swift Dam. The coho and steelhead program might begin with direct releases and if adults show high straying rates or low post smolt survival then acclimation test could be considered. The success of the reintroduction program will hinge, in part, on the post-release survival of hatchery smolts. It would be prudent to explore all options available to increase fish survival, of which the release strategy may play an important part.

Critical Uncertainties

1. *The release strategy (acclimation versus direct release) will have a significant affect on straying of returning adults and post-release survival of hatchery smolts.*

   An option exists to operate a temporary portable acclimation facility and conduct matched release experiments by releasing equal numbers of acclimated and directly released fish above Swift Dam (see previous note). Based on survival comparison between groups determine if acclimation provides a great enough benefit to warrant the cost.

2. *Homing of adults to productive spawning areas will be affected by acclimation.*

   Adult releases can be monitored to assess if the fish are distributing to prime spawning areas.

Strategies for Release for Release into the Lower Lewis

Which initial smolt release strategy should be implemented and tested on smolts captured in Swift Reservoir and trucked to the lower river?

Description & Summary

Smolts captured in the outmigrant trap above Swift Dam will be held for a period of time, loaded into a truck and transported to the lower river and released. The stress associate with the collection and transport process may result in low survival. A method to increase survival may be a rest/relief pond. The literature contained one analysis of survival benefits from a rest/relief pond. Steelhead were the test subjects and were allowed to rest for a 24-hour period before release. A second group was released directly to the river. The survival between the two groups was the same. However, it was not determined if 24 hours of rest and recovery was adequate. Further, steelhead are known for their hardiness and it is not known if spring Chinook would exhibit the same results. Survival information on a directly released group compared to rest/relief pond fish could benefit the program. Poor survival due to a release method is likely surmountable and should be tested. Initial tests could be conducted using temporary portable raceways to limit costs.

Recommendation: Construct a stress relief pond in the lower Lewis to measure handling mortality and improve survival.

Alterations to the Reintroduction Program

To what degree should the Implementation Team consider alterations to the reintroduction program?

Description

Implementation of the reintroduction program will require changes as new information is gathered from the M&E program and hatchery operators. Three levels of decision will be made during the reintroduction program. The first level is the monthly and annual operations decisions, which will consider hatchery and M&E program operations. Decisions would include reviewing and improvement of the logistical aspects for items such as fish marking, adult trapping, and fish releases.

The second level of decision is short-term programmatic changes to compensate for unforeseen obstacles, implementation delays, or M&E results. This type of decision may include changes in the number of fish released into Swift to allow for harvest of hatchery fish during consecutive years of poor ocean survival.

The third level of decision is changing the long-term attributes of a program. For example, after 5 years of failing to obtain adequate trap efficiency at the smolt outmigrant trap in Swift Reservoir, a decision may be made to alter the trapping facility or change the strategy.

An Implementation Team concept would be an appropriate group to make decisions. Of central importance is the latitude given to an Implementation Team in decision making. The choice is whether to empower the Implementation Team to work creatively together finding solutions to complex problems with the most current information or to rely on pre-arranged solutions that were contemplated during the creation of the implementation plan. Both choices represent adaptive management approaches. The differences lie in whether adequate information is available at the time of plan formation to adequately characterize obstacles and potential solutions, or data collected during implementation that would provide greater insights allowing for solutions not anticipated during the plan formation.

Regardless of decision empowerment, the Implementation Team will need to make decisions on a periodic basis. The following are examples of the types of decisions the Implementation Team will face:

Implementation of Reintroduction Experiment

How aggressive should implementation of a reintroduction experiment be?

Three examples are provided as a means to explore the balance between treating the reintroduction program as an experiment with maximum Implementation Team empowerment or as a means to achieve adult abundance goals with little Implementation Team involvement (Appendix Table D- 23). The three examples are based on the priority of the harvest program in comparison to the reintroduction program and to what degree uncertainty requires resolution prior to committing to program changes. The **Single Step** option approaches the reintroduction program as a complicated experiment, requiring careful study and consideration at each implementation step. The pace of moving toward adult production goals would be slow. On the other extreme, the **Do It All** option assumes the experiment will work and therefore moves forward quickly with little energy spent toward monitoring progress or addressing uncertainty. The **Middle of the Road** option attempts to balance the need to conduct experiments with the benefit of moving at a pace that will allow for timely adult production goal attainment.

