Appendix H – Research Monitoring and Evaluation

I. Aquatic RM&E Plan

NOTE: The following represents a draft RM&E plan that is currently under development by the co-management agencies. This product is not yet suitable for ISRP technical review, but was included as a place-holder to describe the objectives, approach, power-analysis and sample design planning that is underway. A formal product, suitable for ISRP technical review, is expected within four weeks following the submittal of the subbasin plan.

Research, Monitoring, and Evaluation Requirements

The qualitative management objectives described in the management plan provide a framework for defining RM&E requirements. Each management objective carries with it a set of assumptions associated with the implementation of actions that can be evaluated in the context of Tier 1 monitoring. In addition, each management objective is based upon a set of biological assumptions regarding the response of species, communities, and ecosystems to implemented actions. Table X depicts the assumptions of each management objective, and a corresponding RM&E objective that should be addressed. These RM&E objectives provide a useful launching pad for sample design, analysis, and evaluation planning.

Management Objective	Assumption	RM&E Objective
Population and Environmental Status		
1: Monitor the status and trends of fish and mussel populations, their habitats and ecosystems throughout the Umatilla Basin.	**1a:** Annual abundance of fish and mussel abundance can be accurately quantified.	**1a:** Assess and monitor the status and trends of fish and mussel abundances.
	1b: The spatial and temporal distribution of adult and juvenile fish and mussels can be assessed throughout the Umatilla Basin.	**1b:** Assess and monitor the distribution and density of spawners on the spawning grounds and juveniles on the rearing grounds.
	1c: The abundance, timing, life history characteristics, and survival of out-migrating fish can be accurately quantified.	**1c:** Assess and monitor the abundance, timing, life history characteristics, and survival of out-migrating fish.
	1e: The spatial distribution and quantitative features of Umatilla Subbasin stream and riparian habitats can be accurately	**1e:** Assess and monitor the distribution, condition and utilization of stream and riparian habitat in the Umatilla Subbasin.

Management Objective	Assumption	RM&E Objective
	quantified.	
	1f: The ecological characteristics of Umatilla Subbasin stream and riparian habitats can be accurately quantified	**1f:** Assess and monitor the ecological characteristics of Umatilla stream and riparian habitats.
Natural Production		
2: Maintain and enhance natural production, productivity, abundance, life history characteristics and genetic diversity of fish and mussels throughout the Umatilla Basin using habitat protection and improvement.	**2a:** Population abundance, life history pathways, and genetic characteristics of fish and mussels are limited in part by the availability of habitat in the Umatilla Subbasin.	**2a:** Assess and monitor the limiting factors for Umatilla fish and mussels.
	2b: Habitat protection and improvement will benefit fish and mussel abundance, productivity, life history and genetic diversity.	**2b:** Assess the impacts of habitat improvement and protection on salmonid production in the Umatilla Subbasin.
	2c: The impacts of habitat protection and improvement can be detected and distinguished from the impacts of ecological interactions.	**2c:** Assess and monitor the ecological interactions of Umatilla steelhead and Chinook.
3: Maintain, augment, and enhance natural production, productivity, abundance, life history characteristics and genetic diversity of steelhead, Chinook, coho, and lamprey throughout the Umatilla Basin using hatchery supplementation and outplanting.	**3a:** Production, abundance, life history and genetic characteristics of steelhead, Chinook, coho, and lamprey are limited in part by spawner escapement and smolt output.	**3a:** Assess and monitor the spawner escapement and natural production of Umatilla steelhead, Chinook, coho, and lamprey.
	3b: Supplementation will not degrade the life history characteristics of naturally reared steelhead, Chinook, coho, and lamprey.	**3b:** Assess and monitor the life history characteristics of naturally reared steelhead, Chinook, coho, and lamprey.
	3c: Residualization rates of hatchery releases will not be greater than those of naturally spawned fishes.	**3c:** Assess and monitor the residualization of hatchery and naturally reared Chinook.
	3d: Hatchery supplementation using endemic broodstock will not negatively impact genetic characteristics of the natural steelhead population.	**3d:** Assess and monitor the genetic characteristics of naturally and hatchery reared steelhead.
	3e: Natural reproductive success of hatchery-reared steelhead will be similar to that of natural-reared steelhead.	**3e:** Assess and monitor the reproductive success of hatchery and naturally reared steelhead.
	3f: Hatchery-reared steelhead will return to natural production areas targeted for supplementation.	**3f:** Assess and monitor hatchery escapement to target areas.

Management Objective	Assumption	RM&E Objective
	3g: Hatchery supplementation will result in increased natural production of steelhead.	**3g:** Assess and monitor the long-term reproductive success of hatchery reared steelhead.
	3h: The ecological relationships of hatchery-reared Steelhead will not negatively impact natural fish populations.	**3h:** Assess and monitor the ecological interactions of hatchery and naturally reared steelhead.
4: Maintain the Birch Creek sub-population as a natural steelhead sanctuary (not supplemented).	**4a:** The summer steelhead supplementation program can be operated to minimize or exclude hatchery steelhead from escaping to Birch Creek.	**4a:** Assess and monitor hatchery steelhead escapement in Birch Creek.
5: Restore and maintain diverse and productive natural populations of Chinook and coho in the Umatilla Subbasin using hatchery reintroductions.	**5a:** Carson stock spring Chinook returning to the Umatilla Subbasin, Upriver Bright stock fall Chinook returning to the Umatilla Basin and Priest Rapids Hatchery, and Bonneville reared coho returning to the Umatilla Subbasin will have the genetic and phenotypic capacity to produce life histories suitable for sustainable natural productivity in the Umatilla Basin.	**5a:** Assess and monitor the natural production of hatchery reared Chinook and coho in the Umatilla Subbasin.
	5b: Hatchery-reared Chinook will return to natural production areas targeted for reintroduction.	**5b:** Assess and monitor the escapement of Chinook to target areas.
	5c: The ecological relationships of hatchery-reared Chinook and coho will not negatively impact natural fish populations.	**5c:** Assess and monitor the ecological interactions of hatchery and naturally reared Chinook and coho.
Hatchery Program		
6: Develop and maintain a local brood source for steelhead and Chinook from returns to the Umatilla River.	**6a:** Adult steelhead and Chinook returns will be adequate to provide brood needs while supporting harvest and natural production.	**6a:** Monitor and assess whether annual broodstock collection targets are met.
	6b: Adequate broodstock survival will be achieved at adult holding facilities.	**6b:** Monitor broodstock survival and disease incidence during holding.
7: Operate hatchery program to achieve subbasin smolt production, smolt to adult return, and hatchery adult return goals from the subbasin plan.	**7a:** The hatchery programs can be operated to achieve subbasin smolt production, smolt-to-adult survival, and adult return goals.	**7a:** Monitor smolt survival, smolt-to-adult survival, adult returns, and harvest and spawning contributions of hatchery-reared steelhead and Chinook to ensure a full accounting of all production strategies.
	7b: Progeny-to-parent ratios for hatchery-produced fish will be considerably higher than those of	**7b:** Monitor and compare progeny-per-parent productivity of hatchery- and naturally-reared

Management Objective	Assumption	RM&E Objective
	natural fish, and provide an adequate hatchery advantage.	steelhead and Chinook.
8: Achieve optimal effectiveness in the operation of the Umatilla Basin steelhead and Chinook hatchery programs while meeting production, population, and conservation objectives for natural- and hatchery-reared fishes.	**8a:** Rearing and release strategies will optimize smolt production, survival, homing, adult return, harvest, and natural spawning of steelhead and Chinook, and minimize residualization and stray rates.	**8a1:** Evaluate if a colder more natural temperature environment in fall will increase smolt-to-adult survival of spring chinook reared at Umatilla Hatchery.
		8a2: Evaluate if smolt-to-adult survival of subyearling fall Chinook can be improved by programmatic changes including larger size-at-release and direct-stream release lower in the basin.
9: Minimize any negative impacts of the Umatilla Basin hatchery program on natural steelhead and Chinook, and non-target populations.	**9a:** Broodstock collection and spawning strategies will optimize life history and genetic diversity of the hatchery steelhead and Chinook populations.	**9a:** Monitor broodstock collection and spawning to assess whether collection and spawning protocols are met.
	9b: Adult returns from the Umatilla subbasin hatchery programs will not stray at rates that exceed 5% of out-of-basin natural steelhead and Chinook populations.	**9b:** Monitor straying of fish from the Umatilla hatchery program to other subbasins and assess straying relative to environmental variables and rearing and release strategies
	9c: The horizontal and vertical transmission of disease from hatchery-reared steelhead and Chinook to natural fish will be minimized by current fish health protocols.	**9c:** Monitor the health of hatchery and natural fish.
Flow and Passage		
10: Maintain and enhance flow for homing and passage of steelhead and Chinook through the lower Umatilla River using flow restoration and enhancement.	**10a:** Flow restoration and enhancement will improve homing of adult steelhead and Chinook to the Umatilla River.	**10a:** Assess and monitor the impact of flow enhancement on homing of steelhead and Chinook to the Umatilla River.
	10b: Flow restoration and enhancement will reduce the need to transport and improve survival of adult and juvenile steelhead and Chinook in the Umatilla River.	**10b:** Assess the impact of flow enhancement on steelhead and Chinook survival and the frequency of fish transport.
11: Maintain and enhance steelhead and Chinook rearing and spawning habitat in the mainstem Umatilla River with flow enhancement and protection.	**11a:** Flow enhancement will increase steelhead and fall Chinook spawning and rearing habitat in the mainstem Umatilla River.	**11a:** Assess and monitor the availability of spawning and rearing habitat in the mainstem Umatilla.

Management Objective	Assumption	RM&E Objective
12: Maintain and enhance passage of adult and juvenile steelhead and Chinook throughout the Umatilla Subbasin with passage protection and restoration.	**12a:** Passage protection and restoration will result in improved migration times and decreased delay.	**12a:** Assess and monitor migration times and delay in the Umatilla mainstem.
	12b: Program actions and facility operations will optimize fish passage at diversion dams.	**12b:** Assess the effects of reduced diversion during water exchange on the relative attraction of smolts to the passage facility and adult fish ladder at TMFD.
Fisheries		
13: Maintain and enhance tribal and non-tribal steelhead, Chinook, coho and lamprey fisheries compatible with production, population, and conservation objectives.	**13a:** Steelhead, Chinook, coho and lamprey will return at a level of abundance adequate to support annual fisheries.	**13a:** Develop models for pre-season estimation of Umatilla River returns to facilitate management of subbasin fisheries.
	13b: Tribal and non-tribal fisheries can be adequately quantified.	**13b1:** Quantify fishing effort, catch, and harvest by gear type for tribal and non-tribal steelhead, Chinook, coho, and lamprey fisheries in the Umatilla River.
		13b2: Quantify harvest of Umatilla steelhead, Chinook, and coho in out-of-subbasin fisheries.
	13c: Management actions can optimize fishery opportunities while meeting production and population performance objectives for steelhead, Chinook, coho, lamprey, and non-target fishes.	**13c:** Assess whether management actions optimize fishery opportunities while meeting production and population objectives
Collaboration and Communication		
14: Maximize effectiveness of Umatilla Subbasin RM&E projects with collaborative study planning and implementation, synthesis of results, and results dissemination.	**14a:** Increased collaboration will result in decreased duplication and an increase in the power and resolution of Umatilla Subbasin RM&E.	**14a:** Conduct collaborative study planning, implementation, synthesis of results, and results dissemination.
15: Maximize management effectiveness of Umatilla Basin fish programs using local and regional protocols in RM&E methodologies that allow exchange of compatible information among local and regional databases and fisheries management entities.	**15a:** Information needed for adaptive management of the Umatilla Subbasin fisheries programs will be maximized by coordination with local regional RM&E efforts.	**15a:** Adopt locally and regionally standardized protocols.

Management Objective	Assumption	RM&E Objective
	15b: Exchanging compatible information to local and regional research and management groups will increase our understanding of out-of-basin impacts to Umatilla fish populations and improve program management.	**15b:** Coordinate with local and regional management groups and integrate information from these groups into assessments of Umatilla Subbasin fisheries program.
16: Maximize our understanding of the impacts of out-of-basin factors on Umatilla smolt-to-adult survival with collaborative assessments, surveys, tagging, data analysis, modeling, and results dissemination.	**16a:** Management of Umatilla Basin fisheries will benefit from cooperative research outside the basin.	**16a:** Conduct collaborative research with out-of-basin research programs that address Umatilla uncertainties.
	16b: Management of Umatilla Basin fisheries will benefit from participation in Columbia Basin research, monitoring, and evaluation forums.	**16b:** Participate in Columbia Basin research, monitoring, and evaluation forums.

Research Agenda

The research agenda was established for focal species using a gap analysis based on EDT, the management objectives, and the working hypotheses. Research agenda items identified for non-focal species were derived from a gap analysis of current information status and future simulation and evaluation requirements for the subbasin. The following items are considered critical Tier 3 uncertainties for the Umatilla Subbasin. Detailed methodologies for implementation of these studies are contained in section 0.

Test the EDT working hypotheses

Status: Partially funded (BPA)

Purpose and Scope:

EDT was developed to provide a spring-board for quantitative decision making in the habitat and fisheries management arena. The model is theoretically well supported, and provides a set of working hypotheses for habitat restoration and off-site mitigation. Although EDT is populated using some real habitat data, much of the environmental data is based on professional judgement, and the response predicted for fish populations is generally theoretical and associative in nature. The fish population component of EDT does not consider the antagonistic, additive, or synergistic effects of restoring multiple species at once, and it does not consider the density dependent complications associated with restoring populations with relatively small numbers of individuals. Therefore EDT could over or underestimate the benefits of habitat restoration in the Umatilla Subbasin. The purpose of this fifteen year project is to test the following null and alternative hypotheses:

Ho: The restoration of habitat, as described in the EDT working hypotheses, will result in salmonid production that is equal to that predicted by EDT.

Ha1: The restoration of habitat, as described in the EDT working hypotheses, will result in salmonid production that is more than that predicted by EDT.

Ha2: The restoration of habitat, as described in the EDT working hypotheses, will result in salmonid production that is less than that predicted by EDT.

The federal management agencies are working closely together to improve Columbia mainstem passage conditions, and to reduce the impacts of marine harvest on endangered salmonids. If the habitat restoration actions described in the working hypotheses are achieved in the Umatilla Subbasin, one might anticipate that Ha1 will be most strongly supported. However, as more and more people relocate to the region, and water resources become increasingly strained, the chances for recovery continue to change. Statistical support of the working hypothesis will help guide the nature and intensity of future habitat protection and restoration actions in the Umatilla Subbasin.

Approach:

Most of the work needed to address this critical uncertainty will take place in the context of long-term monitoring. The experimental approach is to conduct an observational study of the Umatilla Subbasin using collaborative monitoring of fish and their environment; e.g. (Hillman 2003, Jordan et al. 2003, USACOE et al. 2003, ISAB and ISRP 2004). Collectively UMEP will:

- Conduct long-term monitoring and evaluation of stream, watershed, and aquatic conditions
- Conduct long-term monitoring and evaluation of population, environmental, and ecological conditions for all salmonid life stages and rearing types
- Conduct effectiveness monitoring of restoration actions at the watershed scale

These monitoring efforts will take place subbasin-wide for the next fifteen years. A holistic analysis of the relative impacts of habitat restoration, ecological interactions, stochasticity, climate, and out-of-basin effects will be conducted every three to five years using a modified EDT model. Strategy implementation will be assessed under regular Tier 1 monitoring. Action effectiveness will be evaluated using Tier 2 habitat, water quality, and fish population monitoring results. The interaction of project implementation and system response will be evaluated using EDT.

Currently EDT is not fully capable of incorporating the suite of forcing functions that drive salmonid production. There are limitations in the model in terms of regional habitat nuances and population responses (the biological rules) that must be addressed. UMEP will work with Mobrand Biometrics and the University of Washington Columbia Basin Research Center to develop a version of EDT that addresses all sources of focal species production and loss. The biological rules will be updated as new habitat and population response data becomes available.

Once the working hypotheses habitat restoration strategies have been implemented, the predicted (EDT) and realized (M&E) salmonid production levels will be compared. The quantity and rate of predicted and realized responses will be compared using univariate and multivariate statistics. The results of this analysis will be used to better inform EDT on a regional scale, and to better predict the average benefits of habitat restoration work in the Umatilla and Columbia Basins.

Test the assumption that focal species are representative of ecological conditions in the Umatilla Subbasin

Status: Partially funded (BPA)

Purpose and Scope:

Focal species were selected for the purposes of ecosystem restoration planning in the Umatilla. Although single-species restoration is itself a priority in the Subbasin Plan, ecosystem recovery is the ultimate goal of most mitigation actions. The population dynamics of some species (known as keystone species or ecological indicator species) are indicative of ecological change. However, it is unclear if any of the focal species can adequately represent the health of Umatilla rivers and streams in part due to their anadromous life history and the various out of basin factors that affect them. Therefore it is theoretically possible that habitat restoration actions may enable certain aspects of ecological recovery without resulting in increased focal species production. This fifteen year study will test the following null and alternative hypotheses:

> Ho: The restoration of habitat, as described in the EDT working hypotheses, will result in increased focal species production and improved ecological conditions.
>
> Ha1: The restoration of habitat, as described in the EDT working hypotheses, will result in increased focal species production, but no improvement in other ecological conditions.
>
> Ha2: The restoration of habitat, as described in the EDT working hypotheses, will not result in increased focal species production, but will result in improved ecological conditions.

Approach:

Some of the work needed to address this critical uncertainty will take place in the context of long-term monitoring. The experimental approach is to conduct an observational study of the Umatilla Subbasin using collaborative monitoring of fish populations and their environment; e.g. (Hillman 2003, Jordan et al. 2003, USACOE et al. 2003, ISAB and ISRP 2004). Collectively UMEP will:

- Conduct high-resolution monitoring and evaluation of stream, watershed, and aquatic conditions in five priority geographic areas
- Conduct high-resolution monitoring and evaluation of sub-population performance in five priority geographic areas
- Conduct high-resolution monitoring and evaluation of ecological conditions in five priority geographic areas

These monitoring efforts will take place in the five geographic areas for the next fifteen years. UMEP will quantify food web structure, energy flow, and biotic diversity to monitor ecological change in the five priority geographic areas. Change through time will be analyzed using time series, geostatistical, structural, and functional analysis of those systems. Differential change among geographic area will be analyzed using geostatistical models and associative analyses that account for habitat-based variance in production and ecological criteria.

Test the assumption that EMAP surveys can adequately quantify status or change in Umatilla Ecosystems

Status: Partially funded (BPA)

Purpose and Scope:

EMAP surveys were developed as an expansion of EPA’s Rapid Bioassessment Protocols program. The intent was to develop a standardized methodology for assessing and evaluating system impairment across large geographic areas. Currently EMAP protocols are being implemented in a number of subbasins in the Columbia with considerable success.

The spatial scale of EMAP sampling design is the subbasin. This spatial scale differs considerably from the habitat restoration unit (the geographic area) addressed in the management plan. At the subbasin scale EMAP requires 50 sampling sites per year, and it is distinctly unclear how this sampling regime can address within-subbasin management questions. It is theoretically plausible that this small number of samples can be spatially allocated in such a way that both within-subbasin and subbasin-wide questions can be answered simultaneously; however, this assumption has yet to be rigorously tested in the Columbia Plateau. This fifteen year study will test the following null and alternative hypotheses:

> Ho: An EMAP sampling design can adequately quantify sub-population change at the geographic area scale.
>
> Ha1: An EMAP sampling design will under or over estimate sub-population change at the geographic area scale.
>
> Ha2: An EMAP sampling design will fail to produce a statistically sound estimate of sub-population change at the geographic area scale.

Approach:

Some of the work needed to address this critical uncertainty will take place in the context of long-term monitoring. The experimental approach is to conduct an observational study of the Umatilla Subbasin using collaborative monitoring of fish and their environment; e.g. (Hillman 2003, Jordan et al. 2003, USACOE et al. 2003, ISAB and ISRP 2004). Collectively UMEP will:

- Conduct monitoring and evaluation of population and environmental status of the Umatilla Subbasin using an EMAP design
- Conduct high-resolution monitoring and evaluation of population and environmental status of five priority geographic areas using contiguous quadrat sampling

These monitoring efforts will take place subbasin-wide for the next fifteen years. For both sampling methodologies species-habitat curves will be generated along with their 95% confidence intervals. The results of EMAP sampling vs. contiguous quadrat sampling of priority geographic areas will be analyzed using associative analysis, time series analysis, and geostatistical expansions of both data types.

Estimate the relative and long-term success of naturally vs. hatchery reared summer steelhead

The reproductive success and genetic characteristics of hatchery fish can be different from those of naturally reared individuals or populations (Reisenbichler and McIntyre 1977). These affects stem in part from the environmental conditioning of hatchery programs, and in part from the artificial selection associated with the hatchery environment. The problem can in theory impact population growth even when endemic stock is used and traditional stock domestication is avoided (Chilcote 2003, Reisenbichler et al. 2003).

The impacts can be elusive because of the short-term production gains associated with supplementing a diminished population, and could in theory limit the recovery of salmon fisheries in the Umatilla Subbasin and elsewhere. Chilcote is quick to point out that the problem is theoretical in nature, and is “not sensitive to likely levels of data error or confounded by ***extraneous*** habitat correlation with” production (our emphasis, Chilcote 2003, p1057).

Umatilla program mangers have long known that much or most of the limits of production in the Umatilla stem from the deterioration of in-basin and Columbia mainstem habitat conditions. The biological objectives of these programs were developed and pursued to overcome the modern limitations of the system. This restorative approach was adopted without regard to short-term decreased productivity of hatchery reared fish, and with considerable attention paid to the overwhelming impacts of habitat degradation that had extirpated all salmon, and greatly diminished *O. mykiss* stocks. The intent of supplementation and reintroduction actions that have resulted in increased adult returns has been to utilize the UFH as an extension of the ecosystem;

to utilize the hatchery advantage to increase numbers of spawners and thereby further seed the available habitat with juveniles.

Unlike many northwest programs, UFH has used endemic STS stock for more than a decade now. Nonetheless, it is not possible under the current RM&E approach to validate the long-term success of hatchery reared fishes, or to estimate the relative reproductive success of hatchery or naturally reared individuals. Due to increasing concern for the welfare of endemic populations, the reproductive success and genetic characteristics of Umatilla STS remains a critical uncertainty. This fifteen year study will test the following null and alternative hypotheses:

> Ho: The relative and long-term success of hatchery reared Umatilla summer steelhead is equal to that of naturally reared specimens.
>
> Ha1: The relative and long-term success of hatchery reared Umatilla summer steelhead is less than that of naturally reared specimens.
>
> Ha2: The relative and long-term success of hatchery reared Umatilla summer steelhead is greater than that of naturally reared specimens.

Approach:

Polymorphic microsatellite loci have been used in a variety of studies to determine parentage and population structure (O'Reilly et al. 1998, Bernatchez and Duchesne 2000, Letcher and King 2001, Eldridge et al. 2002). The technique and its application have been thoroughly reviewed (Wilson and Ferguson 2002). Microsatellite analysis will be used to estimate the relative reproductive success of hatchery and naturally reared STS, the long-term reproductive success of hatchery reared STS, and the genetic characteristics of both stocks. Although TMFD is available as a potential sampling station, CTUIR and ODFW maintain a policy to minimize fish handling and maximize fish production and health. In addition sampling at TMFD does not address the significant contribution of non-anadromous *O. mykiss* to STS populations. Instead a weir will be constructed at the mouth of Iskuulpa Creek. Adult anadromous returns, resident RBT, and juvenile progeny will be sampled and genotyped for 16 microsatellite markers (0).

Estimate Connectivity of Resident Umatilla Salmonid Populations within the Subbasin, and among Neighboring Populations

Status: Partially funded (USFWS)

Purpose and Scope:

The construction of John Day and McNary Dams dramatically altered the routes and conditions resident salmonids must undertake to connect with neighboring populations. These hurdles are amplified by the acute and chronic stressors that resident and fluvial bull trout and mountain whitefish face within each subbasin. The culmination of these chronic stressors, coupled with direct mortality, have resulted in an ESA listing for bull trout, and increasing concern for the status of mountain whitefish.

Population connectivity is a measurement of interbreeding among arbitrary or allopatric populations. Connectivity can increase the average fitness of a population by increasing heterozygosity and genetic diversity. The mouth of the Umatilla River is most directly juxtaposed to the John Day, Walla Walla, Yakima, and Snake River basins. Connectivity between Walla Walla populations and these neighboring populations is unknown. An understanding of connectivity will help guide mainstem management, and will greatly inform the ESA delisting process. Increased connectivity generally results in decreased jeopardy, and is therefore a critical metric of species conservation. The purpose of this five year project will be to test the following null and alternative hypotheses:

> Ho: Gene flow (F) in Columbia Plateau bull trout and mountain whitefish populations is less than 0.1, and connectivity (Nm) is less than 10 immigrants per generation.
>
> Ha: Gene flow (F) in Columbia Plateau bull trout and mountain whitefish populations is greater than 0.1, and connectivity (Nm) is more than 10 immigrants per generation.

Approach:

The Bull Trout Recovery Team advises critical uncertainties research on this species. A collaborative effort is underway to examine the current status and population trajectory of bull trout in the Walla Walla and Umatilla Subbasins. These efforts put personnel on the ground, and provide substantial opportunities for data collection. The co-managers will work with this collaboration and similar efforts in the John Day, Grande Ronde and Yakima Subbasins to develop a regional program for resident fish genetic sampling. Fin clips will be selected from reproductively active male and female bull trout and mountain whitefish in all four subbasins during normal monitoring activities. These samples will be analyzed using micro-satellite markers to determine the number of immigrants to each subbasin per generation for both species.

Estimate the mortality and survival of Umatilla Coho through all in-subbasin life stages

Status: Partially funded (BPA)

Purpose and Scope:

Based on written and verbal tribal history, and the outputs of EDT, the Umatilla River was once a relatively productive coho system. Anthropogenic degradation of the Umatilla, coupled with out-of-basin changes, have left the system without habitat capable of sustainable coho production. The management plan outlines a series of ambitious habitat restoration actions, including the implementation of Phase III flow enhancement. None of these actions, including the culmination of all habitat restoration actions, were shown to result in sustainable coho production of any significance. While EDT clearly outlines the potential limiting factors for coho, it does not outline a plan of action necessary to increase production. To a great extent managers are left in the dark in terms of how best to address coho productivity in the system. To a great extent the rearing habits of coho populations will impact the survival of emerging and rearing fish (Groot and Margolis 1998). This five year study will address the following null and alternative hypotheses:

Ho: Umatilla coho productivity is limited by spawner success.

Ha1: Umatilla coho productivity is limited by egg-to-fry survival.

Ha2: Umatilla coho productivity is limited by fry-to-smolt survival.

Approach:

Some of the work needed to address this critical uncertainty will take place in the context of long-term monitoring. The experimental approach is to conduct an observational study of the Umatilla mainstem using collaborative monitoring of fish populations and their ecosystem; e.g. (Hillman 2003, Jordan et al. 2003, USACOE et al. 2003, ISAB and ISRP 2004). Collectively UMEP will:

- Monitor coho spawner success in the Umatilla mainstem
- Monitor coho redd production in the Umatilla mainstem
- Monitor coho fry-to-smolt survival in the Umatilla Subbasin

Spawner success will be monitoring using redd and carcass surveys in the Umatilla mainstem. Redd production will be estimated by capping a small number of representative redds. Fry-to-smolt survival will be estimated using a mark-recapture survival model derived from SURPH (www.cbr.washington.edu). From these data a life-history model will be developed that is specific to Umatilla coho, and clearly defines the population bottleneck that is limiting productivity. Managers will use this information to develop a restoration plan for Umatilla coho based on habitat restoration, flow enhancement, and hatchery supplementation.

Monitoring Approach by RM&E Objectives

The following is a description of the proposed approach for addressing each management objective and assumption within UMEP. The Performance metrics addressed, RM&E priority, and current status of the RM&E effort are stated. The general approach descriptions are cross-referenced to precise methodologies described in Section 6.

(1a): Assess and monitor the status and trends of abundance of natural and hatchery origin adult salmonids.

Performance metrics: Adult returns to Umatilla, spawner escapement, brood stock collection, run predictions

Status: Ongoing and funded by BPA through operations and maintenance project, and NPMEP/HMEP evaluation activities

Adult returns to TMFD are perhaps the most basic and critical metric of performance in the Umatilla Subbasin. Return rates by spatial and temporal origin for natural and hatchery fishes is needed to estimate smolt to adult survival, total production, spawner life history characteristics, run timing, and the spawner population for brood stock and natural production.

Approach:

Adults will enumerated at TMFD using trapping and video monitoring (0). Every five out of fourteen days trapped fish will be handled and sampled, allowing for the removal of brood stock. For nine out of fourteen days fish will be passively monitored using video and Passive Integrated Transponder tag (PIT-tag) recoveries. Statistical analysis and evaluation will be based on summary statistics and a trend analysis.

(1b): Assess and monitor the distribution and density of spawners on the spawning grounds and juveniles on the rearing grounds; (3a): Assess and monitor the spawner escapement and natural production of Umatilla steelhead; (5a): Assess and monitor the natural production of hatchery reared Chinook in the Umatilla Subbasin; and (5b): Assess and monitor the escapement of Chinook to areas targeted for natural production.

Performance metrics: Spawner escapement; spawner spatial distribution; spawn timing; pre-spawn mortality; carcass impacts; rearing distribution; juvenile production and distribution; progeny-per-parent ratios

Status: Spawner monitoring is ongoing and funded through BPA NPMEP. Juvenile surveys are not funded and not implemented.

The principle subbasin-scale performance measures for each brood year are assessed from total outmigration and returns to TMFD. However, this information is limited in its explanatory power due to the contingencies associated with watershed-scale variability in spawner abundance and juvenile production. Spawners can escape differentially to each watershed due to habitat conditions, in-basin harvest, pre-spawn mortality, and stochasticity. The production of juveniles can vary among watersheds due to spawner abundance, spawner productivity, habitat quality, habitat quantity, egg mortality, fry mortality, or parr mortality. An understanding of spatial and temporal variance in both spawner and juvenile production and productivity is therefore necessary to estimate a variety of performance measures.

Approach:

In-situ sampling will be conducted for each species within their spawning and rearing habitat (0 and 0). The sampling design will follow a modified EMAP protocol. Spawner and carcass surveys will be randomized by tributary. Juvenile surveys will be randomized by reach. Annual estimates of density will be produced for each life-history stage and watershed. A geostatistical analysis will be conducted using population and habitat data to estimate fish-habitat relationships and to produce a geostatistical stock assessment of spawners and juveniles. Associative and trend analyses will be used to monitor changes in spawner and juvenile populations.

(1c): Assess and monitor the abundance, timing, life history characteristics, and in-stream survival of out-migrating Chinook and steelhead.

Performance metrics: Migration parameters, abundance, survival, and life history characteristics (including age, size and condition) of emigrating smolts.

Status: Modify and expand ongoing activities.

An estimate of smolt abundance for natural species in the lower Umatilla River is essential to answering critical uncertainties surrounding natural production capacity and in-basin productivity. In addition, an understanding of migration success and survival is necessary to identify in and out-of-basin bottlenecks (including environmental conditions, flow, fish habitat, hatchery rearing and release strategies, predation, and passage difficulties) and estimate loss by life stage for hatchery and natural species.

Approach: Smolt abundance will be estimated for natural salmonids leaving the Umatilla River using fish collection and trapping efficiency at Three Mile Falls Dam (RM 3.7). The Bootstrap method with 1,000 iterations will be used to derive a variance. Smolt survival and migration parameters (timing, duration and travel speed) will be monitored for hatchery and natural species using PIT tags and remote interrogation at Three Mile Falls and lower Columbia River dams. Survival estimates will be calculated using the Migrant Abundance Method (Burham et al. 1987 and Dauble et al. 1993) and the SURPH 2 model. The binomial test will be used to test for significant differences in detection between comparable release groups of hatchery fish. Environmental variables including water discharge, flow, temperature and water clarity in the lower river will be monitored and ties to smolt survival and/or migration success assessed (regression and correlation analysis). Juvenile life history characteristics including smolt emigration timing, length, age, health, condition and smolt status will be collected. Associative and trend analysis will be used to evaluate outmigration.

(3b): Assess and monitor the life history characteristics of naturally reared steelhead.

Performance metrics: Migration timing, growth rates, age and size

Status: Partially funded, partially ongoing

Radical anthropogenic changes to the Umatilla system have occurred during the past century and are a significant reason for a lack of recovery to near historic run sizes for all Umatilla salmonids. Understanding Umatilla mainstem migration is critical to understanding the overall production of the system. This requires an estimate of the impacts of ecological and environmental conditions throughout the system.

For animals with indeterminate growth the impacts of ecological and environmental conditions converge in the expression of life-history characteristics (Kitchell et al. 1974, Heino and Kaitala 1999). Unlike animals with determinate growth who must meet metabolic requirements or die, salmonids can buffer the impacts of environmental or ecological changes by modifying energy allocation and behavioral regimes (Stockwell and Johnson 1997, Railsback and Rose 1999). If properly monitored changes in mass-energy allocation can be used as ecological indicators that have direct management implications (Brandt and Hartman 1993, Hansen et al. 1993). This monitoring activity requires estimates of age and growth for pre-smolts and smolts.

Without this information it will not be possible to determine whether changes in adult and juvenile production are related to changes in habitat conditions, mainstem or marine survival, or stochasticity. Estimates of migration timing provide additional information about the hydrology of the system a whole, and the behavior of particular brood years, species, or rearing types. This information can be used to quantify the production benefits of various management scenarios including increased or decreased artificial production or increased flow augmentation.

Approach:
A sub-sample of naturally reared juveniles will be PIT-tagged on the spawning grounds for outmigrant detection at TMFD and Columbia Mainstem facilities. Scales of naturally reared juveniles will be sampled during EMAP surveys and lower river trapping.. Age and growth analysis will be conducted for each managed species. Associative models will be used to evaluate growth of hatchery and naturally reared fishes from each release site and watershed.

(1e): Assess the distribution, condition and utilization of essential salmonid habitat in the Umatilla Subbasin; (11a): Assess and monitor the availability of spawning and rearing habitat in the mainstem Umatilla.

Performance metrics: Quantity, quality, and utilization of essential fish habitat

Status: Not funded, not implemented

Salmonids cannot produce naturally without quality habitat. This pivotal assumption is the backbone of the working hypotheses being developed in the subbasin plan, and the numerous off-site mitigation projects operating in the Umatilla Subbasin. At the macro- and micro-scales land use and riparian conditions are strongly related to in-stream conditions (Crispin et al. 1993, Stednick and Kern 1994, Chen et al. 1998). These features directly impact water quality conditions, and can thereby alter salmonid production through behavioral, physiological, and ecological mechanisms (Torgersen et al. 1999, Ebersole 2002). These powerful in-basin impacts are detectable at multiple scales, and do result in decreased survival and production of juveniles (Paulsen and Fisher 2001) and decreased recruitment of spawners (Regetz 2003) at the subbasin scale.

Approach:

The subbasin plan identifies a set of desired future conditions that may increase natural production and harvest opportunities in the Umatilla Subbasin through habitat restoration and protection, flow augmentation, passage restoration, and hatchery supplementation. There are a number of habitat-based RM&E information needs that must be addressed if the benefits of these management actions are to be effectively detected with sufficient power. The availability and distribution of quality essential fish habitat will be used to define the sampling universe of juvenile and spawner surveys. Spatial and numerical relationships among the habitat and salmonid variables will be used to estimate the degradation through time of essential fish habitat associated with both natural and anthropogenic disturbance; to estimate the absolute abundance and distribution of juveniles and spawners using geostatistical expansions; to estimate the effectiveness of habitat restoration and flow augmentation projects; and to estimate the quantitative relationship between habitat and production. Physical, biological, chemical, and ecological habitat conditions will be monitored throughout the subbasin using a variety of techniques (0).

(1f): Assess and monitor the ecological characteristics of Umatilla essential fish habitat; (2c): Assess and monitor the ecological interactions of Umatilla steelhead and Chinook; (3g): Assess and monitor the ecological interactions of hatchery and naturally reared steelhead; and (5c): Assess and monitor the ecological interactions of hatchery and naturally reared Chinook

Performance metrics: Biological conditions of habitat, trophic relationships of fishes, competition, predation natural mortality, and carcass inputs.

Status: Unfunded; not implemented; innovative monitoring approach.

Ecological relationships have direct and indirect impacts on fish productivity through trophic, physiological, and behavioral interactions. Direct interactions are sometimes considered and managed for, but these may be dwarfed by indirect exchanges (Beamesderfer et al. 1996). There are numerous pathways of confounding relationships in a supplemented salmonid community that might impact egg to fry survival (Vander Haegen et al. 1998). In many systems in-stream mortality of smolts may have a far greater impact on smolt production than early life-stage bottlenecks (Fryer and Mundy 1993, Collis et al. 2001). Given the current state of scientific knowledge it is difficult to discern in any one tributary system between the nominal importance of salmonid abundance and the impacts of ecological relationships on salmonid productivity.

The culmination of direct and indirect processes can negate or amplify the benefits of any restoration action. In general there are two ways these relationships can manifest (Carpenter and Kitchell 1993). Top-down and density-dependent interactions can result in predator mortality or in changes in growth due to increased metabolic expenditures or decreased consumption rates. Bottom-up changes in trophic resources or metabolic conditions can result in direct starvation or in changes in decreased growth associated with consumption rates or metabolic efficiency. The complexities of these factors and their importance to fisheries management has been described in detail (Kitchell et al. 1974). Although these principles have been accepted by the scientific community, they have been rarely incorporated in management. This is true for the Umatilla Subbasin, despite the fact that ecological impacts may, under some conditions, be greater than physical or chemical impacts. A greater understanding of the ecological controls on salmonid productivity will have direct management implications. A quantification of predator mortality and competitive interactions will help guide future release strategies and juvenile production objectives. A detailed understanding of inter- and intra-specific competition will allow for the determination of optimal seeding strategies in a multi-species restoration framework. This information could inform multi-species management throughout the Columbia Plateau.

Approach:

Fish communities will be sampled using a modified EMAP design (0). The biological conditions of habitat will be sampled during EMAP surveys of fish communities, and spawner and carcass surveys (0). Trophic interactions will be surveyed using stable isotope monitoring and ecological inference (0). The ecological characteristics of essential salmonid habitat will be analyzed and evaluated using a multi-species spatially explicit model based on MBI's EDT (0).

(1d): Assess and monitor the residualization of hatchery- and naturally-reared steelhead and Chinook.

Performance metrics: Residualization rates

Status: Unfunded; not-implemented

Hatchery fish are usually released at sizes and conditions that differ from their natural counterparts. Sexually mature residualized fish can compete with anadromous returns for mates, and can compete with resident fish or pre-migrant juveniles for ecological resources. In certain cases hatchery practices can be modified to decrease residualization rates if problems are detected.

Approach:

Residualized steelhead and Chinook will be sampled during EMAP surveys (0). Residuals will be classified based on the length-frequency distribution of the juvenile population using outlier analysis. Resident RBT populations will be similarly noted, but are recognized as part of the steelhead population (Currens and Schreck 1995, Kostow 2003).

(2a): Monitor the limiting factors for Umatilla steelhead and Chinook.

Performance metrics: Mortality and survival at all life-stages

Status: Funded as part of ongoing evaluation activities

Limiting factor analysis is the process by which population bottlenecks are determined for managed species. As conditions are improved through mitigation actions, and population bottlenecks are diminished or eliminated, it is essential to re-assess limiting factors to guide future mitigation actions.

Approach:

Limiting factors will be analyzed every five years as part of regular evaluation activities. A multi-species spatially explicit model of the Umatilla Subbasin will be used to estimate mortality in Umatilla, Columbia, and marine life-history stages of all managed salmonids (0).

(2b): Assess the impacts of habitat improvement and protection on salmonid production in the Umatilla Subbasin.

Performance metrics: Habitat conditions, egg, fry, juvenile, and smolt production and survival

Status: Evaluation is funded; habitat monitoring is not funded and not implemented

Considerable resources are invested in habitat improvement measures as part of BPA and State of Oregon off-site mitigation activities. Each habitat improvement project conducts some monitoring and evaluation at the micro-scale to determine successful project implementation. However, for the most part only the cumulative impacts of watershed restoration can be tied directly to increased salmonid production. The connection between Tier 1 habitat project implementation monitoring and Tier 2 effectiveness monitoring must be addressed across the spatial hierarchy of reaches and watersheds.

Approach:

Habitat status (0) and juvenile production (0) information will be collected during EMAP surveys at the reach scale. These data will be expanded to the watershed scale using associative and geostatistical analysis. Long term effectiveness will be evaluated using trend analysis.

(3c): Assess and monitor the genetic characteristics of naturally and hatchery reared steelhead. (3d): Assess and monitor the reproductive success of hatchery and naturally reared steelhead. And (3f): Assess and monitor the long-term reproductive success of hatchery reared steelhead.

The reproductive success and genetic characteristics of hatchery fish can be different from those of naturally reared individuals or populations (Reisenbichler and McIntyre 1977). These affects stem in part from the environmental conditioning of hatchery programs, and in part from the artificial selection associated with the hatchery environment. The problem can in theory impact population growth even when endemic stock is used and traditional stock domestication is avoided (Chilcote 2003, Reisenbichler et al. 2003).

The impacts can be elusive because of the short-term production gains associated with supplementing a diminished population, and could in theory limit the recovery of salmon fisheries in the Umatilla Subbasin and elsewhere. Chilcote is quick to point out that the problem is theoretical in nature, and is “not sensitive to likely levels of data error or confounded by ***extraneous*** habitat correlation with” production (our emphasis, Chilcote 2003, p1057).

Umatilla program mangers have long known that much or most of the limits of production in the Umatilla stem from the deterioration of in-basin and Columbia mainstem habitat conditions. The biological objectives of these programs were developed and pursued to overcome the modern limitations of the system. This restorative approach was adopted without regard to short-term decreased productivity of hatchery reared fish, and with considerable attention paid to the overwhelming impacts of habitat degradation that had extirpated all salmon, and greatly diminished *O. mykiss* stocks. The intent of supplementation and reintroduction actions that have resulted in increased adult returns has been to utilize the UFH as an extension of the ecosystem; to utilize the hatchery advantage to increase numbers of spawners and thereby further seed the available habitat with juveniles.

Unlike many northwest programs, UFH has used endemic STS stock for more than a decade now. Nonetheless, it is not possible under the current RM&E approach to validate the long-term success of hatchery reared fishes, or to estimate the relative reproductive success of hatchery or naturally reared individuals. Due to increasing concern for the welfare of endemic populations, the reproductive success and genetic characteristics of Umatilla STS remains a critical uncertainty.

Approach:

Polymorphic microsatellite loci have been used in a variety of studies to determine parentage and population structure (O'Reilly et al. 1998, Bernatchez and Duchesne 2000, Letcher and King 2001, Eldridge et al. 2002). The technique and its application have been thoroughly reviewed (Wilson and Ferguson 2002). Microsatellite analysis will be used to estimate the relative reproductive success of hatchery and naturally reared STS, the long-term reproductive success of hatchery reared STS, and the genetic characteristics of both stocks. Although TMFD is available as a potential sampling station, CTUIR and ODFW maintain a policy to minimize fish handling and maximize fish production and health. In addition sampling at TMFD does not address the significant contribution of non-anadromous *O. mykiss* to STS populations. Instead a weir will be constructed at the mouth of Iskuulpa Creek. Adult anadromous returns, resident RBT, and juvenile progeny will be sampled and genotyped for 16 microsatellite markers (0).

(3e): Assess and monitor hatchery escapement to target areas

Performance metrics: Spawner escapement, migration timing, and passage efficiency.

Status: Partially funded; partially implemented

Adult movements were monitored in the Umatilla for a number of years using radio telemetry while physical passage improvements were underway, and spawner flow-requirements were being established (Tribal Fisheries Program 1994, Contor et al. 1995, Contor et al. 1996, 1997). Currently passage efficiency is monitored at a number of sites by the Umatilla Operations and Maintenance Project. Two pending critical uncertainties may require additional radio telemetry work. First, managers are concerned that hatchery reared steelhead escapement to areas targeted for natural production. STS demonstrate iteroparity, and do not often leave carcasses to be sampled. This limits the options for monitoring adult escapement to target tributaries. Second, more information on spring Chinook adult migration and summer holding is needed to understand the causes of high prespawn mortality (55%) and better manage fisheries.

Approach:

A small sub-sample of the natural CHS, CHF, and STS run will be radio tagged at the TMFD trap. The migration rates, passage, and destination of each radio tagged fish will be monitored using fixed station, hand-held, fly-over, and drive-by telemetry (0).

(4a): Assess and monitor hatchery steelhead escapement in Birch Creek.

Performance metrics: Endemic spawner escapement

Status: Unfunded; not-implemented

The Birch Creek watershed has been identified as a possible un-supplemented steelhead sanctuary. Adult escapement was monitored for a number of years by CTUIR and ODFW, and hatchery escapement to the watershed was consistently less than 5%. Unless that fraction changes it will not be necessary to weir and protect the system from hatchery escapement, however regular monitoring of the adult population is warranted.

Approach:

A temporary fish weir will be placed at the mouth of Birch Creek for portions of the STS adult run. Adult hatchery and natural escapement will be monitored using hand-held PIT-tag and CWT detectors and external fish marks (elastomer marks and adipose fin clips). The fraction of natural and hatchery escapement will be monitored, and the management of the watershed will be re-evaluated if necessary.

(7a): Monitor smolt production, smolt to adult survival, and hatchery adult returns of Umatilla hatchery programs; (7a) Monitor and assess the achievement of annual broodstock targets; (6b): Monitor and assess whether annual broodstock collection targets are met; (7b:) Monitor broodstock survival and disease incidence during holding; (8a) Monitor broodstock collection and spawning to assess whether collection and spawning protocols are met.

Performance metrics: Egg-to-fry survival, fry-to-smolt survival, smolt production, smolt-to-adult survival; adult production, percent of brood goal collected, brood collection timing, brood survival, and progeny-to-parent ratio

Status: Funded; ongoing

Hatchery production monitoring is critical to determining whether current hatchery strategies are effective and efficient for meeting smolt and adult production goals established to accomplish regional and subbasin management objectives. Quantifying survival of hatchery fish through all life stages is a fundamental tool used by managers to assess what corrective actions may be necessary if production goals are not met. Whether smolt and adult production goals and hatchery program strategies are appropriate for achieving management objectives for harvest, natural production, protection of life history and genetic diversity, and minimizing negative impacts to natural fish populations will be assessed within the context of information obtained by RM&E Objectives 1b, 1c, 1d, 2a, 2b, 3a, 3b, 3c, 3d, 3e, 3f, 3g, 4a, 5a, 5b, and 5c.

