EVALUATING WATERSHED RESPONSE TO LAND MANAGEMENT AND RESTORATION ACTIONS:

INTENSIVELY MONITORED WATERSHEDS (IMW) 2005 PROGRESS REPORT

Submitted to

Washington Salmon Recovery Funding Board

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Prepared by

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EXECUTIVE SUMMARY

The Intensively Monitored Watershed (IMW) program has been funded by the Salmon Recover Funding Board (SRFB) since June 2003 to evaluate the efficacy of habitat restoration in increasing salmon production. The basic premise of the IMW program is that the complex relationships controlling salmon response to habitat conditions can best be understood by concentrating monitoring and research efforts at a few locations. Focusing efforts on a relatively few locations enables enough data on physical and biological attributes of a system to be collected to develop a comprehensive understanding of the factors affecting salmon production in freshwater.

There are three sets of IMW sites (complexes) in western Washington focusing on coho salmon, and steelhead and cutthroat trout and two areas focusing on chinook salmon; the Skagit River estuary (ocean-type chinook) and the Wenatchee River (river-type chinook) (Figure 1).

This report describes progress to date and outlines restoration and research plans for FY 2006.

INTRODUCTION

The Intensively Monitored Watershed (IMW) program has been funded by the Salmon Recover Funding Board (SRFB) since June 2003 to evaluate the efficacy of habitat restoration in increasing salmon production. The basic premise of the IMW program is that the complex relationships controlling salmon response to habitat conditions can best be understood by concentrating monitoring and research efforts at a few locations. Focusing efforts on a relatively few locations enables enough data on physical and biological attributes of a system to be collected to develop a comprehensive understanding of the factors affecting salmon production in freshwater.

There are three sets of IMW sites (complexes) in western Washington focusing on coho salmon, and steelhead and cutthroat trout and two areas focusing on chinook salmon; the Skagit River estuary (ocean-type chinook) and the Wenatchee River (river-type chinook) (Figure 1). The Wenatchee River monitoring is funded largely through a grant from Bonneville Power Administration and is described in Hillman (2003).

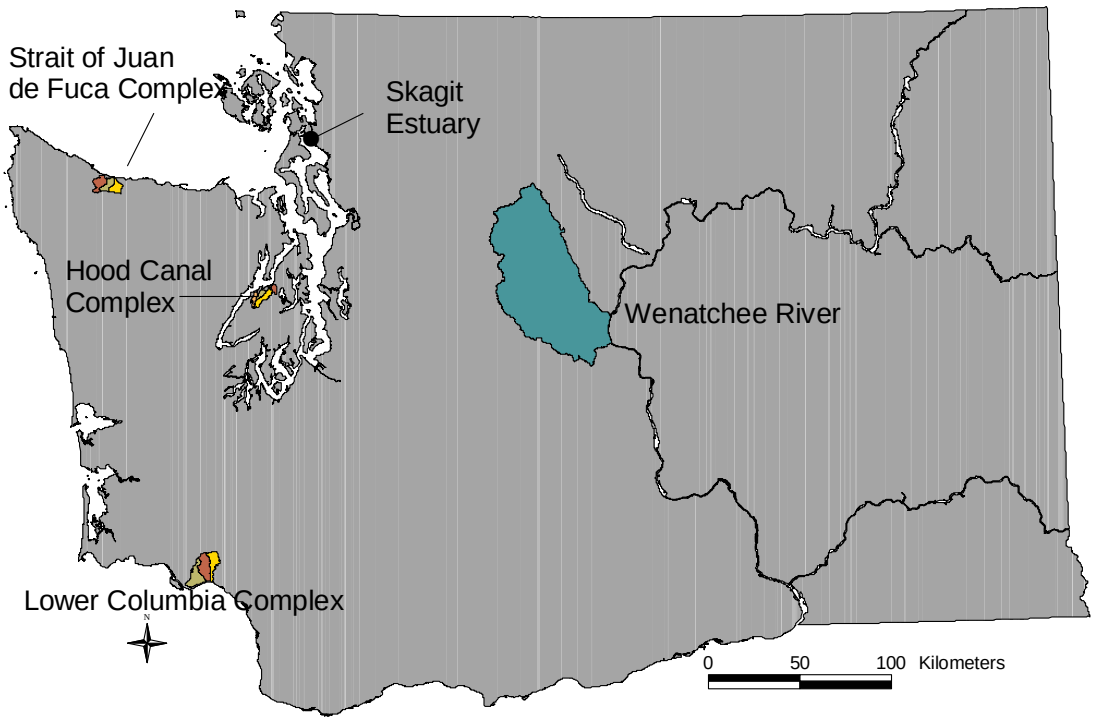

Figure 1. Locations of the three IMW basin complexes, Straits Juan de Fuca (SJF), Hook Canal, and Lower Columbia, and two chinook salmon IMW's, Skagit Estuary and Wenatchee basin**.**