Appendix Table D- 23. Describes a range of implementation options for the reintroduction program.

Implementation Approach	Single Step	Middle of the Road	Do It All
Rate of Implementation	Deliberate	Moderate	Accelerated
Reintroduction Viewed as	A risky experiment requiring careful contemplative action.	Program has a manageable risk level provided a moderate level of resource and forethought are available.	This program does not require an experimental approach if ample resources are provided.
Critical Uncertainties	Investigate one uncertainty at a time, and each uncertainty requires attention. Program implementation decisions cannot be made without removal of significant uncertainties.	Investigate a number of related uncertainties, but until uncertainties are addressed make management decision based on low risk assumptions.	Investigate as many uncertainties as possible, but until uncertainty is addressed make all management decisions based on assumptions, regardless of risk.
Likelihood of Success	Low - Slow pace of implementation will minimize ability to adapt to changing environment limiting success – paralyzed by a lack of understanding and willingness to make decisions when uncertainty is present.	Moderate - Able to adapt at an appropriate pace and willing to accept moderate risk due to uncertainties.	Low - Fast pace of implementation will confound M&E results, limiting success because not able to adapt due to lack of understanding, and risk is not managed due to substituting assumption into significant critical uncertainties.
Initial Reservoir Priority	Swift.	Swift.	Swift.
Additional Reservoir Reintroductions	Yale 13 years and Merwin 17 years into the new license.	Based on success of Swift program to be implemented no earlier than 13 years into the new license.	Yale 13 years and Merwin 17 years into the new license.
Species Reintroduction Order	One species at a time in the following order: coho, steelhead and spring Chinook.	Two species initially: first coho and steelhead, two years later spring Chinook.	All three species at one time: coho, steelhead and spring Chinook.
When to Add an Additional Species	After first species meets trap efficiency milestones for all life stages.	After first and second species meet trap efficiency and adult pre-spawn mortality milestones.	Based on agreed period of release for each species regardless of meeting smolt or adult milestones.

Implementation Approach	Single Step	Middle of the Road	Do It All
M&E Initial Activities	Test smolt and adult trap efficiency with hatchery fish at Swift.	Test smolt and adult trap efficiency, hatchery adult pre-spawn mortality, and acclimated vs. direct release survival at Swift.	Test smolt and adult trap efficiency, hatchery adult dispersion and spawning success, and acclimated vs. direct release survival at Swift.
Hatchery Fish Life Stages Released	Smolts.	Smolts, adults and possible pre-smolts.	Pre-smolts, smolts and adults.
Number of Release Sites	One.	Two.	Three or more.
Release types	Direct releases.	Acclimation testing and direct releases.	Acclimated and direct releases
Number of Hatchery Adults and Smolts Released	Minimum releases numbers.	Median releases numbers.	Maximal releases numbers.
Duration of Reintroduction Experiment	Adults for one generation and smolts for two generations.	Based on achieving periodically negotiated milestones reflecting M&E findings.	Based on achieving periodically negotiated milestones reflecting M&E findings.