Approach:

Brood collection and mortality and detailed spawning information is monitored by CTUIR hatchery satellite facility staff and documented in BPA annual reports (11.9.1 and 11.9.2). Numbers of fish spawned (11.9.2), egg take (11.9.3), and in-hatchery survival and growth of fish to the smolt stage (11.9.4 and 11.9.5) is monitored by hatchery staff and reported to the ODFW hatchery database. Information associated with smolt releases (11.9.7), survival from smolt to adult (11.9.6), and adult disposition (11.9.6) is conducted by the UHMEP and reported in BPA annual reports and to the ODFW hatchery and PSMFC PTAGIS and RMIS databases.

(7b): Monitor and compare progeny-per-parent productivity of hatchery- and naturally-reared steelhead and Chinook.

***Status*:** Existing monitoring.

***Performance metric*:** Progeny-per-parent ratio (P:P ratio)

***Approach*:**

Determine number of adult progeny produced per brood for both hatchery and natural steelhead and Chinook. Calculate P:P ratios for both natural- and hatchery-reared fish as total number of adult progeny / total number of adult parents that spawned. Numbers of adult parents will be known from spawning records for hatchery fish, but will require estimation for natural steelhead and chinook. . Numbers of natural parents will be estimated annually from redd counts and spawner carcass data. Adult progeny from a brood will return over multiple years. Number of progeny per brood for hatchery-reared fish will be estimated from abundance and age information acquired by CWT recoveries. Number of progeny per brood for naturally-reared steelhead will be estimated by collecting and analyzing scales to apportion returning adults by brood year, then summing the brood-apportioned returns across run years to estimate total numbers of progeny produced by each brood. Number of progeny per brood for natural Chinook will be estimated by apportioning adult returns to their appropriate brood year based on age structure. Natural Chinook returns have been too low to accurately estimate age structure, therefore age structure of donor stock or nearby natural populations will be used as a surrogate.

(8a1): Evaluate if a colder more natural temperature environment in fall will increase smolt-to-adult survival of spring chinook reared at Umatilla Hatchery.

Status: Existing monitoring and evaluation.

Performance metric: Smolt-to-adult survival

Impetus for testing this alternative rearing strategy ("fall-transfer") was based on 1) previous trends in performance of well water- and surface water-reared spring chinook smolts released in the Umatilla Basin, and 2) a desire to provide a logistical means of maximizing smolt production at the water supply limited Umatilla-Irrigon Hatchery complex. Survival of the first few broods of spring chinook reared at the well-water-supplied Umatilla Hatchery was extremely poor while survival of spring chinook reared at the surface water-supplied Bonneville Hatchery was much higher. Differences in fish health between the Bonneville and Umatilla production groups during this time was a significant confounding factor in this hypothesis that was subsequently addressed through more rigorous brood screening and medication protocols for Umatilla production. Regardless of whether the fall-transfer rearing strategy improves smolt-to-adult survival, it is considered desirable for increasing smolt production capacity at Umatilla Hatchery provided there is a net gain in adult production. The fall-transfer maximizes summer water use and reduces total biomass of fish in the hatchery during the critical fall-spring time period. This is particularly important because a large draw-down of the John Day Pool in anticipation of a severe flood event will lower the aquifer at the hatchery and can reduce the water supply to critical levels.

Approach:

Tier 3 treatment vs. control experiment. Treatment is early transfer of smolts to the Imeques acclimation facility in mid-November to experience a colder and more natural temperature profile of the surface water-supplied acclimation facility. Control is normal transfer of smolts to the acclimation facility in mid-January with fish remaining in the relatively warm and constant well water-supplied hatchery environment. Difference in smolt-to-adult survival between treatment and control will be tested using Analysis of Variance (ANOVA) with years and raceways as replicates and a significance level $\alpha = 0.05$.

(8a2):Evaluate if smolt-to-adult survival of subyearling fall chinook can be improved by programmatic changes including larger size-at-release and direct-stream release lower in the basin.

Status: Existing monitoring and evaluation.

Performance metric: Smolt-to-adult survival

High marking costs and low SAS (0.03%) for subyearling fall chinook produced at Umatilla Hatchery provided the impetus for reducing smolt production from 2.67 million to 600 thousand smolts until an alternative rearing/release strategy could be found to improve SAS. A review of the subyearling fall Chinook program in 2000 concluded the current release location was undesirable relative to the bimodal thermal profile of the Umatilla River, and small size-at-release was a less important secondary factor to SAS. River conditions at the time of the subyearling release in late-May are typically characterized by rapidly decreasing flow and increasing water temperature. Water temperature gradually rises from the headwaters down to Pendleton, then is rapidly decreased by cold hypolimnetic water releases from McKay Reservoir, followed by gradual warming through the lower river. River temperature in the warmer reaches are typically between 55-65^{o} F at release time, but may be as high as 65-70^{o} F. Release of treatment fish lower in the river at the beginning of cold water inputs from McKay Reservoir eliminates migration through the warm water reach above Pendleton and reduces overall migration distance. Direct stream release provides treatment fish an additional three weeks of rapid growth at the hatchery which helps them reach a larger size-at-release compared to controls.

Approach:

Tier 3 treatment vs. control experiment. Treatment is larger size-at-release (40-50 fish/lb) and direct-stream release at river mile 48.5 (near the start of cold water inputs from McKay Creek). Control is the past program strategy of a normal size-at-release (60-70 fish/lb) and an acclimated release at river mile 73.5 (Thornhollow acclimation facility). Difference in smolt-to-adult survival between treatment and control will be tested using Analysis of Variance (ANOVA) with years and raceways as replicates and a significance level $\alpha = 0.05$.

(9a): Determine whether steelhead and Chinook broodstock are collected proportionate to the timing of adult returns.

Status: Existing monitoring.

Performance metric: Broodstock collection timing

Approach:

Hatchery operating protocols assume collection of broodstock proportionate to adult return timing will maximize life history and genetic diversity of the hatchery population. The ability of hatchery-reared returns to produce naturally reared offspring that have the genetic and life history capacities to restore productive and self-sustaining natural populations in the Umatilla Basin will be assed by RM&E Objective 1e1. For steelhead, compare percent of broodstock collected to the percent of natural-reared run to Three Mile Falls Dam on a monthly basis. For Chinook, compare percent of broodstock collected to the percent of combined run (hatchery- and natural-reared returns) to Three Mile Falls Dam on a biweekly basis. Test for significant differences in brood collection timing and run timing using a Chi-Square analysis.

(9b): Estimate number of adult returns from the Umatilla Basin steelhead and Chinook hatchery programs that stray to other basins, and examine associations between homing to the Umatilla River and hatchery production strategies, flow augmentation, and environmental variables.

Status: Modify and enhance existing monitoring.

Performance metric: Number of hatchery returns that stray to other basins; percent of hatchery escapement to the mouth of the Umatilla River that stray to upriver basins (upriver stray rate); and percent of hatchery escapement to the mouth of the Umatilla River that reaches TMFD

Approach:

Estimate number of adult strays from out-of-basin CWT recoveries. Compare upriver stray rates of varying hatchery production strategies. Compare pre- and post-flow augmentation upriver stray rates. Assess relationships between homing and variations in flow and temperature in the Umatilla and Columbia rivers using correlation analysis.

(9c): Monitor the health of hatchery and natural fish; ; (7b:) Monitor broodstock survival and disease incidence during holding.

Performance metrics: Pathogen prevalence and levels in hatchery and natural fish.

Approach:

The health of hatchery production fish will be monitored starting with broodstock and continue throughout rearing. Fish for natural fish health monitoring will come from screw trap mortalities and spawning ground survey samples if available. All sampling, diagnostic, and statistical analyses will conform if possible with the Integrated Hatchery Operations Team (IHOT) and the Pacific Northwest Fish Health Protection Committee. All monitoring will be consistent with the ODFW fish health policy and the native fish conservation policy. An important aspect to the overall approach is to make it a priority and goal to only release fish into the Umatilla basin that are known to be have a healthy disease history during rearing to minimize the impact on natural or other hatchery-produced fish. Fish health sampling and monitoring will be conducted under supervision of a fish health specialist, and processed at a qualified fish disease laboratory. Analysis of samples will follow standard protocols defined in the latest edition of the American Fisheries Society "Fish Health Blue Book" (Procedures for the Detection and Identification of Certain Fish Pathogens).

(10a): Assess and monitor the impact of flow enhancement on homing of adult steelhead and chinook to the Umatilla River; (10b) Assess the impact of flow enhancement on steelhead and Chinook survival and the frequency of fish transport.

Performance measure: Run timing, escapement to the Umatilla River, migration timing, abundance and survival of juveniles and adults, in-stream flow and water temperature in the lower river.

Approach: Previous assessments of fall Chinook homing to the Umatilla River by Kissner (1993) and Volkman (1994 and 1995) suggest homing is poorest for the early portion of the run when flows are low, and a minimum attraction flow of 150 cfs in the Umatilla River is needed for homing. Run timing and abundance of Umatilla returns to Three Mile Falls and Lower Granite dams will be compared to assess the impact of flow enhancement on the homing and stray rates of Umatilla River fish. Information will be correlated with environmental conditions in the Umatilla and Columbia rivers (flow and temperature).

The percent of juvenile and adult migrations that pass through the lower river during enhanced flows will be estimated by determining the overlap in migration timing to Three Mile Falls Dam with flow enhancement timing, and adjusting this overlap for the additional time required for fish to migrate through the flow enhanced river reach. Estimates of juvenile and adult migration speeds through the lower Umatilla River are available from adult radio tracking studies conducted from 1994-1996 (Volkman 1994 and 1995, Contor et. al 1996 and 1997) and smolt migration monitoring conducted by the ODFW Umatilla River Juvenile Salmonid Outmigration and Survival Project (BPA # 89-024-01) from 1996 to present.

The impacts of flow enhancement on survival will be difficult to assess. Problems include obtaining sufficient numbers of migrating fish and minimizing handling stress. The evaluation would involve a treatment and control type experiment, where treatment fish would be trapped, PIT tagged and released on location during flow enhancement. Control fish would be trapped, PIT-tagged and subsequently transported to the river mouth during flow enhancement. Ideally, we would not want to trap and handle in-river migrating treatment fish. Therefore, the ability of this test to detect the effect of the trapping and handling procedures on survival is diminished to an unknown degree. Secondly, our performance measure would be PIT-tag detections and not smolt survival. PIT-tag detection rates probably wouldn't be meaningful since the treatment and controls will likely have different arrival times at mainstem Columbia River dams. The experiment would be replicated in season and between years. ANOVA would be used to test for differences in PIT-tag detection rates at lower Columbia River Dams of treatments and controls.

(12a): Assess and monitor migration times and delay in the Umatilla mainstem; (12b): Assess the effect of reduced diversion during water exchange on the relative attraction of smolts to the passage facility and east bank fish ladder of TMFD.

Status: (12a) Partially funded; partially implemented. (12b) Proposed.

Performance Measures: Passage abundance, migration timing and patterns at various flows and levels of operation.

Approach*:* Effectiveness of the juvenile fish bypass and adult passage facilities was evaluated between 1990 and 1994 (Knapp 1995). However, the effects of canal operations and water exchange programs on fish passage and attraction efficiency were not included in this evaluation. Associations between canal diversion, Phase 1 & 2 exchange and smolt attraction efficiency will be assessed and compared at West Extension Canals juvenile passage facility and the east bank fish ladder (regression and correlation analysis). Mark recapture and pit tag technology will be used to evaluate timing and fish passage routes at various flows and levels of operation. Marked fish will be released upstream of Three Mile Falls Dam and fish passing thru the juvenile passage facility and the east bank fish ladder will be remotely interrogated. Interrogation within the juvenile facility will occur at three locations: the canal headgates, the juvenile bypass channel and river return structure (fish outfall).

A major passage restoration is planned for the Umatilla Mainstem (Harza Engineering Company 1999). Experience has shown that not all passage restorations are successful, so action effectiveness monitoring is warranted.

(13a): Develop models for pre-season estimation of Umatilla River returns to facilitate management of subbasin fisheries.

Performance metrics: Run timing; adult returns; run prediction

Status: Funded; ongoing

Broodstock, harvest, and spawner escapement goals are developed as part of the long-term planning process for the Umatilla. However, these targets are always set as objectives, and are adaptively altered as conditions change. Run prediction models provide near-term estimates of run timing and size that can be used to plan for adaptive changes to biological objectives.

Approach: Correlation models have been developed for preseason prediction of chinook and steelhead run size to the Umatilla River. Spring Chinook run size to the Umatilla River is predicted from the previous year's jack counts to the Umatilla River mouth (r = 0.93). Regressions for fall Chinook (r = 0.92) and steelhead (r = 0.87) run size to the Umatilla River are based on both forecasted and actual fall Chinook and steelhead counts at Bonneville Dam (total run for fall Chinook, Up-river A-run for steelhead). Models based on forecasted run strength to Bonneville Dam are computed in June as part of the development of the Umatilla Basin's Annual Operating Plan (AOP). The model is then updated for steelhead in late-September after the Upriver A-run to Bonneville Dam has been counted.

(13b1): Quantify fishing effort, catch, and harvest by gear type for tribal and non-tribal fisheries in the Umatilla River.

Performance metrics: Fisher hours, harvest, and catch

Status: Mostly funded; mostly ongoing

Approach:

Tribal fisheries will be monitored using roving creel surveys, phone surveys, and volunteer fishing journals (0.1). Non-tribal fisheries will be monitored using stratified roving creel surveys (0.2).

(13b2): Quantify harvest of Umatilla steelhead and Chinook in out-of-basin fisheries.

Performance metrics: Out-of-basin harvest

Status: Funded; ongoing

Approach:

In out-of-basin fisheries that are selective for hatchery fish, harvest will be estimated from CWT recoveries reported on the Pacific States Marine Fisheries Commission CWT database. In out-of-basin fisheries that are not selective for hatchery fish, harvest of natural fish will be estimated as the number of hatchery fish harvest times the ratio of natural to hatchery run size (run sizes to the mouth of the Umatilla River).

(13c): Assess whether management actions optimize fishery opportunities while meeting production and population objectives.

Performance Metrics: Fishery opportunity

Status: Funded; ongoing

Approach:

Maintaining and improving fisheries is a primary goal of local and regional fishery managers. However, fisheries should be monitored and adaptively managed to ensure they do not negatively impact management objectives for brood collection, natural spawning, life history and genetic diversity, and non-target populations. We will assess whether fishing regulations optimize fishing opportunities with the constraints of the aforementioned management objectives. We will also assess impacts of hatchery program management (smolt production and release locations) on fishing opportunities.

(14a): Conduct collaborative study planning, implementation, synthesis of results, and results dissemination.

Performance metrics: All

Priority: High

Status: Funded; ongoing

Throughout the fourteen year history of UMEP, CTUIR and ODFW projects have faced challenging staffing complications, communication problems, and coordination gaps. ISRP reviews, NPPC feedback, and lingering data-gaps have made clear that increased collaboration is needed to increase RM&E effectiveness in the subbasin. CTUIR and ODFW will work together to increase in-situ planning, data collection, analysis, evaluation, and results dissemination. The projects will combine office, field, and laboratory equipment requirements wherever possible to increase programmatic integration and inter-agency communication.The projects will combine budgets and funding requests wherever possible, and will begin to produce a collaborative annual report to BPA.

(14a): Conduct collaborative study planning, implementation, synthesis of results, and results dissemination; (15a): Adopt locally and regionally standardized protocols; (15b): Coordinate with local and regional management and research groups, and integrate information from these groups into assessments of Umatilla Subbasin fisheries program; (16a): Conduct collaborative research with out-of-basin research programs that address Umatilla uncertainties; (16b): Participate in Columbia Basin research, monitoring, and evaluation forums.

Performance metrics: All

Status: Funded; ongoing

This RM&E Plan for steelhead and chinook has been developed collaboratively by the Umatilla Basin Natural Production, Juvenile Salmonid Outmigration and Survival, and Hatchery M&E projects. It will serve as a first step toward development of a Comprehensive RM&E Plan for all fish programs in the basin that will be incorporated in the Umatilla Subbasin Plan. This RM&E Plan should be considered preliminary as it may require revision depending on the outcome of the Subbasin Planning Process. ODFW and CTUIR basin co-managers have participated in the development of this RM&E Plan and provided their best forecast of management goals, objectives, and approaches that will be incorporated in the Subbasin Plan. Annual collaborative study planning will be achieved through review of Draft Work Statements and subsequent coordination meeting between M&E project sponsors, managers, and operations staff to define priority of information needs and assist in the development of RM&E objectives, approaches, methods, and activities.

Annual reports will be developed with data and information exchanged between the M&E projects to provide integrated summaries, analyses, and interpretations of data in relation to M&E objectives. In particular, the Hatchery M&E project will redirect it's focus of assessments and reporting from internal hatchery operations toward whether the hatchery program is accomplishing natural production and harvest goals for the basin. Annual reports will be one means of providing recommendations for adaptive management of the fisheries program. Integration of RM&E findings into program management and operations is an ongoing process facilitated primarily by regular meetings of the Umatilla Monitoring and Evaluation Oversight

Committee (UMEOC). The UMEOC meets monthly or as needed and is made up of RM&E staff, fisheries managers, and program operations staff working within the basin. Other forums for integrating RM&E findings into program management and operations include River Operations and Research Review meetings. The River Operations Group meets monthly to discuss fish passage facility and water exchange issues in the basin and is made up of RM&E staff, irrigation district managers, and staff from the U.S. Bureau of Reclamation, Oregon Water Resources Department, and Umatilla Fish Passage Operations Project. Research Reviews are held periodically to provide an interactive forum for formal presentation of RM&E findings and recommendations to basin fisheries managers and program operations staff. These research reviews also provide managers and operations staff an additional opportunity to assist in the development and prioritization of RM&E objectives and activities. Although members of the above mentioned meeting groups are primarily local staff, regional staff also attend when agenda topics require their participation.

We will participate in several regional processes to coordinate Umatilla RM&E activities with regional information needs. These processes include independent reviews/audits of anadromous fish hatchery performance initiated by the Northwest Power and Conservation Council, using performance measures developed by Independent Hatchery Operations Team (IHOT) and Artificial Production Review and Evaluations (APRE). Currently, comanagers are coordinating with NOAA to assess the scope and status of information needs identified in the Biological Opinion. The Umatilla RM&E program will also be coordinated with the CBFWA Regional Monitoring and Evaluation program currently being developed. The ISRP Provincial Review process provides an additional means of identifying regional information needs.

We will incorporate regional sampling protocols into our RM&E activities to provide region-wide data compatibility as these standards become defined. Currently, RM&E activities incorporate regional protocols for PIT-tagging, CWT'ing, and marking developed by the Pacific States Marine Fisheries Commission, and fish health monitoring developed by the Independent Hatchery Operations Team (IHOT). We propose in this RM&E to incorporate E-map sampling protocols into our fish habitat and population status monitoring. We will adopt other regional protocols for data collection as they are developed thru the Artificial Production Review and Evaluations (APRE), IHOT, NOAA Biological Opinion, and CBFWA Regional Monitoring and Evaluation program processes.

We will utilize project specific and region-wide databases that have been developed to centralize data management and access. A CTUIR website will be maintained to house a standardized database for primary data and description of meta-data. Appropriate components of program data and results will be provided to the Pacific States Marine Fisheries Commission (PSMFC) websites, including: StreamNet, PIT Tag Information System (PTAGIS), and the Regional Mark Information System (RMIS). Fish production and release summaries including mark applications will be provided to the Fish Passage Center for incorruption in their web based data. Run size information will be provided to the Columbia River Technical Advisory Committee.

We will obtain information from other basins to compare with Umatilla Basin RM&E study findings. We will compare basin-to-basin status and trends of fish abundance, productivity, and habitat. In particular, we will compare trends in Umatilla steelhead abundance and productivity with the unsupplemented steelhead population in the John Day Basin to address impacts of supplementation. We will also compared Umatilla spring chinook productivity with other natural and supplemented populations in nearby basins to assess the status of the Umatilla restoration program. Trends in abundance of Umatilla steelhead and chinook will also be compared with the Columbia/Snake river basin metapopulation to assess whether the Umatilla populations are following regional trends. As e-map protocols are expanded regionally, we will integrate the regional-scale understanding of fish populations and habitat into the assessment of Umatilla fish programs. Lack of uniformity in sampling protocols has confounded the validity and utility of some previous between-basin comparisons. Collection of comparable data may provide the ability to calibrate past data, thus increasing the validity of between-basin comparisons.

Detailed Methodology

Juvenile Abundance and Distribution Monitoring

An EMAP sampling design will be used to quantify the abundance of salmonid juveniles at the reach scale. The sampling universe for juvenile surveys will be the 331 reaches developed for subbasin planning and in-situ sampling designs (Figure 1). We will use reaches these reaches and watershed delineations to allocate sampling evenly across the subbasin. Sampling intensity will be increased in watersheds that are receiving supplementation. Fifty reaches will be selected for surveys during the first year of study. Out of the fifty randomly selected reaches, two per watershed will be selected as permanent index sites. An additional eleven sites (one per watershed) will be selected for sampling every three years. During subsequent surveys an additional twenty-eight reaches will be selected randomly to maintain a sample size of 50+ reaches per year. Within each reach sampling sites will be distributed randomly where possible, but will conform to land-owner requests and trespassing laws.

Sampling will occur in June through October. The spatial distribution will be kept balanced for every month of survey effort so that temporal patterns within the sampling season can be analyzed. Within each reach micro-habitats will be surveyed using the appropriate methodology. Pools will be snorkeled and trapped. Riffles will be trapped, seined, or electro-fished using multiple-pass depletions depending on conditions. Approximately five to ten percent of the catch will be PIT-tagged for survival and out-migration monitoring (0). The total number and CPUE of all salmonid species and cohabitants will be recorded separately for each sampling methodology.

Juvenile Abundance and Distribution Analysis:

The total abundance and CPUE by reach and sampling methodology for all fish species will be analyzed using associative, geostatistical, time series, and structural analysis. The data will be expanded to the watershed scale using geostatistical stock assessment based on habitat data (Petitgas 2001). Temporal patterns will be de-trended and filtered using seasonal and autoregressive functions. Fish community data will be further analyzed from an ecological perspective using functional analysis (0).

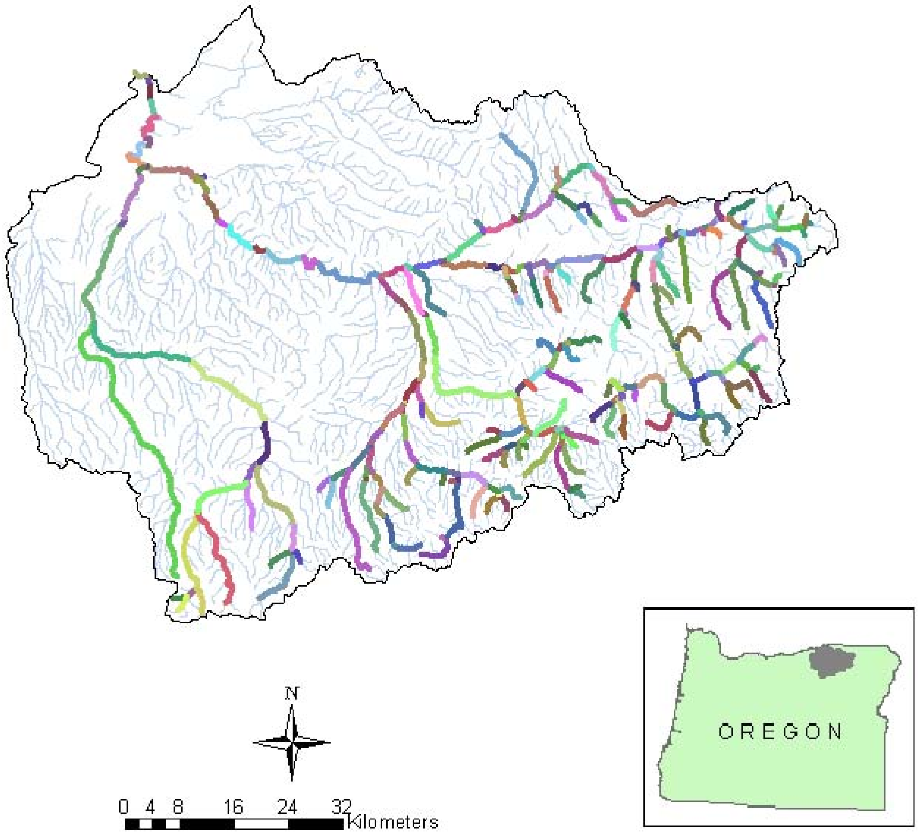


Figure 1. Reach distribution for the Umatilla Subbasin developed for subbasin planning and EMAP sampling design.

Outmigrant Monitoring

Outmigration monitoring is a key M&E activity through which essential components which drive the Subbasin's decision making analysis are derived. Smolt abundance, migration timing, and in-basin survival are all collected through O&S monitoring activities. Smolt yield provides a foundation for relationships such as smolts produced and smolts/spawner, or smolts/spawner regressed by total escapement, which are used to estimate in-basin capacity and productivity. It is also a crucial component required to estimate performance metrics such as smolt-to-adult returns and smolt-to-adult survival for natural species. An understanding of migration success and survival is also necessary to identify in and out-of-basin bottlenecks and estimate loss by life stage for hatchery and natural species. This information can be used to depict trends over time and ultimately assist managers in managing the subbasin.

Existing methodologies include use of mark-recapture techniques to derive in and out-of-basin survival estimates. Smolt abundance is derived from fish collection and expanded by the trap efficiency. We are currently investigating alternate methods to collect outmigrant data in order to improve project operations, estimates, and efficiency, and reduce potential error. Examples of these include moving towards the SURPH model for in-basin survival estimates, changing trap types and locations or applying in-basin survival estimates to upper river abundance to derive a total smolt outmigrant estimate. Options will be analyzed and methodologies finalized for implementation by 2005.

P.I.T. Tagging and Detection

PIT tags have been used to mark hatchery and natural juvenile salmonids in the Umatilla River since 1998. The first remote interrogation system (for 400 kHz tags) was installed at West Extension Canal's juvenile sampling facility off Three Mile Falls Dam in 1999. In 2000, the system was upgraded to a 134 kHz system (to stay aligned with mainstem dam upgrades) and new interrogation software was implemented. Additional upgrades were conducted in 2003, to improve performance and reliability and allow for remote system monitoring.

In the spring of 2001, a second PIT tag interrogation system was installed along the east bank adult fish ladder of Three Mile Falls Dam. Passage evaluation studies conducted in the early 1990's indicated the east bank fish ladder to be a key migration corridor for juvenile salmonids. The temporary system was installed in attempt to supplement juvenile detection data and obtain valuable information on adult returns. With tagging efforts ranging between 14,000-31,000 fish annually since 1999, PIT tag interrogation has provided invaluable data on migration characteristics and in-basin survival of juvenile salmonids. Furthermore, tags implanted between 1998 and 2003 have recently been recovered from adult broodstock during spawning.

Funding is currently being pursued to support installation of improved PIT tag detection capabilities at the east bank fish ladder of Three Mile Falls Dam. Improved detection capabilities would benefit not only juvenile outmigration and survival data, but provide valuable tag information on adult returns (including out-of-basin strays and ESU listed summer steelhead). Furthermore, it will extend interrogation capabilities for juvenile fish beyond operation of the west bank juvenile sampling facility, improve detection efficiency and tag estimates, facilitate data collection, reduce excessive downtime, and ease upload of the current system.

Approximately 6,000 hatchery-reared fish are currently PIT tagged and released annually in the upper Umatilla River between RM 56 and RM 80. An additional 5,000 tagged fish are released in the lower river for use in trap efficiency tests (RM 3.7). Production fish are tagged to monitor hatchery rearing and release strategies. Roughly 300 fish from each release group are tagged at the hatchery or acclimation facility prior to release. Fish are PIT tagged following methods outlined in the PIT Tag Marking Procedures Manual (CBFWA, PIT Tag Steering Committee, 1999. Release groups are sometimes combined to describe comparisons.

Natural fish will be captured and tagged in the headwaters and Umatilla River mainstem using baited minnow traps during abundance surveys (11.1). Approximately 1,000 natural fish are also tagged annually in the lower river during outmigrant sampling for use in trap efficiency tests.

Hatchery and natural smolts leaving the Umatilla River are interrogated for PIT tags at Three Mile Falls Dam (RM 3.7). PIT tag interrogation is conducted at two locations along the dam. Fish traveling along the west bank are interrogated for tags via a 134 kHz stationary PIT tag detection system located within the juvenile bypass facility off West Extension Canal. Fish traveling along the east bank are interrogated by means of temporary PIT tag detection system installed at the viewing window of the adult fish ladder.

Interrogation along the west bank is conducted 24 hr/day, seven days a week, between February and June. This is the primary smolt emigration period for hatchery and natural salmonids. Juvenile fish entering West Extension Canal are directed through the bypass channel, to an inclined plane trap equipped with a separator plate. Small fish (< 400 mm) fall through separator plate into the flume and are diverted to an eight-inch PVC pipe encircled by two hand wrapped antennas. Each antenna is connected to a FS 1001 stationary transceiver which detects and interprets codes from previously tagged fish. Once fish pass through the antennae, they are returned directly to the river via a bypass downwell and pipe extension.

PIT tag data is transferred from the stationary transceivers to a laptop computer via a serial port hub. Files are automatically uploaded to PTAGIS via the Minimon Program and modem. PITTag3 software is used to record codes of implanted tags and track the number of tagged fish Interrogation files are created every 3 hours and completed files are automatically uploaded to the PTAGIS database eight times daily. PIT tag system oversight and maintenance is conducted by Pacific State Marine Fisheries Commission, (PSMFC).

The PIT Tag detection system installed at the east-bank adult fish ladder of Three Mile Falls Dam (TMFD) is operated from September through July. The system consists of two portable transceivers (DA-2001F) equipped with paddle style antennas taped to the viewing window. The antennas are set on high power (80-100%) for maximum reading distance. Detection capability of tags tested through the glass ranges from 2-5 inches. Detection efficiency of tagged juvenile salmonids using the east bank adult ladder is between 0% and 8%. Data from the east bank system is stored in the portable receivers and then manually downloaded into an interrogation file and e-mailed to PTAGIS.

Tagged fish passing by the east and west banks of TMFD are individually differentiated by unique identification codes. Fish passing by the east bank adult fish ladder are identified by (TMA). Fish traversing along the west bank juvenile facility are identified by TMJ (Three Mile Juvenile).

Initial attempts in 2002 to improve detection capabilities at the east bank fish ladder of Three Miles Falls Dam proved too costly (~$194K) at the time to proceed. Subsequent attempts in 2003 also failed due to a large amount of interference from surrounding metalwork. In late 2003, Pacific States Marine Fisheries Commission (PSMFC) was contacted regarding options for improving detection efficiency at the site. Suggested upgrades included installation of three stationary antennas molded into high impact plastic housing and mounted in consecutive succession in the vertical slots (weir walls) of the ladder. The estimated cost was $108K. Funding is currently being pursued to implement recommended upgrades.

Analysis:

Smolt survival is estimated for hatchery and natural salmonids to assess in-basin and out-of-basin loss by species and life-stage. Survival estimates are also generated to evaluate optimal release sites and tactics, rearing strategies, and broods of hatchery reared fish. Mark-recapture methodology utilizing Passive Integrated Transponder (PIT) tags and subsequent detections at Three Mile and downstream Columbia River dams is used to calculate survival.

In-basin survival: In-basin survival is currently estimated using the Migrant Abundance Method (Burham et al. 1987 and Dauble et al. 1993), whereby:

$$S = A/R$$
and
$$A = (TD)/(1/TE)$$

S = survival, A = the outmigrant abundance at RM 3.7, R = the number of tagged fish released at upriver sites (*R*), TD = number of tagged migrants recaptured downstream, and TE = estimated trap efficiency. Since detections are date specific, efficiency estimates used encompass corresponding tag dates. If efficiency estimates do not correspond to the dates tags are detected, trap efficiency data is arbitrarily pooled using the closest daily estimates before and after the detection date.

Confidence intervals (95%) are based on derived population confidence intervals. The binomial test is used to test for significant differences in detection between comparable release groups of hatchery fish.

Alternate methodologies are currently being explored to obtain sound in-basin survival estimates. The SURPH Model (v 2.0) is one of the techniques currently being tested. Preliminary sample size requirements for determining survival probabilities to Three Mile Falls Dam were determined using the SURPH Sample Size program (v 1.2). Observed survival and detection rates from PIT-tagged hatchery and natural salmonids released in the Umatilla River between 1998 and 2003, were used to estimate minimum release groups needed to generate survival probabilities with 90% CI of 2.5%. Estimated minimum release groups ranged in size from 11,714 (natural spring Chinook salmon) to 57,666 (hatchery summer steelhead). All species and their required minimum release size for in-basin survival estimates are presented in Figures TW1 to TW6. Tag numbers needed to estimate in-basin survival would need to be increased by as much as 64 fold over current tag allocations (Table TW1). An increase in tagging would be contingent upon policy decisions by managers, feasibility and funding allocations. We do not currently have the additional funding required to PIT tag high numbers of fish in the Umatilla Subbasin. Additionally, the feasibility and logistics involved in capturing 12,000 to 14,000 natural fish per species to meet in-basin tagging requirements is unrealistic.

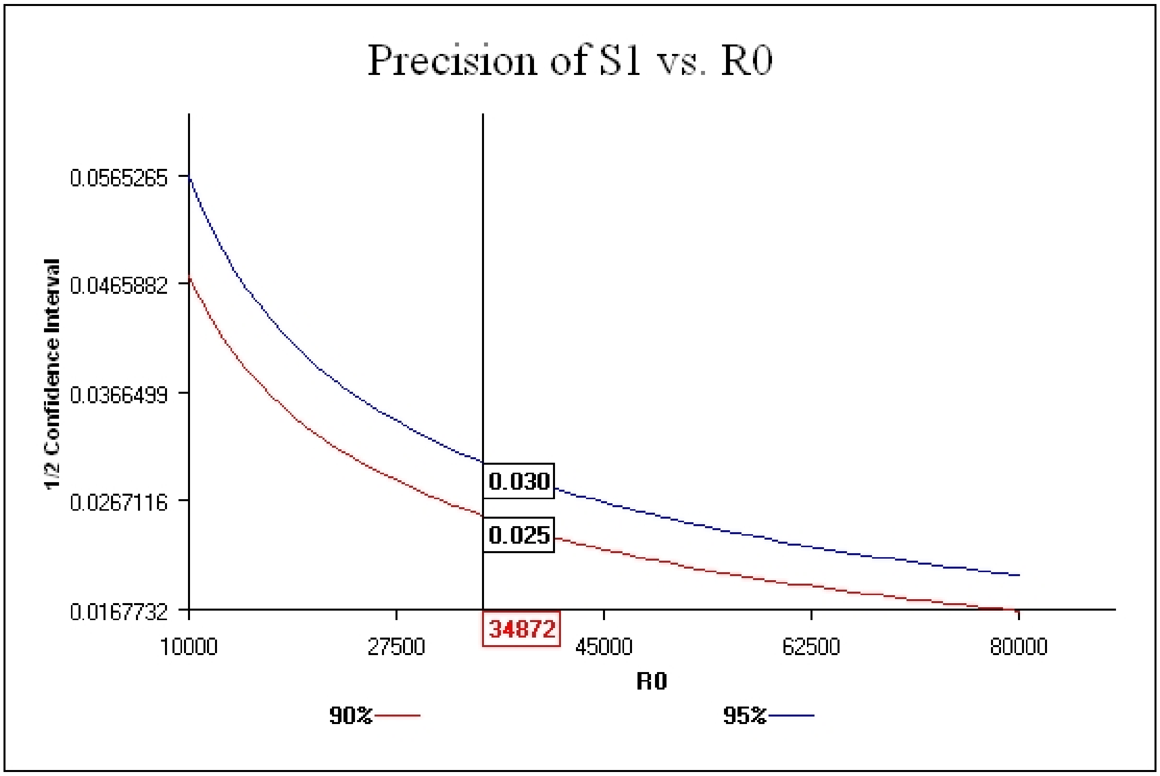


Figure TW1. Hatchery spring chinook salmon tag size needed to obtain a 90% confidence interval at 2.5% for in-basin survival rates.

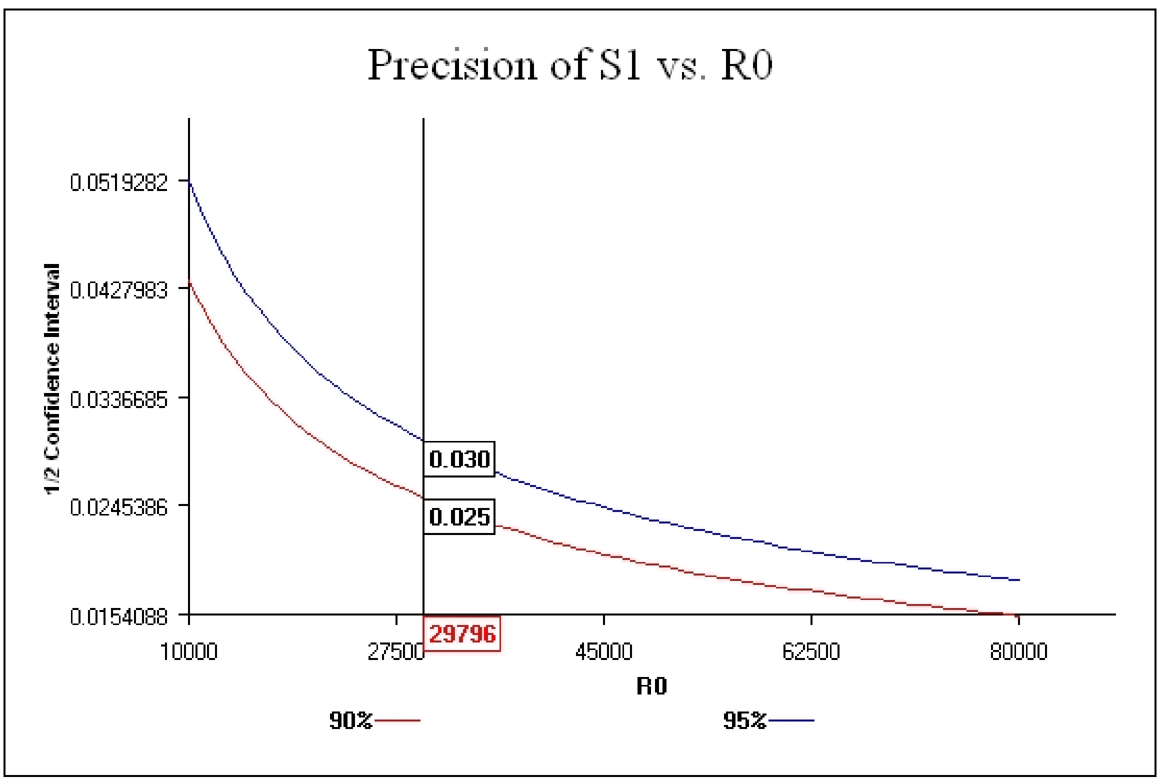


Figure TW2. Hatchery yearling fall chinook salmon tag size needed to obtain a 90% confidence interval at 2.5% for in-basin survival rates.

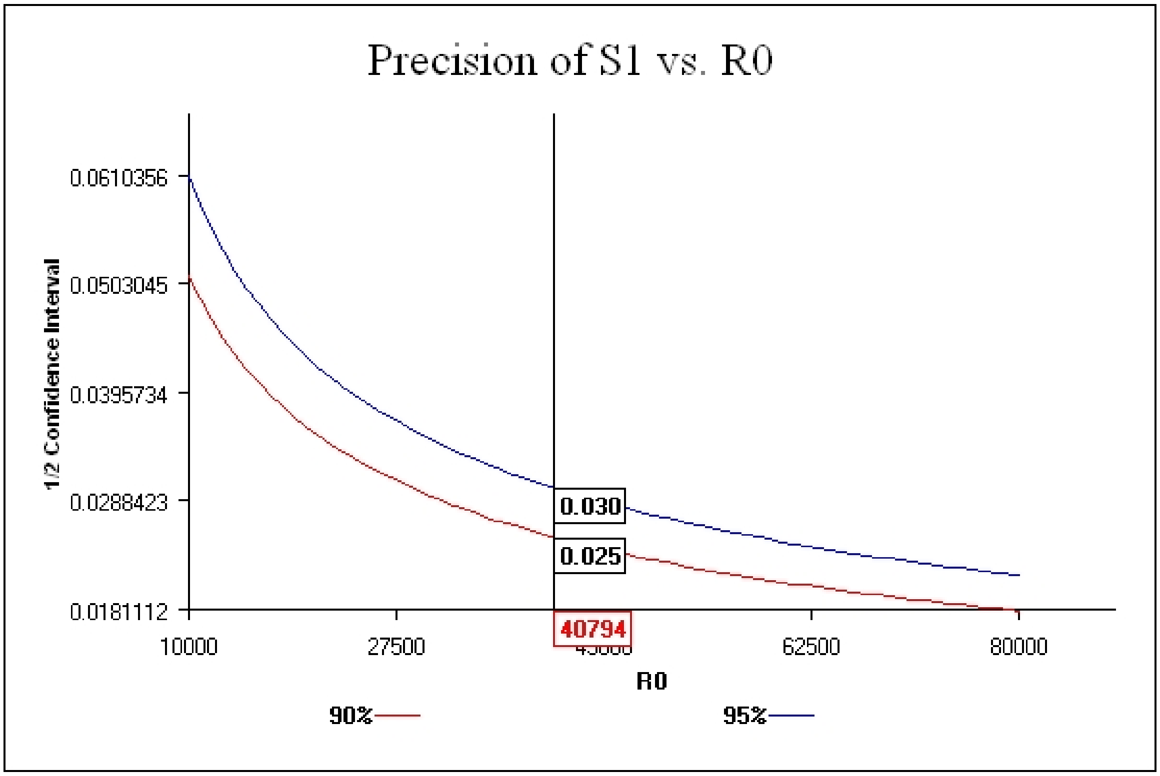


Figure TW3. Hatchery subyearling fall chinook salmon tag size needed to obtain a 90% confidence interval at 2.5% for in-basin survival rates.

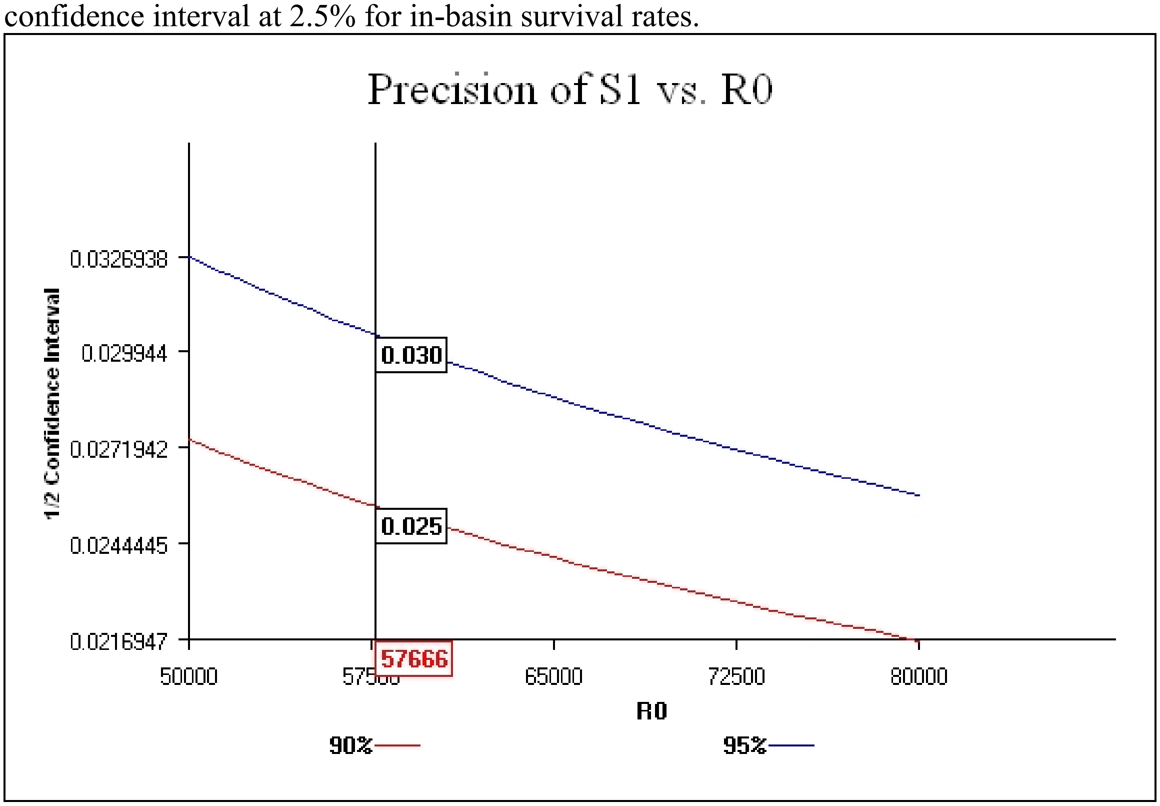


Figure TW4. Hatchery summer steelhead tag size needed to obtain a 90% confidence interval at 2.5% for in-basin survival rates.

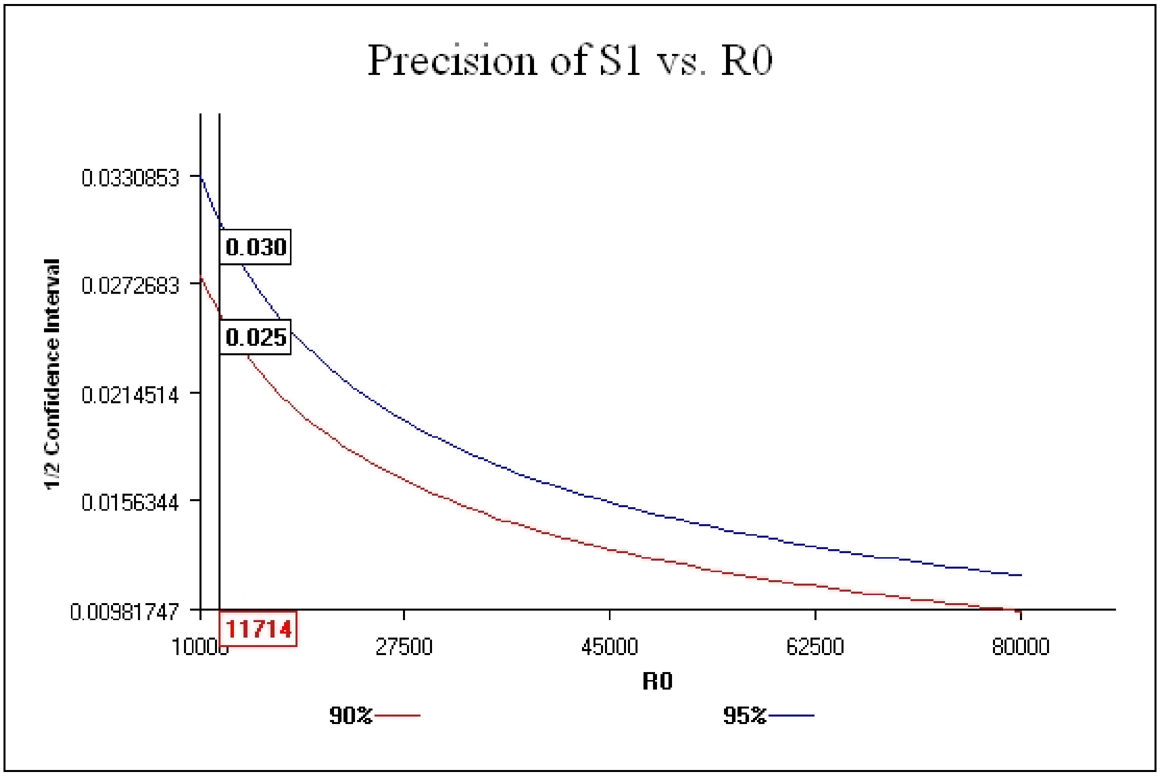


Figure TW5. Natural spring chinook salmon tag size needed to obtain a 90% confidence interval at 2.5% for in-basin survival rates.