Fiscal year (FY) 2005 (July, 04-June 05) was the first year of full implementation. Previous reports have described the sites and the general study plan in detail (Bilby et al. 2004). This

report focuses on the progress to date in meeting the objectives listed in Attachment C (Statement of Work) to the Amendment to IAC Project Agreement, Project Number 03-1205N and the monitoring and research planned for the next fiscal year. Study plans for each IMW complex will be ready for review by the Independent Science Panel in December 2005. Study plans for the Skagit River (http://www.skagitcoop.org/) and Wenatchee River (http://www.cbfwa.org/committees/Documents.cfm?CommShort=RTT) are available online.

OBJECTIVES OF THE IMW PROJECT AGREEMENT

The objectives for FY2004 were:

1. Monitor smolt outmigration and spawner escapement in all 10 streams included in the Strait of Juan de Fuca, Hood Canal and Lower Columbia IMW complexes.
2. Determine summer juvenile fish abundance in all 10 streams in the Strait of Juan de Fuca, Hood Canal and Lower Columbia IMW complexes.
3. Conduct habitat assessments in all 10 streams in the Strait of Juan de Fuca, Hood Canal and Lower Columbia IMW complexes and integrate the data into a GIS-based data management system.
4. Conduct water quantity and quality monitoring in all 10 streams in the Strait of Juan de Fuca, Hood Canal and Lower Columbia IMW complexes and post the data to Ecology's web site as collected and verified.
5. Work with the Skagit River System Cooperative, NOAA-Fisheries Northwest Fisheries Science Center, and WDFW to implement monitoring to test the effectiveness of estuary restoration projects on juvenile Skagit River chinook salmon.
6. Provide progress update to SRFB as needed, issue joint written progress report, and make project information available through the Natural Resources Data Portal.

In addition to the objectives above, we are working with NOAA-Fisheries Northwest Fisheries Science Center on a landscape classification scheme to determine the applicability of the IMW results across Washington State (Objective 7). Because only a few watersheds can be included in the IMW project, extension of the results to other watersheds cannot be accomplished by the traditional method of increasing the sample size (number of watersheds monitored) until a sufficient level of statistical certainty is achieved. Instead, watersheds across Washington State will be classified based on similarity of physical and biological characteristics and patterns of land use. Watersheds which have biophysical characteristics and patterns of human activities comparable to IMW sites will be locations where IMW results can be extended with the greatest degree of certainty.

Objectives 1-4

Objectives 1 through 4 are specific to the collection and accessibility of the baseline biological and physical data in the three IMW complexes in western Washington (Strait of Juan de Fuca, Hood Canal, and Lower Columbia). These tasks are similar across all basins and progress to date is described below (Table 1).

Table 1. Variables measured in all three coho, steelhead, and cutthroat IMW complexes.

	Frequency	Status	Data available
Water Quality & Quantity			
Flow	Continuous	all gauges operational	https://fortress.wa.gov/ecy/wrx/wrx/flows/regions/state.asp
Climate	Continuous	Equipment ordered but not yet installed	N\A
Water temperature	Continuous	Measured at all flow gauges Basin wide monitoring since May 05	https://fortress.wa.gov/ecy/wrx/wrx/flows/regions/state.asp
Water chemistry	Monthly	Measured since Oct 2004	http://www.ecy.wa.gov/programs/eap/fw_riv/rv_main.html
Habitat			
Hankin & Reeves survey	Annual	Accessible anadromous habitat in Lower Columbia completed	Database under development
Probabilistic sampling	Annual	All seven target basins completed.	Database under development
Fish			
Smolt production	Annual	2004 data reported, 2005 data collection in progress	http://wdfw.wa.gov/fish/wild_salmon_monitor/publications.htm
Juvenile abundance	Annual	Completed	Database under development
Spawners	Annual	Completed	Database under development

Water Quantity and Quality

- *Stream Flow*-Continuous stage height recorders are operational in all basins and data are available online.
- *Climate* recording equipment has been ordered and will be installed by September 2005.
- *Water temperature* is measured at all flow gauges and temperature loggers were deployed throughout each basin in April 2005 to record changes in water temperature from headwaters to the mouth.
- *Water chemistry*-Water samples have been collected since October 2004 for chemical analysis at the gauge site. These sites have been folded into the Department of Ecology's ongoing ambient stream monitoring.