Example of Implementation

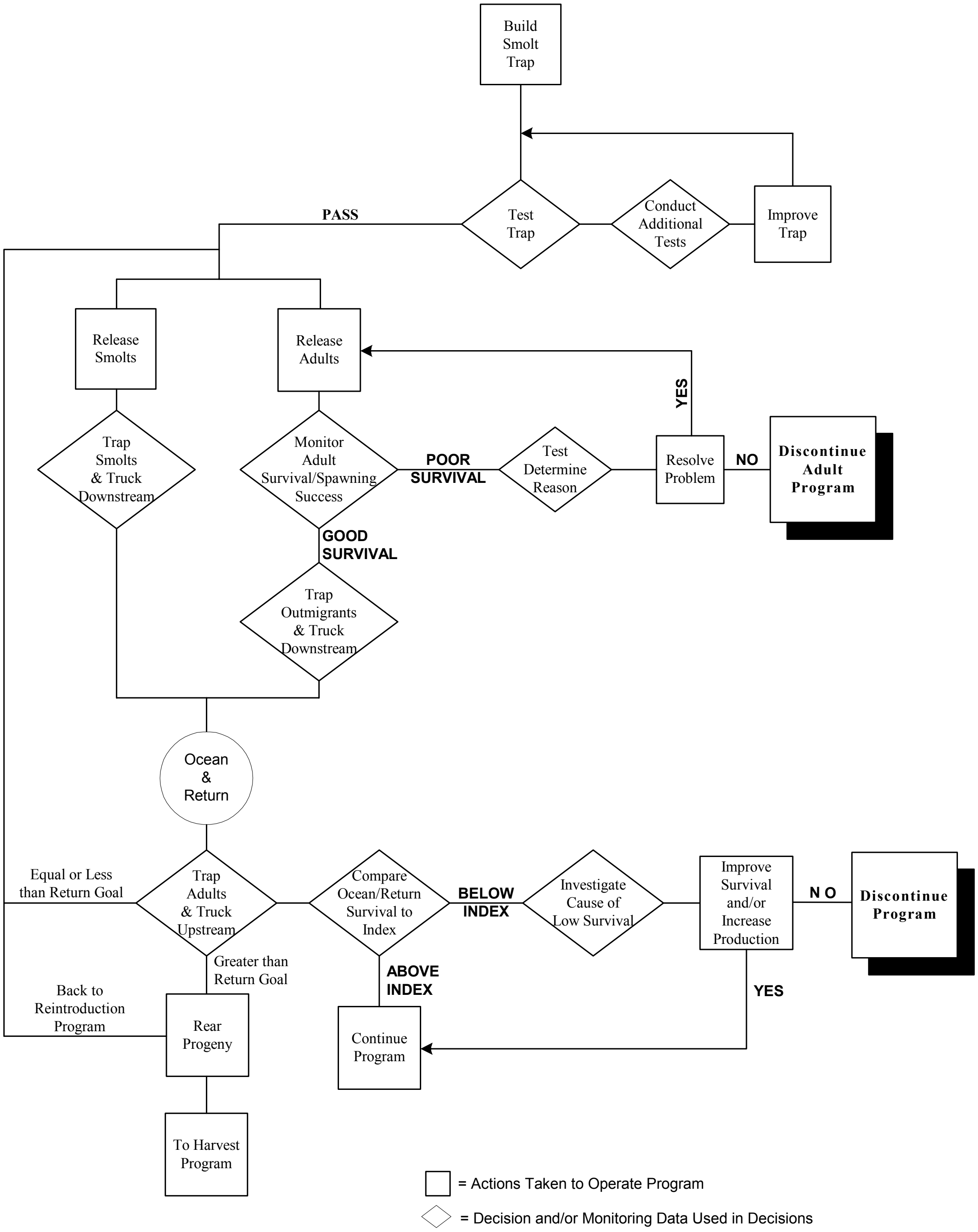
This document has provided a spectrum of approaches that could be used to manage the reintroduction program. This section explores the type and duration of activities and decisions that will require attention during the implementation of the reintroduction program. To simplify this document, the following discussion presumes the implementation strategy will follow close to the middle of the road implementation option (Appendix Table D- 23) and the moderate adaptive management approach (Appendix Table D- 25). **Note: to determine the type and timing of decisions that would be required of an Implementation Team, an implementation plan must be created. The Implementation plan will identify when and where uncertainties will be address and when M&E data will be sufficiently developed to facilitate implementation team decisions.** Our discussion merely provides a brief example of the type of decisions likely to be addressed by an Implementation Team

The reintroduction program is a multifaceted experiment that involves three species and many possible outcomes. As a result, careful consideration must be given to the experimental design with recognition of a need to meet adult return goals as soon as possible. As a rule of thumb, a strong experiment limits the number of variables associated with the study to limit synergistic effects among variables. In a complex reintroduction program, numerous variables are acting on the test subjects (reintroduced fish) and therefore an effort must be made to isolate variables. This means examination of as many external variables and life history aspects of the reintroduced fish as possible to isolate the effects of external forces on the fish population at each major life history stage.

Appendix Figure D- 14 charts the actions consistent with the middle of the road implementation and moderate adaptive management strategies. Rather than describe each step of the flow chart, we limited our attention to areas requiring key decisions to be made. The decision-makers would make program implementation decisions such as when to begin the reintroduction of coho/steelhead adults and smolts based on data gathered during tests of the smolt trap in Swift Reservoir. Furthermore, if the trap did not meet standards, the decision makers would select corrective measures from a suite of pre-determined options, which could range from redesign to minor operational fixes.