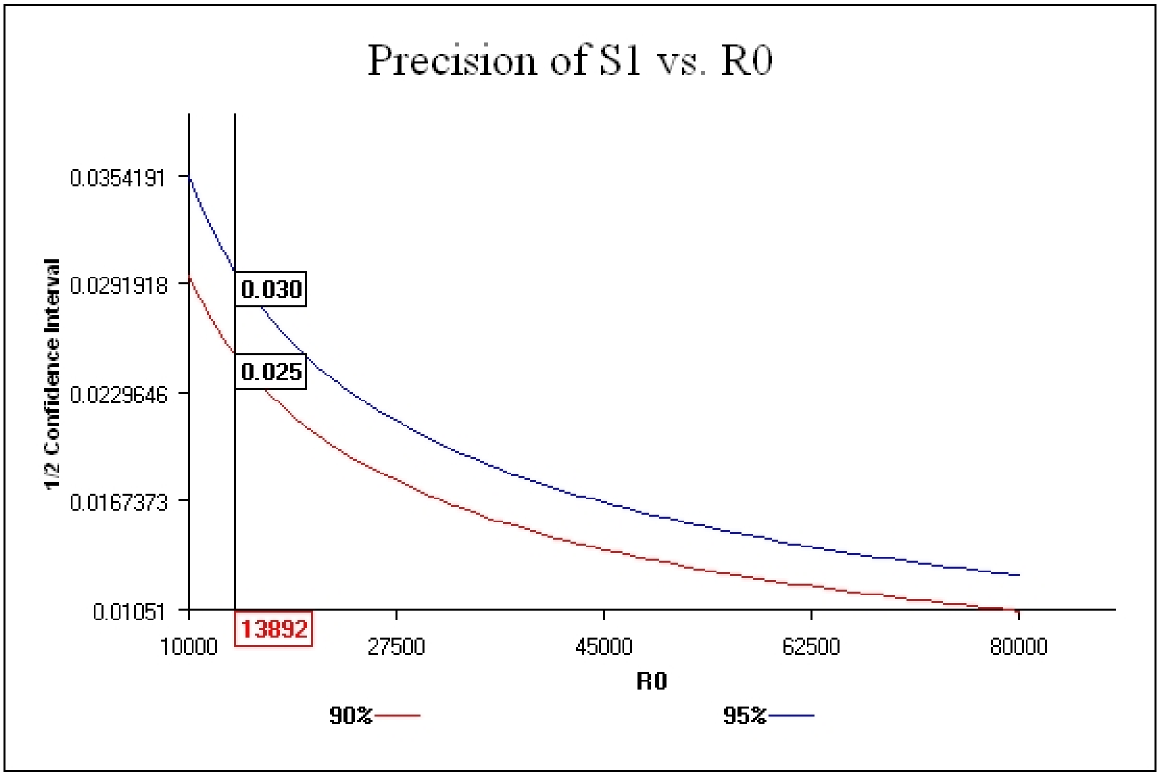


Figure TW6. Natural summer steelhead tag size needed to obtain a 90% confidence interval at 2.5% for in-basin survival rates.

Table TW1. Current and proposed minimum tag sizes needed to obtain in-basin survival rates for hatchery and natural juvenile salmonids using the SURPH 2.0 model.

Species	Current tag size	Proposed tag size
Hatchery spring Chinook	2,500	34,872
Hatchery yearling fall Chinook	600	29,796
Hatchery subyearling fall Chinook	1,200	40,794
Hatchery summer steelhead	900	57,666
Natural spring Chinook	-	11,714
Natural summer steelhead	-	13,892
Total	5,200	188,734

Table TW2. Summary of observed survival and detection rates for hatchery and natural juvenile salmonids released in the Umatilla River.

Species	Survival rate to TMFD	Detection rate at TMFD	Survival rate to JDD*	Detection rate at JDD
Hatchery spring Chinook	0.59	0.25	0.42	0.12
Hatchery yearling fall Chinook	0.63	0.29	--	0.14
Hatchery subyearling Chinook	0.92	0.32	--	0.08
Hatchery summer steelhead	0.78	0.21	0.46	0.05
Natural spring Chinook	0.40	0.35	0.51	0.13

Natural summer steelhead	0.39	0.30	0.54	0.12

*Survival rates to JDD were obtained from Contor 2003.

Testing for significant differences in survival rates will be conducted annually and over five year periods. Smolt survival estimates generated by SURPH include a point estimate and associated variance. ANOVA testing with transformed data will be used to characterize trends over time.

Out-of-subbasin survival: Out-of-subbasin will be estimated using the CRiSP (www.cbr.washington.edu) and SURPH models. Sample Size v. 1.2 (Westhagen et al. 2003) was used to determine the relationship between sample size and power for detecting survival of each brood year of STS, CHS, and CHF using PIT-tags. CTUIR and ODFW PIT-tagged hatchery and wild salmonids in the Umatilla Subbasin during 1999-2001 (Contor 2003). Average detection rates at John Day Dam for STS during 1999-2001 were 0.289 (N=8,718, Table 1). Survival rates varied by rearing type and release group (Table 2). Average STS survival to John Day Dam was 0.54 for all natural STS and 0.45 for all hatchery reared STS. Average survival*detection to Bonneville Dam was 0.379 for all STS (Contor 2003). On average a sample size of 6428 natural and 8007 hatchery reared STS will produce a 90% survival confidence estimate with α=0.05 (Figure 2 and Figure 3). An additional ~2000 naturally reared fish must be tagged so that differences in the survival of natural and hatchery reared STS can be detected with a 95% confidence interval (Figure 4).

Average detection rates at John Day Dam for CHS during 1999-2001 were 0.294 (N=2,980, Table 3). Survival rates of Chinook varied by rearing type and release group (Table 4). Spring and fall Chinook were not differentiated. Average Chinook survival to John Day Dam was 0.55 for natural and 0.39 for naturally reared fish (Contor 2003). Average survival*detection to Bonneville Dam was 0.389 (Contor 2003). On average a sample size of 6516 natural and 9235 hatchery reared Chinook will produce a 90% survival confidence estimate with α=0.05 (Figure 5 and Figure 6). Survival and detection estimates specific to CHF are not available for the Umatilla. It is probably safe to assume that the above Chinook sample sizes should be applied to each species independently. Acquiring this number of natural CHF may be a challenge, but should be possible with sufficient effort. This sampling effort should be sufficient to estimate differences in natural and hatchery reared survival and assign a 90% confidence interval to that estimate (Figure X). Due to the large difference in natural and hatchery survival an additional 4000 hatchery reared Chinook would need to be tagged to assign a 95% confidence interval to that estimate. This additional resolution is probably not cost effective. The variability in outmigration timing is considerable less than the variance in survival. Treatment affects on migration timing were detectable in STS and Chinook populations at sample sizes that were considerably less than those needed for survival monitoring (Contor 2003). Therefore no power analysis was conducted for the assessment of migration timing.

Table 1. PIT-tag detection rates at John Day Dam for Umatilla steelhead. See (Contor 2003) for detection details.

John Day Dam Detection Probability Periods (Steelhead)

1999

Begin Date	End Date	Detection Probability
1/1/1999	4/24/1999	0.22
4/25/1999	4/28/1999	0.21
4/29/1999	5/1/1999	0.12
5/2/1999	5/20/1999	0.29
5/21/1999	5/22/1999	0.35
5/23/1999	5/30/1999	0.39
5/31/1999	6/3/1999	0.33
6/4/1999	6/6/1999	0.43
6/7/1999	6/20/1999	0.29
6/21/1999	6/26/1999	0.42
6/27/1999	6/30/1999	0.25
7/1/1999	12/31/1999	0.10

2000

Begin Date	End Date	Detection Probability
1/1/2000	4/13/2000	0.66
4/14/2000	4/18/2000	0.38
4/19/2000	5/4/2000	0.26
5/5/2000	5/7/2000	0.19
5/8/2000	5/17/2000	0.14
5/18/2000	12/31/2000	0.08

2001

Begin Date	End Date	Detection Probability
1/1/2001	4/30/2001	0.80
5/1/2001	5/17/2001	0.66
5/18/2001	5/19/2001	0.51
5/20/2001	5/24/2001	0.66
5/25/2001	5/25/2001	0.28
5/26/2001	6/21/2001	0.11
6/22/2001	7/29/2001	0.29

2002

Begin Date	End Date	Detection Probability
1/1/2002	4/21/2002	0.45
4/22/2002	4/26/2002	0.20
4/27/2002	4/30/2002	0.09
5/1/2002	5/5/2002	0.23
5/6/2002	5/18/2002	0.11
5/19/2002	5/22/2002	0.20
5/23/2002	5/27/2002	0.05
5/28/2002	5/29/2002	0.19
5/30/2002	6/9/2002	0.06
6/10/2002	6/11/2002	0.20
6/12/2002	6/16/2002	0.31
6/17/2002	7/2/2002	0.10
7/3/2002	12/31/2002	0.39

Table 2. Estimated survival of Umatilla summer steelhead to John Day Dam. See (Contor 2003) for a description of release groups and detection details.

Release Group	Migration Year	Rear Type	Release Locations	Release Dates	Length (mm)	Number Released	Estimated Survivors to JDD	Estimated Survival Rate	Survival Comparison P-Value
Natural Vs. Hatchery Groups									
STH 1	1999	N	All	All	All	3,855	1,990	0.516	<0.001
STH 2	1999	H	All	All	All	4,251	2,159	0.508	
STH 3	2000	N	All	All	All	1,671	650	0.389	<0.001
STH 4	2000	H	All	All	All	4,786	1,413	0.295	
STH 5	2001	N	All	All	All	2,746	464	0.169	<0.001
STH 6	2001	H	All	All	All	13,157	1,962	0.149	
STH 7	2002	N	All	All	All	446	489	1.096	<0.001
STH 8	2002	H	All	All	All	1,276	1,108	0.869	
STH 9	1999	N	Three Mile Dam	3/1-6/30	All	1,830	1,427	0.780	<0.001
STH 27	1999	H	Three Mile Dam	4/20-6/2	All	1,508	1,102	0.731	
STH 54	2000	N	Imeques Acc. Pond	4/1-5/31	All	822	409	0.498	<0.001
STH 55	2000	H	Bonifer Acc. Pond	4/10-4/12	All	822	207	0.252	
STH 49	2001	N	Three Mile Dam	4/1-6/30	All	281	99	0.354	<0.001
STH 29	2001	H	ODFW Trap and Three Mile Dam	5/1-5/31	All	329	77	0.235	
STH 52	2001	N	CTUIR Mainstem Trap	3/1-5/31	All	813	162	0.200	<0.001
STH 53	2001	H	Bonifer Acc. Pond	4/3-4/7	All	2,047	182	0.089	

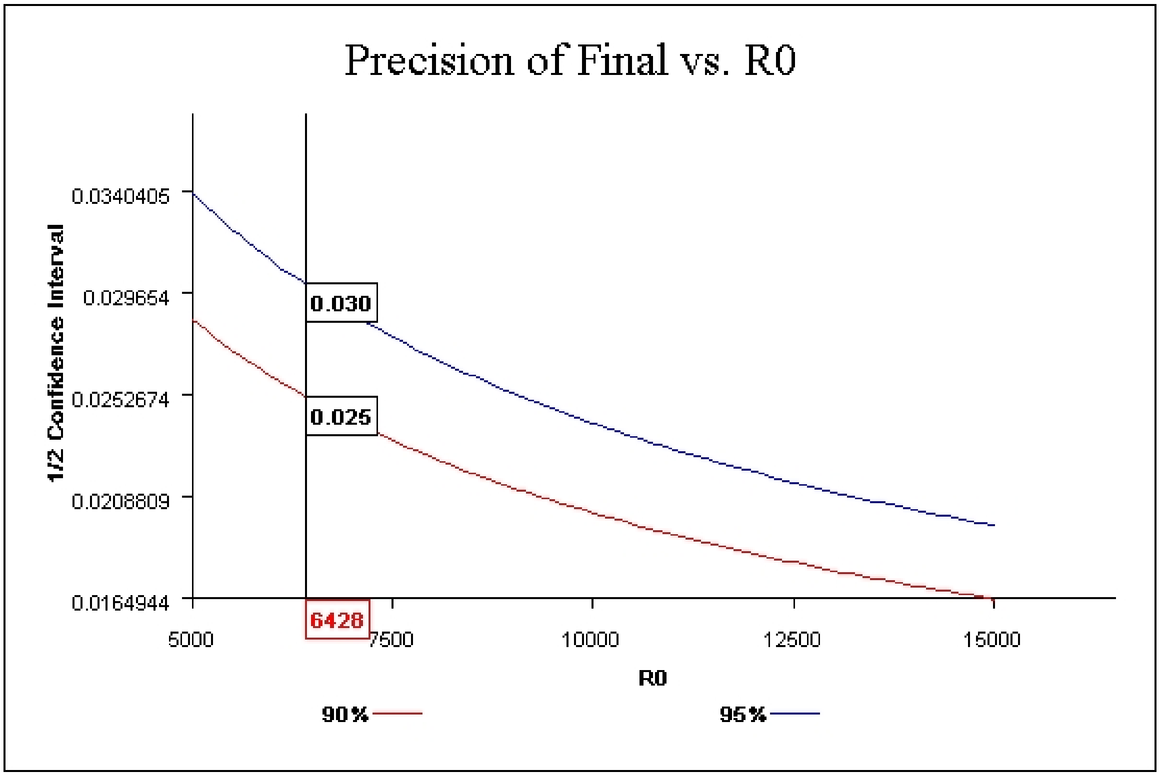


Figure 2. Natural summer steelhead sample size needed to generate a 90% confidence interval for survival rates at John Day and Bonneville Dams using PIT-tags.

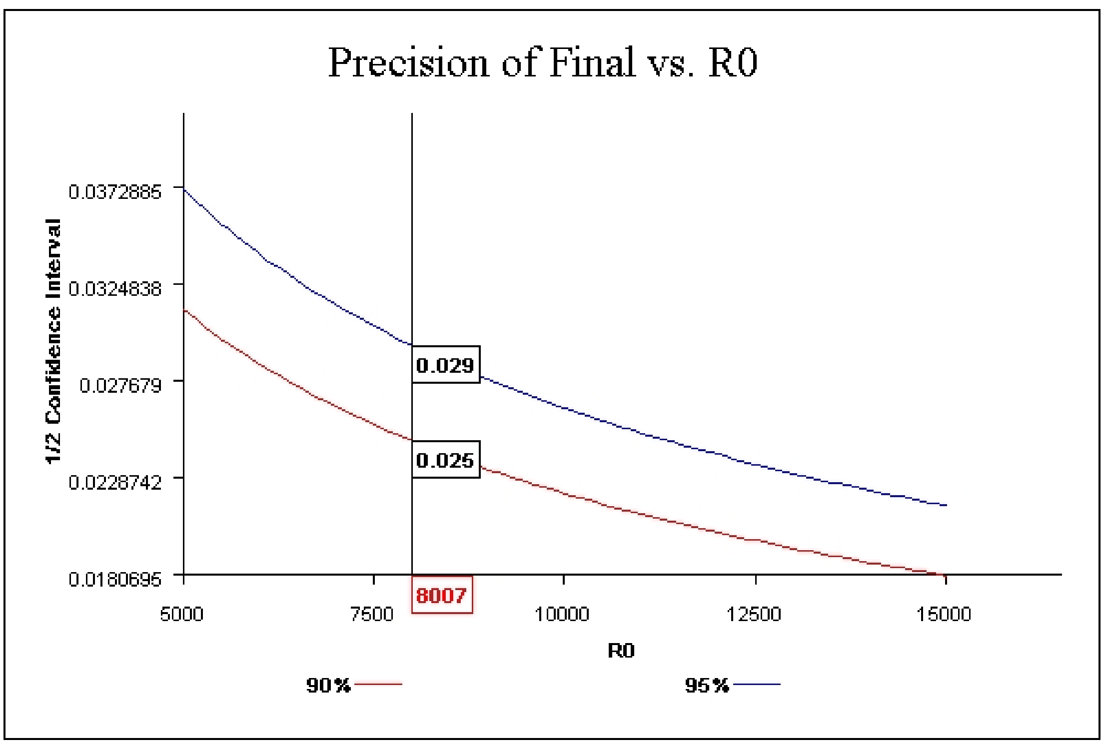


Figure 3. Hatchery summer steelhead sample size needed to generate a 90% confidence interval for survival rates to John Day and Bonneville Dams using PIT-tags.

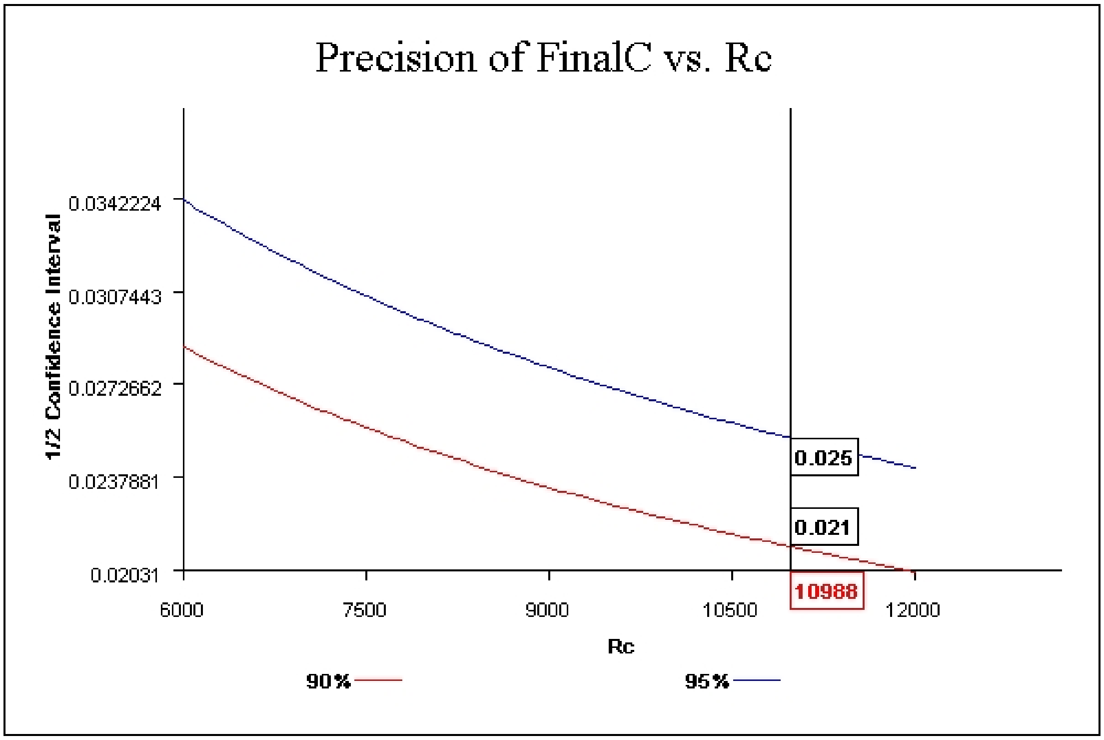


Figure 4. Natural summer steelhead sample size needed to detect 10% survival differences to Bonneville Dam for natural and hatchery summer, provided a hatchery sample size of ~6000 fish.

Table 3. PIT-tag detection rates at John Day Dam for Umatilla Chinook. See (Contor 2003) for a description of detection period details

John Day Dam Detection Probabilities (Chinook)

1999

Begin Date	End Date	Detection Probability
1/1/1999	4/24/1999	0.30
4/25/1999	4/25/1999	0.16
4/26/1999	4/28/1999	0.34
4/29/1999	4/29/1999	0.22
4/30/1999	5/1/1999	0.07
5/2/1999	5/3/1999	0.23
5/4/1999	5/6/1999	0.29
5/7/1999	5/9/1999	0.21
5/10/1999	5/10/1999	0.31
5/11/1999	5/11/1999	0.36
5/12/1999	5/12/1999	0.30
5/13/1999	5/15/1999	0.20
5/16/1999	5/16/1999	0.28
5/17/1999	5/18/1999	0.33
5/19/1999	5/24/1999	0.20
5/25/1999	5/31/1999	0.14
6/1/1999	6/1/1999	0.23
6/2/1999	6/4/1999	0.30
6/5/1999	6/7/1999	0.39
6/8/1999	6/16/1999	0.27
6/17/1999	6/19/1999	0.26
6/20/1999	6/28/1999	0.35
6/29/1999	12/31/1999	0.14

2000

Begin Date	End Date	Detection Probability
1/1/2001	5/8/2001	0.60
5/9/2001	5/11/2001	0.61
5/12/2001	5/14/2001	0.49
5/15/2001	5/21/2001	0.56
5/22/2001	5/23/2001	0.41
5/24/2001	5/24/2001	0.63
5/25/2001	5/25/2001	0.29
5/26/2001	5/28/2001	0.06
5/29/2001	5/29/2001	0.13
5/30/2001	6/1/2001	0.23
6/2/2001	6/4/2001	0.15
6/5/2001	6/6/2001	0.29
6/7/2001	6/9/2001	0.42
6/10/2001	6/14/2001	0.28
6/15/2001	6/17/2001	0.39
6/18/2001	6/19/2001	0.70
6/20/2001	12/31/2001	0.74

2000

Begin Date	End Date	Detection Probability
1/1/2000	4/14/2000	0.57
4/15/2000	4/16/2000	0.50
4/17/2000	4/19/2000	0.36
4/20/2000	4/28/2000	0.30
4/29/2000	5/1/2000	0.36
5/2/2000	5/3/2000	0.32
5/4/2000	5/5/2000	0.24
5/6/2000	5/9/2000	0.17
5/10/2000	5/15/2000	0.08
5/16/2000	12/31/2000	0.03

2000

Begin Date	End Date	Detection Probability
1/1/2002	4/25/2002	0.30
4/26/2002	5/1/2002	0.23
5/2/2002	5/8/2002	0.32
5/9/2002	5/9/2002	0.26
5/10/2002	5/13/2002	0.14
5/14/2002	5/14/2002	0.32
5/15/2002	5/15/2002	0.35
5/16/2002	5/16/2002	0.28
5/17/2002	5/17/2002	0.24
5/18/2002	5/18/2002	0.16
5/19/2002	5/20/2002	0.10
5/21/2002	5/21/2002	0.15
5/22/2002	5/22/2002	0.23
5/23/2002	5/23/2002	0.28
5/24/2002	5/24/2002	0.22
5/25/2002	5/25/2002	0.17
5/26/2002	5/27/2002	0.13
5/28/2002	5/28/2002	0.24
5/29/2002	5/29/2002	0.32
5/30/2002	5/30/2002	0.38
5/31/2002	5/31/2002	0.40
6/1/2002	6/1/2002	0.31
6/2/2002	6/2/2002	0.23
6/3/2002	6/8/2002	0.17
6/9/2002	6/10/2002	0.28
6/11/2002	6/13/2002	0.23
6/14/2002	6/14/2002	0.38
6/15/2002	6/17/2002	0.26
6/18/2002	12/31/2002	0.33

Table 4. Estimated survival rates of Umatilla Chinook to John Day Dam. See (Contor 2003) for a description of release groups and detection details.

Release Group	Migration Year	Rear Type	Release Location	Release Dates	Length (mm)	Number Released	Estimated Survivors to JDD	Estimated Survival Rate	Survival Comparison P-Value
Natural Vs. Hatchery Groups									
CHK1	1999	N	All	All	All	999	767	0.768	<0.001
CHK2	1999	H	All	All	All	3044	1216	0.400	
CHK4	2001	N	All	All	All	1676	423	0.253	<0.001
CHK5	2001	H	All	All	All	3650	1569	0.430	
CHK7	1999	N	Three Mile Dam & ODFW Trap	3/1-5/31	All	653	560	0.858	<0.001
CHK8	1999	H	Three Mile Dam & ODFW Trap	All	All	1104	404	0.366	
CHK9	2001	N	CTUIR Mainstem Trap & Meacham Cr.	3/1-4/30	All	656	219	0.334	<0.001
CHK10	2001	H	Imeques Acc. Pond	All	All	2911	1134	0.390	

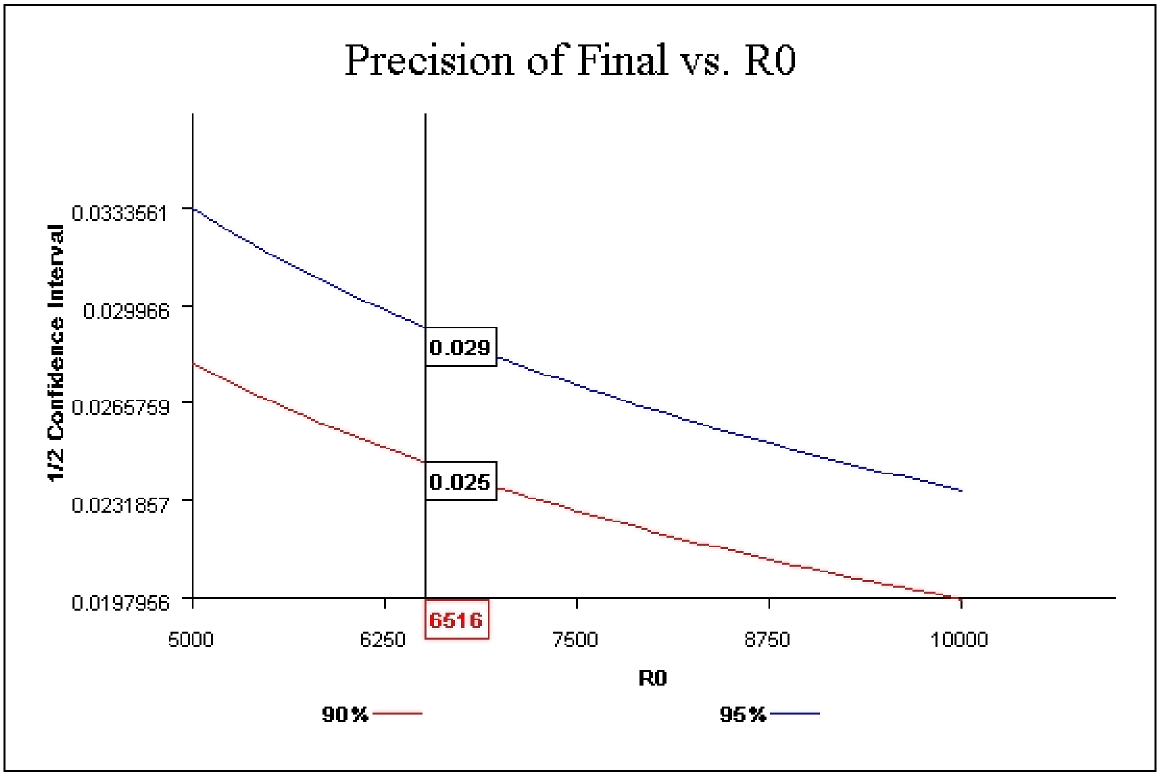


Figure 5. Natural Chinook sample size needed to generate a 90% confidence interval for survival to John Day and Bonneville Dams using PIT-tags.

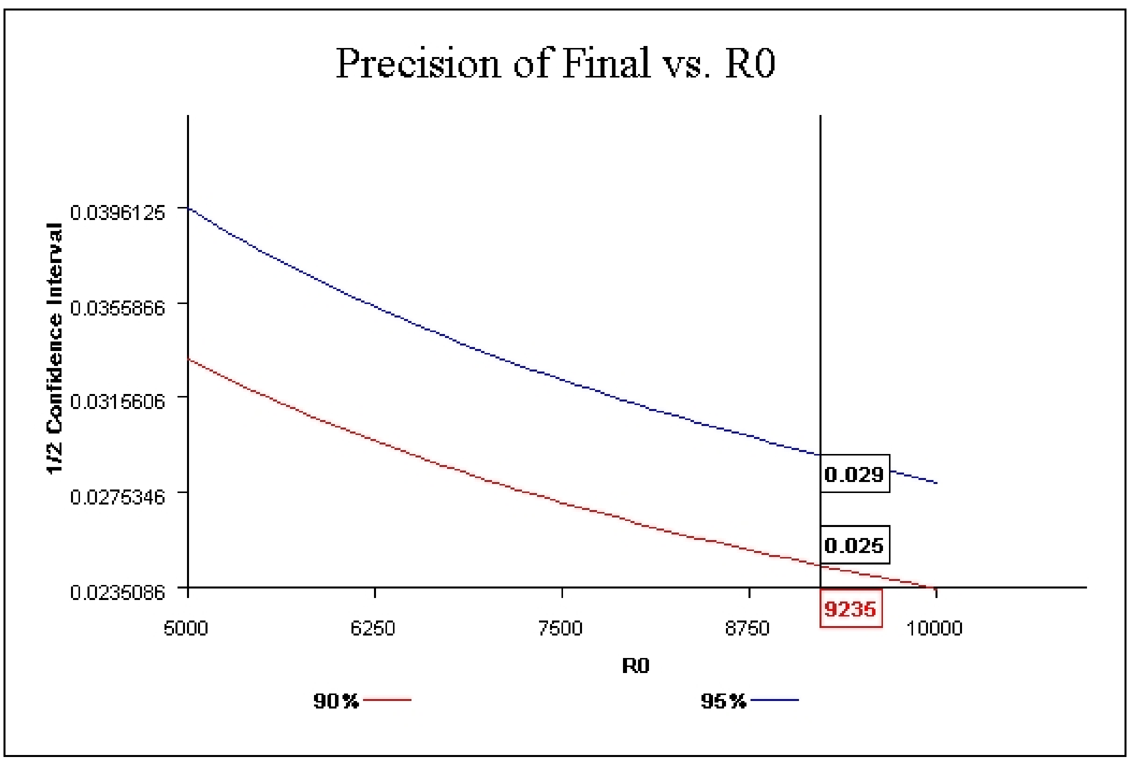


Figure 6. Hatchery Chinook sample size needed to generate a 90% confidence interval for survival to John Day and Bonneville Dams using PIT-tags.

Relative survival of PIT tagged groups to John Day and Bonneville Dams is also tested using the binomial test ($p<0.05$). A minimum of five unique detections are needed to satisfy testing. PIT tag information is submitted and recovery data obtained from the Pacific States Marine Fisheries Commission (PSMFC) database. Number, travel time, and length at PIT tagging are recorded for each release group at all reporting observation sites. Database records are downloaded in December for the entire run year. Detections from fish migrating in later years are combined with their respected release group.

Migration Parameters: Migration parameters are also monitored using PIT tags and subsequent detections at Three Mile Falls and downstream Columbia River dams. Parameters analyzed include emigration timing, duration, and travel speed and are monitored to evaluate the migration success of hatchery species compared with that natural. Smolt emigration timing is considered the proportion of juvenile salmonids moving past Three Mile Falls Dam during a particular period. Peak smolt movement is the date when the maximum number of tagged emigrants pass through the trap. Median emigration is the date when 50% of the tag detections are observed. Diel movement is determined by the percentage of fish detected within hourly blocks of time. Migration duration is considered the period between the first and last date of tag detections.

Travel speed is calculated for each tagged fish detected at West Extension Canal using the following equation:

$$TS = (RM-3.7)/D-R)$$

where *TS* = travel speed, *RM* = river mile of release, *D* = date and time of detection at West Extension Canal, and *R* = date and time of forced release. The median travel speed is calculated for all natural species and comparable release groups of hatchery fish. Median rather than mean travel speeds are computed because detection distributions tended to be skewed. Negative travel speed estimates due to volitional movement of hatchery fishes are omitted from the analysis, as are tagged fish interrogated during fish sampling operations, due to the inability to assign an accurate date and time of detection.

If insufficient numbers of hatchery or natural fish are tagged, a fish passage index is used to analyze the migration parameters of juvenile salmonids emigrating past Three Mile Falls Dam. The fish passage index is the number of fish captured during a designated block of time expanded by the sampling rate. Designated blocks of time range from a few minutes to several hours and sample rates are between 1 and 100%. Regardless of which method is used (PIT tag analysis or fish passage index), migration parameters have been found to be similar.

Trapping

A rotary-screw trap and incline plane trap are utilized to capture emigrating juvenile salmonids in the lower Umatilla River. The rotary-screw trap is operated at RM 1.2 beneath the Interstate 82 bridge and the incline plane trap is situated at RM 3.7 within West Extension Canal's juvenile bypass facility. Trapping is conducted year round, with operations focusing RM 3.7 from February through June and at RM 1.2 between July and January.

The rotary-screw trap consists of a 5-ft diameter perforated cone and 12.8-ft^2 livebox, supported between two 16-ft long aluminum pontoons. Fish enter the upstream end of the trap and are forced rearward into the livebox by rotation of the perforated cone, driven by the water current. Fish captured are held for a maximum of 24hrs prior to sampling.

The incline plane trap is situated within the fish bypass channel and consists of a dewatering plate and fish separator. Large fish (> 400 mm) pass over the separator bars, into the downwell and back to the river through a 24-inch bypass pipe. Small fish (< 400 mm) fall through the separator bars into the flume and are then directed into the sample tank or returned to the river depending upon mode of operation (fish sampling or bypass mode). Mode of operation is determined using a pneumatically actuated gate that is set at timed intervals according to the number of fish moving through the facility. When on sampling mode, fish are diverted into a 100-ft^3 sampling tank equipped with a crowder, divider, and lift basket. Fish are crowded into the forward half of the tank and separated from incoming fish by lowering the divider. On bypass mode of operation, fish are returned directly to the river via the bypass downwell and 24'' river return pipe. Fish are held no longer than 24 hours prior to sampling. Both the rotary screw trap and the inclined plane trap are checked and cleared of debris on a daily basis. Checks are more frequent during high flow and debris events.

Regardless of trapping type or location, all salmonids captured are anesthetized with a stock solution of MS-222 (40 mg/l) prior to sampling. Fish are enumerated by species, race, origin, rear type, and developmental (smoltification) stage. All salmonids are measured for fork length and scales collected, if required. Data is recorded directly into the PITTag3 program using a CalComp Drawing Board III (digitizer).

Fish origin is categorized as "natural" or "hatchery" based on the presence/absence of a fin clip, wire tag, and the worn appearance of the dorsal and ventral fins. Scales are collected on all natural summer steelhead and a subsample of unmarked coho salmon for age and origin analysis. Scales are also taken from natural chinook salmon in May and June in attempt to differentiate age (yearlings versus subyearlings) and race (spring versus fall).

Fork length is recorded to the nearest mm and single character descriptor codes are used to describe descaling, injuries, parasites, and disease for all juvenile salmonids captured during fish sampling. During instances of high fish numbers subsampling is implemented and only 100 to 200 fish are measured and examined. Developmental (smoltification) stage is assessed by visible brightness and the absence or presence of parr marks.

All smolts captured during fish sampling are manually interrogated for PIT tags. Fish are also scanned for the presence of a wire tag using a tabletop coded-wire tag detector. All recaptured PIT tagged smolts are reported to the PTAGIS database.

Trap Efficiency: To calibrate the collection efficiency of the traps and estimate outmigrant abundance and survival, groups of 50 to 100 fish per species are collected, PIT-tagged and released upstream of the traps for recapture. Tests are generally conducted 2 times a week for each species while sufficient numbers of fish are being captured. Tagged fish are typically held for 24 hours prior to release, to assess latent mortality (tagging effect), tag loss and determine the probability of survival of individual release groups. The probability of survival and estimated survival of tagged fish released is calculated using the following equation:

$$s = L/H,$$
and
$$M = N(s)$$

where s = probability of survival, L = number of live tagged fish after holding, H = initial number of tagged fish held, M = estimated survival of tagged fish released, N = total number of tagged fish released. Tagged fish which die or drop their tags prior to release are removed from the test group. Tag retention and fish survival for all factors other than tagging are assumed to be 100% after release. Specific details regarding tagging, holding, and fish transport operations can be found in White et al. 2003.

Recaptured fish are enumerated by species/origin and trap efficiency estimates are computed using the following formula:

$$TE = R/M$$

where, TE = estimated trap efficiency, R = number of recaptured tagged fish, and M = number of tagged fish released and adjusted for survival. Separate trap efficiency estimates within a species are compared using Chi^2 analysis and pooled if the estimates are not significantly different ($P \leq 0.05$). If less than five tagged fish of a particular release group are recaptured, adjacent test groups are pooled until the number of recaptures is greater than five. Pooling is continued until a significant difference was determined. The final trap efficiency estimate is the weighted mean of the pooled estimates.

Smolt Emigrant Abundance: Smolt emigrant abundance is defined as the number of smolts leaving the Umatilla River or reaching Three Mile Falls Dam (RM 3.7). It is calculated for natural emigrants only and is a key component required to address critical uncertainties surrounding in-basin productivity and natural production capacity.

Smolt abundance is derived based on the number of fish collected at lower river trap sites and the estimated trap efficiency. Abundance of fish sampled at West Extension Canal's juvenile bypass facility is estimated by:

$$A = B/TE$$
and
$$B = (C/T)/D$$

where, A = estimated number of outmigrants, B = number of fish passing through the trap, TE = estimated trap efficiency, C = sample rate, T = proportion of time sampled, and D = diel pattern of fish movement.

Smolt abundance at the rotary screw trap is estimated using a slight variation in the formula:

$$A = (C/TR)/TE$$

whereby, A = total number estimated outmigrants, C = the number of fish captured, TR = trap retention efficiency and TE = estimated trap efficiency. Sampling rate and time were not adjusted for due to 24 hr a day trap operation.

Emigrant abundance is calculated on a monthly basis and then summed (for both trap sites) to derive a total number of natural outmigrants for the season. For months where trap efficiencies of natural species are not available or are sparse, efficiency estimates from hatchery conspecifics are used to supplement the average estimate. If hatchery conspecifics are not available for a particular month, efficiency estimates from the month before or month after are used.

The Bootstrap method (Efron and Tibshirani 1986; Thedinga et al. 1994), with 1,000 iterations, is used to derive a variance for abundance estimates. Confidence intervals (95%) for the abundance estimate are calculated using the square root of the variance ($CI = 1.96 \sqrt{V}$).

Alternate means of collecting smolt abundance data are currently being explored. Operations are being reviewed and refined to: 1). Ensure accurate, confident estimates, with the lowest possible standard error; 2). Address fish passage and operational concerns at West Extension Canal; 3) Ensure sampling activities are conducted in the most feasible manner possible; 4). Explore alternate trapping locations and methodologies; and to 5). Keep up-to-date on the latest available science. Alternate trapping options include: 1). Maintaining the current trap location and methods at West Extension Canals juvenile sampling facility, 2). Modifying the juvenile facility, 3). Moving to a rotary screw trap in an alternate location year round. Options for estimating emigrant abundance include utilizing mark- recapture techniques via PIT tag technology or applying in-basin survival rates to upriver smolt estimates. These approaches are contingent upon sufficient numbers of fish being tagged and later approach can only be used if upriver smolt abundance can be estimated.

Juvenile life history characteristics: Juvenile life history characteristics including smolt emigration timing, length, age, health, condition and smolt status is monitored annually during sampling at lower river trap sites. The Spearman rank correlation test is used to assess relationships between fish size, period of peak emigration, and level of smoltification for hatchery emigrants. Testing for trends over time is conducted at five year intervals.

Smolt emigration timing: Smolt emigration timing is considered the proportion of juvenile salmonids moving past Three Mile Falls Dam during a particular period. Methods used to analyze migration timing are described in the "Outmigrant PIT tagging and Detection" section of the methods.

Age at Emigration is characterized as the annual proportion of smolts in a particular age class migrating past Three Mile Falls Dam. Percent age composition analysis from a five year mean of adult returns is applied to annual smolt abundance estimates to derive the total estimated number of emigrants by freshwater age class for a particular year. Validation of age at emigration is accomplished through collection and scale pattern analysis of all summer steelhead and a subsample of coho and chinook salmon annually. Scales are analyzed to decipher ciculi patterns reflecting age and growth.

Size at Emigration: Size at emigration is quantified for each species and race of salmonid. Fork length (FL) is measured to the nearest millimeter (mm) for all natural salmonids and a sample of 60-100 hatchery salmonids per day. All PIT tagged fish encountered in hand samples are measured to assess growth from tag date to recapture date. Length data is used to create length-frequency distributions on a monthly basis for all species and to distinguish race of natural chinook (spring versus fall).

The growth in length (mm/d) for individual tagged fish is calculated as length at recapture minus length at tagging divided by the number of days between tagging and recapture.

Condition at Emigration: Condition at emigration is characterized as the proportion of cumulative scale loss evident on the fish at the time of emigration. Fish condition is divided into three categories: good, partially descaled and descaled. Condition is considered "good" if cumulative scale loss on either side of the fish was less than 3%. Fish are considered "partially descaled" if cumulative scale loss was greater than 3% but less than 20%. Fish with scale loss greater than 20% are considered "descaled". Descaling is categorized following criteria used by the Umatilla Hatchery Monitoring and Evaluation project (Keefe et al. 1994).

The Spearman rank correlation test is used to analyze the possible relationship of fish condition with various independent variables. Independent variables included river discharge, water temperature, and secchi depth (water clarity). A nonparametric test is used because the assumption of bivariate normal distribution was not fulfilled.

Smolt status: Smolt status is the developmental smoltification stage of the fish and is determined by brightness and the absence or presence of parr marks.

Juvenile fish health: Juvenile fish health is monitored during emigration. Unusual marks or indications of disease on dead fish are noted. Single character descriptor codes are used to describe body injuries, external parasites, bird marks, obvious fungal infections of the body surface and potential disease for all juvenile salmonids. Symmetrical bruises on each side of the fish are classified as bird marks. Fish mortalities are noted by species/origin and identified as pre or post sampling. Percent sampling mortality and natural mortality are computed separately. Percent mortality is determined from the total number of fish sampled. All dead natural fish and some diseased and dead hatchery fish sampled are forwarded to the ODFW Fish Pathology Lab. Sample, diagnostic and statistical analyses conform if possible with the Integrated Hatchery Operations Team (IHOT) and the Pacific Northwest Fish Health Protection Committee guidelines. Analysis of samples follow standard protocols defined in the latest edition of the American Fisheries Society " Fish Health Blue Book" (Procedures for the Detection and Identification of Certain Fish Pathogens).

Physical and Environmental Variables: Physical and environmental variables including river discharge, flow augmentation, water temperature and water clarity are monitored annually to characterize conditions in the Umatilla River and to assess their effects on smolt survival and emigration success. Daily river discharge, flow augmentation from McKay Reservoir, and water temperature data is obtained from the USBR Hydromet Achieves: http://mac1.pn.usbr.gov/umatilla/umawebhydreadarc.html. Weekly mean discharge and temperature from the Umatilla gauging station (RM 2.1) is plotted against time. Weekly mean discharge and daily mean water temperature from McKay Reservoir is also plotted against time. Water clarity is measured to the nearest 0.05 m using a 7-in-diameter Secchi disk. Weekly mean secchi depth is plotted against time.

The relationship between river discharge and the number of emigrants passing a trap site (passage index) is tested using a Spearman rank correlation test. A separate test is run for each species/origin type. The Spearman rank correlation test is also used to test for a relationship between water temperature and the number of emigrants passing a trapping site. The variable reflecting the river discharge or water temperature during the passage period is the average of the mean of the day before and the day of passage. The time period used for the analysis is between the day when the first and last emigrant was observed. Discharge and temperature variables from the Yoakum gauging station (RM 37.6) are utilized for the analysis. The Yoakum gauge is located below all anadromous fish bearing tributaries and hatchery acclimation facilities, is directly influenced by McKay Reservoir releases, and is located above any major irrigation diversion operations. Any missing discharge or temperature records are estimated by taking the average of the mean daily discharge or temperature three days prior and three days after the missing record.

The χ^2 goodness-of-fit test is used to analyze the proportion of the emigration (passage index) of natural juvenile salmonids that occurs within a given environmental range. For river discharge, five ranges reflecting the percent change from the previous day are calculated. Changes in discharge are characterized as rapidly decreasing: ≥ -10, slowly decreasing: < -10 to > - 1, no change: ± 1, slowly increasing: > 1 to < 10, and rapidly increasing: ≥ 10 %. For water temperatures, six temperature ranges are utilized: < 10, 10 to < 12.2, 12.2 to < 15.0, 15.0 to < 17.2, 17.2 to < 20.0, and ≥ 20.0°C. The analysis is based on the null hypothesis that the percentage of emigrants captured within an environmental range would not differ from the percentage of the emigration season within that environmental range. The emigration season is defined as being between the day when the first and last emigrant is observed.

Associations between canal diversion rate and trapping efficiency, river discharge and trapping efficiency, and water temperature and trapping efficiency are assessed using regression analysis. The variable reflecting diversion rate, river discharge, and water temperature is the average of the mean of the day of and the day after the trap efficiency release was made. Mean canal diversion rate is calculated by dividing the daily canal flow by the daily river flow. Daily river flow is calculated by adding the RM 2.1 gauge reading and the daily canal flow.

Adult Monitoring

P.I.T. Tagging and Detection

Adults are PIT-tagged regularly by mainstem monitoring programs under BPA, Lower Snake Compensation Program, or ESA mandated support. In addition a number of juveniles tagged in the Umatilla Subbasin will return with PIT-tags intact, and will produce adult detections. Adult

PIT-tag returns will be monitored using PITAGIS, and will be utilized to inform run prediction models.

Adult Trapping, Collection, and Enumeration

The east bank fish ladder at Three Mile Falls Dam is the primary counting and brood collection facility for adult steelhead and Chinook on the Umatilla River (river mile 3.7). All returning adults pass Three Mile Falls Dam through the east-bank fish ladder. Returns have been enumerated at this location using an electronic fish counter from 1966-1987, afterwhich, a fish trapping and collection facility was constructed. The collection and counting facility includes a back-lit viewing window, Denil steeppass, holding pond, and a fish sorting complex. Adults are enumerated at the ladder whenever river flow is adequate to provide fish passage which is typically from mid-August until mid-July.

All returning adults were trapped up until the 1999 return year, afterwhich, alternating trapping - video enumeration was implemented to reduced handing stress on fish, particularly ESA-listed steelhead. Currently, the facility operates in a trapping mode from mid-August thru November, afterwhich a schedule of five days trapping and nine days of video enumeration is followed until summer shutdown. Additional trapping may occur if brood or CWT collection goals are not being met. Video enumeration has been attempted in the fall, but coho and fall chinook could not be reliably differentiated.

During trapping, a diffuser panel with 1” gaps between slats is placed in the ladder to divert fish into the steeppass and holding pond. Fish are then routed into the sorting complex where they are anesthetized with buffered carbon dioxide to facilitate handling. Fish are examined, then routed either to adjacent holding ponds, transport vehicles, or a recovery tank for release to the river. Timing of broodstock collection is intended to be proportional to the run timing of natural steelhead returns and the combined hatchery and natural returns for Chinook. We follow monthly and bi-weekly brood collection schedules that are modeled from the most recent 5-year average run timing of the aforementioned steelhead and Chinook returns, respectively. Proportionate representation of all adult age classes in the brood is also desired, but formal protocols are only defined for jack Chinook. Equal numbers of males and females are collected for brood with one of ten males being jacks for Chinook. Total numbers of brood collected for hatchery production are 100 natural steelhead (plus 20 hatchery males that will only be spawned if needed), 380 fall chinook, and 560 spring chinook. An additional 60 hatchery steelhead are collected for progeny marker research, all CWT’ed fish if possible. Collection of these research steelhead will be at a 1:1 male-female ratio, and timed at 20 within the periods of September - November, December - February, and March - April.

Data collected during the sorting stage includes date, disposition, and number trapped by sex, age class, and marks. Hatchery-natural origin is determined by the respective presence or absence of an adipose fin for steelhead and wire-tag for fall Chinook. Presence of wire tags is determined using R9500 tunnel wire-tag detector. Hatchery- and natural-reared origin of spring Chinook is determined by a combination of recording fin marks on hatchery fish at the sorting complex and examining scale patterns from unmarked fish collected for broodstock, and those sampled in in-subbasin fishery and spawning ground surveys. Scales will be collected from all unmarked fish during these activities. Natural-reared origin of unmarked steelhead and non-wire-tagged or fin-clipped Chinook will be cross-checked by examining scales patterns on all un-marked fish collected for broodstock or sampled in fisheries and on the spawning grounds. The percentage of misclassified natural origin fish determined from the scale analysis will be extrapolated to the entire run and brood, harvest, and spawning components of the run. Age is classified by fork length. One- and two-ocean resident steelhead are split at 660 mm. Subjack, jack, and adult Chinook are split at 381 and 610 mm. Additional age, length, and CWT information is obtained when broodstock collected at Three Mile Falls Dam are spawned. A total of 120 steelhead snouts are collected for CWT data. Twenty CWT's are recovered from broodstock, the remaining 100 are collected either by sacrificing fish at the trap or from snouts collected in the Umatilla River fishery. A monthly CWT collection schedule is followed that is proportional to the 5-year average run timing of hatchery steelhead to Three Mile Falls Dam. Fishery monitoring staff provide trap operators with weekly updates of steelhead CWT recoveries.

During video enumeration, a time-lapse video camera records fish movement past the viewing window 24 hours a day at a rate of 1 frame per second. Total counts of steelhead and Chinook are obtained from review of the video tapes. During the video review, about 50% of steelhead can be classified as hatchery or natural by the presence or absence of an adipose fin, respectively. Origin of the unidentified steelhead, and age, sex, and mark composition of video monitored Chinook and steelhead are estimated as their mean percent composition from trapping periods immediately before and after the video period.

The Fish Passage Operations program has a 3,500 gallon, one 3000, and two 370 gallon fish liberation units available for use. The 3,500 gallon unit is a diesel operated tractor- trailer equipped with a 12 inch discharge opening and a single holding chamber. The 3,000 gallon unit is a diesel operated tractor-trailer equipped with a 12 inch discharge opening and two holding chambers capable of isolating two groups in the same load. Both tractor-trailer units are equipped with liquid oxygen and electric aeration to reduce fish stress during transport. The two 370 gallon transport tanks are mounted on dual axle trailers and are pulled by pick-up trucks. Each is equipped with both compressed oxygen aeration and a re-circulation system. Both units have an eight inch discharge opening. These transportation units are used in the Umatilla and Walla Walla Subbasin. ODFW liberation protocols are used as the basic guideline for hauling operations. In addition to these units, the project also has access to a Bureau of Indian Affairs 750 gallon portable fiberglass tank which can be mounted on a flatbed truck. This unit is also equipped with both compressed oxygen aeration and a re-circulation system and has a 12 inch discharge opening.

Adult transportation requirements are based on flow criteria outlined in the 1981 USFWS study (USFWS 1981) and past project observations of salmon migrations in the Umatilla River. The AOP also identifies criteria for transportation of adults collected at TMFD. Generally, returning adults are to be hauled whenever flows in the Umatilla River are projected to fall below 150 cfs at Dillon within 30 days. The project is also responsible for the collection and transportation of broodstock from TMFD.

The AOP outlines release locations for CHS and STS adults hauled upstream from TMFD. Fish are to be released at either the Pendleton boat ramp (RM 52.5) or Pendleton juvenile acclimation site (RM 56) unless flows at Pendleton drop below 250 cfs. Releases are then to be made as high in the basin as temperature differentials will allow. STS releases are to be alternated between the various upriver release locations. It is not anticipated that CHF would be hauled from TMFD, so no release sites are identified.

Returning adults are released at TMFD whenever flows at Dillon are anticipated to remain above 150 cfs for a minimum of 30 days after release. Now that the Umatilla Subbasinasin Project flow enhancement program is in place, flows generally remain above 150 cfs for all but the very beginning and end of the adult return season. The majority of adults entering the Umatilla River are either released at, or volitionally migrate past, TMFD. The AOP identified the following groups for release at TMFD regardless of flow condition; CHF subjacks and excess CHF jacks, coho adults, and coho jacks.

Passage Monitoring

Radio telemetry study provides critical information to managers regarding the effectiveness of new passage facilities, and potential migration barrriers. Telemetry methods and techniques will follow CTUIR's adult passage evaluations in the Umatilla Basin as conducted by Volkman (1994 and Contor et al. 1996 and 1997). Monitoring will include detailed examination of how fish negotiate the modified Westland-Ramos facility. Following renovations we will tag 40 adult steelhead and Chinook at TMFD during the adult return period (fall-spring).

CTUIR will maintain up to four fixed-site receivers in the Umatilla Subbasin. The mobile and fixed-site receivers will be able to read and differentiate tagged fish from both species. Individually coded radio-tags combined with 4 fixed-site receivers with multiple antennas will allow the tracking of individual steelhead and Chinook at strategic locations 24 hours a day. Having multiple antennas at each fixed-site will show if the fish use the new ladder or jump over the new structure. The fixed-site receivers will also record how long individual fish hold below the facility before migrating over the structure. A mobile receiver will be used to locate individuals away from the fixed-sites and follow individuals to and from the headwaters. It is necessary to follow tagged fish throughout their spawning cycle to determine if delay or stress at the new facility results in aberrant migratory behavior following passage.

Juvenile fish screens/bypasses and adult ladder facilities, associated with irrigation diversions within the basin, will be monitored throughout the year to ensure that adequate passage conditions exist for upstream adult and downstream juvenile and adult migrants. Inspections include checking for proper installation and operation of screens, gaps and holes in screens or seals, debris buildup on screens and trash racks, proper flows to smolt bypasses and adult ladders, adequate access and exit conditions at bypasses and ladders, and signs of fish activity.

Spawning and Carcass Surveys

Spawner and carcass surveys will be conducted during the appropriate spawning and holding season for each species. Effort will be allocated using a stratified randomization of tributaries based on known and historic spawning habitat for each species. Redds and carcasses will be enumerated as an index of spawner abundance using multiple-pass visual surveys of the spawning grounds. The location of each redd and carcass will be georeferenced using OmniSTAR differential GPS. The condition of each redd and any observed spawner activity will be noted. Each observed redd will be flagged by marking tape on adjacent vegetation to avoid re-sampling.

Carcasses will be measured (fork length and MEHP) and weighed, and a scale sample will be collected for age, growth and origin analysis. Each carcass will be cut open to determine the spawning success of females. All external marks and tags will be noted. The snouts of adipose clipped fish will be removed for CWT analysis.

STS survey efforts will be stratified using the six index sites that have ten-year datasets will be visited annually and receive at least three passes each year. An additional two to six tributaries will be surveyed annually. These sites will be divided between three and five year streams using a rolling panel design. The watershed location of three and five year streams will be distributed evenly throughout the spawning grounds.

CHS spawner surveys will be conducted differently due to the limited spawner range of CHS in the Umatilla Subbasin. All spawning grounds will receive at least three passes annually. Historic and marginal habitat will be surveyed during the spawning season to collect carcasses, and to watch for increased colonization of new spawning grounds. CHF spawner surveys will be conducted similar to CHS surveys. A boat will be used to survey the mainstem, conducting at least five passes annually. Additional effort will be allocated to sampling carcasses throughout the spawning grounds. Carcasses will be used as an index of CHF spawner densities because CHF redds are difficult to detect in the mainstem.

Redds and carcasses will serve as independent estimators of spawner density and total spawner abundance. Redds will be compared to TMFD escapement minus harvest estimates and pre-spawn mortalities (total fish available to spawn) to determine the average number of redds per fish, and the approximate spawner success of the population. Spawned carcasses will be used to estimate the spawner density by reach in known spawner habitat. Pre-spawn carcasses will be used to estimate the exploration of new spawning habitat. Spawner and carcass observations will be expanded using habitat data and geostatistical analysis of distribution and abundance. Associative and trend analysis will be used to evaluate temporal correlates of production and return.

Harvest Monitoring

Tribal Fisheries

The purpose of tribal harvest monitoring is to estimate total catch and document the harvest benefit of the Umatilla River salmon and steelhead programs. Limitations in personnel and the low catch rates observed in past years lead to the cessation of field harvest monitoring surveys for the tribal CHF and STS fisheries in the Umatilla River during the 2002-2003 season (fall winter and spring). Past tribal harvest estimates of steelhead consistently found low numbers of tribal anglers catching a total of about 30 to 60 steelhead annually. Limited use of CHF was also consistently observed (Tribal Fisheries Program 1994, Contor et al. 1995, Contor et al. 1996, 1997, Contor et al. 1998, Contor and Kissner 2000). Much of the information gathered during previous STS surveys was collected during interviews away from the river and after the season.

Increased coverage and sampling intensity will be required to develop estimates of variance in tribal CPUE and total catch for STS, CHF, and CHS. Tribal harvest will be monitored using complemented roving creel, volunteer fishing journals, and telephone surveys. NPMEP crews will monitor tribal harvest activities in the field during March through November annually. In addition a number of volunteers will be recruited to keep fishing journals that outline all fishing activities. Harvest monitoring efforts will concentrate on the Umatilla River from the black railroad bridge near Homely (RM 71.9) to the upper boundary of the harvest area at Fred Gray's Bridge (RM 80.1), and the mainstem of Meacham Creek (Figure 7, and Table 5). All sections of the reservation and above will be surveyed at least once during every sampling shift.

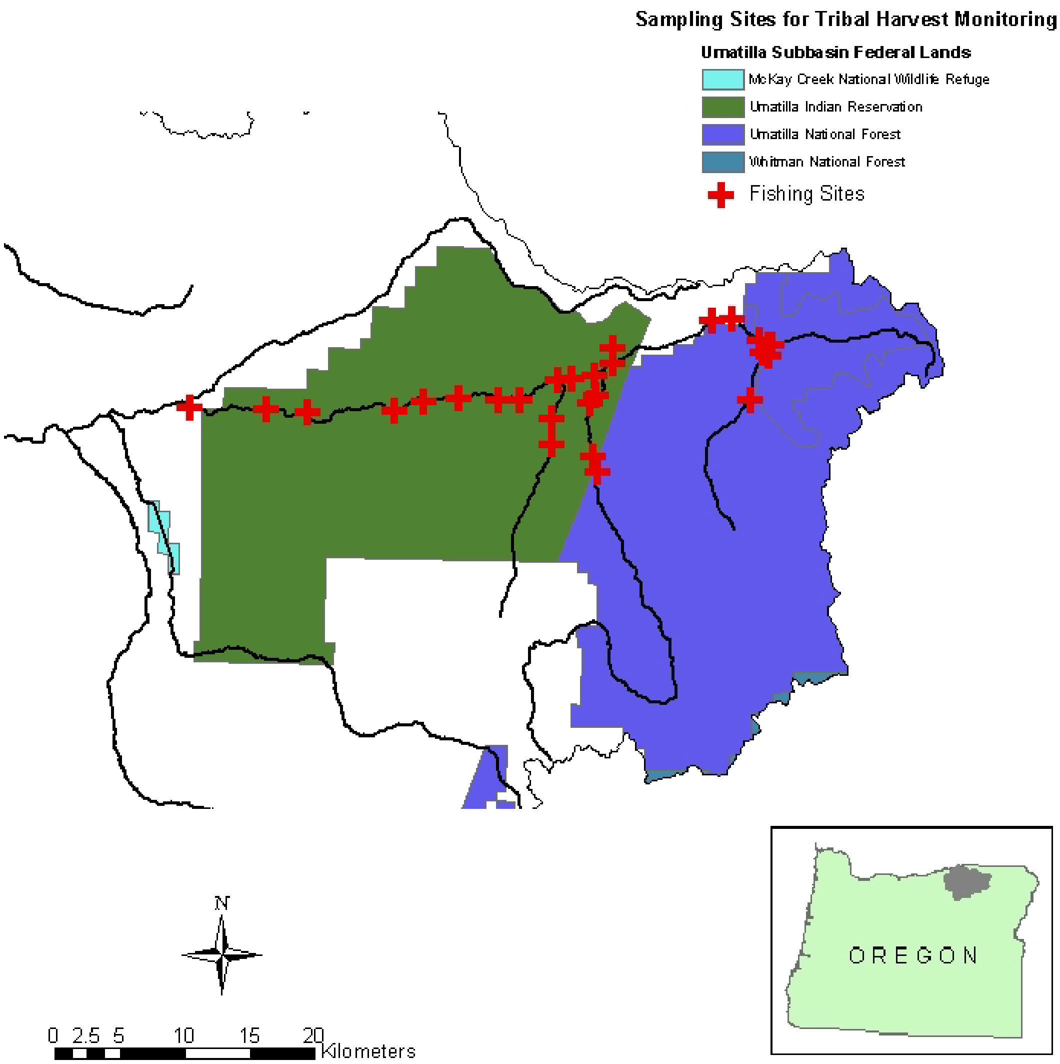


Figure 7. Probable encounter sites during roving creel sampling for tribal harvest monitoring.

Field surveys will incorporate a roving strategy with a schedule that is stratified between weekdays, weekend days and holidays as well as between morning and evening sample periods (05:00 to 13:00 and 13:00 to 21:00 hours). Effort will be allocated using stratified two-stage sampling of weekdays, weekends and holidays, mornings, afternoons, and evenings (Malvestuto 1996). All tribal fishers encountered will be approached and interviewed if received. Daily and year-to-date questions will be asked. The number, size, origin, and destination of all fish hooked will be recorded. Whenever possible the catch will be measured, weighed, and checked for PIT-tags and CWT, and sampled for scales

All information will be georeferenced and recorded on a hand-held computer. For fishermen counts, surveyors will record the reach name, survey direction, date, start time, stop time and the total number of fishers observed. Start time will be recorded when the river reach is first approached. The stop time will be recorded when the surveyor leaves the reach. The time spent in each reach can be variable depending on the presence of anglers and the number of interviews conducted. Reach boundaries are flexible and fishermen observed outside the described boundaries will be recorded with counts of the nearest defined reach. Fishers outside of the entire monitoring area will also be recorded and interviewed with a special notation in the reach location.

Table 5. Roving creel sites for tribal harvest monitoring.

Survey Reach	Sub Reach	RM	Procedure
Black Bridge	Black Bridge	71.9	check pool at the bridge and go over RR tracks, walk 300 yards upstream to bend with large pool at RM 72.1 along the bedrock corner
City Levee	City Levee	73.7	stop at gate, walk 400 yards to levee, check long pool
Thorn Hollow	Buckaroo Confluence	74.1	from Thorn Hollow Bridge walk downstream to pool at the mouth of Buckaroo
	Below Thorn Hollow Bridge	74.3	pool at acclimation facility, 20 yard below outlet
	Above Thorn Hollow Bridge	74.5	bedrock pool 250 yards above bridge
Weathers' Levee	Weathers' Levee	75.3	survey 1 mile of river above, below and along the river levee
Squaw Creek	Squaw Cr. Confluence	77.8	one pool at mouth of Saddle Hollow (200 yards long)
Gibbon	Lower Graybeal Pool	78.2	cross RR tracks, turn left, drive 200 yards to gate, from gate walk to river, two pools next to hillside
	Upper Graybeal Pool	78.6	100 yds above Graybeal's, follow trail from RR switch to bend next to north hillside
	Gibbon Right of Way	78.8	pools and runs along tracks for 0.3 miles
Meacham Confluence	Ed Clarks Lower Pool	79.4	300 yards below Ed Clark's upper pool
	Ed Clarks Upper Pool	79.6	old mouth of Meacham Creek
	Mouth of Meacham	79.8	walk up from upper Ed Clarks pool
	Beehive	79.9	walk up from Meacham C., 2 pools north of beehives
Imaques	Imaques Facility	80.1	walk from upper bridge to outlet, pools near hillside

Telephone surveys and postseason interviews will be conducted in two separate ways. Initially, everyone available on a list of known tribal fishers will be asked about yearly catch through a standardized set of questions. These surveys will include questions about their catch of STS, CHF, and CHS. During a second interview process, individuals will be randomly selected from a list of all tribal members and asked the same questions as the initial post season survey of known tribal fishers. If a randomly selected individual has already been interviewed during the first stage, their first response will be used for the second survey as well. This will prevent fishermen from being interviewed twice. Responses will be compiled and expanded depending on the sub-sample rate obtained. The interview rate goal is 90% of the known fishers and about 30% (600) of the tribal-membership. The large numbers of interviews are needed for quality tribal-wide estimates because not all tribal members are fishers, and fishing effort is highly variable between individuals.

Analysis will follow Malvestuto (1983) for the field work by expanding sub-samples by sample strata and proportional coverage rates. Similar expansions will be used to extrapolate tribal wide harvest estimates based on postseason interviews. CPUE will be estimated directly from interview responses and fishing journals. Total fishing effort will be estimated based on time period, week period, and site encounter probabilities. Tribal harvest estimates for each species will be reported along with a discussion of the limitation of each survey method and the implications to management and monitoring strategies.

Non-Tribal Fisheries

Overview: We have been monitoring the non-tribal steelhead and Chinook fisheries in the Umatilla River since 1992. Complete survey of the entire fishery from Pendleton to the river mouth from 1992 thru 1995 indicated angling effort is concentrated in two locations. Concentrations of anglers occur in the lower river from Three Mile Falls Dam (RM 3.7) to the river mouth and in the upper river in Pendleton (RM 51.5) and the 15 miles downstream of town (Keefe et al. 1993 and 1994, Hayes et al. 1996a and 1996b). Overall, angling effort and catch is considerably higher in the lower river. The middle 33 miles of river receives light angling effort due to limited public access for both bank and boat anglers.

The fall chinook fishery in the Umatilla River is open from 1 September to 30 November and occurs almost exclusively in the lower river. The steelhead fishery occurs primarily in the lower river from September through January or February, and the upper river survey area from January or February through 15 April. The spring chinook fishery is scheduled for April 16 thru 30 June. The occurrence and duration of the spring Chinook fishery is dependant on adequate run strength and in-season harvest rate, respectively. Typical timing for the fishery is late-April through late-May in the lower river and May through mid-June in the upper river.

Creel surveys are composed of three main components: 1) angler counts, 2) interviews to obtain information on catch rate, harvest rate, gear types, and angler demographics, and 3) collection of biological, mark, and coded-wire tag information from catch. Creel survey design and data analysis are the same in the steelhead and fall Chinook fisheries, but slightly modified to better fit the spring Chinook fishery.

Steelhead and Fall Chinook: A roving creel survey is used to count and contact anglers in the steelhead and fall Chinook fisheries. Sampling is stratified into lower and upper river survey areas, two day types (weekdays and weekend-holidays), and morning and evening when day length is > 10 hours. We conduct 5 surveys/week and schedule equal numbers of early- and late-shifts within weekday and weekend strata each month. Selection of survey days follows a systematic design with the starting date selected randomly. We sample 90% of weekend-holiday days and 40-60% of weekdays. Total number of survey days scheduled is 172 minus unfishable days due to flooding or high turbidity. We survey the lower river from September 15 to January or February, then survey the upper river from January or February until April 15. The month in which the survey location transitions from the lower to upper river is determined by which area is receiving (or is expected to receive) the higher amount of angling effort and catch. During this transition period, we gauge upriver angling activity by periodically contacting anglers in the upper river and maintaining frequent communication with a local sporting goods vendor and angling club in Pendleton.

We estimate fishing effort from three angler counts per survey day. The counts are obtained by tallying the number of steelhead and Chinook anglers observed while driving the full length of the survey area. Upstream-downstream direction of travel for the first count is randomized. Travel direction of subsequent counts within a day are in the same direction as the first count. During winter months, counts are made 1-2 h after sunrise, at mid-day, and 1-2 h before sunset. In fall and spring, counts are three hours apart with the first count made 1-2 h after sunrise on the early-shift and 1-2 h before sunset on the late-shift.

We interview anglers in between effort counts. There are some fairly consistent spatial and temporal fishing patterns in both the lower and upper river. Our travel routes for contacting anglers is aligned with these fishing patterns to maximize numbers of anglers contacted and interviews conducted near the end of their fishing trip. During interviews we obtain information on residency, hours fished, whether their angling trip was complete or incomplete, target species, gear type, and catch and harvest by species. Residency is categorized as 1) Umatilla and Morrow counties, 2) any other county in Oregon, and 3) out-of-state. Categories for gear types are 1) fly, 2) bait, and 3) lure. On harvested steelhead and Chinook, we record species, sex, fin clips, and marks, measure fork length, and collect snouts and scales from coded-wire-tagged fish. We record number of released natural and hatchery steelhead, and adult and jack Chinook.

Spring Chinook: Creel survey methodology and design for the spring Chinook fishery are similar to those used for the steelhead and fall Chinook fisheries with some exceptions. Staffing requirements for surveying the spring Chinook fishery are at least 2.5 times greater than surveys conducted in the fall and winter because the spring Chinook fishery occurs simultaneously in both the lower and upper river throughout most of the season and day length in spring is considerably longer than in fall and winter. Temporary staff for surveying the spring Chinook fishery was reduced from two to one seasonal in 2003 due to reduced funding levels. Present funding levels do not provide enough staff to adequately sample all four survey strata (morning and evening time blocks in both the upper and lower survey areas). As a result, we streamlined our past survey design to focus on adequately surveying the locations and times of greatest angling effort and harvest. We only survey the lower river where about 84% of the total non-tribal harvest occurs, based on past survey of both the lower and upper river (Chess et al. 2003). Upriver harvest is estimated as the mean percent of total run harvested upriver from 2000-2002 (2.2%, Chess et al. 2003).

Most surveys are conducted in the "morning" from sunrise to early afternoon (1500 h) because past surveys have indicated 67% of angling effort and 84% of the harvest occurs during this time period. For 2000-2002, proportionate evening effort was 41%, 30%, and 28% of morning effort, and proportionate evening harvest was 14.5%, 13.2%, and 20.0% of morning harvest (Chess et al. 2003). We conduct morning surveys 5 days per week, and on two or three of those days, we conduct an "evening" survey (1500 h - sunset) to estimate the proportion of daily effort, catch, and harvest that occurs in the morning and evening time blocks.

Computation of effort, catch, and harvest for tribal and non-tribal fisheries: We estimate fishing effort, catch, and harvest within monthly and weekday/weekend strata for the fall salmon and steelhead fisheries, and within weekly, weekday/weekend, and morning/evening strata for the spring Chinook fishery. We use one-half hour before sunrise and one-half hour after sunset to determine angling start and end times. We estimate fishing effort (angler hours) as the area under an angling pressure curve (number of anglers by time of day). Total angling effort within each strata is calculated as mean daily effort times the number of fishable days with the strata. Fishable days are when river flow and water clarity provide suitable fishing conditions. The river is generally not fishable when flow exceeded 2,000 cfs or turbidity imparts a brown color to the water and reduces visibility to <10 cm.

Fishing effort for a sampling day (E_i) is estimated from angling pressure counts according to the following formula:

$$E_i = ½ \sum_{k=1}^{r} (T_k - T_{k-1})(C_k + C_{k-1})$$

where:
r = number of angling pressure counts per day,
C_k = angler count at time k, and
T_k = time at the k^{th} count.

Both catch rate (CR_i) and harvest rate (HR_i) are estimated by the following formula:

$$CR_i \text{ or } HR_i = \sum_{k=1}^{mi} f_{ij} \;/\; \sum_{j=1}^{mi} h_{ij}$$

where:
m_i = number of anglers interviewed on the i^{th} day,
f_{ij} = number of fish caught or harvested by the j^{th} angler on the i^{th} day, and
h_{ij} = number of hours fished by the j^{th} angler on the i^{th} day.

Mean catch rates and harvest rates for combined monthly strata and the total season are weighted by the proportion of total hours fished in each stratum.

Both total daily catch (TC_i) and total daily harvest (TH_i) are estimated by the following formula:

$$TC_i = (CR_i)(E_i) \text{ and } TH_i = (HR_i)(E_i)$$

Both total catch (TC) and total harvest (TH) for a stratum are estimated by the following formula:

$$TC = (N/n) \sum_{i=1}^{n} TC_i \text{ and } TH = (N/n) \sum_{i=1}^{n} TH_i$$

where
N = number of days in the stratum, and
n = number of days sampled in the stratum.

Both the variance of catch V(TC) and variance of harvest V(TH) for each stratum are estimated following Cochran (1977):

$$V(TC) \text{ or } V(TH) = N^2(1 - (n/N))(S_i^2/n) + (N/n) \sum_{i=1}^{n}(1-(\sum_{i=1}^{n} h_{ij}) / E_i) (E_i^2) (S_{2i}^2 / m)$$

where:

$$S_i^2 = \sum_{i=1}^{n}(TC - TC_i) / (n - 1) \text{ or } \sum_{i=1}^{n}(TH - TH_i) / (n - 1), \text{ and}$$

$$S_{2i}^2 = \sum_{i=1}^{n}((f_{ij} / h_{ij}) - CR_i)^2 / (m_i - 1) \text{ or } \sum_{i=1}^{n}((f_{ij} / h_{ij}) - HR_i)^2 / (m_i - 1),$$

Total monthly catch, harvest, and variances are calculated by summing stratum totals. Catch and harvest rates for combined monthly strata and season total will be weighted by the proportion of total angling effort in each stratum.

A bound on the error of estimation (bound) is then calculated to approximate a 95% confidence interval for strata and season total catch and harvest estimates. A bound is approximately equal to a 95% confidence interval if data have a normal probability distribution and at least a 75% confidence interval regardless of the probability distribution (Scheaffer et al. 1979). Bounds for total catch (BTC) and total harvest (BTH) are calculated by the following formulas:

$$\text{BTC} = \pm 2 * \sqrt{V(TC)}$$

Out-of-Basin Harvest

Described in Methods section 11.9.6

Age and Growth Monitoring

Hard structures will be collected from juvenile and adult fishes during a variety of sampling activities. These hard structures will be analyzed to detect growth rings and other growth patterns including accelerated development of the nuclei (indicating hatchery origin) and marine/freshwater transitional depositions (indicating years at sea and years in-river). A centralized age and growth lab is being developed at CTUIR facilities. The lab will be capable of detecting growth patterns from scale, otolith, vertebrae, and rays of fishes. The lab will use light-microscopy and computer digitalization to create a digital archive of all hard structures analyzed. The lab will be staffed with CTUIR and ODFW personnel who will share responsibility for age and growth determinations.

Scales will be mounted on gum cards and pressed in cellulose acetate. Hard structures will be sanded flat and mounted in CrystalBond © medium and sanded or sectioned using a diamond saw. Adult scales will be examined under a stereo microscope at a magnification of 42x and/or 72x. Age designation utilized the European method; a fish returning in 2002 at age 1.2 was spawned in 1998, emerged from the gravel in January-March of 1999, migrated to the ocean in the spring of 2000, returned to freshwater in the spring 2002 and spawned in the late summer of 2002 at total age 4. Juvenile scales, otoliths, rays, and vertebrae will be examined under a compound scope at 100X or greater magnification. Daily, lunar, seasonal, and annual patterns will be discerned. Growth curves will be developed using von Bertalanffy (Bertalanffy 1934) and Parker and Larkin (Parker and Larkin 1959) equations.

Habitat and Environmental Monitoring

A variety of complementary habitat monitoring activities will be regularly conducted in the Umatilla Subbasin to capture variance in physical, biological, and chemical conditions. The sampling regime of these activities will vary from continuous monitoring of flow and temperature, to decadal monitoring of riparian conditions. Monitoring will focus on factors that are not primarily controlled by upstream conditions so that measurable improvements can be detected in important elements of salmon habitat. Habitat recovery will be measured in terms of regrowth of the riparian vegetation, vegetation structure and cover. In addition, vegetative recovery is related to improvements in bank stability and channel morphology; therefore geomorphic characteristics will also be monitored. These broader parameters, though not useful for project specific monitoring, are more important when tracking comprehensive basin-wide recovery. The spatial coverage of these activities will vary as well. Protocols were developed using a variety of tools, and follow guidelines of the current regional and local protocols (Hankin and Reeves 1988, ODFW 1993, Johnson et al. 2001).

In-Stream Features

The quantitative goal of the habitat monitoring program is to estimate the total abundance and distribution of essential fish habitat throughout the subbasin for each species every ten years. EMAP sampling routines will be used to determine the order and magnitude of each reach that is surveyed annually. Reaches will be divided into contiguous quadrats based on linear habitat characteristics. The percent substrate composition will be estimated using the following categories;

1. Silt and fine organic matter
2. Sand
3. Gravel (pea to baseball; 2-64 mm)
4. Cobble (baseball to bowling ball; 64-256 mm)
5. Boulders
6. Bedrock

Relative embededness and approximate depth of annual bedscour will be recorded. A longitudinal and cross-sectional survey of conditions will be made to quantify wetted width, bank full width, and bank full (maximum) depth. The in-stream conditions of pools, glides, riffles, rapids, cascades and steps will be assessed using the following attributes.

POOLS

PP **Plunge Pool:** Formed by scour below a complete or nearly complete channel obstruction (logs, boulders, or bedrock). Substrate is highly variable. Frequently, but not always, shorter than the active channel width.

SP **Straight scour Pool:** Formed by mid-channel scour. Generally with a broad scour hole and symmetrical cross section.

LP **Lateral scour Pool:** Formed by flow impinging against one stream bank or partial obstruction (logs, rootwads, or bedrock). Asymmetrical cross section. Includes corner pools in meandering lowland or valley bottom streams.

TP **Trench Pool:** Slow flow with U or V-shaped cross section typically flanked by bedrock walls. Often very long and narrow.

DP **Dammed Pool:** Water impounded upstream of channel blockage (debris jams, rock landslides).

BP **Beaver dam Pool:** Dammed pool formed by beaver activity.

AL **Alcove:** Most protected type of pool. Alcoves are laterally displaced from the general bounds of the active channel. Substrate is typically sand and organic matter. Formed during extreme flow events or by beaver activity; not scoured during typical high flows.

BW **Backwater Pool:** Found along channel margins; created by eddies around obstructions such as boulders, rootwads, or woody debris. Part of active channel at most flows; scoured at high flow. Substrate typically sand, gravel, and cobble.

IP Isolated Pool: Pools formed outside the primary wetted channel, but within the active channel. Isolated pools are usually associated with gravel bars and may dry up or be dependent on inter-gravel flow during late summer. Substrate is highly variable. Isolated pool units do not include pools of ponded or perched water found in bedrock depressions.

GLIDES

GL **Glide:** An area with generally uniform depth and flow with no surface turbulence. Low gradient; 0-1% slope. Glides may have some small scour areas but are distinguished from pools by their overall homogeneity and lack of structure. Generally deeper than riffles with few major flow obstructions and low habitat complexity.

RIFFLES

RI **Riffle:** Fast, turbulent, shallow flow over submerged or partially submerged substrate. Often with 5-15% of surface area with white water. Generally broad, uniform cross section. Low gradient; usually 0.5-2.0% slope.

RP **Riffle with Pockets:** Same flow and gradient as Riffle but with numerous sub-unit sized pools or pocket water created by scour associated with small boulders, wood, or streambed dunes and ridges.

RAPIDS

RB **Rapid with protruding Boulders:** Swift, turbulent flow including chutes and some hydraulic jumps. Surface with 15-50% white water. Exposed substrate composed of individual boulders, boulder clusters, and partial bars. Moderate gradient; 2-4% slope.

RR **Rapid over Bedrock:** Swift, turbulent, "sheeting" flow over smooth bedrock. Sometimes called chutes. Little or no exposed substrate, 15-50% white water. Moderate to steep gradient; 2-20% slope.

CASCADES

CB **Cascade over Boulders:** Very fast, turbulent flow; many hydraulic jumps, strong chutes and eddies; 30-80% white water. Much of the exposed substrate composed of boulders organized into clusters, partial bars, or step-pool sequences. High gradient; usually 3.5-10% slope, sometimes greater.

CR **Cascade over Bedrock:** Same flow characteristics as Cascade over boulders but structure is derived from sequence of bedrock steps. Slope 3.5% or greater.

STEPS

Steps do not fit our general definition of channel units because they usually are much shorter than the channel width. However, they are important, discrete breaks in channel gradient with 10 to >100% slope. Steps are classified by the type of structure forming the step.

SR **Step over Bedrock (include hardpan and clay steps**
SB **Step over Boulders**
SC **Step over face of Cobble bar**
SL **Step over Logs(s), branches**
SS **Step created by Structure (culvert, weir, dam, beaver dam)**

SPECIAL CASES

DU **Dry Unit:** Dry section of stream separating wetted channel units. Typical examples are riffles with subsurface flow or portions of side channels separated by large isolated pools. Record the length, active channel width, and other variables for the dry areas.

PD **Puddled:** Nearly dry channel but with sequence of small isolated pools less than one channel width in length or width.

DC **Dry Channel:** Section of the main channel or side channel that is completely dry at time of survey. Record all unit data, use active channel width for width.

CC **Culvert Crossing:** Stream flowing through a culvert. The height from the culvert lip to the stream surface (drop), diameter, and shape of culvert will be recorded.

LARGE WOODY DEBRIS

Class 1 Woody debris absent or in very low abundance. No habitat complexity or cover created.

Class 2 Wood present, but contributes little to habitat complexity. Mostly small, single pieces, creating little cover or complex flow patterns. Ineffective at moderate to high discharge.

Class 3 Wood was present as combinations of single pieces and small accumulations. Providing cover and some complex habitat at low to moderate discharge, less effective at high discharge

Class 4 Wood present with medium and large pieces comprising accumulations and debris jams that incorporate smaller rootwads and branches. Good hiding cover for fish. Woody debris providing cover and complex habitat that persists over most stream discharge levels.

Class 5 Wood present as large single pieces, accumulations, and jams that trap large amounts of additional material and create a variety of cover and refuge habitats. Woody debris providing excellent persistent and complex habitat. Complex flow patterns will exist at all discharge levels.

Riparian and Land Use Conditions

Riparian conditions are excellent indicators of land use, and help describe the interface of water and watershed. For each in-stream contiguous quadrat we will estimate the primary, secondary, and tertiary structural components. Percent canopy cover will be visually estimated. Riparian and adjacent land use conditions will be categorized using the following attributes.

Riparian Conditions

RIPARIAN VEGETATION

N No vegetation (bare soil, rock)

B Sagebrush (sagebrush, greasewood, rabbit brush, etc.)

G Annual grasses and herbs

P Perennial grasses, forbs, sedges and rushes

S Shrubs (willow, salmonberry, some alder)

D Deciduous dominated (canopy more than 70% alder, cottonwood, big leaf maple, or other deciduous species)

M Mixed conifer/deciduous (approximately a 50:50 distribution)

BANK STABALIZATION

NE **Non-Erodible**. Stable bedrock, hardpan, or boulder-lined bank

BC **Boulder Cobble**. Stable matrix dominated by boulders and cobble combined with soil, vegetation, and large roots.

VS **Vegetated-Stabilized**. Vegetated and/or overhanging bank, partly or wholly stabilized by root systems. Some exposed soils may be present, but with no evidence of recent bank failure.

AE **Actively Eroding**. Actively or recently eroding or collapsing banks. Exposed soils and inorganic material. Superficial vegetation may be present, but it does not contribute to bank stability.

Land Use Conditions

AG Agricultural crop land

TH Timber Harvest. Active timber management including tree felling, logging, etc. Not yet replanted.

YT Young forest Trees. Can range from recently planted harvest units to stands with trees up to 15 cm dbh.

ST Second growth Timber. Trees 15-30 cm dbh in generally dense, rapidly growing, uniform stands.

LT Large Timber (30-90 cm dbh)

MT Mature Timber (50-90 cm dbh)

OG Old Growth Forest. Many trees with 90+ cm dbh and plant community with old growth characteristics.

PT Partial cut Timber. Selection cut or shelterwood cut with partial removal of large trees. Combination of stumps and standing timber. If only a few live trees or snags in the unit, describe in notes.

FF Forest Fire. Evidence of recent charring and tree mortality.

BK Bug Kill. Eastside forests with >60% mortality from pests and diseases. Enter bug kill as a comment in the notes when it is observed in small patches.

LG Light Grazing Pressure. Grasses, forbs and shrubs present, banks not broken down, animal presence obvious only at limited points such as water crossings. Cow pies evident.

HG Heavy Grazing Pressure. Broken banks, well established cow paths. Primarily bare earth or early successional stages of grasses and forbs present.

UR Urban

RR Rural Residential

IN Industrial

MI Mining

Biological Conditions

Biological habitat conditions will be sampled during EMAP surveys. The examination of aquatic macroinvertebrate communities is an important aspect of monitoring and evaluation programs because these communities are an integral component of aquatic and riparian ecosystems, and they can be used as an index of potential stream reach quality for salmonids and other cold-water fishes. One of the most important ecosystem functions of macroinvertebrates is the role they play in aquatic and riparian food webs. Macroinvertebrates are the main conduit of energy between basal resources (primary production and detritus) and fish (Allan 1995b), and they are an important energy subsidy to surrounding riparian areas (Nakano and Murakami 2001).

The use of macroinvertebrate communities as an index of stream quality has a long history (Cairns and Pratt 1993), and indices of community structure exist that allow assessments of the types and degrees of various disturbances (Resh and Jackson 1993). Most species are affected by conditions at fairly small scales (e.g., a stream reach) because many species have small home range sizes (Platts et al. 1983a). Thus, communities are likely to be influenced by local environmental conditions within a specific stream reach. This feature makes macroinvertebrates ideal for assessing the impact of restoration projects at the reach and watershed scales (Laasonen et al. 1998, Weigel et al. 2000).

Many species of aquatic invertebrates live for about one year (Wallace and Anderson 1996). This lifespan is long enough that individuals and populations integrate inherent variability in water quality that occurs on a daily and seasonal cycle. This is in contrast to many chemical and physical measures which are only snapshots of immediate conditions. However, this lifespan is short enough that impacts of environmental conditions on populations can be determined in just several years.

Quantitative samples of macroinvertebrate communities will be made at EMAP reaches following the standard USDA Forest Service methods (Platts et al. 1983b). Invertebrates will be sampled at 5 points within each study reach using a Surber sampler, a device with a sampling quadrat of known size. Only riffle areas will be sampled for several reasons. Sampling riffles minimizes between-sample and between-site variability that results from habitat type and not habitat quality. In addition, riffles are known for their high invertebrate productivity (Allan 1995a) and many of the invertebrates useful in biomonitoring are found primarily in riffles (Hilsenhoff 1987a).

Four indices will be used to assess stream reach quality. Each of these metrics has potential biases, which can influence assessments based on only one metric. By measuring multiple indices, these biases can be at least partially taken into account (Karr and Chu 1999). The four metrics are: Simpson's Diversity Index, the number of Ephemeroptera, Plecoptera and Trichoptera (EPT) taxa, the number of disturbance-tolerant taxa, and the Hilsenhoff Biotic Index (HBI). Diversity is predicted to increase with decreasing human disturbance (Karr and Chu 1999). EPT taxa are sensitive to many anthropogenic disturbances and are most abundant in cold, clean-water reaches with little sediment (i.e., conditions good for salmonids) (Karr and Chu 1999). Their numbers are expected to decline with increasing human disturbance (Karr and Chu 1999). In contrast, the number of disturbance-tolerant taxa is expected to increase with increasing human disturbance. The HBI measures the dominance of taxa known to be insensitive to organic pollution (Hilsenhoff 1987b).

Instream Flow

Instream flow is monitored continuously be BOR, NOAA, and USGS. These federal agencies are responsible for data management, data archiving, flow predictions, and flow analysis. The following web-sites describe flow monitoring programs in the Umatilla Subbasin.

http://www.usbr.gov/pn/hydromet/umatilla/umatea.html (Subbasin overview, link to archive data)

http://ahps.wrh.noaa.gov/cgi-bin/ahps.cgi?pdt&tchw1 (NOAA flow predictions and real time data) http://www.usbr.gov/pn/hydromet/graphs/wcro_qd_wy.html (Wildhorse Creek flow data)

http://waterdata.usgs.gov/or/nwis/uv?site_no=14020300 (Real time data for Meacham with archive data)

http://water.usgs.gov/waterwatch/ (Over view map of real time data for USGS)

http://waterdata.usgs.gov/or/nwis/current/?type=flow (Real time data index for Oregon)

Water Temperature

Thermographs will be deployed throughout the Umatilla Subbasin in coordination with other projects and agencies to maximize consistency and coverage without duplicating effort.

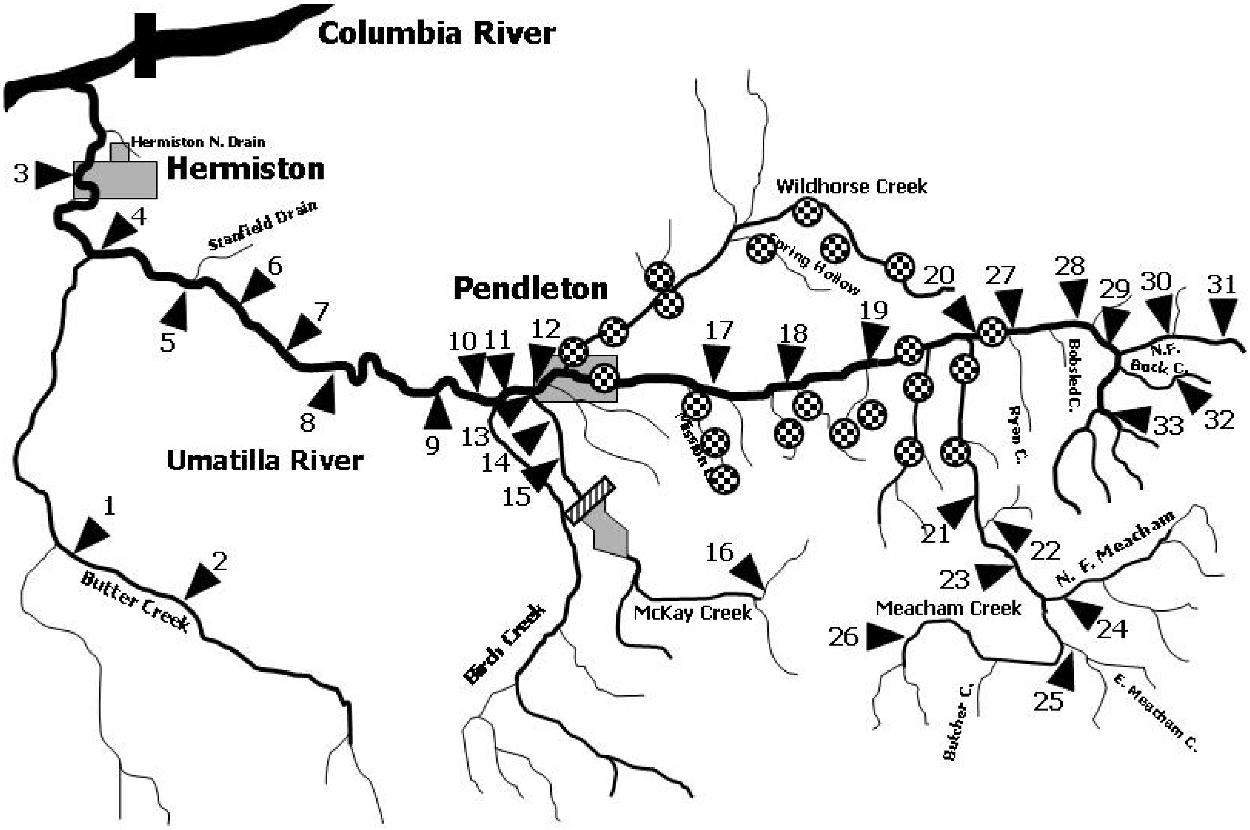


Figure 8 shows the location of thermograph deployment for UMEP. Some of the thermograph locations have been monitored consistently since 1993 while other sites were only monitored one or two years. Details of all project water temperature data are currently available at http://www.umatilla.nsn.us (CTUIR website). The website also lists water temperature from other projects with additional data being added regularly. NPMEP used Ryan RTM2000 thermographs from 1993 through 1996. In 1997 NPMEP began using the newly developed Vemco Mini-Loggers because of their smaller size, lower cost, and improved reliability. The Vemco instruments replaced all the Ryan instruments by 2001. Instruments are initialized in the office. The batteries, seals and clamps of the Ryan instruments are cleaned, inspected and changed as needed. Steel chains or cables are used to anchor all units to large trees or boulders on the shore. We conceal thermographs, chains and cables to minimize tampering by the public. Thermographs are checked regularly after deployment to ensure proper function and placement. In November and December we collected all thermographs and downloaded data. During 1993 and 1994 we deployed thermographs during the winter but we discontinued that practice in 1995 to avoid instrument loss and damage during high flows. UMEP will calculate and report the number of hours (by month) when water temperatures exceed benchmark temperatures of 12.78, 17.78, 20.0 and 25°C (55, 64, 68, and 77°F respectively). Temperature data will be examined in relation to past data, seasonal discharge, water quality standards. Associative and trend analysis will be used to analyze and evaluate temperature data.