In this example, the next critical decision would be during the review of the hatchery adults released above Swift Dam. If the adult release to smolt survival does not meet the agreed to standards, the decision-makers would evaluate the need for additional studies or implement corrective actions. The decision-makers could go as far as to discontinue hatchery adult releases and implement other alternatives thoroughly described in an Implementation Plan.

Other pertinent issues for the decision-makers could be when to bring naturally produced adults from the Swift reintroduction into the hatchery for creating locally adapted hatchery stocks or discontinuing the reintroduction program earlier than planned due to poor survival owing to insurmountable factors.



Appendix Figure D- 14. Flow chart providing an example of actions and decisions.

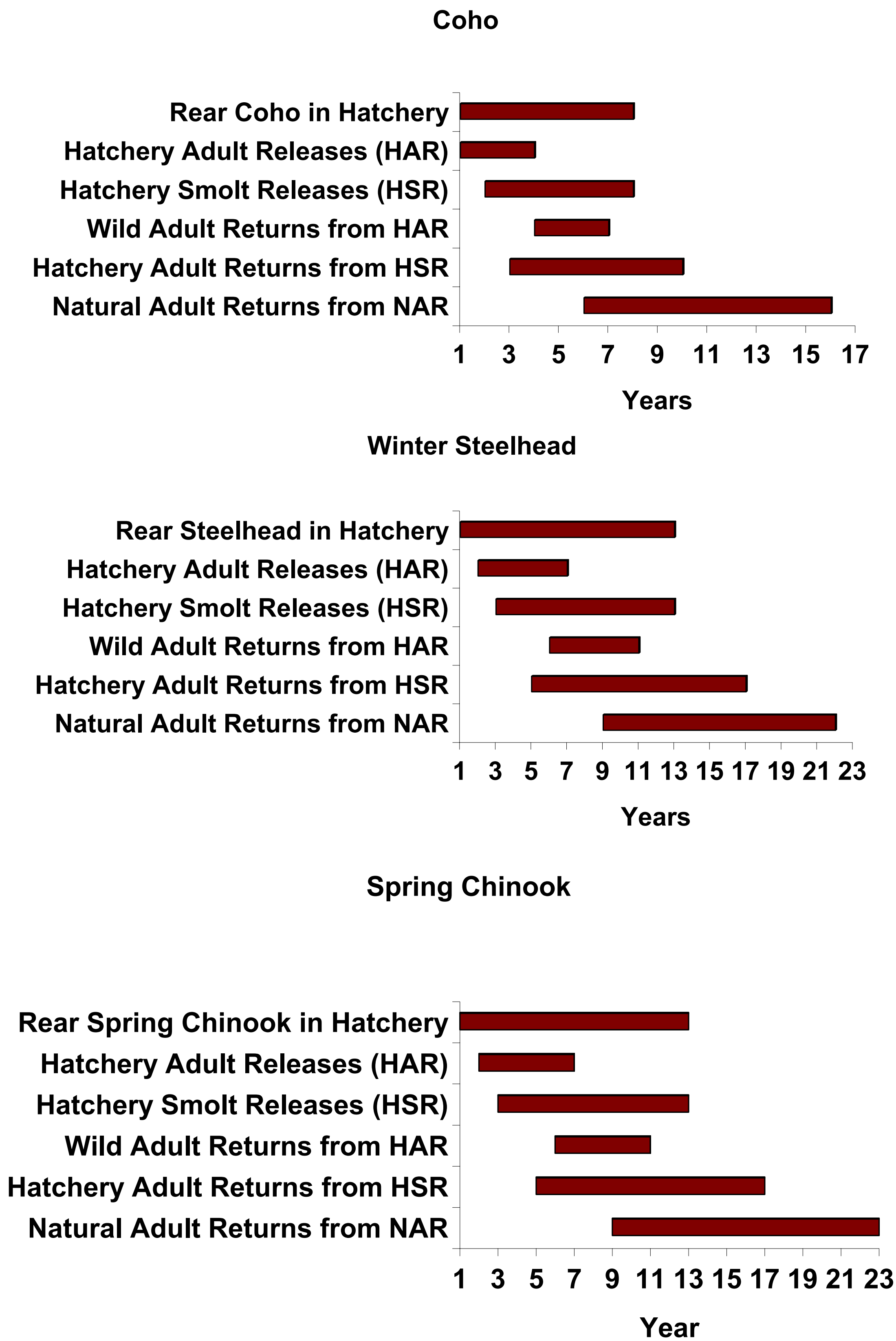
Reintroduction Timeline

An example for a reintroduction timeline is portrayed in Appendix Figure D- 15. This timeline attempts to outline the reintroduction activities consistent with the middle of the road example. The timeline does not identify the first year of operation, but start up is assumed to begin no earlier than 2006, when the FERC license is expected to be issued. However, the program may be implemented earlier or later based on considerations such as smolt collection facility design and construction duration, initial testing requirements, and rearing capacity of current facilities.

Based on this proposed timeline, an Implementation Team would be faced with key program decisions at milestones in the program. Examples of the key milestone decisions include: whether or not to continue releasing adults above Swift Dam after one generation of releases; continue releasing smolts above Swift Dam after two generations; and, determination of reintroduction program continuation or abandonment. There will likely be justifiable deviations from the schedule identified here due to implementation delays (e.g.. smolt trap efficiency, poor ocean survival, or fish disease problems) and so the Implementation Team may be required to decide whether to continue the program past expected timeline or discontinue due to what appears to be insurmountable obstacles. Appendix Table D- 24 provides an example of the years when the reintroduction program would receive a programmatic review by an Implementation Team and the decisions that would be required in that year based on a 2006 startup.

Appendix Table D- 24. An example of years when major decision would be required.

	Early Coho	Winter Steelhead	Spring Chinook
Begin Releases Above Swift Dam	2006	2006	2006
Discontinue Adult Releases	2009	2011	2011
Discontinue Smolt Releases	2013	2016	2016
Abandon Reintroduction Program	2014	2018	2018



Appendix Figure D- 15. Possible reintroduction timeline.

ADAPTIVE MANAGEMENT

How intense should the adaptive management approach be?

A question likely before an Implementation Team would be determining if the rate of progress is appropriate and if not how should the program be altered. Three management approaches could be considered 1) **minimal**, 2) **moderate** and 3) **maximum** adjustments to implementation program based on; experiences gained from program execution through adaptive management practices.

Adaptive management is a process used to monitor and evaluate (M&E) the successes and failures of the program and use the M&E data to alter the program in order to surmount unforeseen obstacles or increase the rate of reaching stated goals and objectives. Adaptive management, when effectively employed, increases the chances for success of the program by recognizing the initial implementation plan can contain flaws and will require adjustments. Successful adaptive management programs contain at minimum: 1) establishment of performance milestones and a means to measure progress toward milestones; 2) identification of critical uncertainties that place the program at risk of failure and an M&E program designed to address those uncertainties; and 3) a formalized method of using newly gathered information in decision-making. Appendix Table D- 25 outlines the degree of change allowed in the reintroduction program through adaptive management and the types of information and activities required to invoke adaptive management at a specified level. The implication of each category in Appendix Table D- 25 is further identified in the Fish Planning Document.

The **minimal** option relies mainly on the implementation plan with little room for adjustments during execution. This option ensures the greatest level of investment certainty for the funding source and minimizes the need for negotiating future choices. However, this option does a poor job of assuring adult production goal attainment, if unanticipated difficulties are encountered.

The **maximum** option allows for the greatest level of flexibility relying on M&E data and a set of choices to determine each step. This option has little investment certainty for the funding source and would require extensive involvement those involved in future decisions. Provided a detailed decision making process was reasonable to establish, this option would have the highest degree of success surmounting unforeseen obstacles. However if the decision processes were dysfunctional this would be the worst option. The maximum option relies on data to be collected in the future to steer the execution of the reintroduction. Therefore, the decision-makers would not have predetermined solutions to rely on when faced with disagreement.

The **moderate** option attempts to blend the strengths of the minimal and maximal options. The Implementation Plan would contemplate as many potential obstacles as practical providing a range of acceptable options and boundaries. The decision-makers would rely on M&E data and the Implementation Plan to negotiate acceptable solutions. This option provides a moderate level of certainty for the funding source, allows flexibility for resolving obstacles, and provides a framework for negotiating solutions to complex problems.

Appendix Table D- 25. Examples of alternative adaptive management strategy implications on hatchery and M&E program activities.