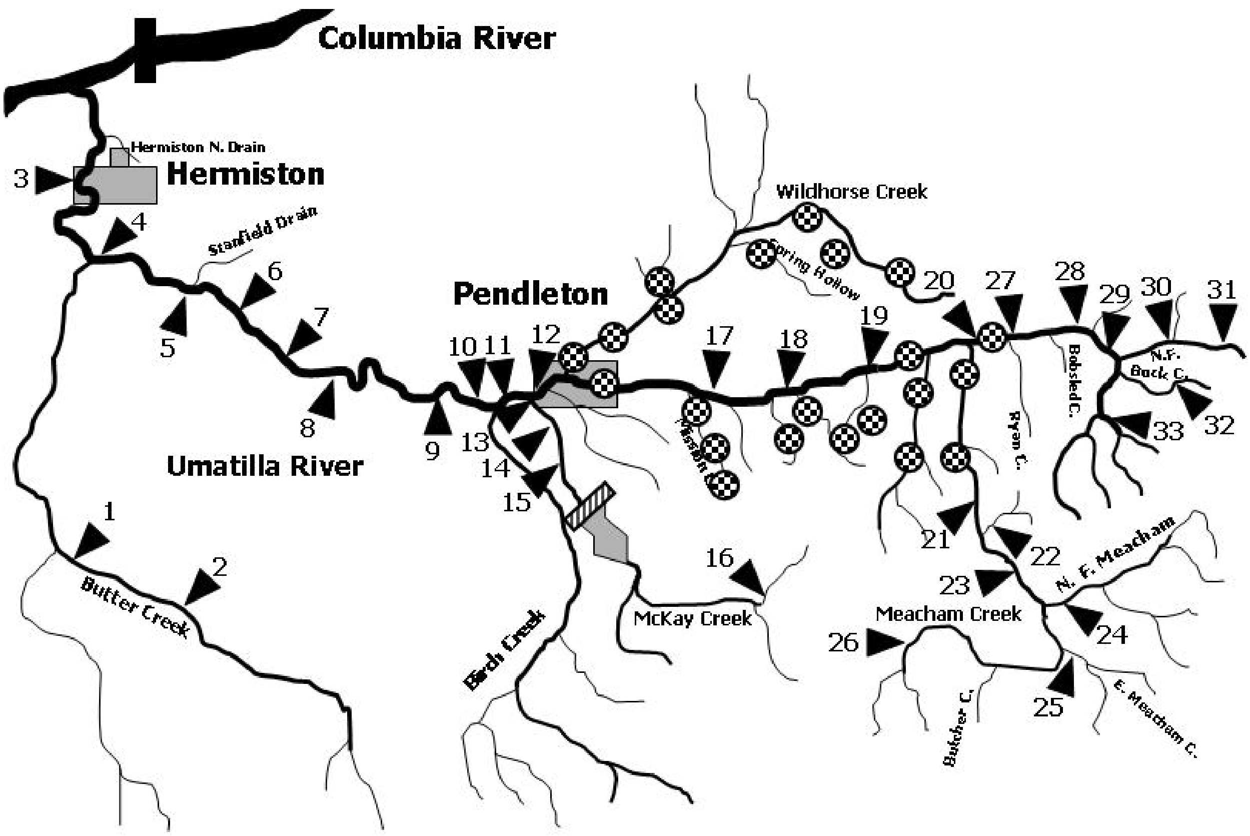


Figure 8. Location of UNPMEP thermograph deployment. Thirty three units are deployed throughout the Umatilla Subbasin to monitor summer temperatures by EDT reach in CHS and CHF spawning areas. A number of additional thermographs are deployed by habitat, water quality, and water planning programs (some of which are shown as checkered circles) to monitor site-specific habitat restoration projects.

Water Quality and Chemical Conditions

Thirty water quality samples will be collected from each watershed each summer, and studied by CTUIR's Water Quality Department under support of the Environmental Protection Agency.

To assess and monitor the toxicological conditions of each watershed, a maximum of thirty whole juvenile STS and juvenile Chinook and thirty carcass tissue samples will be collected from each watershed annually during EMAP juvenile and spawner/carcass surveys. Tissue samples will be analyzed to estimate the concentrations of persistent organics and heavy metals, to estimate the corresponding realized contiguous trophic level from stable isotopic composition (Satterfield and Finney 2002). Based on prior studies this sample size should be sufficient to test for a 10% difference in size and age adjusted bioaccumulation rates of adult carcasses (Easton et al. 2002) and juveniles (Warren and Liss 1977) from different watersheds.

Derived Habitat Metrics

A number of habitat metrics, including land use, total solar radiation, total chlorophyll and thermal irradiation will be derived from remotely sensed data. These watershed-scale metrics will be analyzed for their watershed-scale variability to develop associations between total land-use and waterscape use conditions and in-stream biological performance of managed species and their cohabitants.

Habitat and Environmental Analysis

The quantitative goals for habitat assessment and monitoring require ongoing monitoring subbasin wide. Therefore no power analysis is necessary. In-stream and riparian habitat features will be surveyed for every reach of stream every ten years, and annually where specific habitat restoration actions are implemented. Flow and temperature monitoring will be continuous. Every five years UMEP will work with MBI to develop a revised ecosystem based model (0), and will estimate salmon survival rates in the Umatilla Subbasin as a function of habitat condition (Cuenco and McCullough 1996).

Ecological Monitoring

Community and Trophic Monitoring

Fish community information will be collected during EMAP surveys (0), and will be monitored throughout the subbasin using baited passive fish traps. Predator, competitor, and prey relationships will be derived. Trophic relationships will be assembled using stable isotope values (0), previously published research, and ecological inference (Gatz 1979).

Bioenergetics models have been drafted for several Columbia Basin fishes (Hanson et al. 1997). We will refine bioenergetics models for CHS, CHF, and STS based on observed age and growth data (0), locally adapted trophic relationships, and environmental correlates (0), using perturbation protocols (Bartell et al. 1986, Stockwell and Johnson 1997). The bioenergetics models will be used to produce absolute estimates of energy flow within and through each managed fish juvenile and spawner populations. These interactions will be used to estimate the strength of community-wide interactions between fishes, their predators, and their prey (e.g. (Rodriguez and Magnan 1995, Sala and Graham 2002).

Community and trophic metrics for each watershed will be analyzed structurally to monitor changes in the flow of resources to target and non-target species. Fish diversity, food web structure, connectivity, food web lengths, link densities, omnivory rates, cannibalism, and predator prey ratios will be evaluated. Undesirable structural changes in fish communities or their food webs will be described quantitatively and qualitatively as part of regular reporting.

Ecosystem Monitoring

The subbasin planning process has made imminently clear the benefits of an ecosystem perspective in off-site mitigation. MBI's EDT model has been used with considerable success to describe ecological conditions where data is available. EDT provides a general estimate of carrying capacity, and presents a hypothetical increase in production associated with habitat, passage, and flow restoration.

Unfortunately EDT falls short of addressing three pit-falls that have been clearly pointed out by ecosystem modelers. First, EDT fails to address variability in individual behavior, growth, and physiology. This variance can contribute significantly to salmonid production and productivity (Kooijman et al. 1989, Werner 1992, Werner and Anholt 1993), and is relatively easy to address mathematically. Second, EDT is associative at several critical scales. Numerous subbasins have noted a need to "tune" EDT to regional stream and climatic conditions. This inaccuracy of the model stems from its lack of mechanistic detail that is essential to models with portable applicability (DeAngelis 1988). Last, EDT does not incorporate the density-dependent consequences a of age-structured or spatially-structured life history variability. This variance represents a critical compensatory response of most fish populations (McCauly et al. 1993, Walters et al. 1999), and must be mathematically represented in aquatic ecosystem models approaching carrying capacity (Christensen and Pauly 1998).
UMEP will work with MBI and CBR to develop an individual-based version of EDT that is more portable to the diversity of ecosystems that is represented within and among the Columbia's subbasin. We will build upon EDT's "biological rules" using data derived from the UMEP comprehensive monitoring program, and parallel programs around the Columbia Basin. The revised EDT model will be developed from EDT core algorithms, and less proprietary models such as SURPH, CRiSP, Vitality, and egg-growth models (www.cbr.washington.edu). This product will be less empirical and more mechanistic and explanatory, and less associative and empirical, in part because it will represent a combination of bottom-up (UMEP) and top down (MBI and CBR) developmental forces. It will consist of a single software package in which every aspect of survival, production, productivity, emigration, and immigration can be evaluated and assessed under future conditions. The model will produce estimates of the community, aggregate, and ecosystem metrics that describe ecological function, including the flow of energy throughout Umatilla fish populations, and the survival and production of all species and life-stages of interest.

Genetic Sampling

Genetic samples will be collected from a sub-sample of TMFD run STS, all Iskuulpa Creek spawners, a sub-sample of Iskuulpa RBT (n=10-50), and a sub-sample (n=300) of Iskuulpa pre-smolts annually. Samples will be taken from adipose or ventral fin clips. Samples will be frozen, stored in ethanol, or placed directly in lysis buffer. This sampling regime will be followed for ten years; the completion of two full STS generations.

In parallel with these efforts NPMEP will begin testing a progeny marker currently under development at Oregon State University. Approximately 10% of the hatchery escapement to Iskuulpa will be injected with the marker. The strontium progeny marker is a new tool that has only recently been developed to assess reproductive success of anadromous fishes. Although the marker has shown great utility in the laboratory, there are physical and physiological complications that might hinder its utility in the field. We will mark fish using the progeny marker for three years and assess its utility. If significant marked progeny are not recovered, we will conclude that the progeny marker is unable to detect the reproductive success of hatchery reared fish in the Umatilla Subbasin. It will not be clear at that time whether hatchery reared fish are not successful, or the progeny marker is not robust enough to detect their success. Results from the pedigree study will be used to validate or invalidate the utility of strontium marking in hatchery programs.

Umatilla STS samples will be analyzed by the Columbia Rive Inter-Tribal Fisheries Commission cooperative genetics program at the Hagerman Fish Culture Experiment Station using microsatellite loci that have been optimized for steelhead studies. Samples will be analyzed for each brood and return year. DNA will be extracted using a Qiagen® 3000 robot. A polymerase chain reaction (PCR) will be used to amplify 10-12 microsatellite loci. PCR amplifications will be performed using the AmpliTaq Reagent System (Applied Biosystems®) in an MJ Research® PTC-100 thermal cycler following manufacturer’s protocols. Forward PCR primers will be fluorescently labeled (Applied Biosystems®), and PCR products genotyped using manufacture’s protocols with an Applied Biosystems® model 3100 or 3730 genetic analyzer.

Genotypes will be assembled using 16 microsatellite markers. Parentage will be estimated using a variety of exclusion, likelihood, pair-wise relatedness, and genetic similarity algorithms (Wilson and Ferguson 2002). The relative and “long-term” reproductive success of hatcheryXhatchery, hatcheryXwild, and wildxwild (including STSXSTS and STSXRBT) crosses will be evaluated.

Pedigree studies are being used in a variety of subbasins to answer a number of questions, including NMFS RPAs 182 and 184. These endeavors are costly and resource intensive, but may provide essential management information. Unless the utility of an ongoing pedigree analysis is established by one of the co-management entities, this study will terminate following a final report in December 2015. During each year of operations the project will be evaluated to determine if biologically or statistically significant patterns in fitness can be detected, to determine the likely importance of this information given the status of ongoing artificial and natural production, and to determine if new insight is being produced that can effectively inform the population or harvest recovery strategies.

Hatchery Monitoring

Holding

Information on adult holding is documented in annual reports produced by the CTUIR Umatilla Hatchery and Satellite Facilities O&M Project (BPA Project # 83-435).

Spawning

Spawning information is documented in annual reports produced by the CTUIR Umatilla Hatchery and Satellite Facilities O&M Project (BPA Project # 83-435). The information is also reported to the ODFW Hatchery Database. Lengths (fork and mid-eye to peduncle), fin clips and marks are recorded for all spawned fish. Snouts are collected from all CWT fish and sent to ODFW fish identification laboratory in Clackamas for reading. The CWT in steelheads are read immediately to prevent spawning of strays into the Umatilla River. Scales are collected from all unmarked Chinook salmon, and a number of STS and CHF to verify natural-reared origin.

Egg Take Enumeration

Numbers of eggs taken during spawning is monitored by hatchery staff at Umatilla and Bonneville hatcheries and reported to the ODFW Hatchery Database. Total egg take is determined for each species by counting eyed embryos and discarded eggs. All eggs are physical shocked at eyeing stage to break the yolks of the unfertilized eggs. Eyed eggs are counted with a Denny McLeary egg counter. Female fecundity for each group is determined by dividing the total number of eggs by the total number of spawned females. An average fecundity is determined for all years of spawning. The average fecundities for spring and fall Chinook salmon and steelhead are 4,000, 3,800, and 5,289.

Growth and Production Monitoring

Fish growth is monitored by hatchery staff and reported to the ODFW Hatchery Database for fish reared at Umatilla, Bonneville, Cascade, and Oxbow hatcheries and for fish reared at Little White Salmon Hatchery. Fish growth is monitored by estimating average fish weight over time. Fish weight expressed as number of fish per pound (fish/lb) is measured monthly by averaging three weight samples of 100 fish per raceway. Feed is then adjusted to meet size-at-release targets.

Mass Marking

All steelhead and Chinook in the Umatilla Subbasin hatchery program receive a “mass” mark to identify their hatchery-reared origin. The mass mark for steelhead and spring Chinook salmon is an adipose fin clip. The mass mark for fall Chinook is a blank-wire tag. A portion of each hatchery group are also CWT’ed and given and external fin clip to identify presence of the tag for monitoring their total adult production, smolt-to-adult survival, out-of-subbasin stray rates, and contributions to harvest and spawning. Coho are CWT’ed, but not mass marked. The mark to identify presence of a coded-wire tag is a left ventral fin clip for steelhead, left or right ventral fin clip (alternates annually) for spring chinook, and an adipose fin clip for fall Chinook and coho.Detailed CWT methods are described below in section 11.9.6. Appendix Table XX summarizes marking and CWT’ing of the various hatchery production groups.

Tag retention and fin clip quality in each group is determined at least 30 days after tagging. Missed tags and clips along with total number released are reported to ODFW Hatchery Database and PSMFC RMIS database

Coded-wire Tagging and Associated Monitoring

Coded-wire tags (CWT’s) are one of the key tools used to assess the performance of each rearing and release strategy utilized in the Umatilla Subbasin hatchery program. Each hatchery production group (G_i) that has a unique rearing or release strategy is CWT’ed with a unique code for either monitoring or evaluation purposes. Fish that are CWT’ed also receive an external mark (adipose or ventral fin clip) to indicate presence of the tag. Performance measures that can be tracked if adequate numbers of fish are coded-wire tagged and recovered include total adult production, smolt-to-adult survival, out-of-subbasin stray rates, harvest contributions to fisheries, and relative survival to spawning of hatchery groups. Descriptive characteristics of the hatchery groups can also be obtained if adequate numbers of fish are coded-wire tagged and recovered including age-at-return, sex ratios, return timing, and spawning distribution. Table XX lists upcoming rearing and release strategies, smolt production targets, and coded-wire tagging rates utilized in the subbasin hatchery program.

Determination of how many fish in each hatchery production group should be CWT’ed is dependant on several factors including the number of CWT recoveries required to provide a reasonable level of statistical confidence, annual variability in smolt-to-adult survival, intensity and success of CWT recovery efforts in various locations, and the proportionate representation of a hatchery group in the conglomerate of adults at a particular recovery location. Maximum number of fish that can be CWT’ed is capped by smolt production. To determine the desired number of CWT recoveries required to provide a reasonable level of statistical confidence, we utilized the mathematical relationship between precision of the statistical comparison and observed numbers of CWT recoveries established by De Libero (1986). In this relationship, covarince (CV) of estimating total numbers of fish from hatchery group G_i at location L_i decreases as the number of CWT recoveries increases, but the CV does not significantly decrease further beyond a certain number of CWT recoveries. On the basis of De Libero (1986)’s findings, it takes about 30 observed recoveries per replicate (or hatchery group G_i) to achieve a

CV of 28.2%. As a general rule, 30 to 35 tag recoveries are needed to provide evaluation with a reasonable chance to detect change (Figure CWT1; Lichatowich and Cramer 1979, De Libero 1986). We will use 35 CWT recoveries as our target to provide for a margin of error in the analysis of power and realization of recoveries.

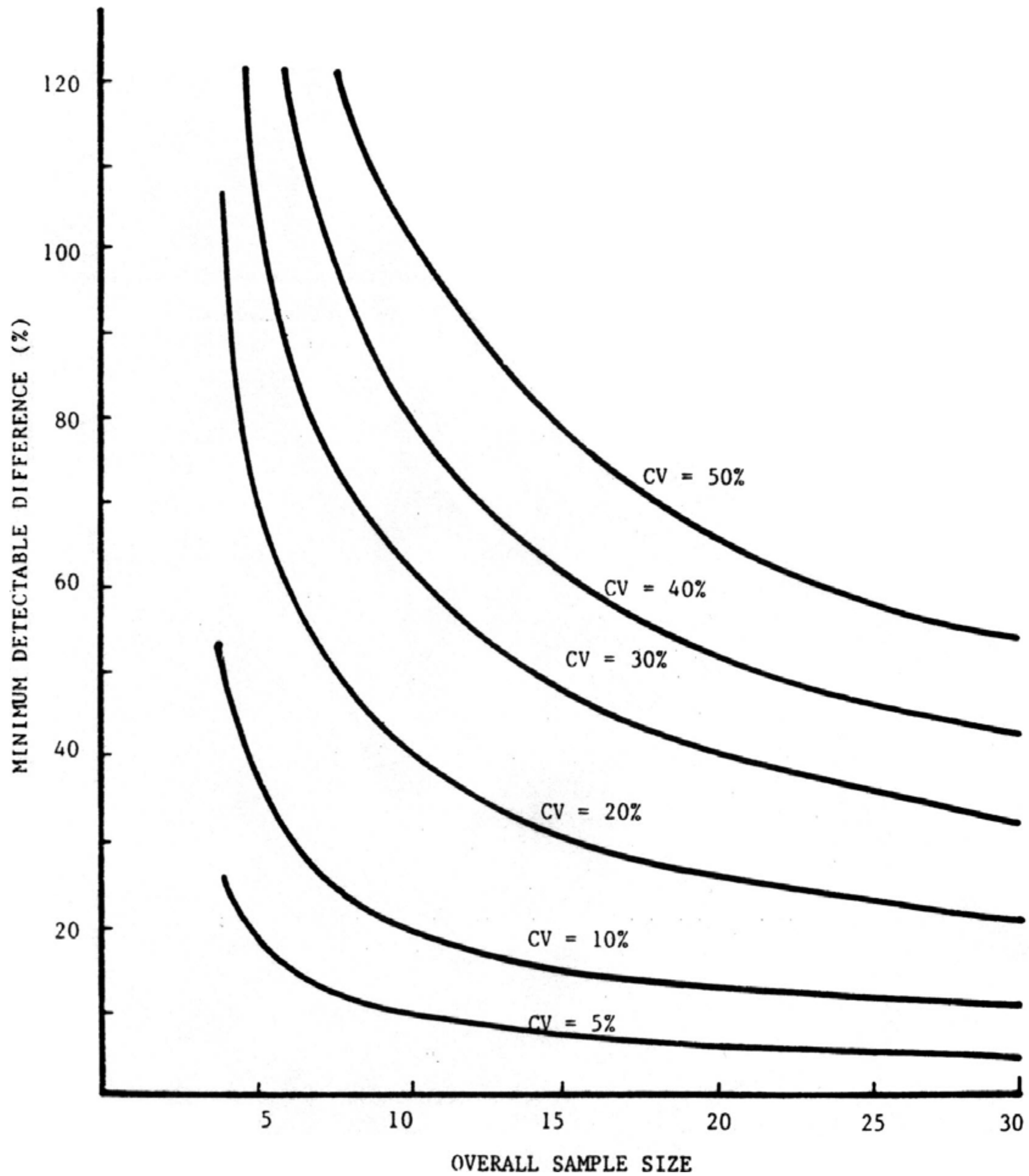


Figure CWT1. The effect of overall sample size (unexpanded number of coded-wire tag recoveries) on minimum detectable difference (ß = 0.2) for different levels of variability (CV). Taken from Lichatowich and Cramer (1979).

Determination of tagging rates for a hatchery group will be influenced by the uncertainties and monitoring strategies comanagers decide are a priority for the program along with policy and regulatory considerations. Tagging rates needed to recover 35 CWT's will be lowest if the only question of interest is determining overall SAS. In this case, CWT recoveries are pooled from all locations and tagging rates are minimal. However, if we want to assess contributions of a hatchery group to spawning, a specific fishery, or a stray location, appropriate tagging rates will be determined by our ability to recover CWT from those specific locations.

Ability to recover 35 CWT's is primarily influenced by SAS and sampling intensity at most recovery locations except Three Mile Falls Dam. At Three Mile Falls Dam, ability to recover CWT's is primarily influenced by trapping rates for steelhead, and total numbers of brood collected for Chinook. For steelhead, most CWT recoveries are obtained by sacrificing fish at Three Mile Falls Dam because numbers of recoveries from fisheries, strays, spawning grounds, and brood collection is typically low. Therefore, trapping rate at Three Mile Falls Dam is the primary factor we used in our calculation of tagging rates needed to recover 35 CWT's. We also factored in recoveries from all other sources in the calculation. For Chinook, fish collected for brood can supply most or all of the 35 CWT recoveries needed to assess survival to Three Mile Falls Dam for most hatchery groups. Numbers of CWT recoveries in brood for hatchery group G_i is determined by the proportionate representation of CWT'ed fish from hatchery group G_i in the run. Proportionate representation of hatchery groups in the run are in turn determined by the relative smolt production and SAS of the hatchery groups and proportion of natural fish collected in brood.

In order to model expected numbers of recoveries for a specific hatchery group G_i, we must make the following assumptions. It is important to mention that tagging rates will need to be reassessed if any of the relationships in these assumptions are not met in the future.

1) smolt production of hatchery group G_i remains relatively constant,
2) relative survival of hatchery groups remains relatively constant,
3) relative proportion of natural- to hatchery-reared Chinook in the run remains relatively constant,
4) recovery rates at location L_i remains relatively constant over time with varying SAS rates, and
5) number of brood collected at Three Mile Falls Dam remains relatively constant.

We used the most representative data we have on recovery rates of CWT's for fish produced in the Umatilla hatchery program at various recovery locations (L_i) and smolt-to-adult survival rates (SAS_i). We used the following formula to estimate, over a range of SAS, the number of fish that would need to be tagged in hatchery group G_i to recover 35 CWT's in out-of-subbasin fisheries, in-subbasin fisheries, spawning grounds, and stray location.

$$RNT_{Gi\ Li\ SASi} = (35 / \bar{x}\ REC_{Gi\ Li})\ (\bar{x}\ SAS_{Gi} / SAS_i)\ (\bar{x}\ NT_{Gi})$$

where:
$RNT_{Gi\ Li\ SASi}$ = Required number of fish to CWT to recover 35 CWT's for hatchery group G_i at location L_i and smolt-to-adult survival SAS_i,

$\bar{x}\ REC_{Gi\ Li}$ = mean number of CWT recoveries for hatchery group G_i at location L_i (calculated from data),
$\bar{x}\ SAS_{Gi}$ = mean smolt-to-adult survival (SAS) for hatchery group G_i (calculated from data),
SAS_i = SAS (variable), and
$\bar{x}\ NT_{Gi}$ = mean number of fish CWT'ed (NT) for hatchery group G_i.

We used the following formula to calculate numbers of CWT's recovered for hatchery group G_i in brood collected at Three Mile Falls Dam. Brood collection is the first priority for returns to Three Mile Falls Dam, and collection goals are typically met except in cases when SAS is very low.

$$REC_{Gi\ Lbc} = (N_{bc})\ (PRET_{Gi})\ (PTAG_{Gi})$$

where:
$REC_{Lbc\ Gi}$ = Number of CWT's recovered in brood collection for hatchery group G_i,
N_{bc} = Total number of brood collected,
$PRET_{Gi}$ = Proportion of hatchery group G_i in the return to Three Mile Falls Dam, and
$PTAG_{Gi}$ = Proportion of hatchery group G_i returning to Three Mile Falls Dam that is CWT'ed.

We solved the following formula at varying SAS to calculate the number of fish in hatchery group G_i that would need to be tagged to recover 35 CWT's from brood collection and one or more other locations.

$$35\ REC = REC_{Gi\ Lbc\ SASi\ NTi} + REC_{Gi\ Li\ SASi\ NTi}$$

where:
35 REC = 35 CWT recoveries,
$REC_{Gi\ Lbc\ SASi\ Ti}$ = Number of CWT recoveries for hatchery group G_i from brood collection (L_{bc}) at SAS_i and tagging rate NT_i, and
$REC_{Gi\ Li\ SASi\ Ti}$ = Number of CWT recoveries for hatchery group G_i from one or more locations other than brood (L_i). at SAS_i and tagging rate NT_i.

In general, greater numbers of fish need to be CWT'ed to achieve a desired number of CWT recoveries when SAS decreases. The key to determining what number of fish to tag is the ability to predict SAS prior to tagging. Figure CWT2 summarizes representative past SAS for steelhead and Chinook produced by the Umatilla Subbasin hatchery program. Lower 90% and 95% confidence limits for SAS are presented on the figure to illustrate how often low SAS might be expected. Note that logarithmic y-axis's were needed for Chinook due to their highly variable and sometimes very low SAS compared to steelhead. Results of modeling tagging rates required to recover 35 CWT from various locations and hatchery production groups G*i* are presented in Figures CWT3-6. Recovery locations used in the models vary by hatchery group due to varying M&E information needs for each group. These models provide comangers with the information needed to balance tagging cost or policies with M&E needs to recover a statistically sound data. Given these opposing considerations, it is probable statistically sound numbers of CWT recoveries will not be achieved when SAS is very low. Table CWT1 summarizes current and required numbers of CWT'ed fish to achieve 35 recoveries at varying locations at the lower 90% and 95% SAS confidence interval. From this table we can conclude current tagging rates for

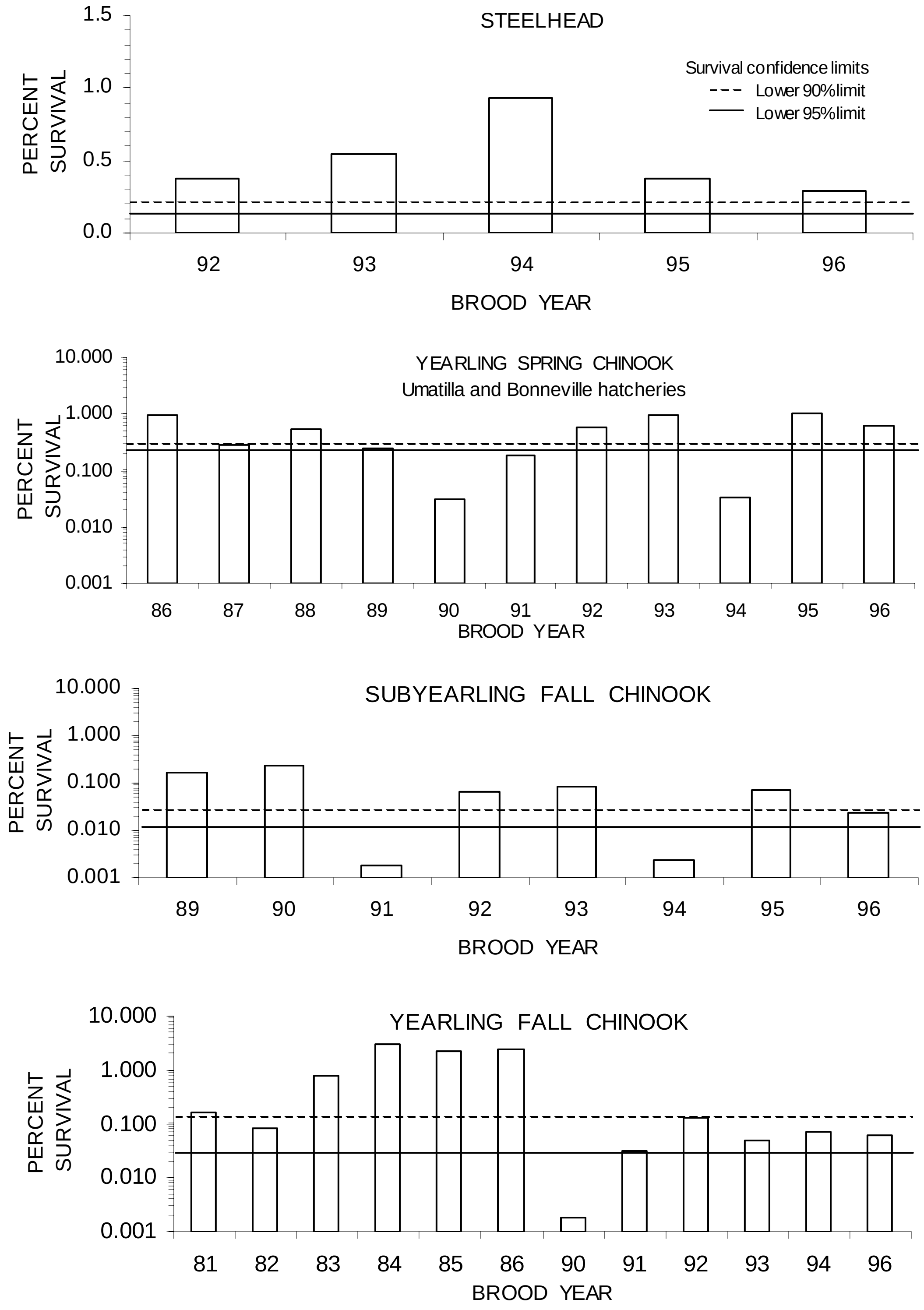
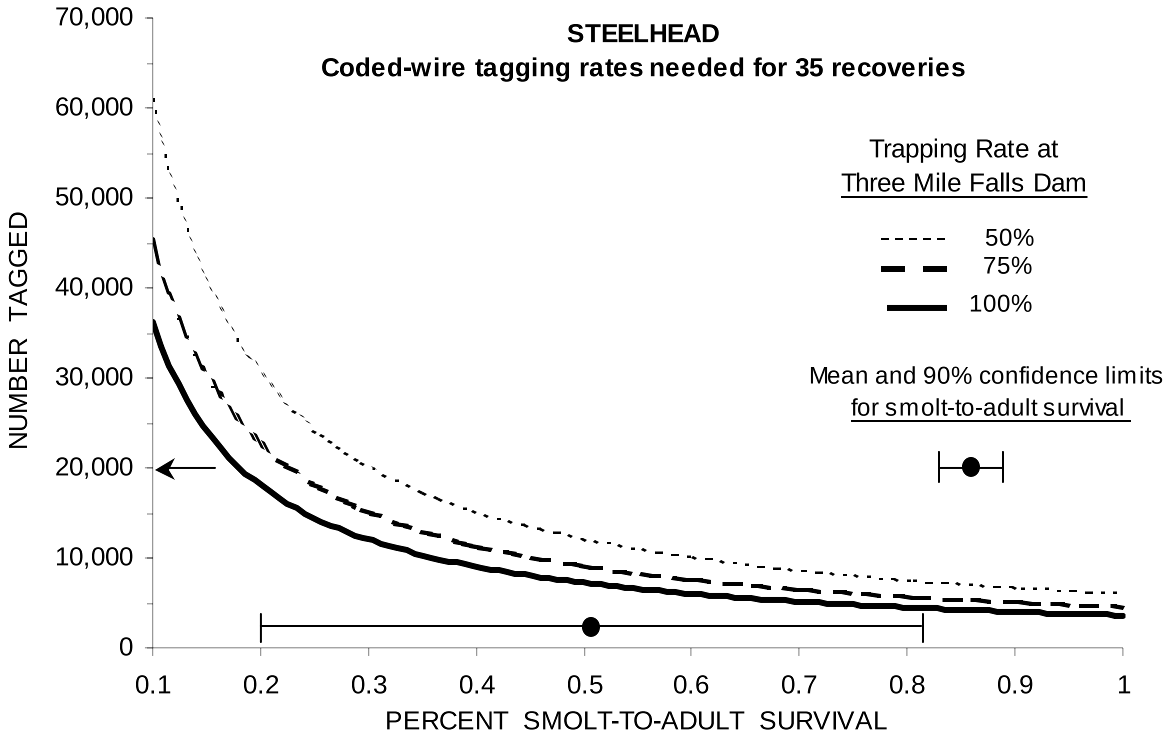


Figure CWT2. Past smolt-to-adult survival of hatchery steelhead and Chinook released in the Umatilla River that are most representative of current hatchery production strategies. Graphs include lower 90% and 95% confidence interval for smolt-to-adult survival assuming a normal distribution.



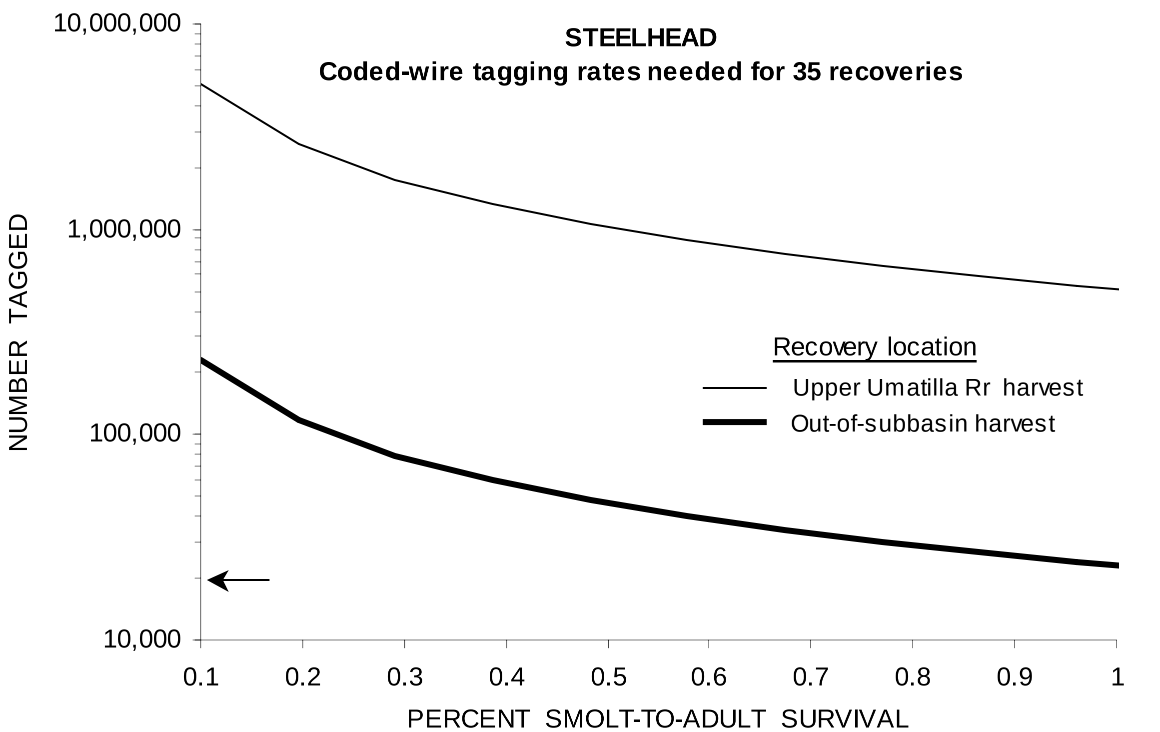
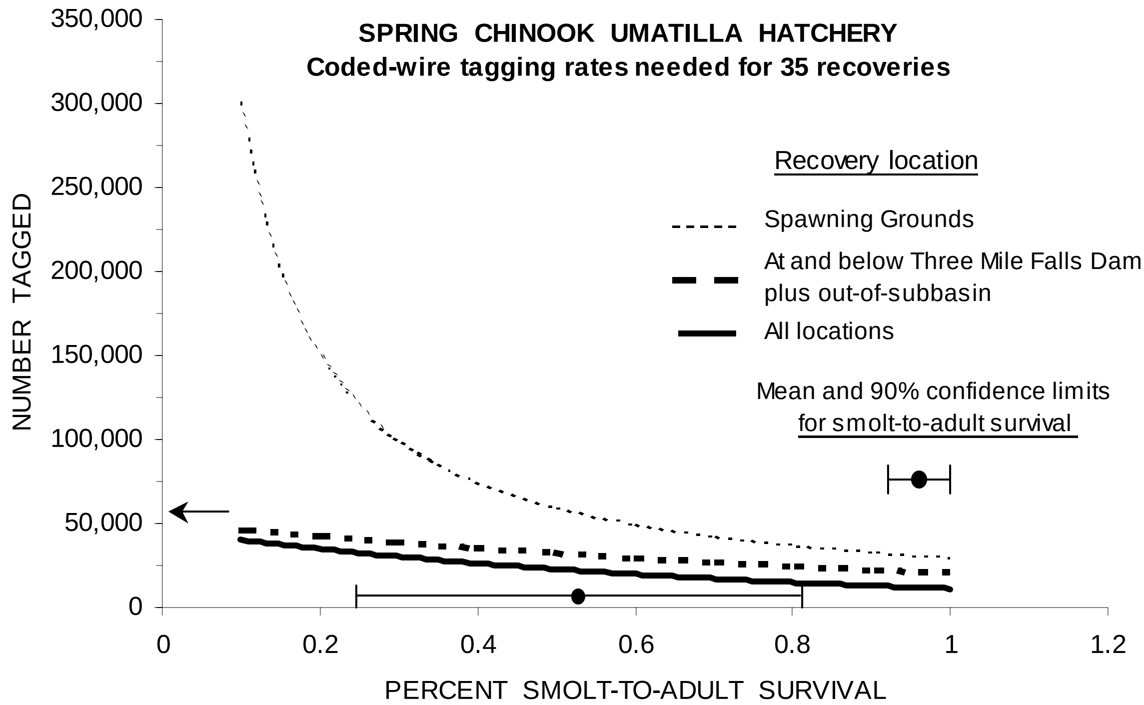


Figure CWT3. Coded-wire tagging rates at varying smolt-to-adult survival rates for steelhead reared at Umatilla Hatchery (per unique rearing/release group) required to recover 35 tags in the Umatilla River when trapping rate at Three Mile Falls Dam is 50%, 75%, and 100% of the run, and in the Upper Umatilla and Columbia river fisheries. Arrows indicate current coded-wire tagging rate.



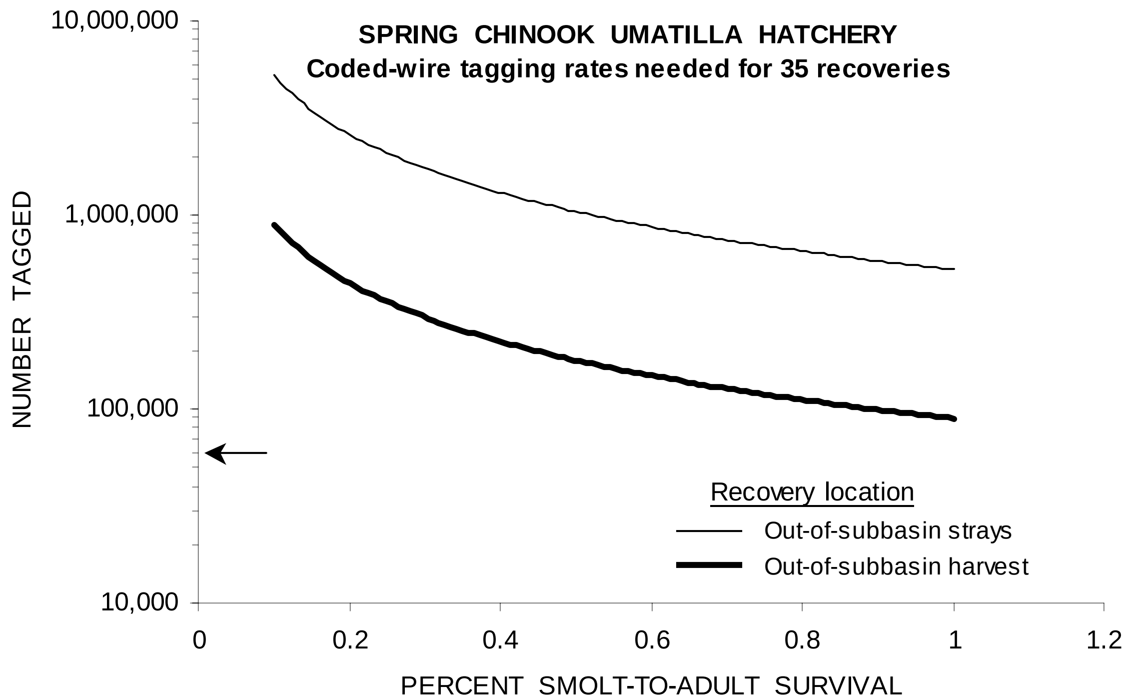


Figure CWT4. Coded-wire tagging rates at varying smolt-to-adult survival rates for spring Chinook reared at Umatilla Hatchery (per unique rearing/release group) required to recover 35 tags at varying locations. Recovery locations include the spawning grounds, out-of-subbasin strays and fisheries, at and below Three Mile Falls Dam plus out-of-subbasin locations, and all locations combined. Arrows indicate current coded-wire tagging rate.

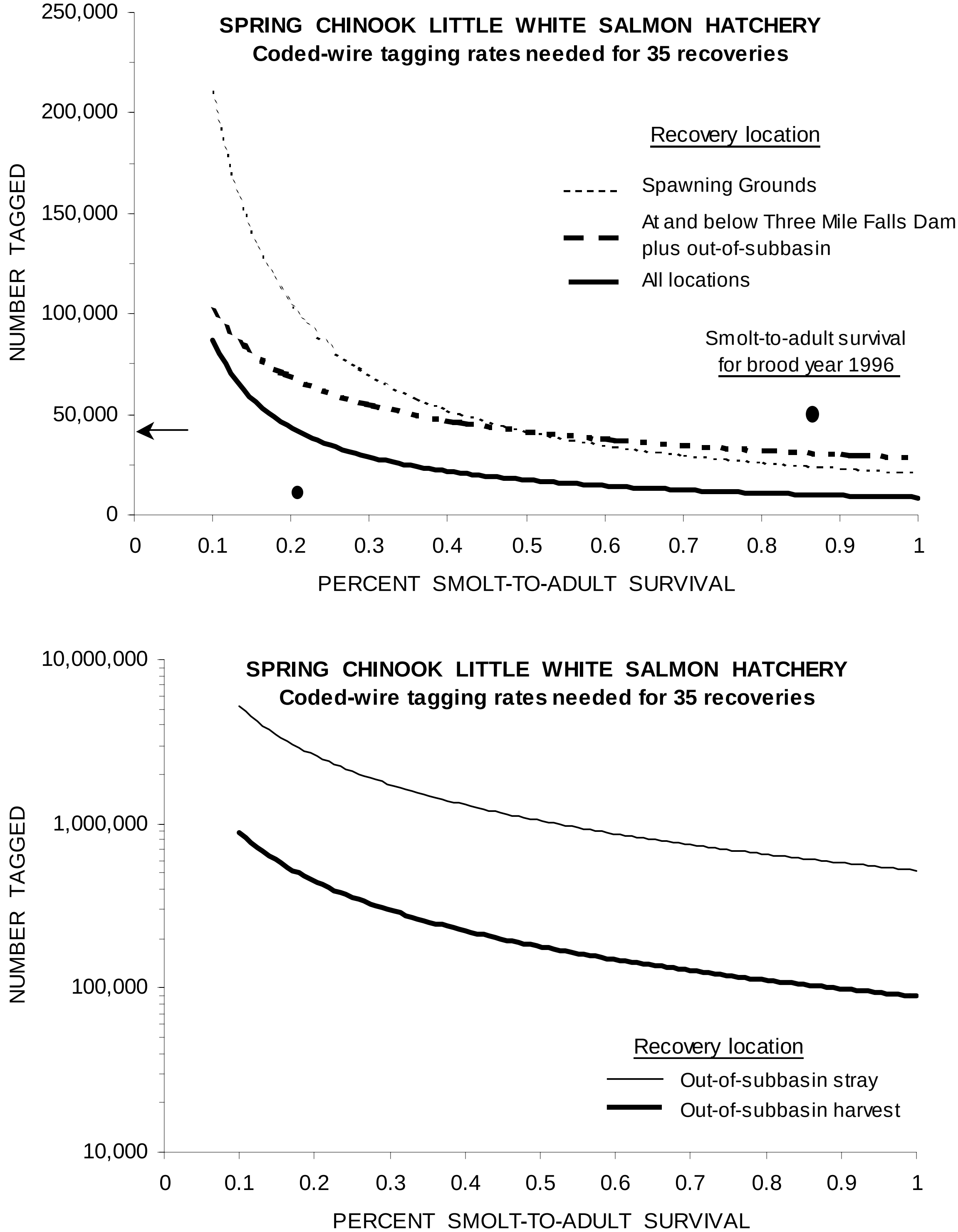


Figure CWT5. Coded-wire tagging rates at varying smolt-to-adult survival rates for spring Chinook reared at Little White Salmon Hatchery (per unique rearing/release group) required to recover 35 tags at varying locations. Recovery locations include the spawning grounds, out-of-subbasin strays and fisheries, at and below Three Mile Falls Dam plus out-of-subbasin locations, and all locations combined. Arrow indicates current coded-wire tagging rate.

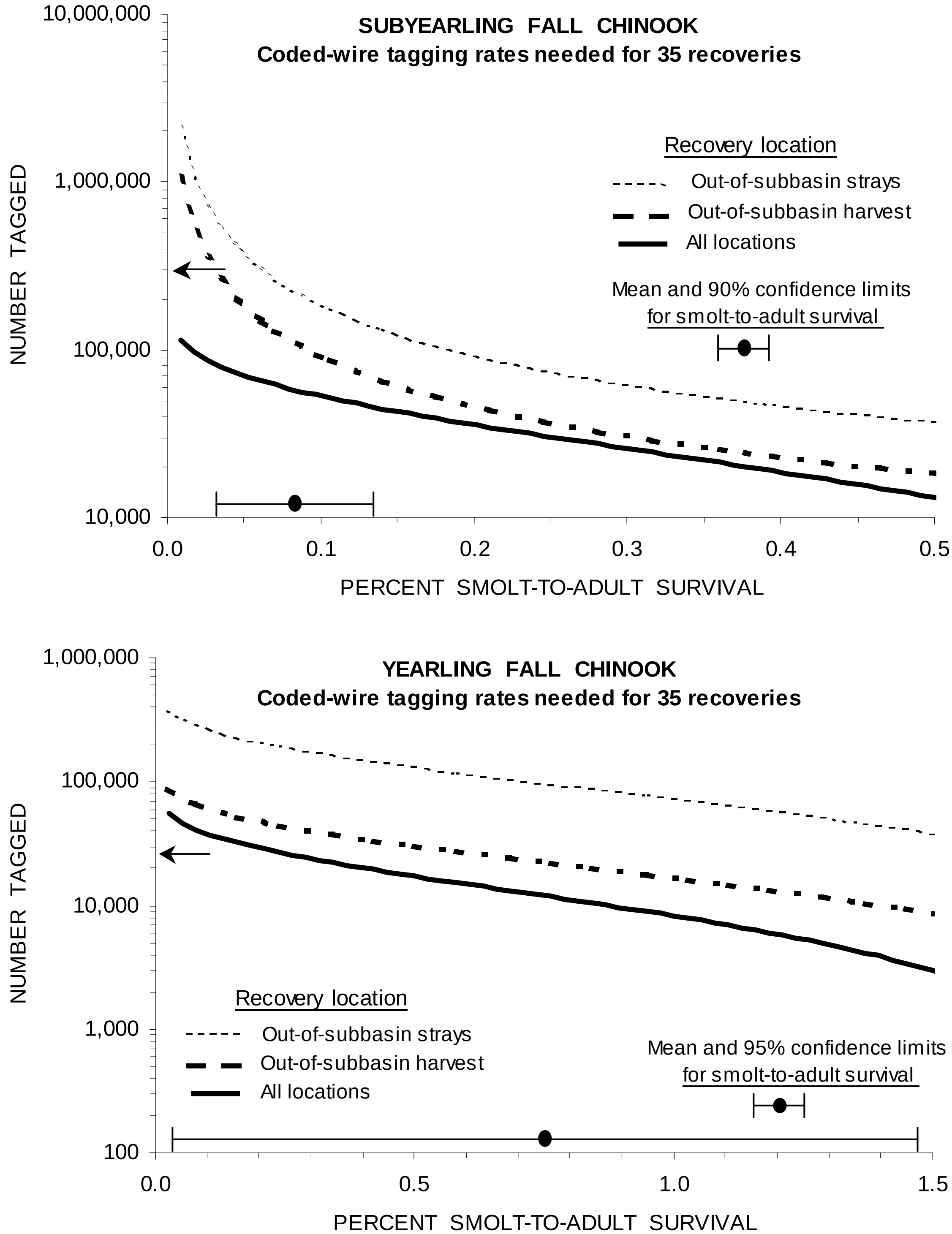


Figure CWT6. Coded-wire tagging rates at varying smolt-to-adult survival rates for fall Chinook reared at Umatilla Hatchery (per unique rearing/release group) required to recover 35 tags at varying locations. Recovery locations include out-of-subbasin strays and fisheries, and all locations combined. Arrows indicate current coded-wire tagging rate.