Adaptive Management Scenario	Minimal	Moderate	Maximum
Hatchery Operation	Annual adjustments.	Annual adjustments.	Annual adjustments.
Hatchery Facility Investments	Based solely on Implementation Plan.	Consider additional facility updates outlined in the Implementation Plan.	Consider additional facility updates above and beyond Implementation Plan.
Capital Changes to Hatchery Facilities	None.	Considered every 5-10 years.	Considered annually.
M&E investment	Low.	Medium.	High.
M&E Measures	Performance milestones.	Milestones and select critical uncertainties.	Milestones and numerous uncertainties.
M&E Flexibility	Minimal – employ activities prescribed in Implementation Plan.	Moderate – employ activities prescribed in implementation plan with the ability to adjust to collect better data.	Maximal – begin with prescribed activities in implementation plan and then deviate as needed conducting activities not addressed within the Implementation Plan.
Milestones	Prescribed in Implementation Plan.	Prescribed in Implementation Plan with ability to alter rate towards reaching milestone.	Flexible based initially on Implementation Plan but rate of reaching and content of milestone subject to change.
Likelihood of Program Significantly Changing Scope	Low.	Medium.	High.
Probability of Program Meeting Goals	Medium.	High.	Very High.
Cost Estimate Confidence	High.	Medium.	Low.
Overall Costs	Moderate.	High.	High.
Periodicity of Implementation/ Operational Staff Coordination	Annually.	Annually.	Annually
Policy Level Agreement Reconsideration	Not anticipated.	Every 5 to 10 years based on topic boundaries and conditions in the Implementation Plan.	Annually without boundaries.

Fish Production Indicators

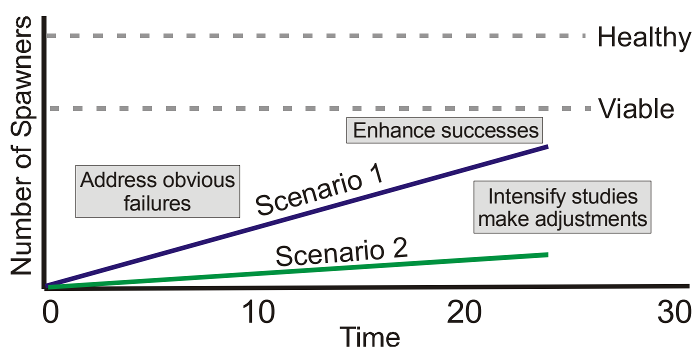
The bottom-line indicator to guide adaptive management decisions is the response of the fish themselves. The basic needs are to produce sufficient juveniles in the habitat, pass sufficient juveniles to the lower river, have sufficient numbers of juveniles survival to adults, have sufficient numbers of adults escape fisheries, pass sufficient adults above the dams, and have sufficient adults find productive spawning areas. These basic needs are monitored to provide information that will reveal any limiting factors which are precluding success in rebuilding the population.

Initial studies should be conducted at the beginning of the reintroduction experiment to provide the data necessary to link failure of the adult population to rebuild with specific data concerning limiting factors. Those studies would be linked to the above basic needs of the fish and would include measurement of:

- smolt passage success through Swift Reservoir
- smolt collection efficiency at Swift Dam
- juvenile trap and haul handling mortality
- smolt to adult marine survival
- adult harvest impacts
- adult trap and haul handling mortality
- adult passage from release to spawning area (effective spawners)
- juvenile production from natural spawners

These studies would provide two purposes: 1) An early year indicator if there is an obvious problem that needs to be addressed such as extremely low smolt collection efficiency or low numbers of adults passing from the reservoir to productive spawning area, and 2) data in which to trigger actions in the form of more detailed studies or changes in approach after a 10 year review.

Significant weight should be placed upon the performance of the fish themselves in the 10 year review, in particular the juveniles produced from natural spawning parents and the adult returns from those juveniles. The primary objective is to build a natural population to viable status and eventually to healthy stable levels. Tracking adult natural production will be the main indication of how serious a problem it is when a particular factor is not performing to expectations. It may indeed be serious and need immediate attention, or there may be some compensation from the performance of another factor. The ultimate test, to determine the need to make program adjustments, will be fish production accounting (Appendix Figure D- 16.)



Appendix Figure D- 16. Example of a successful and unsuccessful scenario and management responses.