Table CWT1. Predicted coded-wire tagging rates required to obtain 35 tag recoveries at various sampling locations when smolt-to-adult survival is at the lower 90% and 95% confidence limit of the mean (90% L.C.L. and 95% L.C.L.).

Hatchery[a] - Production Group (Current no. CWT'ed)	Coded-wire tag recovery locations[b]: Trapping rate at Three Mile Falls Dam: 50% of run	75% of run	100% of run	Out-subbasin harvest	Upper Umatilla River harvest
UFH - Steelhead					
95% L.C.L.	48 K	36 K	28 K	181 K	4.0 M
90% L.C.L.	28 K	21 K	16 K	105 K	2.3 M
(20,000 CWT'ed)					
	All locations	Out-subbasin + at and below TMFD	Spawning grounds	Out-subbasin harvest	Out-subbasin strays
UFH - Spring Chinook					
95% L.C.L.	35 K	43 K	133 K		2.3 M
90% L.C.L.	35 K	43 K	108 K		1.9 M
0.5% SAS (fisheries open)				110 K	
(60,000 CWT'ed)					
LWSH - Spring Chinook					
Current survival	42 K	64 K	101 K	431 K	2.5 M
(40,000 CWT'ed)					
UFH - Subyearling fall Chinook					
95% L.C.L.	112 K			832 K	1.7 M
90% L.C.L.	79 K			262 K	528 K
(300,000 CWT'ed)					
BFH - Yearling fall Chinook					
95% L.C.L.	57 K			344 K	1.5 M
90% L.C.L.	30 K			64 K	279 K
(25,000 CWT'ed)					

[a] *CWT'ed = coded-wire tagged, UFH = Umatilla Hatchery, LWSH = Little White Salmon Hatchery, BFH = Bonneville Hatchery, SAS = smolt-to-adult survival.*
[b] *K = thousand, M = million.*

steelhead are adequate for years when the trapping rate at Three Mile Falls Dam is 75% and SAS is at or above the 90% lower confidence limit (LCL) for mean SAS. Trapping rate at Three Mile Falls Dam has averaged 70% with a low of 49%. However, trapping rates are adjusted inseason if monthly CWT collection goals are not expected to be met. Setting tagging rates according to the 90% LCL (0.23% SAS) would seem reasonable given observed SAS for steelhead reared at Umatilla Hatchery (Figure CWT2). Smolt production is too low to provide tagging rates required for comparison of harvest contributions in out-of-subbasin and upper Umatilla River fisheries between the hatchery groups. However, pooling CWT recoveries from the hatchery groups will provide adequate CWT recoveries to monitor harvest contributions in out-of-subbasin fisheries when SAS is > 0.4%. Current tagging rates for spring Chinook are adequate for monitoring SAS, but not for comparing contributions of the individual hatchery groups to spawning, or out-of-subbasin harvest and straying. The ISRP has repeatedly recommended monitoring all these fates for each hatchery production group in previous reviews of the Umatilla Hatchery Evaluation (ISRP 2001-8, ISRP 2003-10). Increasing coded-wire tagging to about 100,000 per hatchery group would allow comparison of spawner contributions for all hatchery groups and comparison of out-of-subbasin harvest for Umatilla Hatchery groups. Low numbers of CWT recoveries from out-of-basin strays result in unachievable tagging needs to monitor out-of-basin straying when SAS is low. Current tagging of subyearling fall Chinook hatchery groups is adequate to monitor SAS and out-of-subbasin harvest when SAS is at the 90% LCL, and out-of-subbasin strays when SAS is about 0.05%. Tagging rate of subyearlings can not be increased because all production is already CWT'ed. Current tagging of yearling fall Chinook is inadequate. Since yearlings are currently mass marked with a blank-wire tag, coded-wire tagging rates of this group could be increased at a minimal cost. If all production were CWT'ed, adequate numbers of CWT's could be recovered to monitor SAS, and out-of-subbasin harvest and strays. Monitoring out-of-subbasin straying of both subyearling and yearling fall chinook is an ESA BiOp mandate.

Computation of total adults produced, and harvest, natural spawning, and straying components

Total adults produced: Numbers of adults produced for a specific hatchery group and their final fate is calculated from CWT recovery data and associated marking rates reported on the PSMFC RMIS database. This database compiles CWT recoveries from multiple locations and entities. Individuals will report observed numbers of CWT's recovered by tag code for their location, and if known, an estimated total number of CWT'ed fish calculated by expanding observed recoveries by sampling rate of CWT'ed fish at that location. Total number of adults at a specific location are estimated by expanding total CWT recoveries for that location by an expansion factor that adjust for the proportion of marked to unmarked fish. Summing total number of adults from all locations provides an estimate of total numbers of adults produced for specific hatchery groups.

Harvest contributions: Harvest contributions are grouped by three main fishery areas: ocean, Columbia River, and in-subbasin fisheries. We will report number of adult harvested by individual hatchery groups and total numbers for all hatchery groups by run year. We will also maintain a database of recoveries by brood year contributions. More detailed breakdown of the three main fishery areas is as follows. We segregate ocean harvest by United States, Canadian, and tribal treaty commercial fisheries and provide a single category for all ocean sport fisheries. Categories of Columbia River fisheries include tribal commercial, tribal subsistence, non-tribal commercial, and non-tribal sport above and below Bonneville Dam. Categories for in-subbasin fisheries are tribal, lower-river non-tribal, and upper-river non-tribal. Computation of number of adults harvest by location and hatchery group are described above in "Total adults produced".

Spawners: Spawning contributions are calculated from CWT's recovered during spawning ground surveys. Spawning contributions can only be reported for spring Chinook, because few or no CWT's are recovered during steelhead and fall Chinook spawning ground surveys (We will increase fall Chinook carcass survey efforts, and should be able to get sufficient carcasses in coming years). Computation of number of adults contributing to spawning by hatchery group are described above in "Total adults produced". We will use graphic analysis to describe the distribution of CWT's recovered during spring Chinook spawning ground surveys. Spatial locations of CWT recoveries will correspond with river reaches used as sampling units in spawning ground surveys. We will only use CWT's recovered from female carcasses to describe spawner distribution since their carcasses are more likely to be recovered close to their spawning location, whereas this is less likely for male spawners. We will describe the following variations of spawner distributions for each hatchery group: successful spawners, prespawn mortalities, and age-at-return. Annual CWT recoveries for some locations and spawner categories will likely be low, therefore recoveries will be pooled across years or groups of years with similar environmental conditions.

Strays: Numbers of adults that are recovered at terminal locations outside of the Umatilla subbasin (spawning grounds, hatcheries, and adult traps) will be reported for the following four areas: Snake River Basin, Columbia River Basin above McNary Dam, Columbia River Basin below McNary Dam, and all other locations. Most out-of-subbasin strays are from our fall chinook hatchery program. No steelhead and few spring Chinook CWT's have been recovered at terminal locations to date.

Computation of smolt-to-adult survival: Percent SAS is reported for each hatchery group and all production combined. Percent survival is calculated as total adults produced time 100, divided by total number of smolts released. Computation of total numbers of adults produced are described above in "Total adults produced".

Umatilla River run composition monitoring: Rearing and release history of hatchery steelhead and Chinook returns to the Umatilla Subbasin is monitored using CWT's recovered from all locations within the subbasin, PIT-tag recoveries from mainstem and TMF dams, and scale analysis. Computation of total numbers of adults in the run by hatchery group are described above in "Total adults produced". A correction factor is applied to total numbers of adults for each hatchery group so that total numbers of adults from all hatchery groups equals total numbers of hatchery fish counted at Three Mile Falls Dam plus in-subbasin harvest below Three Mile Falls Dam. Applying this correction factor assumes the differences between the two estimates of total number of hatchery fish returning to the Umatilla Subbasin is attributable to sampling error rather than other factors such as unmarked production groups in the return. We are not able to directly test this assumption. However, if significant numbers of unmarked hatchery fish are in the return, hatchery run size would be consistently underestimated using the

CWT method, which is not the case. We can provide a gross description of arrival timing to Three Mile Falls Dam for the more abundant groups hatchery steelhead by pooling data over years. In particular, we will describe percent of return by month for hatchery groups released within the Umatilla Subbasin and the most prevalent hatchery groups released outside of the subbasin. Of particular regional interest is the identification of non-Umatilla origin hatchery groups that enter the Umatilla River in spring that will likely spawn with ESA listed Umatilla steelhead. It is questionable whether non-Umatilla origin steelhead observed in the lower Umatilla River (RM 3.7) in fall and early winter will remain and spawn in the subbasin or fall back out of the Umatilla Subbasin.

Life history monitoring: Life history information is obtained from several sources; from fish trapped at Three Mile Fall Dam, from CWT recoveries, from PIT-tag detections, from carcass surveys, and from scale analysis. Trap data is used for comparison of life history traits for hatchery-reared and natural-reared fish. However, CWT recoveries are the method used to obtain adult life history information individual hatchery groups. We pool CWT recoveries from all freshwater locations to describe age-at-return, size-at-return, and sex ratios by brood year for each hatchery group. Value of differences in life history traits expressed by hatchery groups will be assessed in terms of their effect on meeting management objectives for natural and hatchery production, harvest, minimizing impacts to natural populations.

Release Monitoring

All fish are forced out of the acclimation facilities by draining and seining them through the outlet. Fish are randomly sampled and 300 fork lengths (mm) and 100 weights (g), and condition factors (wieight/length^3*10^5) are determined. Smoltification and descaling were estimated from 100 randomly sampled fish from each acclimation pond. Each fish was judged to be smolted if parr marks were absent and body was silvery, intermediate if parr marks and silvery body was faded, or parr if parr marks were present and body was dull. Each fish was judged to be descaled if scales were more than 50% lacking on either side, partial if scales on either side were lacking between 25-50%, or no descaling if scales on either side were less than 25 % lacking

Pathology Monitoring

Detailed fish health sampling of hatchery production groups is outlined annually in the AOP (Umatilla Hatchery and Basin Annual Operation Plan 2004 and work statement). Fish that are removed from rearing facilities because they are dead or moribund will be temporarily frozen and examined monthly for fish pathogens. Routine health examinations will be conducted annually on grab-sampled fish before release at each facility. In addition a minimum of 60 spawning adults per stock (if available) and adult mortality will be tested as per AOP and work statement guidelines.

Brood

Hatchery Rearing

Smolt Release

In-stream

TableX. Performance metrics, spatial scale, sampling frequency, methods, and linkage to Umatilla Management and RM&E Objectives.

Performance Indicator	Life Stage	Performance Measure	Spatial Scale	Sampling Frequency	Method	Management Objective, Assumption and RM&E Objective
Abundance	Adult	Escapement to the Umatilla River	Subbasin	Annual	Visual observation and trapping	1a, 9b, 10a, 13a, 14a, 15a, 15b, 16a, and 16b
Abundance	Adult	Harvest	Subbasin	Annual	Creel surveys	13b2, 14a, 15a, 15b, 16a, and 16b
Abundance	Adult	Run to Three Mile Falls Dam	Watershed, release group, and subbasin	Annual	PIT-tagging	1a, 9a, 9b, 10a, 10b, 13a, 14a, 15a, 15b, 16a, and 16b
Abundance	Adult	Broodstock Collected	Subbasin	Annual	TMFD trap plus mainstem traps	1a, 9a, 14a, 15a, 15b, 16a, and 16b
Abundance	Adult	Spawner Escapement	Subbasin	Annual	Spawner surveys	1a, 3a, 5a, 3e, 4e, 12a, 14a, 15a, 15b, 16a, and 16b
Abundance	Adult	Spawner Abundance	Reach and Subbasin	Annual	Redd Counts	1b, 2b, 3a, 5b, 5a, 7b, 8a1, 8a2, 9a, 14a, 15a, 15b, 16a, and 16b
Abundance	Adult	Run Prediction	Subbasin	Annual	Modeling	1a, 13a, 14a, 15a, 15b, 16a, and 16b
Abundance	Juvenile	Fry Abundance	Reach	Annual	Emap surveys	1b, 2b, 14a, 15a, 15b, 16a, and 16b
Abundance	Juvenile	Parr and Pre-smolt Abundance	Reach	Annual	Emap surveys	1b, 2b, 1d, 14a, 15a, 15b, 16a, and 16b
Abundance	Juvenile	Smolt Abundance	Watershed and release group.	Annual	Trapping, outmigration monitoring	3a, 5a, 1c, 2b, 7a, 8a1, 8a2, 10b, and 12b

Performance Indicator	Life Stage	Performance Measure	Spatial Scale	Sampling Frequency	Method	Management Objective, Assumption and RM&E Objective
Abundance	Juvenile	Residual Abundance	Reach	Annual	Trapping	1b, 1d, 14a, 15a, 15b, 16a, and 16b
Survival and Productivity	Adult	Broodstock Survival	Subbasin	Annual	Hatchery M&E	2a, 7a, 6a, 6b, 14a, 15a, 15b, 16a, and 16b
		Harvest	Out-of-Subbasin	Annual	CWT analysis	7a, 13b2, 14a, 15a, 15b, 16a, and 16b
		Smolt-to-Adult Return	Subbasin and release group	Annual	PIT-tagging, CWT, and population modeling	3a, 5a, 7a, 14a, 15a, 15b, 16a, and 16b
		Smolt-to-Adult Survival	Subbasin and release group	Annual	PIT-tagging, CWT, modeling	2a, 3a, 5a, 7a, 7b, 8a1, 8a2, 14a, 15a, 15b, 16a, and 16b
		Parent Progeny Ratio	Subbasin and release group	Annual	PIT-tagging, CWT, modeling	3a, 5a, 7a, 14a, 15a, 15b, 16a, and 16b
		Pre-spawn Mortality	Reach	Annual	Spawner surveys	2a, 3a, 5a, 14a, 15a, 15b, 16a, and 16b
		Recruit per spawner	Subbasin and watershed	Annual	PIT-tagging, CWT, modeling, passage operations	3a, 5a, 7a, 14a, 15a, 15b, 16a, and 16b

Performance Indicator	Life Stage	Performance Measure	Spatial Scale	Sampling Frequency	Method	Management Objective, Assumption and RM&E Objective
Survival-Productivity	Juvenile	Egg to Fry Survival	Reach	Annual	Spawner surveys, juvenile surveys, modeling	2a, 2b, 14a, 15a, 15b, 16a, and 16b
		Fry to parr and parr to smolt survival	Reach and Subbasin	Annual	Spawner surveys, juvenile surveys, modeling	2a, 2b, 14a, 15a, 15b, 16a, and 16b
		Smolt Survival to Three Mile Falls Dam	Subbasin and release group	Annual	PIT-tagging, modeling	1c, 2a, 2b, 7a, and 10b, 14a, 15a, 15b, 16a, and 16b
		Smolt Survival through the Columbia River	Subbasin, watershed, and release group	Annual	PIT-tagging, modeling	1c, 2a, 7a, 14a, 15a, 15b, 16a, and 16b
Distribution and Movement	Adult	Spawner Spatial Distribution	Subbasin, watershed, and reach	Annual	Spawner surveys	1b, 3e, 4e, 5b, 14a, 15a, 15b, 16a, and 16b
		Stray Rate	Subbasin and release group	Annual	PIT-tagging, CWT	9b, 14a, 15a, 15b, 16a, and 16b
	Juvenile	Rearing Distribution	Subbasin, watershed, and reach	Annual	Juvenile surveys	1b, 14a, 15a, 15b, 16a, and 16b

Performance Indicator	Life Stage	Performance Measure	Spatial Scale	Sampling Frequency	Method	Management Objective, Assumption and RM&E Objective
Distribution and Movement	Juvenile	Residual Distribution	Reach	Annual	Trapping	1b, 14a, 15a, 15b, 16a, and 16b
Life History	Adult	Run Timing	Subbasin and release group	Annual	PIT-tagging, CWT, passage operations, run modeling	3b, 3e, 4e, 9a, 10a, 10b, 12a, 14a, 15a, 15b, 16a, and 16b
		Passage efficiency	Subbasin	Annual	Telemetry, passage operations	3b, 3e, 14a, 15a, 15b, 16a, and 16b
		Age at Return	Subbasin and watershed	Annual	Passage operations, age and growth, CWT, PIT-tagging	3b, 7b, 14a, 15a, 15b, 16a, and 16b
		Size at Return	Subbasin and watershed	Annual	Passage operations, spawner surveys	3b, 14a, 15a, 15b, 16a, and 16b
		Sex Ratio at Return	Subbasin and watershed	Annual	Passage operations, PIT-tagging, spawner surveys	3b, 14a, 15a, 15b, 16a, and 16b
		Fecundity	Subbasin	Annual	Hatchery M&E	9a, 14a, 15a, 15b, 16a, and 16b
		Spawn-timing	Subbasin and watershed	Annual	Spawner surveys	3b, 5b, 14a, 15a, 15b, 16a, and 16b
	Juvenile	Size at Release	Release group	Annual	Hatchery M&E	1c, 14a, 15a, 15b, 16a, and 16b
		Release Location	Release group	Annual	Hatchery M&E	1c, 14a, 15a, 15b, 16a, and 16b
		Emigration Timing	Subbasin, watershed, and release group	Annual	PIT-tagging, outmigration monitoring	1c, 3b, 10b, 12a, 12b, 14a, 15a, 15b, 16a, and 16b

Performance Indicator	Life Stage	Performance Measure	Spatial Scale	Sampling Frequency	Method	Management Objective, Assumption and RM&E Objective
Life History	Juvenile	Age at Emigration	Subbasin, watershed, and release group	Annual	Trapping, outmigration monitoring	1c, 3b, 14a, 15a, 15b, 16a, and 16b
		Size at Emigration	Subbasin, watershed, and release group	Annual	Trapping, outmigration monitoring	1c, 3b, 14a, 15a, 15b, 16a, and 16b
		Condition at Emigration	Subbasin, watershed, and release group	Annual	Trapping, Outmigration monitoring	1c, 3b, 14a, 15a, 15b, 16a, and 16b
Fish Health	Adult and Juvenile	Disease Incidence	Subbasin and watershed	Annual	Pathology	1c, 6b, 9c, 14a, 15a, 15b, 16a, and 16b
		Disease Severity	Subbasin and watershed	Annual	Pathology	1c, 6b, 9c, 14a, 15a, 15b, 16a, and 16b
Genetic	Adult and Juvenile	Genetic Diversity and Integrity	Subbasin and watershed	Annual (two 5 year cycles)	Juvenile surveys, passage operations, molecular studies	3c, 3d, 3f, 9a, 14a, 15a, 15b, 16a, and 16b

Performance Indicator	Life Stage	Performance Measure	Spatial Scale	Sampling Frequency	Method	Management Objective, Assumption and RM&E Objective
Genetics	Adult and Juvenile	Reproductive Success	Subbasin and watershed	Annual (5 year cycle)	Juvenile surveys, passage operations, molecular studies	3d, 3f, 14a, 15a, 15b, 16a, and 16b
		Effective Population Size	Subbasin, watershed	Annual (two 5 year cycles)	Juvenile surveys, passage operations, molecular studies	3c, 14a, 15a, 15b, 16a, and 16b
Fisheries	Adult	Spatial and temporal amount of Catch & Effort	Subbasin	Annual	Harvest monitoring	13b1, 14a, 15a, 15b, 16a, and 16b
		Gear types	Subbasin	Annual	Harvest monitoring	13b1, 14a, 15a, 15b, 16a, and 16b
		Angler demographics	Subbasin	Annual	Harvest monitoring	13b1, 14a, 15a, 15b, 16a, and 16b
Habitat	Adult and Juvenile	Instream flow	Subbasin and reach	Continual	Gauge stations	1e, 10a, 10b, 12a, and 12b, 14a, 15a, 15b, 16a, and 16b
		Water temperature	Subbasin and reach	Continual	Water quality monitoring	1e, 10a, 10b, 14a, 15a, 15b, 16a, and 16b
		Water quality	Subbasin and reach	Annual	Water quality monitoring	1e1, , 15a, 15b, 16a, and 16b
		Physical habitat conditions	Reach	Every 10 years	Habitat surveys	1e, 2b, 14a, 15a, 15b, 16a, and 16b
		Biological habitat conditions	Reach	Every 10 years	Habitat surveys	1e, 2b, 14a, 15a, 15b, 16a, and 16b

Performance Indicator	Life Stage	Performance Measure	Spatial Scale	Sampling Frequency	Method	Management Objective, Assumption and RM&E Objective
Habitat	Adult and Juvenile	Habitat Quantity	Reach	Every 10 years	Habitat surveys	1e, 2b, 11a, 14a, 15a, 15b, 16a, and 16b
		Passage barriers and diversions	Reach	Every 10 years	Telemetrey, passage operations	1e, 14a, 15a, 15b, 16a, and 16b
		Habitat utilization	Reach and watershed	Annual	Juvenile surveys, spawner surveys	1e, 14a, 15a, 15b, 16a, and 16b
		Smolt production of habitat	Reach and watershed	Annual	Juvenile surveys, PIT-tagging,	1e, 2b, 3e, 11a, 14a, 15a, 15b, 16a, and 16b
Ecosystem	Juvenile and Adult	Trophic relationships	Reach and watershed		Juvenile surveys, spawner surveys, stable isotope studies, modeling	1e, 12b, 14a, 15a, 15b, 16a, and 16b
		Competition	Reach and watershed		Juvenile surveys, spawner surveys, stable isotope studies, modeling	1f, 2c, 3g, 5c, 14a, 15a, 15b, 16a, and 16b
		Natural mortality	Reach and watershed		Juvenile surveys, spawner surveys, stable isotope studies, modeling	1f, 2c, 3g, 5c, 14a, 15a, 15b, 16a, and 16b
		Marine ecology	Out of basin		New project	1f, 2c, 3g, 5c, 14a, 15a, 15b, 16a, and 16b

Performance Indicator	Life Stage	Performance Measure	Spatial Scale	Sampling Frequency	Method	Management Objective, Assumption and RM&E Objective
		Redd impacts	Reach and watershed		Spawner surveys, stable isotope studies, modeling	1f, 2c, 3g, 5c, 14a, 15a, 15b, 16a, and 16b
		Carcass impacts	Reach and watershed		Spawner surveys, stable isotope studies, modeling	1f, 2c, 3g, 5c, 14a, 15a, 15b, 16a, and 16b

STATUS AND PRIORITIZATION

Prioritization can be expressed at multiple scales within the management processes. We can set priorities for the management objectives down to the performance measures that we quantify (i.e. what data is accurately collected). It is unlikely that we will acquire the resources necessary to implement all of the monitoring and evaluation activities identified in the plan. However, we believe the goals are important regardless of our ability to achieve all of the objectives. The prioritization scheme identifies all of the activities according to current status, relative importance and ability to provide the most useful information. Performance measures will be prioritized into three levels (essential, recommended, and low importance). Considerations during ranking will include:

- Position within the overall management list
- Multifunction of performance measures. This is best portrayed in Appendix Table C as the relative number of monitoring and evaluation objectives that require a specific performance measure.
- Spatial scale of application appropriate at only the local population or regionally useful (tributary specific versus basin).
- Ability and appropriateness to use surrogate information;
    - Small-scale studies,
    - Basin wide average or index,
    - Published/literature demonstrated processes,
    - Hatchery surrogates
- Number of focal ESA species present.
- Cost/infrastructure required to address the objective and collect the data

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II. Terrestrial Wildlife Research, Monitoring, and Evaluation Plan

UMATILLA/WILLOW SUBBASIN MANAGEMENT PLAN FOR TERRESTRIAL RESEARCH, MONITORING AND EVALUATION

INTRODUCTION

The following plan was developed by the Umatilla/Willow Basin Terrestrial Technical Team through the adaptation of the Draft Terrestrial Research Monitoring and Evaluation plan for the SE Washington Ecoregion (Ashley and Stovel, 2004) and the Draft Monitoring and Evaluation Plan for The Albeni Falls Wildlife Mitigation Project, (Albeni Falls Work Group, August 2001). These two products were considered by the planners in the Subbasin to be the best representation of terrestrial R, M and E planning in the Columbia Basin to date. Subbasin planners in the Region understand the importance of consistency in application of common monitoring and evaluation tools to inform the larger landscape level management decisions. Planners expect to continue to work at the regional level to reach the goal of common standards for terrestrial R, M and E and to modify this plan to meet those standards once they are established. A summary of other ongoing R, M and E efforts in the subbasin is found at the end of this document.

The process used to develop wildlife assessments and management plan objectives and strategies was based on the need for a landscape level holistic approach to protecting the full range of biological diversity at the Province scale. Attention was focused on the size and condition of core habitat areas at a subbasin scale, maintaining physical connections between core areas, and providing buffer zones surrounding core areas to ameliorate impacts from incompatible land uses. As most wildlife populations extend beyond subbasin or other political boundaries, this “conservation network” must contain habitat of sufficient extent, quality, and connectivity to ensure long-term viability of obligate/focal wildlife species. Subbasin planners recognized the need for large-scale planning that would lead to effective and efficient conservation of wildlife resources.

In developing Subbasin plans, managers made the following assumptions which served to focus planning efforts:

1. Planners assumed that by focusing resources primarily on generalized focal habitats, the needs of most listed and managed terrestrial and aquatic species would be addressed during this planning period. As more detailed data becomes available on specific habitat conditions and distributions, additional habitats and species assemblages will be addressed as needed in plan updates.
2. It was assumed that focal and other obligate species requirements can be used to guide ecosystem management. The main premise is that the requirements of an obligate focal species or demanding focal species/assemblage encapsulate those of many co-occurring less demanding species. This assumption guided selection of the

subbasin focal wildlife species. While the planners tried to limit the number of focal species in the plan, they used existing species assemblage information and multi species databases to support the monitoring efforts. These focal and other obligate species population trends may be monitored and evaluated over time. Focal habitats are functional if a focal and other obligate species recommended management conditions are achieved.

3. For purposes of development of habitat objectives and strategies, focal species assemblages adequately represent focal habitats. However, planners recognized that the development of multi species data bases, such as IBIS, provide for a more complex species/habitat assessment than has been practical in the past. This lessens the need for single species or guild assessments to represent a range of desired management issues for each focal habitat within the subbasins. Additionally, application of general trend monitoring for land birds, herptofauna, small mammals and plant communities can help inform managers on landscape level ecological changes that may not be captured through monitoring of focal species and habitats at a project level. The results of these species monitoring and evaluation efforts are expected to function as potential performance measures to monitor and evaluate the results of implementing future management strategies and actions on focal habitats.

Working hypotheses for focal habitat types were developed based on factors that affect focal habitats (the term, "factors that affect habitat" is synonymous with "limiting factors" for wildlife species). Working hypotheses are statements that assist subbasin planners and their communities to clearly articulate a program aimed at addressing the most pressing needs in a given area. The basis for the hypothesis is the proximate or major factors affecting focal habitats as described within individual subbasin assessments. The relationship subbasin planners attempted to address is that between management objectives, strategies or actions, and recommended (desired future) focal habitat conditions necessary to meet habitat and/or wildlife objectives and goals. These relationships are tested through implementation, followed by monitoring and evaluation. Ultimately, adaptive management is used to respond to the outcomes of these "tests" of "working hypotheses."

The assessment and inventory synthesis cycle is illustrated in Figure 1. Movement through the cycle is summarized below:

1. Document and compare historic and current conditions of focal habitats to determine the extent of change.
2. Review habitat needs of focal and other obligate wildlife species/assemblages to assist in characterizing the "range" of recommended future conditions for focal habitats. Combine species habitat needs with desired ecological/habitat objectives to determine recommended future habitat conditions.
3. Determine the factors that affect habitat conditions and species (limiting factors) and compare to current and recommended future habitat conditions to establish needed future action/direction.
4. Develop strategies to address habitat "needs" and identify "road blocks" to obtaining biological goals.

5. Review strategies and compare to existing projects, programs, and regulatory statutes (Inventory) to determine the level at which existing inventory activities address, or contribute towards amelioration of factors that affect habitat conditions and species assemblages.
6. Develop goals and objectives to address strategies that define the key components of the management plan.

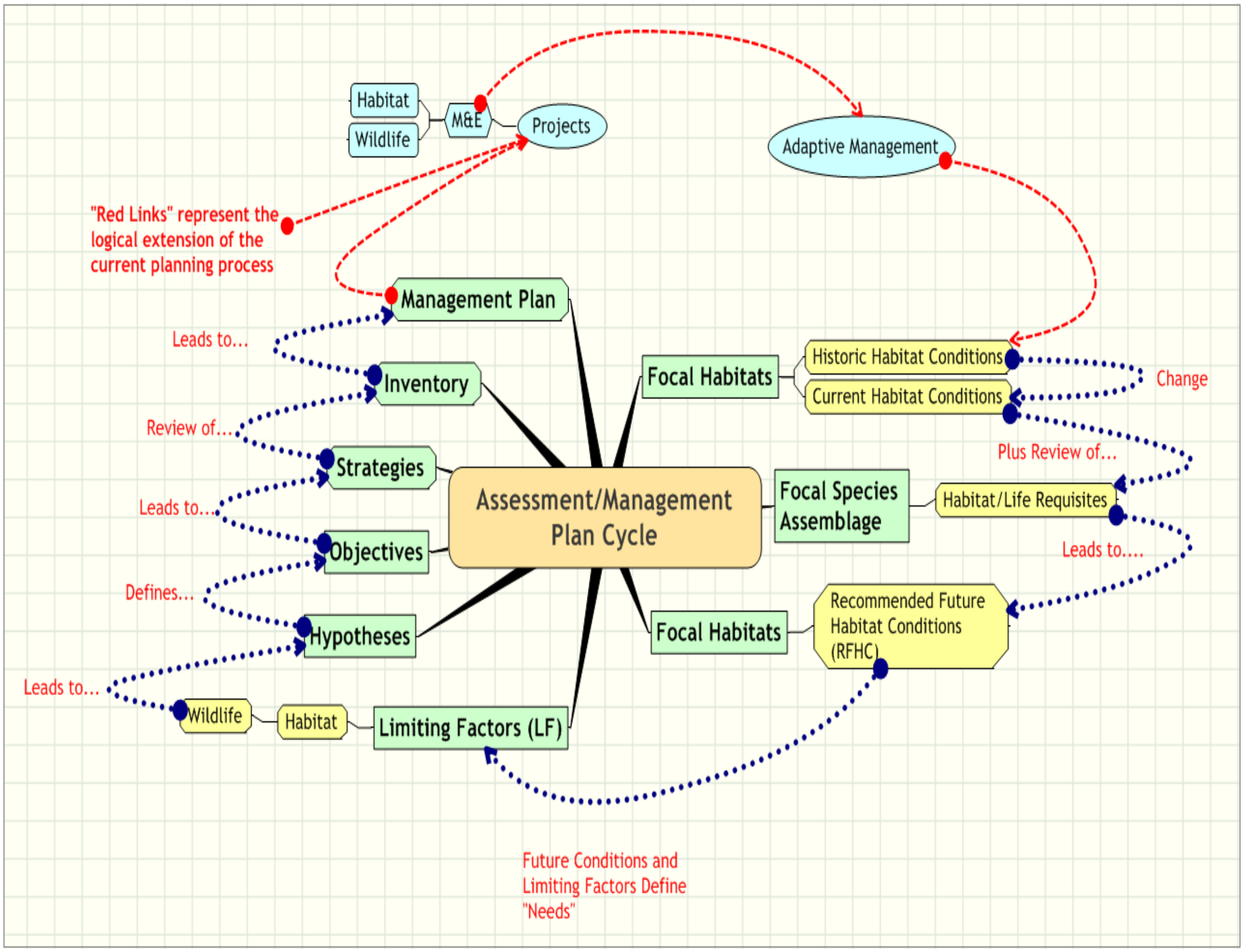

Figure 1. Assessment and Inventory Synthesis Cycle

Post subbasin planning algorithms (Research, Monitoring and Evaluation) are described in 7 through 9 below.

7. Projects are approved, based on management plan strategies, goals, and objectives, and implemented.
8. Habitat and species response to habitat changes are monitored at the project level and compared to anticipated results.
9. Adaptive management principles are applied as needed, which leads back to the "new" current conditions restarting the cycle.

The Research Monitoring and Evaluation (RME) Plan lays out the framework that will allow for evaluation of the efficacy of employed strategies in achieving corresponding focal habitat objectives for the subbasin, as per post subbasin planning algorithms 8 and 9. The RME plan emphasizes cooperative efforts among managers and stakeholders, and is designed to:

- evaluate success of focal habitat management strategies, via monitoring of focal wildlife species (The results of focal species monitoring and evaluation efforts are expected to function as potential performance measures to monitor and evaluate the results of implementing management strategies and actions on focal habitats).

- determine if management strategies undertaken are achieving recommended range of habitat management conditions, via monitoring and assessment of habitat conditions over time

- allow for evaluation of the assumptions and working hypotheses upon which the management plan is based, by determining if a correlation does indeed exist between focal habitat management conditions and focal species population trends

- Finally, the Adaptive Management portion of this REM plan outlines a strategy that will allow managers to adjust and/or focus management activities within the subbasin, based upon monitoring and evaluation data. The feedback loop thus formed will facilitate development of future iterations of the subbasin management plan.

The RME plan, as presented, consists of a variety of quantitative elements, ranging from scientific wildlife and vegetation surveys, spatial analyses of project location and acreage, to simple enumeration of land use projects/regulations commented upon by cooperating agencies. Summaries of other ongoing R, M and E activities in the basin that are not focused on subbasin planning under the NPCC Fish and Wildlife Program are appended for informational purposes.

Implementation of the Subbasin Plans is ultimately the responsibility of all managers and stakeholders who participated in its development. It is recommended that this group form an "Implementation Oversight Committee", to track and guide research, monitoring and reporting activities included in the plan.

Monitoring can be conducted at three qualitative levels of intensity:

Tier 1 (trend or routine) monitoring obtains repeated measurements, usually representing a single spatial unit over a period of time, with a view to quantifying changes over time. Changes must be distinguished from background noise. In general, Tier 1 monitoring does not establish cause and effect relationships (i.e., is not research) and does not provide statistical inductive inferences to larger areas or time periods (ISRP 2003). On a programmatic scale (the NPPC Fish and Wildlife Program) we believe that

HEP analysis (U.S. Fish and Wildlife Service 1980a) falls into this category. Particularly for projects that endeavor to mitigate a finite ledger of HUs associated with losses from a specific hydropower project, HEP adequately meets the monitoring needs, at a programmatic level, to ensure mitigation goals are being achieved. Consequently, HEP will remain an integral part of our overall monitoring strategy. Modern GIS will be used to geo-reference Tier 1 data.

Tier 2 (statistical) monitoring provides statistical inferences to parameters in the study area as measured by certain data collection protocols (i.e., the methods in a report). These inferences apply to areas larger than the sampled sites and to time periods not studied. The inferences require both probabilistic selection of study sites and repeated visits over time. Individual proposals can support larger Tier 2 statistical monitoring projects such as the Oregon Plan by using the same field methods and methods to select study sites that contribute information to Tier 2 statistical monitoring. Most large projects should implement sampling designs that allow Tier 2 statistical monitoring or contribute data to statistical monitoring (ISRP, Comments on the Clearwater Plan, 2003). Most of the methods outlined in the M&E plan fall into this level of monitoring. A purposeful effort was made to select methods that are widely employed in field biology or to adopt appropriate monitoring protocols from national monitoring programs to maximize the utility of the data collected.

Tier 3 (research) monitoring is for those projects or groups of projects whose objectives include establishment of mechanistic links between management actions and salmon or other fish or wildlife population response. Tier 3 research monitoring requires the use of experimental designs incorporating “treatments” and “controls” randomly assigned to study sites (ISRP 2003).

RESEARCH, MONITORING AND EVALUATION PLAN

Organization of the RME plan is as follows:

Existing Data Gaps and Research Needs

- Existing Data Gaps, as identified through the subbasin planning process, are listed in this section, because many will require effort above routine monitoring and evaluation to address.
- Research needs, with justification, are also listed. Detailed research project design is not presented, however, being beyond the scope of the current planning effort

Monitoring and Evaluation: Ecological Trend, Focal Habitats and Species Monitoring Methodology

- Ecological Trend Monitoring (Plant Community, Land Birds, Herptofauna, Small Mammals)
- Focal habitat monitoring methodology, and Management Plan strategies addressed
- Focal species monitoring methodology, and Management Plan strategies addressed

- Other Research, Monitoring and Evaluation Efforts in the Subbasin including those from managed species plans.

EXISTING DATA GAPS AND RESEARCH NEEDS

In the course of subbasin plan development, a number of data gaps were identified. Some of these gaps will be filled as data is collected via the monitoring and evaluation process as the plan is implemented. Others will require formal research efforts to address. Data gaps and research needs identified during development of the subbasin plan are listed in Table 1.

As part of the adaptive management philosophy of subbasin planning, managers believe that additional research needs not yet identified will become apparent over time. These needs will be addressed in future subbasin plan iterations.

Table 1. Data Gaps and Research Needs, Umatilla/Willow Subbasin, as identified during subbasin planning.

GENERAL		
RESEARCH NEEDS AND DATA GAPS	**STRATEGY TO ADDRESS**	**AGENCY/ PERSONNE L**
Testing of assumption that focal habitats are functional if a focal species assemblage's recommended management conditions are achieved		Coordinated government & NGO effort
Testing of assumption that selected focal or other obligate species/assemblages adequately represent focal habitats		Coordinated government & NGO effort
Current, broad-scale, high quality habitat data including structural KEC data	Spatial data collection and GIS analysis	Coordinated government & NGO effort
Accurate habitat type maps are needed to improve assessment quality and support management strategies and actions, including, updated and fine resolution historic/current data, current CREP, WHIP program/field delineations and GIS products e.g., structural conditions and KEC ground-truthed maps	Coordinated, standardized monitoring efforts; Spatial data collection and GIS analysis	Subbasin managers
Refinement of recommended management conditions for all habitats	Research need; use for update to future subbasin plan iterations	Coordinated government & NGO effort.
Local population/distribution data for focal species	Species Monitoring,	Subbasin managers

Evaluate the role of management treatments to maintain/improve habitat quality	Spatial data collection, and GIS analysis Coordinated, standardized monitoring efforts	Subbasin managers

Ponderosa Pine

- Obtain data on the quality of ponderosa pine habitat in the Umatilla/Willow subbasin, including data on structural state, seral stage, and ecological function as related to the White-headed Woodpecker and other obligate species. Use these data to improve existing information on habitat suitability for the White-headed Woodpecker (see Section 3.2.4.1).
- Refine and field-truth data on the location, size, spatial distribution, ownership, and protected status of ponderosa pine.
- Identify areas that could be converted to ponderosa pine habitat to enlarge habitat patches, provide new reservoir habitat, or enhance connectivity between two or more extant patches.
- Generate population and distribution data for the White-headed Woodpecker and other species associated with ponderosa pine.
- Determine the amount of good quality ponderosa pine habitat needed to support viable populations of the White-headed Woodpecker in the subbasin.

Quaking Aspen

- Gather comprehensive data on the location, size, spatial distribution, ownership, and protected status of quaking aspen in the subbasin.
- Obtain data on the quality of quaking aspen habitat in the Umatilla/Willow subbasin, including data on ecological function as related to the Red-naped Sapsucker and other obligate species. Use these data to improve existing information on habitat suitability for the Red-naped Sapsucker (see Section 3.2.4.1).
- Identify areas in the subbasin that could be converted to quaking aspen habitat to enlarge habitat remnants, provide new reservoir habitat, or enhance connectivity between two or more extant remnants.
- Generate population and distribution data for the Red-naped Sapsucker and other species associated with quaking aspen.
- Determine the amount of good quality quaking aspen habitat needed to support viable populations of the Red-naped Sapsucker in the subbasin.

Western Juniper Woodland

- Gather comprehensive data on the location, size, spatial distribution, ownership, and protected status of western juniper in the subbasin.
- Obtain data on the quality of western juniper habitat in the Umatilla/Willow subbasin, including data on its ecological function as related to the Ferruginous Hawk and its prey and other obligate species. Use these data to refine existing information on habitat suitability for Ferruginous Hawk (see Section 3.2.4.1).

- Identify areas that could be converted to western juniper habitat to enlarge habitat remnants, provide new reservoir habitat, or enhance connectivity between two or more extant remnants.
- Generate population and distribution data for the Ferruginous Hawk, it prey, and other species associated with western juniper.
- Determine the amount of good quality western juniper habitat needed to support viable populations of the Ferruginous Hawk in the subbasin.

Shrub-steppe

- Obtain data on the quality of shrub-steppe habitat in the Umatilla/Willow subbasin, including data on ecological function as related to the Sage Sparrow and other obligate species. Use these data to improve existing information on habitat suitability for the Sage Sparrow (see Section 3.2.4.1).
- Reconcile differences between IBIS and other data with regard to the total acreage and distribution of shrub-steppe habitat in the subbasin, and refine and field-truth data on ownership and protected status of shrub-steppe in the subbasin.
- Identify areas in the subbasin that could be converted to shrub-steppe habitat to enlarge habitat remnants, provide new reservoir habitat, or enhance connectivity between two or more extant remnants.
- Generate population and distribution data for the Sage Sparrow and other species associated with shrub-steppe in the Umatilla/Willow subbasin.
- Determine the amount of good quality shrub-steppe habitat needed to support viable populations of the Sage Sparrow in the subbasin.

Interior Grassland

- Obtain data on the quality of grassland habitat in the Umatilla/Willow subbasin, including data on ecological function as related to the Grasshopper Sparrow and other obligate species. Use these data to refine existing information on habitat suitability for the Grasshopper Sparrow (see Section 3.2.4.1).
- Refine and field-truth data on the location, size, spatial distribution, ownership, and protected status of grassland in the subbasin.
- Identify areas in the subbasin that could be converted to grassland habitat to enlarge habitat patches, provide new reservoir habitat, or enhance connectivity between two or more extant patches.
- Generate population and distribution data for the Grasshopper Sparrow and other species associated with grassland in the Umatilla/Willow subbasin.
- Determine the amount of good quality grassland habitat needed to support viable populations of the Grasshopper Sparrow in the subbasin.

Herbaceous Wetlands

- Obtain data on the quality of herbaceous wetland habitat in the Umatilla/Willow subbasin, including data on ecological function as related to the Columbia spotted frog and other obligate species.
- Refine and field-truth data on the location, size, spatial distribution, ownership, and protected status of herbaceous wetlands in the subbasin.

- Identify areas in the subbasin that could be converted to herbaceous wetland habitat to enlarge existing wetlands, provide new reservoir habitat, or enhance connectivity between two or more extant wetlands.
- Generate population and distribution data for the Columbia spotted frog and other species associated with herbaceous wetlands in the Umatilla/Willow subbasin.
- Determine the amount of good quality herbaceous wetland habitat needed to support viable populations of the Columbia spotted frog in the subbasin.

Riparian Wetlands

- Supplement, refine, and field-truth existing data on the location, size, spatial distribution, and protected status of riparian wetlands in the subbasin. Reconcile differences in estimates of ownership of riparian wetlands in the subbasin.
- Obtain data on the quality of riparian wetland habitat in the Umatilla/Willow subbasin, including data on ecological function as related to the Great Blue Heron, the Yellow Warbler, and the American beaver and other obligate species. Use these data to create maps of habitat suitability for the Great Blue Heron, the Yellow Warbler, and the American beaver.
- Identify areas in the subbasin that could be converted to riparian wetland habitat to enlarge habitat patches, provide new reservoir habitat, or enhance connectivity between two or more extant patches.
- Generate population and distribution data for the Great Blue Heron, Yellow Warbler, and American beaver and other species associated with riparian wetland in the Umatilla/Willow subbasin.
- Determine the amount of good quality riparian wetland habitat needed to support viable populations of the Great Blue Heron, Yellow Warbler, and American beaver in the subbasin.

MONITORING AND EVALUATION: ECOLOGICAL TREND, FOCAL HABITAT, AND SPECIES MONITORING METHODOLOGY

Recommended monitoring and evaluation strategies contained below for each focal habitat type, including sampling and data analysis and storage, are derived from national standards established by Partners in Flight for avian species (Ralph et al, 1993, 1995) and habitat monitoring (Nott et al, 2003). In addition, protocols for specific vegetation monitoring/sampling methodologies are drawn from USDA Habitat Evaluation Procedure standards (USFWS 1980a and 1980b) and Sampling Vegetation for Monitoring Plant Communities (Johnson, C.G. Jr., USDA Forest Service, Area 3 – Malheur, Umatilla, and Wallowa-Whitman National Forests, May 1998).

A common thread in the monitoring strategies which follow is the establishment of permanent roadside and off-road census stations to monitor bird population and habitat changes (See Land Bird Monitoring Section Below), small mammal census to track abundance, diversity and trends (see Small Mammal Monitoring Section below), herptofauna census to track presence/absence and abundance (see Herptofauna Monitoring section below).

Wildlife managers will include statically rigorous sampling methods to establish links between
habitat enhancement prescriptions, changes in habitat conditions and target wildlife population
responses at the project level.

Specific methodology for selection of Project Level Monitoring and Evaluation sites within all focal habitat types follows a probabilistic (statistical) sampling procedure, allowing for statistical inferences to be made within the area of interest. The following protocols describe how M&E sites will be selected:

- Vegetation/HEP monitoring and evaluation sites are selected by combining stratified random sampling elements with systematic sampling. Project sites are stratified by cover types (strata) to provide homogeneity within strata, which tends to reduce the standard error, allows for use of different sampling techniques between strata, improves precision, and allows for optimal allocation of sampling effort resulting in possible cost savings (Block et al. 2001). Macro cover types such as shrub-steppe and forest are further sub-cover typed based on dominant vegetation features i.e., percent shrub cover, percent tree cover, and/or deciduous versus evergreen shrubs and conifer versus deciduous forest. Cover type designations and maps are validated prior to conducting surveys in order to reduce sampling inaccuracies.

- Pilot studies are conducted to estimate the sample size needed for a 95% confidence level with a 10% tolerable error level (Avery 1975) and to determine the most appropriate sampling unit for the habitat variable of interest (BLM 1998). In addition, a power analysis is conducted on pilot study data (and periodically throughout data collection) to ensure that sample sizes are sufficient to identify a minimal detectable change of 20% in the variable of interest with a Type I error rate # 0.10 and P = 0.9 (BLM 1998, Hintze 1999, Block et al. 2001). M&E includes habitat trend condition monitoring on the landscape scale (Tier 1-HEP) and plant community monitoring (Tier 2) i.e., measuring changes in vegetative communities on specific sites.

- For HEP surveys, specific transect locations within strata are determined by placing a Universal Transverse Mercator (UTM) grid over the study area (strata) and randomly selecting “X” and “Y” coordinates to designate transect start points. Random transect azimuths are chosen from a computer generated random number program, or from a standard random number table. Data points and micro plots are systematically placed along the line intercept transect at assigned intervals as described in Part 2 – monitoring section of the proposal. Sample sizes for statistical inferences are determined by replication and systematic placement of lines of intercept within the strata with sufficient distance between the lines to assume independence and to provide uniform coverage over the study site.

- Permanent vegetation monitoring transect locations are determined by placing a UTM grid over the strata and randomly selecting “X” and “Y” coordinates to designate plot locations as described for HEP surveys. One hundred meter baseline transect azimuths are randomly selected from a random numbers table. Ten perpendicular 30 meter transects are established at 10 meter intervals along the baseline transect to form a 100m x 30m rectangle (sample unit). Micro plot and shrub intercept data are collected at systematic intervals on the perpendicular transects.

By systematically collecting and analyzing plant species frequency, abundance, density, height, and percent cover data, vegetative trends through time can be described. Likewise, the effectiveness of exotic weed control methods can be evaluated and weed control plans can be adjusted accordingly.

Presence of all exotic weeds i.e., knapweed, yellow starthistle (*Centaurea solistitialis*), cheatgrass etc. will be mapped in GIS using Global Positioning System (GPS) equipment. This information will be used to develop an annual exotic vegetation control plan.

Causes of seeding or planting failure will be identified and planting methods/site preparation will be modified as necessary. Data will be collected and analyzed, and, where necessary, changes in the management plan (adaptive management) will be identified and implemented.

General and site specific M&E protocols, outlining monitoring goals and objectives and specific sampling designs are included in the following monitoring section.

In addition to defining habitat and species population trends, monitoring will also be used to determine if management actions have been carried out as planned (implementation monitoring). In addition to monitoring plan implementation, monitoring results will be evaluated to determine if management actions are achieving desired goals and objectives (effectiveness monitoring) and to provide evidence supporting the continuation of proposed management actions. Areas planted to native shrubs/trees and/or seeded to herbaceous cover will be monitored twice a year to determine shrub/seeding survival, and causes of shrub mortality and seeding failure i.e. depredation, climatic impacts, poor site conditions, poor seed/shrub sources.

Monitoring of habitat attributes and focal species in this manner will provide a standardized means of tracking progress towards conservation, not only within the Subbasins of the Blue Mountain and Province Provinces, but within a national context as well. Monitoring will provide essential feedback for demonstrating adequacy of conservation efforts on the ground, and guide the adaptive management component that is inherent in the subbasin planning process.

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Plant Community Monitoring:

Sampling Vegetation for Monitoring Plant Communities

Charles G. Johnson Jr., Ecologist
USDA Forest Service, Area 3 – Malheur, Umatilla, and Wallowa-Whitman National Forests
May 1998

Introduction

Landscape level plant community monitoring builds on the foundation of the reference sites for plant communities of the Blue Mountains and surrounding area as documented in Plant Associations of the Blue and Ochoco Mountains,(C. G. Johnson Jr. and R. R. Clausnitzer, 1992) and Plant Associations of the Wallowa-Snake Province, (C. G. Johnson Jr. and S. A. Simon, 1986). These larger scale monitoring efforts can provide important reference data for comparing project level monitoring results when the same methodology is implemented at a project level.

A monitoring location is selected to exemplify a particular plant community, stand, or site. Several locations may be selected to portray the variation within the plant communities across a particular landscape. The decision when and where to locate a sample point for monitoring is made by the investigator for the purposes of a particular project need. This approach will help in the standardization of procedures utilized by the investigator once a decision is made to establish a monitoring point.

Plot Location and Orientation

As much as possible, plot centers are located to avoid areas with variation due to site disturbance. Patches of disturbance may be included, however, to see how they change over time. In forested stands, old-growth vegetation representing site potential may be sought to serve as a reference point or benchmark to an adjacent monitoring plot located in an area of disturbance. The ecological condition or status of the vegetation is one of the foremost attributes evaluated in the decision as to where a plot should be located. Another rationale for plot center location is the desire for characterization of a specific plant species in relation to the associated vegetation.

Establishment of Permanent Monitoring Point

Each monitoring point, whether followed by extensive or intensive sampling, is important for trend analysis and comparative analysis at two or more points in time. Therefore, it is important to utilize metal stakes, which will withstand the ravages of time, fire, and other possible threats to the existence of the stake. In general, an 18-inch angle iron with 1 to 1-1/4 inch sides is utilized. Ideally this stake should be marked with location or reference information. The stake may be marked by either fixing a tag (which is aluminum) or marking with a letter and number punch. If the primary job is to leave a camera point behind, or conduct a reconnaissance level sampling procedure, the stake will then represent the plot center. Reconnaissance sampling techniques may be conducted in a circular plot:

1. 10.93 meters in radius (which is equivalent to 375 square meters) and 36 feet in radius.

2. One-tenth acre which is 37 feet in radius. After establishing the distance from plot center, locate a reference object such as a meter pole at the end of this measurement on the contour of the slope. This defines the perimeter of a visualized circle.

Photography of the Reconnaissance Plot

The plot center stake can become a camera point. A general view should be taken from the plot center to the perimeter. Additional photographic views can be taken in a clockwise fashion pivoting from the plot center to capture various views. These views should be recorded by azimuth on a form for future use when revisiting the camera point.

Additionally, it is recommended that a square yard be delineated using folding carpenter rulers at a point 5 feet distant from the plot center stake with the 5 foot mark in the center of the square yard. This square yard defines an area which can be redefined in future years to assess the change in stand structure and composition. More than one can be established to show the vegetation at different locations within the sample area. The locations must be measured for distance from the plot center.

Sampling of the Reconnaissance Plot

The reconnaissance vegetation sample is conducted following the photography by traversing throughout the circular area. A species list is derived in this traverse and upon the conclusion, estimates are made of percent canopy coverage of all principle species found within the area. The estimates should be made to the nearest 5 percent. Additional information taken for the plant community should include surface cover by mosses and lichens, litter, bare ground, rock, gravel, and erosion pavement.

Environmental attributes are measured to conclude the measurement process. Some attributes should always be measured, such as: elevation, aspect, slope, position on the slope, the relief of the site, and the micro relief of the plot. Other information which might be derived if desired, would include: soils information, productivity information, utilization information, down woody material, wildlife signs, etc.

Establishing the Sampling Transects

Line transects define specific locations for more labor-intensive investigation and micro-site analysis. Establishment of transects require a definite bias by the investigator to either avoid or include patches of vegetation which are deemed desirable or undesirable. Two 100-foot transects should be located approximately parallel and no closer than 30 feet between each other. A cloth or steel 100-foot tape is used to create the line. Stakes are then set at 0, 50, and 100-foot marks based on the configuration shown on the attached diagram. The zero foot stakes of Transect 1 and Transect 2 are then referenced by measurements of distance and bearing in relation to a reference or witness (i.e. tree, fence post, large rock).

Photographing the Transects

The two transects are then photographed following a very precise procedure, which is as follows: Standing at the zero stake of Transect 1, a general picture is taken down the line to the horizon. Then a long oblique picture is taken with the top of the view in the camera being the base of the 100-foot stake. This gives a good view of the composition of the vegetation along the transect. Next, square yards are defined using the carpenter's rulers with the mid points at 5, 30, 55, 80, and 95, and photographed with the photographer standing at 0, 25, 50, 75, and 100. After taking the quadrate picture at 95, the photographer then shoots a long oblique picture with the top of the view at the base of the zero foot stake. The photography of Transect 1 is concluded by shooting the general view including the horizon form the 100' stake. The photography is accomplished on Transect 2 in the same manner. Any deviation from this procedure should be noted on the plot card for subsequent investigators to note before trying to retake the photography in subsequent years.

Sampling the Transects

The transects may be sampled at 5-foot intervals along the 100-foot transect with plot frames placed at the appropriate foot marks on the tape. The plot frames are located on the upslope side of the line and on the left side when facing the 100' stake at the 0' location. Therefore, take care not to walk on the area immediately to the left of the line prior to sampling. Crown canopy cover by species are estimated to the 5 percent level. The sampling concludes after 20 plot frames are evaluated on each transect. Plot frames should be rectangular and a square foot of area in size. Density counts could also be made at each quadrant setting.

Completing the Sampling Process

After all photography and sampling has occurred, it is now time for the investigator to reflect upon what has been observed at the site and to note those observations accurately and completely in prose on the front of the sampling form. Among the observations made should be the condition of the vegetation, disturbance indicators, additional species occurring in the stand but not located in the sample area, and any other factors influencing the health and vigor of the plant species within the community.

Referencing the Plot

Transect installation and sampling requires a good deal of energy and cost. Therefore, the most important event following this expenditure is to properly reference the permanent monitoring point location so that future investigators can relocate the site and the plot. Before leaving the plot, pinprick an aerial photo and place the appropriate designation of the plot on the back of the photo. Mark a map with the location (preferably a USGS quadrangle). Place location information on the plot form. The referencing of the monitoring point in the field should utilize semi-permanent objects located in the periphery of the plot. These include fenceposts, large rocks, and trees. Metal tags appropriate for referencing should be located on trees and fenceposts with rocks being referenced either silently or with paint. A sketch map should accompany the form showing the location of the plot center or the transects in relationship to the referenced objects. The azimuth and distances should be provided from these reference objects to the plot center or the Transect 1 zero end stake.

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Land Bird Monitoring
(Adapted from the Draft Monitoring and Evaluation Plan for The Albeni Falls Wildlife Mitigation
Project, August 2001)

Introduction

Birds are important components of biological diversity in most ecosystems. Monitoring the health and long-term stability of bird communities can provide an important measure of overall environmental health (Morrison 1986). Birds are good environmental monitors for several reasons: many species can be monitored simultaneously with a single method, methods for monitoring are well understood and standardized, birds occupy all habitat types, and as a community represent several trophic levels and habitat use guilds. Monitoring species abundance, community diversity, and trends provides information that can be used to determine the effectiveness of management actions in moving towards conservation goals.

Perhaps more than any other species or community proposed for monitoring, land birds present the opportunity for standardized data collection that can be incorporated into national monitoring programs. Dovetailing our monitoring efforts with national monitoring efforts can be important in interpreting the results of our monitoring efforts. Many species of birds are neo-tropical migrants whose populations are effected by factors remote from the data collection point. Standardized methods allow for recognition of declines in abundance or diversity as a local phenomenon (triggering a change in local management) or a broader scale phenomenon that does not necessarily implicate failed management at the local level.

Methods

Point counts will be used to monitor land birds on this project. Point counts are the most widely used quantitative method used for monitoring land birds and involve an observer recording birds from a single point for a standardized time period (Ralph et al. 1995). The methodology follows the recommendations of Ralph et al. (1995) and is consistent with the methodology employed by the U.S.D.A Forest Service Northern Region Land bird Monitoring Project (Hutto et al. 2001) and recommendations for the Idaho Partners in Flight Bird Monitoring Plan (Leukering et al 2000).

A ten-minute point count will be conducted at each of the randomly selected permanent sample points within a cover type. All points will be visited a minimum of two and preferably three times during the breeding season (mid-May to early July) with a minimum of 7 days between counts. Point counts should be started at 15 minutes after official sunrise and completed by 10:00 a.m. Weather conditions should be warm and calm enough for bird detection by sight or sound. All birds seen or heard within the 10-minute count period are recorded. During the count, data should be recorded in three time periods (0-3 minutes, 3-5 minutes, and 5-10 minutes). This will allow the data to be partitioned or pooled for comparison to the U.S. Fish and Wildlife breeding bird survey data, research data reported in the literature that commonly use 5-minute point counts, and 10-minute point count data recommended and collected by national bird monitoring programs. Field observers should be highly qualified to detect birds by sight and sound. Fixed-radius plots (where the radius is arbitrarily small) reduce the interspecific difference in delectability by assuming that: a) all the birds within the fixed radius are detectable; b) observers do not actively attract or repel birds; and c) birds do not move into or out of the fix-radius during the counting period. This allows for comparisons of abundance among species. Unlimited radius plots maximize the amount of data collected because they include all detections and are appropriate when the objective is to monitor population changes within a single population (Ralph et al. 1995). Birds should be tallied in two distance bands, one 0-50 meters from the point center and one >50 meters from the point center. This will maximize data collection while permitting interspecific analysis. If density estimation is desired then additional distance data must be collected. However, density estimation is beyond the scope of this monitoring plan. Additional information on establishing point count stations, data collection, and sample data forms can be found by referencing Ralph et al. (1993, 1995) and Huff et al. (2000).

Data Analysis

Data will be pooled both within cover types, and across cover types within land management units. The mean number of detections per point (by species) within a cover type will used as an index to species abundance. Abundance across cover types within a land management unit will be expressed as the grand mean of the individual cover-type data pooled across the land management unit and weighted by the proportionate areal extent of each cover type. Trend analysis on abundance data will be done by regressing abundance on time and testing the null hypothesis that the slope of the regression is equal to 0 (Zar 1984). Regression analysis will not be conducted with less than 6 data points. The Shannon-Weaver information function (H') will be used to measure land bird community diversity, and Pielou's equitability index (J') will be used to measure the evenness of species distribution with in the community (Hair 1980). Diversity indices will be compared using a t-test following methodology described by Hutcheson (1970) and Zar (1984). A species list will also be developed as a measure of diversity. The species list will be developed and supplemented with incidental sightings from throughout the year.

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Small Mammal Monitoring

(Adapted from the Draft Monitoring and Evaluation Plan For The Albeni Falls Wildlife Mitigation
Project, August 2001)

Introduction

The small mammal community is an important component of biological diversity in most ecosystems. Small mammals act as seed dispersal agents, their burrowing disturbs soil and creates microsites for seedling development, and they provide a prey base for higher trophic level consumers. Monitoring species abundance, community diversity, and trends provides information that can be used to determine the effectiveness of management actions in moving towards conservation goals.

Methods

Small mammal populations will be sampled by snap trapping with museum special traps at the randomly selected sample points. Traps will be baited with a mixture of peanut butter and rolled oats. An array of traps will be laid out as follows. A 100-meter baseline transect centered at the sample point and running along a random compass bearing and its back azimuth will be established. From the baseline transect, five 50-meter long trap-lines that are centered on and run perpendicular to the baseline transect at 25-meter intervals will be established. Pairs of museum special snap traps will be placed at 12.5-meter intervals along the trap-lines. Trapping will be conducted for two consecutive nights yielding a total of 100 trap nights per sample point. Sample point, cover type, date of capture, and species will be recorded for each small mammal captured. Small mammals killed in snap traps will be disposed of off site.

Snap trapping will be the backbone of our small mammal sampling effort. However, snap traps are known to underestimate the relative abundance of shrews in the small mammal community (Mangak and Guynn 1987, McComb et al. 1991). Managers, at their discretion, may augment their snap trapping efforts with pit trap arrays. Trap night data from pit traps will be recorded separately from the snap trap data.

Data Analysis

Data be will be pooled both within cover types, and across cover types within land management units. An index of the abundance of each species within a cover type will be expressed as number caught/100 trap nights. Indices of abundance across cover types within a land management unit will be expressed as the mean of the individual cover type data pooled across the land management unit and weighted by the proportionate areal extent of each cover type. Trend analysis on abundance data will be done by regressing abundance on time and testing the null hypothesis that the slope of the regression is equal to 0 (Zar 1984). Regression analysis will not be performed with less than 6 data points. The Shannon-Weaver information function (H') will be used to measure small mammal community diversity, and Pielou's equitability index (J') will be used to measure the evenness of species distribution with in the community (Hair 1980). Diversity indices will be compared using a t-test (P=0.1) following methodology described by Hutcheson (1970) and Zar (1984). A species list of all mammals will be developed and supplemented with observations throughout each year.

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Herptofauna Monitoring

(Adapted from the Draft Monitoring and Evaluation Plan for The Albeni Falls Wildlife Mitigation
Project, August 2001)

Introduction

Amphibians are important components of ecosystem biodiversity that are frequently overlooked by fish and wildlife habitat managers. There is growing worldwide concern about perceived and actual declines in populations of amphibians. Permeable skin and a life cycle that involves both aquatic and terrestrial habitats makes amphibians especially susceptible to altered conditions they may encounter in their habitat. They can serve as indicators of environmental health. Local management activities may disproportionately effect amphibians (and reptiles) because of their relatively sedentary lives in contrast to species with greater mobility such as larger mammals and birds.
Many wildlife mitigation properties, especially those not yet acquired, have never been intensively surveyed for herptofauna. We have designed this monitoring program to provide managers with information about what species presently occur on individual projects (the inventory phase) and to provide them with information about the effectiveness of their habitat management practices (monitoring phase) toward benefiting the species assemblages that occur there.

Methods

Amphibian activity and reproductive biology are closely tied to local weather patterns. Consequently, weather data is a necessary component of amphibian monitoring. Basic weather data should include daily min-max temperature and precipitation. Other information about microhabitats could include water temperature and other factors known to influence distribution and abundance of amphibians including relative humidity, substrate moisture, barometric pressure, wind speed and direction, water level at breeding sites, and water pH.

Heyer et al. (1994) suggest the use of several standard sampling techniques to monitor amphibians. Managers should not be constrained by these suggestions and further development of these and other techniques is encouraged.

Visual Encounter Survey (VES)

1. A trained observer walks through a defined area for a prescribed period of time searching for and recording the presence of animals.
2. Time searching is expressed in man-hours.
3. This technique yields species richness and species lists and count data can be used to estimate relative abundance.
4. Repeated VES surveys combined with marking-recapture techniques can be used to estimate animal density.

Audio Strip Transects (AST)

1. A trained observer moves along a strip transect and records all animals heard.
2. Transect width is approximately 2 times the maximum distance the target animals can be heard.
3. Linear habitats (shorelines) can be sampled by counting calling individuals with no need to determine detection distance.
4. Calling-male density is calculated as the number of calling males per linear unit of transect.

Surveys at known breeding sites can be done using VES and AST techniques. Breeding site surveys can be used to estimate effective population size and operational sex ratio but must be done over an extended period (several nights) because of nightly variation in breeding populations. Managers must keep in mind that calling (by frogs) does not necessarily indicate breeding. More explicit indicators such as amplexus, egg masses or larvae are needed to demonstrate breeding. Managers may, at their option, decide to augment VES and AST methodologies with larval traps and dip net transects to determine abundance and reproductive status.

Data Analysis

Data be will be pooled both within cover types, and across cover types within land management units. An index of the abundance of each species within a cover type will be expressed as number/man-hour effort. Indices of abundance across cover types within a land management unit will be expressed as the mean of the individual cover type data pooled across the land management unit and weighted by the proportionate areal extent of each cover type. Trend analysis on abundance data will be done by regressing abundance on time and testing the null hypothesis that the slope of the regression is equal to 0 (Zar 1984). Regression analysis will not be performed with less than 6 data points. The Shannon-Weaver information function (H') will be used to measure herptofauna community diversity, and Pielou's equitability index (J') will be used to measure the evenness of species distribution with in the community (Hair 1980). Diversity indices will be compared using a t-test (P=0.1) following methodology described by Hutcheson (1970) and Zar (1984). A species list to include all reptiles and amphibians will be developed and supplemented with incidental observations from throughout the year.

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Focal Habitat Monitoring:
Adapted from Ashley and Stovel, 2004

Eastside (Interior) Riparian Wetlands

Focal Species: Yellow Warbler (*Dendroica petechia*), Great Blue Heron (*Ardea herodias*), and American Beaver (*Castor canadensis*)

Overall Habitat and Species Monitoring Strategy: Establish monitoring program for protected and managed Eastside (Interior) Riparian Wetland sites to monitor focal species population and habitat changes and evaluate success of efforts.

Overall Habitat and Species Monitoring Strategy: Establish permanent roadside and off-road censusing stations to monitor bird population and habitat changes.

Factors affecting habitat: 1.) Direct loss of riparian deciduous and shrub understory, 2.) Fragmentation of wetland habitat, 3.) agricultural and sub-urban development and disturbance, 4.) reduction in water quality, 5.) organochlorines such as dieldrin or DDE may cause thinning in egg shells which results in reproductive failure (Graber *et al*. 1978; Ohlendorf *et. al.* 1980; Konermann *et. al*. 1978)

Riparian Wetlands Working Hypothesis Statement: As indicated in the assessment (see Section 3.6.2 for summary), major factors affecting riparian wetlands in the Umatilla/Willow subbasin are agricultural and urban development, exotic weed invasion, livestock grazing, transportation corridors, hydropower, and recreational activities. Agricultural and urban development and the construction of transportation corridor have led to habitat loss through channelization and conversion and have contributed to habitat degradation and fragmentation This coupled with poor habitat quality of existing vegetation have resulted in extirpation and or significant reductions in riparian habitat obligate wildlife species.

Recommended Range of Management Conditions*:

1. Forty (40) to sixty (60) percent tree canopy closure (cottonwood and other hardwood species)
2. Multi-structure/age tree canopy (includes trees less than 6 inches in diameter and mature/decadent trees)
3. Woody vegetation within 328 feet of shoreline
4. Tree groves greater than 1 acre within 800 feet of water (where applicable)
5. Forty to 80 percent native shrub cover (greater than 50 percent comprised of hydrophytic shrubs)
6. Multi-structured shrub canopy greater than 3 feet in height

Focal Habitat Monitoring Strategies: Establish an inventory and long-term monitoring program for protected and restored Eastside (Interior) Riparian/Riverine wetlands to determine success of efforts.

1. Identify riparian wetland sites within the subbasin that support populations of focal species for this habitat.
2. Evaluate habitat site potential on existing public lands and adjacent private lands for protection of great blue heron habitat. (short-term strategy i.e., < 2 years).
3. Enhance habitat on public lands and adjacent private lands, employing strategies outlined in the subbasin management plans (intermediate strategy; 2 to 10 years) and

4. Identify high quality/functional privately owned riparian wetlands sites that are not adjacent to public lands (long-term strategy 2 to 15 years).
5. Establish permanent roadside and off-road censusing stations to monitor bird population and habitat changes

Sampling Design: HEP is a standardized habitat-analysis strategy developed by the U.S. Fish and Wildlife Service. It uses a variety of Habitat Suitability Indices (HSI) for select wildlife species to evaluate the plant community as a whole (Anderson and Gutzwiller 1996). Sites are stratified by cover type, and starting points are established using a random number grid. Minimum length of a HEP transect is 600 ft, and patches of cover must be large enough to contain a minimum transect without extending past a 100 foot buffer inside the edge of the cover type. (Riparian zone width within the subbasins may require modification of this 100 foot buffer requirement.)

Sampling Methods (USFWS 1980a and 1980b):

1. Herbaceous measurements are taken every 20 ft. on the right side of the tape (the right is always determined by standing at 0 ft and facing the line of travel). The sampling quadrat is a rectangular $0.5m^2$ microplot, placed with the long axis perpendicular to the tape, and the lower right corner on the sampling interval.

2. Shrub canopy cover is measured using a point intercept method and is visually estimated before starting each transect. If the total shrub cover is anticipated to be >20%, shrub data are collected every 5 ft (20 possible "hits" per 100 ft segment). If shrub canopy cover is anticipated to be <20%, data are collected every 2 ft (50 possible "hits" per 100 ft segment).

   Shrub height measurements are collected on the tallest part of a shrub that crosses directly above each sampling intercept mark. For shorter shrub classifications (i.e. all shrubs less than 3 feet), the tallest shrub is measured that falls within that category.

3. Tree canopy cover measurements are taken every ten feet along a transect. Basal and snag measurements are taken within a tenth-acre circular plot at the end of each 100 ft segment. The center point of the circular plot is the 100 ft mark of the transect tape, and the radius of the circle is 37.2 ft.

In addition, at any permanently established avian, herptofaunal, and small mammal species monitoring sites established within the Riverine Wetland habitat, structural habitat conditions will be monitored every 5 years as per Habitat Structure Assessment protocol (Nott et al 2003).
(http://www.birdpop.org/DownloadDocuments/manual/HSAManual03.PDF).

Analysis: Transects are divided into 100 ft. segments, and total transect length is determined
using a "running mean" to estimate variance (95% probability of being within 10% of the true mean).

Sample size equation: $n = \frac{t^2 \times s^2}{E^2}$

Where: t = value at 95 percent confidence interval with suitable degrees of freedom
s = standard deviation
E = desired level of precision, or bounds

Literature Cited:

Anderson, S. and K. Gutzwiller. 1996. Habitat Evaluation Methods. Pages 592-606 in: T. A. Bookhout, ed. Research and Management Techniques for Wildlife and Habitats. Fifth ed., rev. The Wildlife Society, Bethesda, MD. xiii + 740pp.

Nott, R., D.F. DeSante, and N. Michel. 2003. Monitoring Avian Productivity and Survivorship (MAPS) Habitat Structure Assessment (HAS) Protocol 2003. The Institure for Bird Populations, Pt. Reyes Station, CA.

USFWS. 1980a. Habitat as a Basis for Environmental Assessment, Ecological Services Manual (ESM) 101. Division of Ecological Services, U.S. Fish and Wildlife Service, Department of the Interior, Washington, D.C. Unnumbered.

USFWS. 1980b. Habitat Evaluation Procedures (HEP), Ecological Services Manual (ESM) 102. Division of Ecological Services, U.S. Fish and Wildlife Service, Department of the Interior, Washington, D.C. Unnumbered.

Herbaceous Wetlands

Focal Species: Columbia Spotted Frog

Overall Habitat and Species Monitoring Strategy: Establish monitoring program for protected and managed Herbaceous Wetland sites to monitor focal species population and habitat changes and evaluate success of efforts.

Overall Habitat and Species Monitoring Strategy: Establish permanent roadside and off-road censusing stations to monitor bird, herptile, small and small mammal populations and plant community changes. Establish monitoring program for protected and managed Herbaceous Wetland sites to monitor focal species population and habitat changes and evaluate success of efforts.

Factors affecting habitat: 1.) disturbance, conversion and draining for agricultural and sub-urban development 2.) alteration of natural hydrologic processes resulting in lowering of ground water levels, separation of flood plain from active stream channels, 3) exotic plant invasions 4) reduction in water quality, 5) livestock grazing.

Herbaceous Wetlands Working Hypothesis Statement: **:** As indicated in the assessment (see Section 3.6.2 for summary), major factors affecting herbaceous wetlands in the Umatilla/Willow subbasin are habitat conversion and draining, lowering of ground water level, separation of floodplain from the stream channel due to dikes and levees, exotic plant invasions, and livestock grazing. As discussed in Section 3.4.2, existing information on wetlands in the subbasin is limited, and many of these habitats are small and badly underrepresented in most surveys and databases. Also make point that these habitats are important to a disproportionately large number of species.

Recommended Range of Management Conditions: As described in Section 3.4.2, the desired functional conditions or key environmental correlates for functional herbaceous wetlands are:

- Abundant aquatic vegetation dominated by herbaceous species such as grasses, sedges and rushes and emergent vegetation
- Clear, slow-moving or ponded perennial surface waters
- Relatively exposed, shallow-water (<60 cm)
- Deep silt or muck substrate
- Small mammal burrows
- Undercut banks and spring heads

Focal Habitat Monitoring Strategies: Establish an inventory and long-term monitoring program for protected and restored herbaceous wetlands to determine success of efforts.

1. Identify herbaceous wetland sites within the subbasin that support populations of focal species for this habitat.
2. Evaluate habitat site potential on existing public lands and adjacent private lands for protection of Columbian Spotted Frog. (short-term strategy i.e., < 2 years).
3. Enhance habitat on public lands and adjacent private lands, employing strategies outlined in the subbasin management plans (intermediate strategy; 2 to 10 years) and
4. Identify high quality/functional privately owned herbaceous wetlands sites that are not adjacent to public lands (long-term strategy 2 to 15 years).
5. Establish permanent roadside and off-road censusing stations to monitor bird population and habitat changes

Sampling Design: HEP is a standardized habitat-analysis strategy developed by the U.S. Fish and Wildlife Service. It uses a variety of Habitat Suitability Indices (HSI) for select wildlife species to evaluate the plant community as a whole (Anderson and Gutzwiller 1996). Sites are stratified by cover type, and starting points are established using a random number grid.

In addition, at any permanently established avian, herptofaunal, and small mammal species monitoring sites established within the Herbaceous Wetland habitat, structural

habitat conditions will be monitored every 5 years as per Habitat Structure Assessment protocol (Nott et al 2003).
(http://www.birdpop.org/DownloadDocuments/manual/HSAManual03.PDF).

Sampling Methods (USFWS 1980a and 1980b):

1. Herbaceous measurements are taken every 20 ft. on the right side of the tape (the right is always determined by standing at 0 ft and facing the line of travel). The sampling quadrat is a rectangular $0.5m^2$ microplot, placed with the long axis perpendicular to the tape, and the lower right corner on the sampling interval.

Analysis: Transects are divided into 100 ft. segments, and total transect length is determined
using a "running mean" to estimate variance (95% probability of being within 10% of the true mean).

Sample size equation: $n = \frac{t^2 \times s^2}{E^2}$

Where: t = value at 95 percent confidence interval with suitable degrees of freedom
s = standard deviation
E = desired level of precision, or bounds

Literature Cited:

Anderson, S. and K. Gutzwiller. 1996. Habitat Evaluation Methods. Pages 592-606 in: T. A. Bookhout, ed. Research and Management Techniques for Wildlife and Habitats. Fifth ed., rev. The Wildlife Society, Bethesda, MD. xiii + 740pp.

Nott, R., D.F. DeSante, and N. Michel. 2003. Monitoring Avian Productivity and Survivorship (MAPS) Habitat Structure Assessment (HAS) Protocol 2003. The Institute for Bird Populations, Pt. Reyes Station, CA.

USFWS. 1980a. Habitat as a Basis for Environmental Assessment, Ecological Services Manual (ESM) 101. Division of Ecological Services, U.S. Fish and Wildlife Service, Department of the Interior, Washington, D.C. Unnumbered.

USFWS. 1980b. Habitat Evaluation Procedures (HEP), Ecological Services Manual (ESM) 102. Division of Ecological Services, U.S. Fish and Wildlife Service, Department of the Interior, Washington, D.C. Unnumbered.

Quaking Aspen *Focal Species:* Red-napped Sapsucker

Overall Habitat and Species Monitoring Strategy: Establish monitoring program for protected and managed Quaking Aspen sites to monitor focal species population and habitat changes and evaluate success of efforts.

Establish permanent roadside and off-road censusing stations to monitor bird, herptile, small and small mammal populations and plant community changes. Establish monitoring program for protected and managed Herbaceous Wetland sites to monitor focal species population and habitat changes and evaluate success of efforts.

Factors affecting habitat: 1) livestock and wild ungulate grazing, 2) fire suppression, 3) invasion of coniferous species.

Quaking Aspen Working Hypothesis Statement: Quaking aspen habitat is extremely limited in the Umatilla/Willow subbasin and is believed to be greatly reduced from historical conditions (see Section 3.2.4). As indicated in the assessment (see Section 3.6.2 for summary), the major factors affecting aspen habitat in the Umatilla/Willow subbasin are intensive grazing by livestock and native ungulates, fire suppression, and the invasion of coniferous species.

Recommended Range of Management Conditions: As described in Section 3.4.2, the desired functional conditions or key environmental correlates for functional aspen habitat are:

- > 1.5 snags per acre
- trees > 39 feet in height and
- > 10 inch dbh

Focal Habitat Monitoring Strategies: Establish an inventory and long-term monitoring program for protected and restored quaking aspen habitats to determine success of efforts.

1. Identify quaking aspen sites within the subbasin that support populations of focal species for this habitat.
2. Evaluate habitat site potential on existing public lands and adjacent private lands for protection of Red-naped Spapsucker. (short-term strategy i.e., < 2 years).
3. Enhance habitat on public lands and adjacent private lands, employing strategies outlined in the subbasin management plans (intermediate strategy; 2 to 10 years) and
4. Identify high quality/functional privately owned quaking aspen sites that are not adjacent to public lands (long-term strategy 2 to 15 years).
5. Establish permanent roadside and off-road censusing stations to monitor bird, herptile, and small mammal population and plant communtiy changes

Sampling Design: HEP is a standardized habitat-analysis strategy developed by the U.S. Fish and Wildlife Service. It uses a variety of Habitat Suitability Indices (HSI) for select wildlife species to evaluate the plant community as a whole (Anderson and Gutzwiller 1996). Sites are stratified by cover type, and starting points are established using a random number grid.

In addition, at any permanently established avian, herptofaunal, and small mammal species monitoring sites established within the Herbaceous Wetland habitat, structural habitat conditions will be monitored every 5 years as per Habitat Structure Assessment protocol (Nott et al 2003).
(http://www.birdpop.org/DownloadDocuments/manual/HSAManual03.PDF

Sampling Methods (USFWS 1980a and 1980b):

1. Herbaceous measurements are taken every 20 ft. on the right side of the tape (the right is always determined by standing at 0 ft and facing the line of travel). The sampling quadrat is a rectangular $0.5m^2$ microplot, placed with the long axis perpendicular to the tape, and the lower right corner on the sampling interval.

2. Shrub canopy cover is measured using a point intercept method and is visually estimated before starting each transect. If the total shrub cover is anticipated to be >20%, shrub data are collected every 5 ft (20 possible "hits" per 100 ft segment). If shrub canopy cover is anticipated to be <20%, data are collected every 2 ft (50 possible "hits" per 100 ft segment).

3. Shrub height measurements are collected on the tallest part of a shrub that crosses directly above each sampling intercept mark. For shorter shrub classifications (i.e. all shrubs less than 3 feet), the tallest shrub is measured that falls within that category.

4. Tree canopy cover measurements are taken every ten feet along a transect. Basal and snag measurements are taken within a tenth-acre circular plot at the end of each 100 ft segment. The center point of the circular plot is the 100 ft mark of the transect tape, and the radius of the circle is 37.2 ft.

Analysis: Transects are divided into 100 ft. segments, and total transect length is determined
using a "running mean" to estimate variance (95% probability of being within 10% of the true mean).

Sample size equation: $$n = \frac{t^2 \times s^2}{E^2}$$

Where: t = value at 95 percent confidence interval with suitable degrees of freedom
s = standard deviation
E = desired level of precision, or bounds

Literature Cited:

Anderson, S. and K. Gutzwiller. 1996. Habitat Evaluation Methods. Pages 592-606 in: T. A. Bookhout, ed. Research and Management Techniques for Wildlife and Habitats. Fifth ed., rev. The Wildlife Society, Bethesda, MD. xiii + 740pp.

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USFWS. 1980b. Habitat Evaluation Procedures (HEP), Ecological Services Manual (ESM) 102. Division of Ecological Services, U.S. Fish and Wildlife Service, Department of the Interior, Washington, D.C. Unnumbered.

Mixed Conifer Forest *Focal Species:* Pileated Woodpecker (*Dryocopus pileatus*)

Overall Habitat and Species Monitoring Strategy: : Establish monitoring program for protected and managed mixed conifer forest sites to monitor focal species population and habitat changes and evaluate success of efforts.

Establish permanent roadside and off-road censusing stations to monitor bird, herptile, small and small mammal populations and plant community changes. Establish monitoring program for protected and managed Herbaceous Wetland sites to monitor focal species population and habitat changes and evaluate success of efforts.

Factors affecting habitat: 1) timber harvest and silvicultural practices, 2) altered fire regimes, 3) insect outbreaks, 4) exotic plant invasions

Mixed Conifer Working Hypothesis Statement: Although the area of mixed conifer forest in the Umatilla/Willow subbasin appears to have doubled since c. 1850 (see Table 1; Figure x), the quality of this habitat is believed to have declined due to timber harvest, altered fire regimes, ponderosa pine encroachment, development, outbreaks of western spruce budworm and Douglas-fir tussock moth, and exotic plant invasion (see Section 3.6.2 for summary). These factors have resulted in direct loss of old growth habitat and fragmentation and degradation of remaining mixed conifer forest. Loss of old growth habitat has occurred primarily because of timber harvesting, while habitat degradation is primarily associated with altered fire regimes. Fire suppression has promoted less fire-resistant, shade-intolerant trees, and led to mixed conifer forests with low snag density, high tree density, and stands dominated by smaller and more shade-tolerant trees.

Recommended Range of Management Conditions: As described in Section 3.4.2, the desired functional conditions or key environmental correlates for the Pileated Woodpecker and other mixed conifer obligates are:

- complex multi-layered closed canopies with a major component of large trees (>90 feet in height) and high basal area
- mature seed producing trees
- numerous uneven-aged individual trees and smaller woody plants with emphasis on multi-conifer species composition including lodgepole pine, Douglas fir, Western larch, Engelmann spruce, subalpine fir, and white pine
- dead and dying trees 39 – 69 feet tall, 100-300 years old, and > 20 inches dbh
- dead and decaying wood, with an abundance of insects
- a minimum forest parcel size of 1,000 acres

Focal Habitat Monitoring Strategies: Establish an inventory and long-term monitoring program for protected and restored mixed conifer forest habitats to determine success of efforts.

1. Identify mixed conifer forest sites within the subbasin that support populations of focal species for this habitat.
2. Evaluate habitat site potential on existing public lands and adjacent private lands for protection of Pileated Woodpecker. (short-term strategy i.e., < 2 years).
3. Enhance habitat on public lands and adjacent private lands, employing strategies outlined in the subbasin management plans (intermediate strategy; 2 to 10 years) and
4. Identify high quality/functional privately owned mixed conifer forest sites that are not adjacent to public lands (long-term strategy 2 to 15 years).
5. Establish permanent roadside and off-road censusing stations to monitor bird, herptile, and small mammal population and plant communtiy changes

Sampling Design: HEP is a standardized habitat-analysis strategy developed by the U.S. Fish and Wildlife Service. It uses a variety of Habitat Suitability Indices (HSI) for select wildlife species to evaluate the plant community as a whole (Anderson and Gutzwiller 1996). Sites are stratified by cover type, and starting points are established using a random number grid.

In addition, at any permanently established avian, herptofaunal, and small mammal species monitoring sites established within the Herbaceous Wetland habitat, structural habitat conditions will be monitored every 5 years as per Habitat Structure Assessment protocol (Nott et al 2003).
(http://www.birdpop.org/DownloadDocuments/manual/HSAManual03.PDF

Sampling Methods (USFWS 1980a and 1980b):

2. Herbaceous measurements are taken every 20 ft. on the right side of the tape (the right is always determined by standing at 0 ft and facing the line of travel). The sampling quadrat is a rectangular $0.5m^2$ microplot, placed with the long axis perpendicular to the tape, and the lower right corner on the sampling interval.

3. Shrub canopy cover is measured using a point intercept method and is visually estimated before starting each transect. If the total shrub cover is anticipated to be >20%, shrub data are collected every 5 ft (20 possible "hits" per 100 ft segment). If shrub canopy cover is anticipated to be <20%, data are collected every 2 ft (50 possible "hits" per 100 ft segment).

4. Shrub height measurements are collected on the tallest part of a shrub that crosses directly above each sampling intercept mark. For shorter shrub classifications (i.e. all shrubs less than 3 feet), the tallest shrub is measured that falls within that category.

5. Tree canopy cover measurements are taken every ten feet along a transect. Basal and snag measurements are taken within a tenth-acre circular plot at the end of each 100 ft segment. The center point of the circular plot is the 100 ft mark of the transect tape, and the radius of the circle is 37.2 ft.

Analysis: Transects are divided into 100 ft. segments, and total transect length is determined
using a "running mean" to estimate variance (95% probability of being within 10% of the true mean).

Sample size equation: $$n = \frac{t^2 \text{ x } s^2}{E^2}$$

Where: t = value at 95 percent confidence interval with suitable degrees of freedom
s = standard deviation
E = desired level of precision, or bounds

Literature Cited:

Anderson, S. and K. Gutzwiller. 1996. Habitat Evaluation Methods. Pages 592-606 in: T. A. Bookhout, ed. Research and Management Techniques for Wildlife and Habitats. Fifth ed., rev. The Wildlife Society, Bethesda, MD. xiii + 740pp.

Nott, R., D.F. DeSante, and N. Michel. 2003. Monitoring Avian Productivity and Survivorship (MAPS) Habitat Structure Assessment (HAS) Protocol 2003. The Institure for Bird Populations, Pt. Reyes Station, CA.

Parks, C. G., E. L. Bull and T. R. Torgersen. 1997. Field Guide for the Identification of Snags and Logs in the Interior Columbia River Basin. USDA Forest Service, Pacific Northwest Research Station, PNW-GTR-390. 40 p.

USFWS. 1980a. Habitat as a Basis for Environmental Assessment, Ecological Services Manual (ESM) 101. Division of Ecological Services, U.S. Fish and Wildlife Service, Department of the Interior, Washington, D.C. Unnumbered.

USFWS. 1980b. Habitat Evaluation Procedures (HEP), Ecological Services Manual (ESM) 102. Division of Ecological Services, U.S. Fish and Wildlife Service, Department of the Interior, Washington, D.C. Unnumbered.

Ponderosa Pine Focal Species: white-headed woodpecker (*Picoides albolarvatus)*

Overall Habitat and Species Monitoring Strategy: Establish monitoring program for protected and managed Ponderosa pine sites to monitor focal species population and habitat changes and evaluate success of efforts.

Factors affecting habitat:

1. Direct loss old growth forest and associated large diameter trees and snags;
2. Fragmentation of remaining Ponderosa pine habitat;
3. Agricultural and sub-urban development and disturbance;
4. Hostile landscapes which may have high densities of nest parasites, exotic nest competitors, and domestic predators;
5. Fire suppression/wildfire;
6. Overgrazing;
7. Noxious weeds;
8. Timing of silvicultural practices;
9. Insecticide use.

Ponerosa Pine Working Hypothesis Statement: As indicated in the assessment (see Section 3.6.2 for summary), major factors affecting ponderosa pine habitat in the Umatilla/Willow subbasin are mixed forest encroachment, altered fire regimes, timber harvest, exotic plant invasion, outbreaks of western spruce budworm and Douglas-fir tussock moth, livestock grazing, development, and recreational activities. Two of the major factors responsible for habitat loss and degradation of functional ponderosa pine forest is harvest of late and old structure pine and the encroachment of Douglas-fir and grand fir into ponderosa pine dominated habitats. The encroachment is due primarily to fire suppression and intense, stand-replacing wildfires; the latter results from high fuel loads associated with increases in brushy species and the establishment of ladder fuels from encroaching shade tolerant understory trees.

Recommended Range of Management Conditions: Recognizing that extant ponderosa pine habitat within the Blue Mountain and Columbia Plateau Provinces currently covers a wide range of seral conditions, Ecoregion wildlife habitat managers have identified three general ecological / management conditions that, if met, will provide suitable habitat for multiple wildlife species at the Ecoregion scale within the ponderosa pine habitat type.

These ecological conditions correspond to life requisites represented by a species' assemblage that includes white-headed woodpecker (*Picoides albolarvatus*).

1. Mature ponderosa pine forest: The white-headed woodpecker represents species that require/prefer large patches (greater than 350 acres) of open mature/old growth ponderosa pine stands with canopy closures between 10 - 50 percent and snags (a partially collapsed, dead tree) and stumps for nesting (nesting stumps and snags greater than 31 inches DBH).

2. Multiple canopy ponderosa pine mosaic: Flammulated owls represent wildlife species that occupy ponderosa pine sites that are comprised of multiple canopy, mature ponderosa pine stands or mixed ponderosa pine/Douglas-fir forest interspersed with grassy openings and dense thickets. Flammulated owls nest in habitat types with low to intermediate canopy closure (Zeiner et al. 1990), two layered canopies, tree density of 508 trees/acre (9 foot spacing), basal area of 250 $feet^2$/acre (McCallum 1994b), and snags greater than 20 inches DBH 3-39 feet tall (Zeiner et al. 1990). Food requirements are met by the presence of at least one snag greater than 12 inches DBH/10 acres and 8 trees/acre greater than 21 inches DBH.

3. Dense canopy closure: Rocky Mountain Elk were selected to characterize ponderosa pine habitat that is greater than 70 percent canopy closure and 40 feet in height.

Focal Habitat Monitoring Strategies: Establish an inventory and long-term monitoring program for protected and managed Ponderosa pine habitats to determine success of efforts. Subbasin managers recognize that restoration of late-successional forest is a long-term process, but these short-term (i.e., up to 15 years) strategies reflect the commitment and initiation of the process of management.

1. Identify Ponderosa pine habitat sites within the subbasin that support populations of focal species for this habitat.
2. Evaluate habitat site potential on existing public lands and adjacent private lands for protection of focal species habitat (short-term strategy i.e., < 2 years).
3. Enhance habitat on public lands and adjacent private lands (intermediate strategy; 2 to 10 years)
4. Identify high quality/functional privately owned Ponderosa pine sites that are not adjacent to public lands (long-term strategy 2 to 15 years).
5. Establish permanent roadside and off-road censusing stations to monitor bird, herptile and small mammal population and plant community changes.

Sampling Design: Permanent survey transects will be located within Ponderosa pine habitats using HEP protocols. HEP is a standardized habitat-analysis strategy developed by the U.S. Fish and Wildlife Service. It uses a variety of Habitat Suitability Indices (HSI) for select wildlife species to evaluate the plant community as a whole (Anderson and Gutzwiller 1996). Sites are stratified by cover type, and starting points are established using a random number grid. Minimum length of a HEP transect is 600 ft, and patches of cover must be large enough to contain a minimum transect without extending past a 100 foot buffer inside the edge of the cover type.

In addition, at any permanently established avian, herptile, and small mammal species monitoring site established within the Ponderosa Pine habitat, structural habitat conditions will be monitored every 5 years as per Habitat Structure Assessment protocol (Nott et al 2003).