AMP-Yale/Merwin Alternatives

Passage experiments initiated in the early license years are focused in habitats above Swift Dam only, but are expected to expand to include Yale habitats after year 13 and Merwin habitats after year 17, unless not biologically feasible. The Swift reintroduction experiment should provide information which can validate EDT habitat production estimates and also flag feasibility bottle-necks with regard to the adequacy of the passage system. The EDT habitat information along with life cycle modeling indicates that there is far more potential for successful reintroduction of spring Chinook, steelhead, and coho in Swift Reservoir compared to Yale or Merwin reservoirs. Coho production appears to be more likely than spring Chinook or steelhead in Yale or Merwin.

Included in the 10 year review should be a feasibility update concerning a reintroduction experiment in Yale and Merwin. Data acquired in the initial years of the Swift experiment may be useful for assessing the potential for success in the lower reservoirs. Early license year studies may also include experiments with adult supplementation in Yale and Merwin reservoirs to assess spawning success and juvenile production as a means to validate EDT results in the habitats of the lower reservoirs. Review of the information may provide assurance that a reintroduction effort has a reasonable chance of success in the lower reservoirs which would provide confidence in expanding the experiment beyond Swift Reservoir. Knowledge gained from the Swift experiment could help strategize the lower reservoir experiments. However, if it is determined that the information from the Swift experiment, and supplemental studies in the lower reservoirs, indicate it is highly unlikely that viable populations could be established in the lower reservoirs, then alternative ways to invest in natural fish should be considered. This assessment should be made for each species independently. For example, the conclusion for coho may be different than for spring Chinook or steelhead.

If reintroduction of anadromous fish is not attempted in Merwin or Yale reservoirs, alternative options for biological investment may include:

- Increase efforts to reintroduce spring Chinook, coho, and steelhead in Swift Reservoir
- Increase efforts to enhance bull trout in Yale and Swift reservoirs
- Invest in fish enhancement efforts in Cedar Creek, East Fork Lewis, or lower Lewis
- Downstream enhancement could include actions to benefit chum, cutthroat trout, steelhead, coho, Chinook, or lamprey populations.

M & E considerations

The following is a “shopping list” to be considered when developing an M&E program for the reintroduction experiment:

Broodstock Collection

- Enumerate adult spawning returns to key reaches
- Measure juvenile (age zero) abundance in key reaches
- Measure smolt outmigrants from key reaches

- Quantify and time smolt release migration
- Determine juvenile collection efficiency at Swift Dam.
- Measure SAR for natural produced and for smolt releases

Hatchery Production Performance

- Determine SAR for hatchery produced smolts
- Quantify total ocean production
- Assess regional salmon survival as benchmark
- Assess adult production relative to the population goal

Interactions

- Monitor effect of reintroduction program on existing wild fall Chinook populations
    1. Continue to monitor fall Chinook abundance
    2. Assess additional interactions as a result of released juveniles from reintroduction program
- Monitor interactions with bull trout populations above Swift
- Monitor interactions between and within species introduction above Swift

Facility Performance

- Adult collection efficiency
- Adult holding capacity
- Adult transportation ability/survival
- Juvenile collection efficiency / transport survival
- Juvenile rearing at holding capacity
- Acclimation facility adequacy

Rearing Evaluation

- Size at release
- Diet
- Rearing environment
- Pond densities

Release Evaluation

- Release location and numbers by site above Swift
    1. Locations for release below Swift
    2. Release life stage
    3. Destination for residual fish or early migrants

Management

- Data structure and organization, program
- Data sharing – coordination with parties
- Total production review
- Harvest review
- Existing natural production risk review
- Set up decision criteria
    1. short-term review for initial trouble-shooting adjustments
    2. longer-term reviews for broader decisions
        a. production level
        b. alternative reintroduction strategy (species changes, site change, expansion or elimination, supplementation adjustment)

c. mitigation alternatives
d. harvest management alternatives
e. hatchery operation changes, facility inventory

Key Monitor Strategies

Adult Spawners

- Deliver adults to key habitat areas
- Floy tag for distribution tracking
- Spawning surveys – measure spawning success
- Redd counts
- Steelhead – kelts (consider trap and release below Merwin)
- 2008 naturally produced fish volunteer distribution, consider radio-tracking

Juvenile Monitor

- Abundance surveys
  1. Juveniles – electroshock, seine, snorkel
  2. Smolts – snorkel, trap at key stream mouths
- Distribution – evaluate habitat utilization
- Observe interaction between species
- Assess reservoir utilization
- Assess residualism

Smolt Acclimation / Release

- Experiment with
  1. Locations
  2. Acclimation time
  3. Release time
- Duration of smolt release program dependent on success of natural spawner production

Smolt Collection

- Monitor collection efficiency
  1. Utilize smolt releases to measure efficiency
  2. Smolt timing and conversion from release site to reservoir
  3. Estimate smolt conversion through reservoir
  4. Estimate smolt collection efficiency at trap
  5. Experiment with sub-group at trap area
     a. Attraction experiments
        * Acoustics
        * Attraction lights, etc

Adult Trapping

- Trapping efficiency
  1. Survey unmarked spring Chinook, coho, steelhead abundance below Merwin
  2. Recycle marked fish
  3. Measure mortality of trap and haul

Key Questions to Answer Through M& E Projects

Following is a list of questions (critical uncertainties) that may need to be addressed as a result of information gained from the M&E program:

Habitat

1. Is habitat able to support fish production?
2. Where is habitat most productive?
3. Can we identify habitat productivity changes over time?
4. Will adult fish find most productive habitat?

Juveniles

1. What is the egg to smolt survival?
2. Are there species interaction concerns?
3. What is the residualism rate?
4. Downstream migration timing?
5. Will we be able to effectively collect juveniles?
6. Is the current production of hatchery smolts adequate to meet the total production goals?

Adults

1. Will smolt to adult survival rates be adequate to support a natural run?
2. Was the correct stock chosen to begin reintroduction?
3. Will adults home to most productive habitat?
4. Will Merwin trap be effective in collecting returning adults?
5. What is the proper mix of first generation hatchery and natural produced adults above Swift?
6. At what point should the hatchery transition to natural broodstock?
7. Under what circumstances would the hatchery be used as an egg bank for above Swift production?
8. Under what circumstances would natural production be considered for harvest?
9. What is an acceptable level of harvest reduction to support the reintroduction effort?
10. Is total adult production meeting the integrated production goal?

Facilities

1. Are the current hatchery complex facilities adequate for an integrated program?
2. Should re-distribution of production be considered?
3. Should new construction for rearing be considered for space for alternative rearing options?
4. Are adult holding facilities needed to support integrated program?
5. Are modifications needed at Merwin Trap?
6. Can juvenile collection efficiency be improved with changes in collection facility?
7. Is it necessary to make modifications to juvenile holding facilities at Swift?

Key Decision Points

Following is a list of decisions that could be considered during annual reviews and periodic review periods. Key decisions would be addressed as part of the periodic review.

	Decision
Annual Review	Adult planting locations Smolt acclimation sites Smolt release sites Juvenile collection efficiency Adult hatchery / natural distribution
Periodic Review **10 years**	Assess total production compared to goal Assess natural production success by species Assess existing wild populations status (fall Chinook, bull trout) Assess hatchery integration status (broodstock, rearing, etc.) Assess facilities adequacy Assess effects on harvest **Key Decisions Concerning:** Continuation of reintroduction effort Modifications of reintroduction effort Expansion of reintroduction to Yale and Merwin reservoirs Hatchery operation changes (facilities) Hatchery brood transitions Supplementation levels Harvest management changes Smolt and adult trapping changes

Natural Population Abundance for Program Evaluation

Predicted natural population size under the current habitat conditions and properly functioning habitat conditions may serve as an example of boundaries for evaluating the performance of the natural production program over time. The success of the program could be linked initially to progress in meeting equilibrium spawner expectations (as per EDT/Salmon PopCycle models) and in future years linked to progress towards PFC+ habitat conditions. The success and adaptive response may be categorized in four general conditions:

Condition 1 – The population is performing beyond expectations; the hatchery supplementation program can be phased out and natural production can be used to transition to hatchery broodstock. Hatchery program is reduced.

Condition 2 – The population is self-sustaining and hatchery supplementation can cease; however, some capacity in hatchery support should be maintained should the population abundance decline. Hatchery broodstock can be phased in.

Condition 3 – Natural production is occurring at moderate levels, but hatchery supplementation should continue and problems investigated.

Condition 4 – The population is performing below expectations; troubleshooting is necessary and bottle necks resolved, or alternative programs may be considered.

Finally, part of the adaptive management program would include updates of the models in response to a continuum of new biological data and technical advances which will provide new tools for measuring and predicting biological response of fish populations to Lewis basin conditions.

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