Sampling Methods (USFWS 1980a and 1980b):

1. Herbaceous measurements are taken every 20 ft. on the right side of the tape (the right is always determined by standing at 0 ft and facing the line of travel). The sampling quadrat is a rectangular 0.5m^2 microplot, placed with the long axis perpendicular to the tape, and the lower right corner on the sampling interval.

2. Shrub canopy cover is measured using a point intercept method and is visually estimated before starting each transect. If the total shrub cover is anticipated to be >20%, shrub data are collected every 5 ft (20 possible "hits" per 100 ft segment). If shrub canopy cover is anticipated to be <20%, data are collected every 2 ft (50 possible "hits" per 100 ft segment).

   Shrub height measurements are collected on the tallest part of a shrub that crosses directly above each sampling intercept mark. For shorter shrub classifications (i.e. all shrubs less than 3 feet), the tallest shrub is measured that falls within that category.

3. Tree canopy cover measurements are taken every ten feet along a transect. Basal and snag measurements are taken within a tenth-acre circular plot at the end of each 100 ft segment. The center point of the circular plot is the 100 ft mark of the transect tape, and the radius of the circle is 37.2 ft.

Measurement of Attributes (Habitat Conditions):
>10 snags/40 ha (>30cm DBH and 1.8m tall)

Method: A direct count in the 1/10 acre circle plot at the end of each 100 ft segment of the transect. DBH (measured with a loggers tape) and condition is noted for each snag. Snag condition scale follows Parks et al. (1997).

>20 trees /ha (>21" DBH)

Method: A direct count in the 1/10 acre circle plot. DBH measured with a logger's tape.

Ponderosa Pine – old growth: >10 trees/ac (>21" DBH w/ >2 trees >31" DBH)

Method: A direct count in the 1/10 acre circle plot. DBH measured with a logger's tape.

10-50% canopy closure

Method: A line intercept 'hit' or 'miss' measurement. Ten direct measurements along each 100 foot section of the transect (one every 10 feet) taken with a moosehorn densitometer.

> 1.4 snags/ac (>8" DBH w/ >50% >25")

Method: A direct count in the 1/10 acre circle plot at the end of each 100 ft segment of the transect. DBH (measured with a loggers tape) and condition is noted for each snag. Snag condition scale follows Parks et al. (1997).

In addition, at any permanently established avian species monitoring site established within the Riverine Wetland habitat, structural habitat conditions will be monitored every 5 years as per Habitat Structure Assessment protocol (Nott et al 2003).

<u>Analysis:</u> Transects are divided into 100 ft. segments, and total transect length is determined
using a "running mean" to estimate variance (95% probability of being within 10% of the true ean).

Sample size equation: $n = \frac{t^2 \times s^2}{E^2}$

Where: t = value at 95 percent confidence interval with suitable degrees of freedom
s = standard deviation
E = desired level of precision, or bounds

<u>Literature Cited:</u>

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Nott, R., D.F. DeSante, and N. Michel. 2003. Monitoring Avian Productivity and Survivorship (MAPS) Habitat Structure Assessment (HAS) Protocol 2003. The Institure for Bird Populations, Pt. Reyes Station, CA.

Parks, C. G., E. L. Bull and T. R. Torgersen. 1997. Field Guide for the Identification of Snags and Logs in the Interior Columbia River Basin. USDA Forest Service, Pacific Northwest Research Station, PNW-GTR-390. 40 p.

USFWS. 1980a. Habitat as a Basis for Environmental Assessment, Ecological Services Manual (ESM) 101. Division of Ecological Services, U.S. Fish and Wildlife Service, Department of the Interior, Washington, D.C. Unnumbered.

USFWS. 1980b. Habitat Evaluation Procedures (HEP), Ecological Services Manual (ESM) 102. Division of Ecological Services, U.S. Fish and Wildlife Service, Department of the Interior, Washington, D.C. Unnumbered.

Eastside Interior Grassland *Focal Species:* grasshopper sparrow (*Ammodramus savannarum)*

Overall Habitat and Species Monitoring Strategy: Establish monitoring program for protected and managed Interior Grassland sites to monitor focal species population and habitat changes and evaluate success of efforts.

Factors affecting habitat:

1. Direct loss grasslands due to conversion to agriculture
2. Fragmentation of remaining grassland habitat, with resultant increase in nest parasites
3. Fire Management, either suppression or over-use, and wildfires
4. Invasion of exotic vegetation
5. Habitat degradation due to overgrazing, and invasion of exotic plant species
6. Loss and reduction of cryptogamic crusts, which help maintain the ecological integrity of shrubsteppe/grassland communities.
7. Conversion of CRP lands back to cropland.

Eastside Interior Grassland Working Hypothesis Statement: As indicated in the assessment (see Section 3.6.2 for summary), major factors affecting grassland habitat in the Umatilla/Willow subbasin are agricultural conversion (including the conversion of CRP back into cropland), exotic weed invasion, purposeful seeding of non-native grasses, overgrazing, and human-altered fire regimes. These factors result in direct habitat loss, fragmentation, and degradation. The single largest factor in habitat loss is conversion to agriculture. The largest factor in habitat degradation is the proliferation of annual grasses and noxious weeds, such as cheat grass and yellow starthistle, which either replace or radically alter native bunchgrass communities. This invasion of exotic weeds is facilitated by the loss of cryptogamic crusts[1], resulting from soil disturbances associated with tillage and livestock grazing. Non-native animal species, including nest competitors (e.g., European Starlings, House Sparrow), nest parasites (e.g., Brown Headed Cowbirds), and domestic predators (e.g., cats, dogs) also impact native species productivity. The effects of non-native species are magnified by habitat fragmentation. Additionally, grassland habitats in proximity to agricultural and recreational areas may be subject to high levels of human disturbance. All of these factors are responsible for significant reductions in grassland obligate species.

*Recommended Range of Management Conditions; S*ubbasin planners selected the grasshopper sparrow to represent the range of habitat conditions required by grassland obligate wildlife species and to serve as potential performance measures to monitor and evaluate the results of implementing future management strategies and actions on interior grassland habitats. In addition, sharp-tailed grouse winter food/roosting needs account for

[1] cryptogamic crusts: a complex association of living cyanobacteria, microfungi, lichens, and mosses that live within and immediately on top of the soil in arid and semi-arid regions of the world, forming a cohesive crust that resists wind and water erosion (Belnap and Lange 2001).

macrophyllus shrub draws and riparian shrublands that historically punctuated interior grassland habitats.

For Native Grasslands

- native bunchgrass cover > 15% and comprising than 60% of total grassland cover
- tall bunchgrass > 10 inches tall
- native shrub cover < 10%

For Non-Native and Agricultural Grasslands (e.g. CRP lands)

- grass forb cover > 90%
- shrub cover < 10%
- variable grass heights (6-18 inches)

Landscape Level

- patch size greater > 100 acres or multiple small patches greater than 20 acres, within a mosaic of suitable grassland conditions

Focal Habitat Monitoring Strategies:

1. Enhance habitat on public lands and adjacent private lands (intermediate strategy; 2 to 10 years)
2. Identify high quality/functional privately owned grassland sites that are not adjacent to public lands (long-term strategy 2 to 15 years).
3. Establish permanent roadside and off-road censusing stations to monitor bird, herptile, and small mammal population and plant community changes

Sampling Design: Permanent survey transects will be located within Eastside Interior Grassland habitats using HEP protocols. HEP is a standardized habitat-analysis strategy developed by the U.S. Fish and Wildlife Service. It uses a variety of Habitat Suitability Indices (HSI) for select wildlife species to evaluate the plant community as a whole (Anderson and Gutzwiller 1996). Sites are stratified by cover type, and starting points are established using a random number grid. Minimum length of a HEP transect is 600 ft, and patches of cover must be large enough to contain a minimum transect without extending past a 100 foot buffer inside the edge of the cover type.

In addition, at any permanently established avian, herptile and small mammal species monitoring site established within the Eastside Interior Grassland habitat, structural habitat conditions will be monitored every 5 years as per Habitat Structure Assessment protocol (Nott et al 2003).

Sampling Methods (USFWS 1980a and 1980b):

1. Herbaceous measurements are taken every 20 ft. on the right side of the tape (the right is always determined by standing at 0 ft and facing the line of travel). The sampling quadrat is a rectangular $0.5m^2$ microplot, placed with the long axis perpendicular to the tape, and the lower right corner on the sampling interval.

2. Shrub canopy cover is measured using a point intercept method and is visually estimated before starting each transect. If the total shrub cover is anticipated to be >20%, shrub data are collected every 5 ft (20 possible "hits" per 100 ft segment).

If shrub canopy cover is anticipated to be <20%, data are collected every 2 ft (50 possible "hits" per 100 ft segment).

Shrub height measurements are collected on the tallest part of a shrub that crosses directly above each sampling intercept mark. For shorter shrub classifications (i.e. all shrubs less than 3 feet), the tallest shrub is measured that falls within that category.

3. Tree canopy cover measurements are taken every ten feet along a transect. Basal and snag measurements are taken within a tenth-acre circular plot at the end of each 100 ft segment. The center point of the circular plot is the 100 ft mark of the transect tape, and the radius of the circle is 37.2 ft.

Analysis: Transects are divided into 100 ft. segments, and total transect length is determined using a "running mean" to estimate variance (95% probability of being within 10% of the true mean).

Sample size equation: $n = \frac{t^2 \times s^2}{E^2}$

Where: t = value at 95 percent confidence interval with suitable degrees of freedom
s = standard deviation
E = desired level of precision, or bounds

Literature Cited:

Anderson, S. and K. Gutzwiller. 1996. Habitat Evaluation Methods. Pages 592-606 in: T. A. Bookhout, ed. Research and Management Techniques for Wildlife and Habitats. Fifth ed., rev. The Wildlife Society, Bethesda, MD. xiii + 740pp.

Nott, R., D.F. DeSante, and N. Michel. 2003. Monitoring Avian Productivity and Survivorship (MAPS) Habitat Structure Assessment (HAS) Protocol 2003. The Institute for Bird Populations, Pt. Reyes Station, CA.

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USFWS. 1980b. Habitat Evaluation Procedures (HEP), Ecological Services Manual (ESM) 102. Division of Ecological Services, U.S. Fish and Wildlife Service, Department of the Interior, Washington, D.C. Unnumbered.

Shrubsteppe *Focal Species:* Sage Sparrow (*Amphispiza bilineata*), Ferruginous hawk (*Buteo regalis*) for Juniper within Shrub-steppe

Overall Habitat and Species Monitoring Strategy: Establish monitoring program for protected and managed Shrubsteppe sites and scattered juniper within shrubsteppe habitats to monitor focal species population and habitat changes and evaluate success of efforts.

Factors affecting habitat:

1. Direct loss shrubsteppe due to conversion to agriculture
2. Fragmentation of remaining shrubsteppe habitat, with resultant increase in nest parasites
3. Fire Management, either suppression or over-use, and wildfires
4. Invasion of exotic vegetation
5. Habitat degradation due to overgrazing, and invasion of exotic plant species
6. Loss and reduction of cryptogamic crusts, which help maintain the ecological integrity of shrubsteppe/grassland communities.
7. Conversion of CRP lands back to cropland.

Shrubsteppe Working Hypothesis Statement: The near term or major factors affecting this focal habitat type are direct loss of habitat due primarily to conversion to agriculture, reduction of habitat diversity and function resulting from invasion of exotic vegetation and wildfires, and livestock grazing. The principal habitat diversity stressor is the spread and proliferation of annual grasses and noxious weeds such as cheatgrass and yellow-star thistle that either supplant and/or radically alter entire native bunchgrass communities significantly reducing wildlife habitat quality. Habitat loss and fragmentation (including fragmentation resulting from extensive areas of undesirable vegetation) coupled with poor habitat quality of extant vegetation have resulted in extirpation and or significant reductions in grassland obligate wildlife species.

Recommended Range of Management Conditions:

Characterizing very specific critical environmental correlates that apply to all shrub-steppe habitat is difficult because shrub-steppe habitats are highly variable with respect to structure and plant species composition, both of which are strongly influenced by site conditions (e.g., hydrology, soil, topography). Sound management will take into account site conditions, and thus the inherent capability of the site to support a particular type of shrub-steppe community and wildlife assemblage. However, general ranges of critical environmental correlates that support the sage sparrow and most other obligate shrub species (e.g., loggerhead shrike, burrowing owl, sage thrasher) are as follows:

- late seral big sagebrush or bitterbrush with patches of tall shrubs with a height greater than 1 m
- mean sagebrush cover of 5-30%
- mean native herbaceous cover of 10-20% with <10% cover of non-native annual grass (e.g., cheatgrass) or forbs
- mean open ground cover, including bare ground and cryptogamic crusts > 20%
- mean native forb cover > 10%

Ferruginous hawk was selected to represent juniper which, in the Umatilla Subbasin, is an important KEC component of shrubsteppe, functioning as nest and perch sites for Ferruginous hawks and other species.

As described in Section 3.4.2, the desired functional conditions or key environmental correlates for functional ponderosa pine habitat are:

- isolated, mature juniper trees with a density > one per square mile
- native perennial grasses and other low shrub cover between 6-24 inches to support ground squirrels and jackrabbits, which are major prey of Ferruginous Hawks
- mature, short (< 33 ft. in height) juniper for Ferruginous Hawk nesting trees

Focal Habitat Monitoring Strategies: Establish an inventory and long-term monitoring program for protected and managed shrubsteppe habitats to determine success of management strategies. Subbasin managers recognize that restoration of shrubsteppe is still very much a fledgling field, and complete restoration of degraded or converted shrubsteppe may not be feasible. These Monitoring strategies reflect the commitment to and initiation of the process of longterm management.

1. Identify shrubsteppe habitat sites within the subbasin that support populations of focal species
2. Evaluate habitat site potential on existing public lands and adjacent private lands for protection of focal species habitat (short-term strategy i.e., < 2 years).
3. Enhance habitat on public lands and adjacent private lands (intermediate strategy; 2 to 10 years)
4. Identify high quality/functional privately owned shrubsteppesites that are not adjacent to public lands (long-term strategy 2 to 15 years).
5. Establish permanent roadside and off-road censusing stations to monitor bird population and habitat changes.

Sampling Design: Permanent survey transects will be located within shrubsteppe habitats using HEP protocols. HEP is a standardized habitat-analysis strategy developed by the U.S. Fish and Wildlife Service. It uses a variety of Habitat Suitability Indices (HSI) for select wildlife species to evaluate the plant community as a whole (Anderson and Gutzwiller 1996). Sites are stratified by cover type, and starting points are established using a random number grid. Minimum length of a HEP transect is 600 ft, and patches of cover must be large enough to contain a minimum transect without extending past a 100 foot buffer inside the edge of the cover type.

In addition, at any permanently established avian, herptile and small mammal species monitoring site established within the Shrubsteppe habitat, structural habitat conditions will be monitored every 5 years as per Habitat Structure Assessment protocol (Nott et al 2003).

Sampling Methods (USFWS 1980a and 1980b):

1. Bare ground or cryptogram crust measurements are taken every 20 ft. on the right side of the tape (the right is always determined by standing at 0 ft and facing the line of travel). The sampling quadrat is a rectangular $0.5m^2$ microplot, placed with the long axis perpendicular to the tape, and the lower right corner on the sampling interval.

   The percentage of the microplot consisting of either bare ground or cryptogram crust is estimated via ocular estimate.

2. Herbaceous measurements are taken every 20 ft. on the right side of the tape (the right is always determined by standing at 0 ft and facing the line of travel). The sampling quadrat is a rectangular $0.5m^2$ microplot, placed with the long axis perpendicular to the tape, and the lower right corner on the sampling interval.

   Herbaceous cover % is measured via an ocular estimate of the percentage of the microplot shaded by any grass or forb species.

3. Shrub canopy cover is measured using a point intercept method and is visually estimated before starting each transect. If the total shrub cover is anticipated to be >20%, shrub data are collected every 5 ft (20 possible "hits" per 100 ft segment). If shrub canopy cover is anticipated to be <20%, data are collected every 2 ft (50 possible "hits" per 100 ft segment).

   Shrub canopy cover is measured on a line intercept 'hit' or 'miss'. Measurements are taken every 2 or 5 feet, depending upon shrub density.

   Shrub height measurements are collected on the tallest part of a shrub that crosses directly above each sampling intercept mark. For shorter shrub classifications (i.e. all shrubs less than 3 feet), the tallest shrub is measured that falls within that category.

4. Tree canopy cover measurements are taken every ten feet along a transect. Basal and snag measurements are taken within a tenth-acre circular plot at the end of each 100 ft segment. The center point of the circular plot is the 100 ft mark of the transect tape, and the radius of the circle is 37.2 ft.

Analysis: Transects are divided into 100 ft. segments, and total transect length is determined
using a "running mean" to estimate variance (95% probability of being within 10% of the true mean).

Sample size equation: $n = \frac{t^2 \times s^2}{E^2}$

Where: t = value at 95 percent confidence interval with suitable degrees of freedom
s = standard deviation

E = desired level of precision, or bounds

Literature Cited:
Anderson, S. and K. Gutzwiller. 1996. Habitat Evaluation Methods. Pages 592-606 in: T. A. Bookhout, ed. Research and Management Techniques for Wildlife and Habitats. Fifth ed., rev. The Wildlife Society, Bethesda, MD. xiii + 740pp.

Nott, R., D.F. DeSante, and N. Michel. 2003. Monitoring Avian Productivity and Survivorship (MAPS) Habitat Structure Assessment (HAS) Protocol 2003. The Institure for Bird Populations, Pt. Reyes Station, CA.

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Focal Species Monitoring:

Yellow Warbler
Rationale: Maintaining and enhancing yellow warbler populations within the Eco-region will assure the maintenance and rehabilitation of riparian wetlands.

Limiting Factors: 1) Loss of deciduous tree cover and sub-canopy/shrub habitat in riparian zones. 2.) Conversion of riparian habitat due to channelization, agriculture, and development, 3) flooding of habitat resulting from hydropower facilities, 4) habitat fragmentation, 5) degradation of existing habitats from overgrazing and introduced weedy vegetation, and 6) tree/shrub removal in riparian areas (Sec 5.2.3.1). Proximity to agriculture, suburban development creates a hostile landscape where a high density of nest parasites, such as, brown cow bird and predation by domestic cats may occur. Disturbance from agriculture and recreational activities can also cause nest abandonment (Sec. 5.2.3.1.2).

Assumptions: 1) Addressing factors that affect eastside (interior) riparian wetlands, will also address yellow warbler and other wetland obligate species limiting factors. 2) If riparian wetland habitat is of sufficient quality, extent, and distribution to support viable yellow warbler and beaver populations, the needs of most other riparian wetland obligate species will also be addressed and habitat functionality could be inferred.

Sampling Strategy: Survey points will be placed among habitat types of interest using a stratified random design. Number of survey points in each habitat type will be determined using power analysis with the goal of being able to detect a 25% increase in abundance of yellow warbler with a power of 0.8 or greater (pers. comm. Ferguson). This protocol is based on the point count survey (Ralph et al. 1993, Ralph et al. 1995), with each survey station referred to as a "point count station." In addition to these bird survey data, information about the distance at which individual birds are detected will also be collected, allowing absolute density estimated to be made using distance-sampling methodology (e.g., the program DISTANCE).

Methods: We will survey birds on randomly selected (stratified) points along the riparian corridor. Each site will have 4 100-m fixed-radius point counts (Ralph et al. 1993) established along a transect and spaced 200m apart (Fig 4). Each point will be marked with a permanent fiberglass stake (1m electric fence post) and colored flagging will be placed on shrubs at 50 and 100m from the point in each of the 4 cardinal directions to aid in determining distance. Counts at each point will be 5 minutes in duration during which all birds seen or heard will be noted, along with their sex (if known), distance from the point (within 50m, >50 but <100m, or beyond 100m), and behavior (singing, calling, silent, or flying over the site). Surveys will be conducted once each in May and June and within prescribed weather parameters (e.g., no rain and low wind).

Analysis: Analysis is described by Nur et al. (1999). Absolute density estimation (see Buckland et al. 1993) can be estimated using the program DISTANCE, a free program available on the World-Wide Web (http://www.ruwpa.st-and.ac.uk/distance); an example is given in Nur et al. (1997). In brief: for species richness and species diversity, these can be analyzed as total species richness or as species richness for a subset of species; the same is true for species diversity. Species diversity can be measured using the Shannon index (Nur et al. 1999), also called the Shannon-Weiner or Shannon-Weaver index. Statistical analysis can be carried out using linear models (regression, ANOVA, etc.), after appropriate transformations (examples in Nur et al. 1999).

References:

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Nur, N., S. Zack, J. Evens, and T. Gardali. 1997. Tidal marsh birds of the San Francisco Bay region: Status, distribution, and conservation of five Category 2 taxa. Final draft report to National Biological Survey (now US Geological Survey). Available from Point Reyes Bird Observatory, Stinson Beach, CA. Wetlands Regional Monitoring Program Plan 2002 Part 2: Data Collection Protocols Tidal Marsh Passerines.

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Ralph, C.J., S. Droege, and J.R. Sauer. 1995. Managing and monitoring birds using point counts: standards and applications. In C. J. Ralph, J. R. Sauer and S. Droege (Eds.), Monitoring Bird Populations by Point Counts. USDA Forest Service Publication, Gen. Tech. Rep. PSW-GTR-149, Albany, CA.

Great Blue Heron

Rationale: The great blue heron is the only focal species that has a direct relationship with salmonids (Ashley and Stovel 2004, Table 55). The great blue heron requires multiple cover types to meet its life requisites. Suitable great blue heron habitats include herbaceous wetlands, scrub-shrub wetlands, forested wetlands, riverine, lacustrine or estuarine habitats within 0.5 mil of heronries (Sec. 5.2.3.3). Maintaining great blue heron populations will require a wide diversity of riparian wetlands be maintained or enhanced within the Ecoregion.

Limiting Factors: 1.) loss of nesting habitat near riparian zones, 2.) loss of foraging areas due to stream alteration or flows, 3.) reproductive failure due to pesticides.

Assumptions: Addressing factors that affect eastside interior riparian wetlands, will also address great blue heron and other riparian wetland obligate species limiting factors. 2.) If interior riparian wetland is of sufficient quality, extent, and distribution to support viable great blue heron populations, the needs of most riparian wetland obligate species will also be addressed and wetland functionality could be inferred.

Sampling Strategy: The sampling strategy was developed by the Bird Focus Group of the Wetland Regional Monitoring Program Plan 2002 - Part 2: Data Collection Protocols Herons and Egrets: Heron and Egret Breeding Distribution, Abundance, and Success By John P. Kelly

Methods: At each known colony site, establishing a monitoring effort involves five steps:
1. Determine number of "active nests" early in the season. Before 1 April, nests are considered active if two adults are present or if one adult is seen carrying nest material or incubating. After 1 April, any occupied nest is considered active.

2. Create a nesting panorama. The nesting panorama is a landscape sketch or photograph that indicates the location of numbered nests to be followed through the season. Each panorama includes an exact description of the viewing position, which should be located far enough from the colony to avoid disturbance to the nesting birds. More than one panorama may be necessary to monitor all focal nests in the colony (see below).

3. Identify focal nests. Focal nests are numbered nests and monitored through the season to measure nest survivorship. Focal nests must be observed as "active" either before incubation or at Stage 1 (incubation, see below), and should be observed as active in March, although new focal nests can be added until 15 April. In colonies with 15 or fewer active nests, or with volunteer observers that can commit to monitor every nest in the

colony, all nests that meet the above criteria are considered focal nests. *Random samples:* In colonies with more than 15 active nests, which cannot be monitored on every visit, a random subset of at least 15 focal nests is selected for each species. Observers are encouraged to monitor as many nests as they can.

4. Obtain necessary access permits or authorization to enter the area. Most colony sites are on privately owned lands, or on public wildlife refuges with restricted access.

5. Visit each site at least four times during the nesting season. Observers are encouraged to conduct more frequent visits if possible (weekly or biweekly). Regional observation periods are scheduled each year, during five 3-day windows at approximately monthly intervals: early March, early April, early May, early June, and late June. During each of these periods, all colony sites are visited. Diurnal timing of observations is generally not important, but site-specific effects on viewing conditions should be considered. For example, position of the sun might affect visibility of nests; low temperatures can cause brooding adults to hide nest contents; and afternoon wind can enhance the visibility of hidden nests. Because average timing of nesting varies among years, colony sites, and species, closely synchronizing colony site visits with nesting phenology is problematical.

Ancillary Information

The following information is recorded for each colony site:
1. geographic location in UTMs
2. description of nesting habitat, including vegetation, topography, and available nesting space
3. nest locations numbered on a standardized panoramic sketch or photo, updated each visit
4. property ownership
5. number of active nests on each visit, and peak number during the season, using the following criteria: *Before 1 April, "active" nests must have either two adults present or one adult carrying nest*
6. focal nest status: active or inactive
7. nesting stage of each focal nest. Seasonal timing is indexed by the distribution of focal nests across 5 nesting stages:
   - Stage 1: Egg-laying or incubation; adult lying down in nest for long periods, standing to turn eggs, defecate, or for nest relief
   - Stage 2: Hatching; small (downy) nestlings, or feeding observed low in the nest
   - Stage 3: Nestlings usually standing; most or all of down replaced by juvenal plumage; parent(s) continuously at the nest
   - Stage 4: Adults not continuously at the nest, but may be present for some time after feeding; nestlings usually on the nest platform
   - Stage 5: Young often off the nest, on nearby branches
8. number of adults and chicks on each focal nest
9. prefledging brood size in completely visible broods 4-8 weeks old, for Great Blue Heron
10. type and level of disturbance, observed or inferred: A=avian; H=human; O=observer; M=mammal; W=weather; P=other predator; U=unknown

Levels: 0=none 1=behavioral response only; 2=nest or nestling mortality 3=colony abandonment
11. human land use: a description of human activity and development in the immediate vicinity (within 300 m) of the colonies

Analysis: Reproductive success (rs) is calculated as the product of focal nest survivorship (s) and prefledging brood size (b): rs = *s x b*. Regional estimates should use weighted averages of *s* and *b* among colonies, based on colony size. Variance of reproductive success is estimated following Goodman (1960, *J. Am. Stat. Assoc.* 55:708- 713): var(rs) = [*s*2 (var(*b*)] + [*b*2 (var(*s*)] - [var(*b*) · var(*s*)].

Nest survivorship (*s*) is “apparent” survivorship based on focal nests monitored through the nesting season. Great Blue Heron and Great Egret nests are considered successful if they survive to 8 weeks post-hatch. Snowy Egret and Black-crowned Night-Heron nests are considered successful at 15 days post-hatch, but this level of resolution is not achieved unless monitored frequently.

Prefledging brood size (*b*) is based on the latest counts of completely visible broods observed during Stage 4 (nestlings 4-8 weeks old). During this period, most nestlings are old enough to be standing and visible, but too young to hop away from the nest platform. Most brood reduction in occurs during the first four weeks after hatching (Pratt 1970, *Condor* 72:407-416).

Sample size: Previous (unpublished) data suggest that observations from 65 nests (within or among colony sites) may be adequate to detect a 20% difference in prefledging brood size between consecutive years 80% of the time, with a significance level (a) of 0.10. At some colony sites, the number of brood size observations possible may be substantially limited by incomplete visibility of broods.

Literature Cited:
Kelly, John P. 2002. Bird Focus Group of the Wetland Regional Monitoring Program Plan 2002 - Part 2: Data Collection Protocols Herons and Egrets: Heron and Egret Breeding Distribution, Abundance, and Success

American Beaver

No monitoring protocol established under Terrestrial program.

White-headed woodpecker

Rationale: Suitable white-headed woodpecker habitat includes large patches (greater than 350 acres) of open mature/old growth ponderosa pine stands with canopy closures between 10 - 50 percent and snags (a partially collapsed, dead tree) and stumps for nesting (nesting stumps and snags greater than 31 inches DBH). Maintaining white-headed woodpecker populations will require that this mature/old growth component of ponderosa pine habitat is maintained or enhanced within the Ecoregion.

Limiting Factors: 1) Silvicultural practices that reduce habitat quality; 2) pesticide use; 3) predation/competitors; 4) exotics. (Sec. 5.2.1.2.2)

Assumptions: If ponderosa pine habitat is of sufficient quality, extent, and distribution to support viable white-headed woodpecker populations, the needs of most other ponderosa pine obligate species will also be addressed and ponderosa pine functionality could be inferred.

Sampling Strategy: Survey points will be placed among habitat types of interest using a stratified random design. Number of survey points in each habitat type will be determined using power analysis with the goal of being able to detect a 25% increase in abundance of white-headed woodpecker with a power of 0.8 or greater (pers. comm. Ferguson).

Methods: The method used, point counts, is derived from Dixon (1998)
POINT COUNTS
Each observer will conduct one transect per day individually. Survey low-elevation transects first to assure accessibility. The protocol for point counts will follow standardized methods for variable circular plots (Reynolds et al. 1980, Ralph et al.1995, Hutto and Hoffland 1996), but modified to better census White-headed Woodpeckers.

WHEN TO SURVEY: Point counts should be conducted between April 1 and May 15 when the detectability of White-headed Woodpeckers is highest and most stable. After this period the woodpeckers typically excavate from within the nest cavity and become less visible and less vocal. Counts should begin at official sunrise and end no later than 1030 and 1100. Each transect will be visited once.

POINT COUNTS: Counts will begin as soon as the observer arrives at the station and will be comprised of a 5-minute listening period without the use of tape playbacks followed by a 6-minute sequence of tape playbacks of White-headed Woodpecker calls and drums for a total count of 11 minutes. Data from the two types of counts will be recorded separately-with a code-on a the bird data sheet.

TAPE PLAYBACK PROCEDURE: Tape playback procedures will essentially follow the Payette National Forest Protocol for Broadcast Vocalizations (Payette National Forest 1993). The tape playback sequence should begin immediately after the 5-min unsolicited point count-be ready to start the tape at exactly 5 min. A total of four 30-second tape-playbacks of White-headed Woodpecker drums and calls will be projected at 1-min intervals (e.g. using a Johnny Stewart™ game caller); that is, begin the first sequence of vocalizations to the north. During the one minute pause after the first sequence, rotate 90° for the second sequence, pause, then rotate another 90° for the third sequence of vocalizations after the second one minute break. When the third sequence is complete, rotate 90° for the fourth and final sequence for a total of 6 minutes of tape-playbacks.

WHEN NOT TO SURVEY: Surveys will not be conducted during heavy rain, fog, or when wind interferes with an observer's ability to detect calls (greater than 20 mph). If the weather appears prohibitive, wait 1 to 1.5 hours, or until you cannot reasonably complete the transect by 1100 hours. If the weather puts you in danger, STOP-your safety comes first.

WHAT TO RECORD: Record all species detected, visual or auditory. At the bottom of the data sheet, record any birds you might have detected either before or after a point count, or between stations.

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Grasshopper Sparrow

Rationale: Suitable grasshopper sparrow habitat consists of undisturbed grasslands of intermediate height, often associated with clumped vegetation interspersed with patches of bare ground (Bent 1968; Blankespoor 1980; Vickery 1996). Other habitat requirements include moderately deep litter and sparse coverage of woody vegetation (Smith 1963; Bent 1968; Wiens 1969, 1970; Kahl et al. 1985; Arnold and Higgins 1986). In addition, the grasshopper sparrow like other grassland species shows a sensitivity to the grassland patch size (Herkert 1994; Samson 1980; Vickery 1994; Bock *et al.* 1999). Within the entire Interior Columbia Basin, overall decline in source habitats for grasshopper sparrow (71 percent) was third greatest among 91 species of vertebrates analyzed (Wisdom et al. in press). Maintaining grasshopper sparrow populations will require that native grassland habitat is maintained or enhanced within the Ecoregion.

Limiting Factors: 1) Conversion of native steppe habitat for agricultural purposes, 2) flooding of habitat resulting from hydropower facilities, 3) habitat fragmentation, 4) degradation of existing habitats from overgrazing and introduced weedy vegetation, 5) alteration of historic fire regimes (Sec. 5.2.4.1.2).

Assumptions: 1) Addressing factors that affect eastside (interior) grasslands, will also address sharp-tailed grouse and other grassland obligate species limiting factors. 2) If grassland habitat is of sufficient quality, extent, and distribution (Hyperlink to SHGR requirements and/or recommended conditions) to support viable sharp-tailed grouse and grasshopper sparrow populations, the needs of most other grassland obligate species will also be addressed and grassland functionality could be inferred.

Sampling Strategy: Survey points will be placed among habitat types of interest using a stratified random design. Number of survey points in each habitat type will be determined using power analysis with the goal of being able to detect a 25% increase in abundance of key species with a power of 0.8 or greater.

Methods: We will survey birds on 64 sites in different vegetation types and levels of fragmentation. Each site will have 4 100-m fixed-radius point counts (Ralph et al. 1993) established along a transect and spaced 200m apart (Fig 4). The outer points of the point-count circles will describe a rectangular plot of 16ha that will be the focus of all survey work in Objectives 2-4. Each point will be marked with a permanent fiberglass stake (1m electric fence post) and colored flagging will be placed on shrubs at 50 and 100m from the point in each of the 4 cardinal directions to aid in determining distance. Counts at each point will be 5 minutes in duration during which all birds seen or heard will be noted, along with their sex (if known), distance from the point (within 50m, >50 but <100m, or beyond 100m), and behavior (singing, calling, silent, or flying over the site). Surveys will be conducted once each in May and June and within prescribed weather parameters (e.g., no rain and low wind).

References:

Ralph, C. J., G. R. Geupel, P. Pyle, T. E. Martin and D. F. DeSante. 1993. Handbook of field methods for monitoring birds, Pacific Southwest Research Station, Forest Service, U. S. Department of Agriculture, Albany, CA, pp. 41.

Sage Sparrow, Brewer's Sparrow, Sage Thrasher

Rationale: The main premise for focal species selection is that the requirements of a demanding species assemblage such as sage thrasher, sage sparrow and Brewer's sparrow encapsulate those of many co-occurring less demanding species. By directing management efforts toward the requirements of the most exigent species, the requirements of many cohabitants that use the same habitat type are met. Therefore, managing habitat conditions for a species assemblage comprised of these three species should provide life requisite needs for most other shrubsteppe obligate species.

Limiting Factors: 1) Conversion of native shrub-steppe habitat for agricultural purposes, 2) habitat fragmentation; 3) degradation of existing habitats from overgrazing and introduced weedy vegetation, and 5) brush removal, 6.) wildfire (Sec. 5.2.2)

Assumptions: 1) Addressing factors that affect shrub steppe habitat will address our three-species assemblage; 2) If shrub steppe habitat is of sufficient quality, extent, and distribution to support viable sage thrasher, sage sparrow and Brewer's sparrow populations, the needs of most other shrub steppe obligate species will also be addressed and shrub steppe functionality could be inferred.

Sampling Strategy: Survey points will be placed among habitat types of interest using a stratified random design. Number of survey points in each habitat type will be determined using power analysis with the goal of being able to detect a 35% increase in abundance of key species with a power of 0.8 or greater.

Methods: We will survey birds on 64 sites in different vegetation types and levels of fragmentation. Each site will have 4 100-m fixed-radius point counts (Ralph et al. 1993) established along a transect and spaced 200m apart (Fig 4). The outer points of the point-count circles will describe a rectangular plot of 16ha that will be the focus of all survey work in Objectives 2-4. Each point will be marked with a permanent fiberglass stake (1m electric fence post) and colored flagging will be placed on shrubs at 50 and 100m from the point in each of the 4 cardinal directions to aid in determining distance. Counts at each point will be 5 minutes in duration during which all birds seen or heard will be noted, along with their sex (if known), distance from the point (within 50m, >50 but <100m, or beyond 100m), and behavior (singing, calling, silent, or flying over the site). Surveys will be conducted once each in May and June and within prescribed weather parameters (e.g., no rain and low wind).

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Vander Haegen, W. M., F. C. Dobler, and D. J. Pierce. 2000. Shrubsteppe bird response to habitat and landscape variables in eastern Washington, USA. Conservation Biology 14:1145-1160.

Other Ongoing Research and Monitoring In the Subbasin:

Research

Interior Northwest Landscape Analysis System (INLAS)
A suite of analytical tools (models) that evaluate succession and disturbance dynamics across landscapes and potential changes in ecological and socioeconomic systems. Analyzes vegetation, aquatic, terrestrial species habitat, economic conditions, and socioculture systems at multiple scales (fine, mid, and broad).
USDA, Forest Service. Pacific Northwest Region, La Grande Forest and Range Science Laboratory http://www.fs.fed.us/pnw/lagrande/inlas/index.htm

Effects of Ungulates on the Ecosystem (Starkey Project)
The Starkey Project involves four major studies that document deer, elk and cattle response to intensively managed National Forests. Research animal numbers within the Starkey enclosure include 550 cow-calf pairs, 450 elk and 250 deer. Primary studies include, Breeding Bull Efficiency, Roads and Traffic, Animal Units, and Intensive Forest Management.
USDA, Forest Service. Pacific Northwest Region, La Grande Forest and Range Science Laboratory
http://www.fs.fed.us/pnw/starkey/

Sagebrush Landscape Project
The project conducts research on habitats for species of conservation concern in the sagebrush ecosystem. Current work includes, identifying regional assessment procedures to evaluate multiple species of concern in sagebrush ecoregions; develop methods to address systematic and defensible trade-offs between single versus multiple species for land use planning; complete a regional assessment in the Great Basin Ecoregion; and provide guidance for effective multi-species planning at regional scales.
USDA, Forest Service. Pacific Northwest Region, La Grande Forest and Range Science Laboratory
http://www.fs.fed.us/pnw/lagrande/sagebrush/index.htm

Effects of Reintroducing Fire in Eastside Ponderosa Pine Forests
Throughout the West, forest managers are interested in prescribing a series of repeated underburns in an attempt to return fire to pre-exclusion frequencies and to maintain and protect old-growth structural characteristics that are important for wildlife. Yet there is little quantitative information available on the effects of repeated prescribed fires. This study will help fill that void.
USDA, Forest Service. Pacific Northwest Region, La Grande Forest and Range Science Laboratory
http://www.fs.fed.us/pnw/lagrande/dem/metolius.htm

Eastside Forest Prescribed Fire Study
The intent of the study is to document effects of both fall and spring prescribed burning on forest songbirds by comparing avian nesting success and productivity between burned units and unburned controls. Direct comparison of fall vs. spring burns also may be possible. The results will be applicable to a range of dry forest conditions (ponderosa pine, dry Douglas fir, and dry grand fir habitats) throughout the region.
The Sustainable Ecosystems Institute and USDA Forest Service, Wallowa-Whitman National Forest, Baker City, OR

Inventory and Monitoring

Current Vegetative Survey (CVS)
A plot-grid system on National Forest lands in the Pacific Northwest that collect data on all above ground vegetation (live and dead). The collected data is used to answer questions about a particular resource area, used for resource planning at a broad scale.
USDA, Forest Service. Pacific Northwest Region. http://www.fs.fed.us/r6/survey/

Monitoring Avian Production and Survivorship (MAPS)
The program provides annual indices of adult populations size and post-fledging productivity, as well as annual estimates of adult survivorship, recruitment into the adult population, and population growth rate as multiple spatial scales for many landbird species. The Umatilla and Wallowa-Whitman National Forests have six MAPS stations in various habitats on the Forest. The study was initiated in 1992 and is expected to terminate in 2004.
The Institute for Bird Populations, Point Reyes Station, CA

Terrestrial Wildlife Inventory on CVS Plots
Conduct a variety of wildlife surveys on CVS plots across the Umatilla National Forest. The intent is to provide basic occurrence and distribution data for project planning and Forest Plan monitoring. Habitat relationships for some species in general forest vegetation types may be possible.
USDA, Forest Service. Umatilla National Forest, Pendleton, OR.

Designated and Managed Old Growth Monitoring
Determine changes in inventoried old growth habitat and effects of projects on old growth (maintain integrity of old growth units). Determine if old growth habitat is meeting management objectives (characteristics, species, etc.). Conduct inventories or surveys to validate all old growth and dedicated habitat units documenting suitability and use.
USDA, Forest Service. Umatilla National Forest, Pendleton, OR.

Inventory Basic Watershed Resources
Proper management of Forest watersheds requires a good understanding of its basic components - soil, water, climate, and vegetation. The Umatilla National Forest upgrades its resource information base by conducting the following inventories and surveys: soil, water, fishery resources, potential watershed, improvement projects, and riparian zones (areas adjacent to streams and lakes)
These watershed surveys provide vital information for improving the management of surface water resources.
USDA, Forest Service. Umatilla National Forest, Pendleton, OR.

Monitoring Water Temperatures
Annually, thermographs are deployed in streams across the Forest to record water temperatures changes through the year. Instruments are collected at the end of the year and data is downloaded and used to evaluate stream condition.
USDA, Forest Service. Umatilla National Forest, Pendleton, OR.

Managed Species Monitoring

Big Game:

Definition: Big game mammals in the state of Oregon are defined as deer, elk, pronghorn, bighorn sheep, Rocky Mountain goat, black bear, and cougar.

Why: Big game mammals are managed species in the state of Oregon, which are subjected to recreational harvest by the hunting public. As a result, the Oregon Department of Fish and Wildlife is required to monitor the composition and population size of managed species in order to determine biological surpluses to be allocated each year.

Harvest: For each species, harvest statistics of hunter harvested animals are collected through the use of hunter telephone surveys. The harvest statistics are gathered to achieve a statistical confidence of 90% with 10% error.

Reference:

Composition counts: All composition counts conducted by the Oregon Department of Fish and Wildlife on big game mammals seek to achieve an 80% confidence with 20% error as a minimum precision for each count.

Reference:

Mule Deer: One composition count in late November or early December to determine the number of bucks per 100 does present in the population. In addition, a subordinate count on the number of fawns per 100 does is obtained at that time. A second composition count or trend count is obtained in the spring, usually in March or early April. The spring count provides a measure of winter fawn survival in the form of the number of fawns per 100 adults. In the case of computer modeled populations, the spring count is a composition count only. Where population size is determined from an observed index, the count serves as a trend measurement as well.

Reference: Oregon Department of Fish and Wildlife. 2003. Oregon's mule deer management plan. Salem, Oregon, USA.

Elk: One helicopter composition count is conducted in March or early April. The count derives a statistically measured estimate of the number of bulls and calves per 100 cow elk. In the case of computer modeled populations, the count is a composition count only. Where population size is determined from an observed index, the count sometimes serves as a trend measurement as well. In other cases a second trend flight using a fixed wing aircraft is conducted in April, which only observes the total number of elk observed.

Reference: Oregon Department of Fish and Wildlife. 2003. Oregon's elk management plan. Salem, Oregon, USA.

Bighorn Sheep: There are no bighorn sheep in the Umatilla Sub-Basin. In the John Day Sub-Basin one composition count is conducted in March to determine the number of post winter lambs per 100 ewes and to obtain a ram age structure count. An additional count of prewinter lamb production is conducted in late May or early June.

Rocky Mountain Goat: There is no functioning population of Rocky Mountain goats in either the Umatilla or John Day sub-basins. A small number of individual goats have taken up residence in the Strawberry Mountains of the John Day sub-basin, but no structured counts have been established.

Reference: Oregon Department of Fish and Wildlife. 2003. Oregon's bighorn sheep and Rocky Mountain goat management plan. Salem, Oregon, USA.

Pronghorn: In the Umatilla Sub-Basin, the pronghorn population is monitored when the opportunity arises since the population is almost entirely on private land and structured ground based counts are not feasible. Currently there is no excess flight time available to monitor pronghorn populations in the Umatilla Sub-Basin.

In the John Day Sub-Basin, a winter trend count is conducted in late February, which is used to assess whether the population is increasing, decreasing, or stable. An aerial composition count is conducted in late July or early August which is used to determine the number of fawns per 100 does and the number of bucks per 100 does.

Black Bear: Teeth are collected voluntarily on hunter harvested bears and all bears taken on damage complaints to determine age structure as a measure of trend in the average age of bears. A trend toward younger age bears in the population would indicate harvest rates in excess of recruitment. A trend toward older age structure would indicate harvest lower than recruitment to the adult age classess. Reproductive tracts are also collected voluntarily from hunter harvested female bears and all female bears taken on damage complaints to gain a measure of reproductive capability.

Reference: Oregon Department of Fish and Wildlife. 1992. Oregon's black bear management plan. Salem, Oregon, USA.

Cougar: Managed with an emphasis on the dame data collection as black bears except that all hunter harvested cougars are required to be checked in. Teeth are removed from all cougars when they are checked in at an ODFW office. If the cougar is a female and the reproductive tract is present at the time of check-in, the reproductive tract is also taken.

Reference: Oregon Department of Fish and Wildlife. 1993. Oregon's cougar management plan. Salem, Oregon, USA.

Non-Game Wildlife Monitoring Activities By the OREGON DEPARTMENT OF FISH AND WILDLIFE

Type of Monitoring: Winter Raptor Counts. Conducted in several routes of specific length.
Timing: January or February.
Frequency: Annually
Purpose: Trend of wintering raptors
Location: Heppner and Umatilla Wildlife Districts
Level of Analysis: No statistical analysis

Type of Monitoring: Shrub steppe, grassland species monitoring through point counts (ferruginous hawk, grasshopper sparrow, loggerhead shrike, and Washington ground squirrels)
Timing: Spring. Began in 2003
Frequency: Once every three years
Purpose: Population estimates of species
Location: Boardman Conservation Area.
Level of Analysis: Statistical bounds on population estimates.

Type of Monitoring: Gull and Caspian tern and goose nest surveys on Columbia River islands.
Timing:. Late March or early April
Frequency: Annually
Purpose: Trend
Location: Columbia River Islands near Boardman, Oregon
Level of Analysis: No statistical analysis

Type of Monitoring: Golden Eagle and Perregrin falcon survey on lower John Day R.
Timing:. Late May
Frequency: Annually
Purpose: Trend
Location: Lower John Day River from Butte Creek to Cottonwood bridge.
Level of Analysis: No statistical analysis

Type of Monitoring: Bald eagle nest monitoring
Timing:. April and May
Frequency: 2 to 3 visits annually
Purpose: Count of nests for Oregon as well as avg. nest success
Location: John Day River system
Level of Analysis: No statistical analysis

Type of Monitoring: Winter bald eagle survey
Timing:. January 1 - 15
Frequency: Annually
Purpose: Total count of wintering bald eagles in Oregon
Location: 199 miles of John Day River and tributaries (mainstem, south fork, and lower north fork)
Level of Analysis: Direct count with no statistical analysis

Type of Monitoring: Breeding Bird survey conducted for US Fish & Wildlife Service
Timing:. June
Frequency: Annually
Purpose: Trend of breeding birds on a national and species scale
Location: Fixed route from Logan Valley to mainstem John Day River
Level of Analysis: no statistical analysis conducted by ODFW

Ongoing Research:

Wenaha/Sled Springs Elk Predation Nutrition Study. Study is designed to statistically measure the effect of nutrition of cow elk and predation of elk calves to determine the most significant cause of low calf survival in the study area. The study is occurring outside the sub-basin, but has management implications inside the Umatilla and John Day sub-basins