Habitat

Two methods of collecting habitat data were employed; a spatially continuous, temporally infrequent survey based on the basinwide methods developed by Hankin and Reeves (H-R)

(Hankin 1984, Hankin and Reeves 1988) and a spatially discontinuous, temporally frequent survey based on methods developed by the U.S. Environmental Protection Agency's Environmental Monitoring and Assessment Program (EMAP) (Kaufmann et al. 1999, Peck et al. 2001). The H-R assessment will be repeated following major floods or other events that are likely to cause major changes to habitat. The EMAP measures will be repeated annually.

- Hankin and Reeves-The H-R-based approach was conducted in all the entire anadromous zone in Mill Creek and Abernathy Creek, in the Lower Columbia Complex, and in Big Beef Creek in the Hood Canal complex to provide initial estimates of habitat abundance and distribution (Hankin and Reeves 1988).

- The EMAP-based approach (Table 2) was conducted on 10 randomly selected sites in each basin on the Hood Canal complex and Straits complex (Simonson et al. 1994, Angermeier and Smogor 1995). These measurements will be taken at all three complexes in 2005 and repeated annually.

- Both datasets are being integrated into a common GIS database to facilitate transfer.

Table 2. Habitat measurements and calculated metrics procured using the EMAP sampling protocol.

Measurements	Metrics
bankfull width	width-depth ratio
wetted width	channel confinement
valley width	average pool depth
cross-section depth	residual pool depths
channel type	Substrate size distribution
substrate size counts	bank stability
bank angle	bank cover
riparian cover proportions	Shading
canopy cover	LWD size distribution
embededness	channel slope
channel slope	channel sinuosity
channel bearing	water flow profile
woody debris talley	
thalweg profile	
bar width	
pool-forming process	
backwater talley	
fish cover proportions	
Human influence proportions	
incised height	
water flow	

Fish

- *Smolts*- The smolts leaving each of the 10 watersheds in the three complexes were monitored in spring 2005. Smolt production estimates for spring 2004 for the Hood Canal and Lower Columbia complexes are included in Appendix A to this report.
- *Juveniles*-Juvenile fish were collected by electroshocking from randomly-selected stream reaches in all 10 study watersheds during summer 2004. Captured fish were marked, either by clipping the adipose fin or using PIT tags, and released. Tagged fish were enumerated at the smolt traps during spring 2005 outmigration. The rate of recapture of the tagged fish and the ration of tagged to untagged smolts enable us to estimate overwinter survival and summer juvenile population size. These values will be reported in the June 2006 progress report along with the 2005 smolt production estimates.
- *Spawners*-Spawner and redd counts and location within the stream system were recorded at approximately weekly intervals throughout the spawning period. These data have been compiled and are being integrated into a spatial database linked to the GIS stream coverage to evaluate changes in distribution over time as a function of restoration or other effects. Online links to the database will be made available in 2005.

Objective 5. Skagit River chinook

The IMW oversight committee entered into an agreement with the Skagit River System Cooperative and NOAA-Fisheries NWFSC to supplement ongoing monitoring of chinook salmon in the Skagit River delta (SRSC) and Skagit Bay (NWFSC) in order to detect changes in juvenile chinook abundance, distribution, growth, and survival due to estuary restoration projects. Monitoring has been underway since February 2005.

Objective 6. Reporting and data availability

The progress report serves as our update to the SRFB. Study plans for each IMW complex will be updated and ready for review by the Governor's Independent Science Panel in December 2005. Individual datasets may be obtained via the web sites listed in Table 1. The databases listed as under development are being incorporated into a GIS spatial database. These data will be housed at WDFW or Department of Ecology, updated annually, and made available online.

Objective 7. Landscape classification and extrapolation of results

Because only a few watersheds can be included in the IMW project, extension of the results to other watersheds cannot be accomplished by the traditional method of increasing the sample size (number of watersheds monitored) until a sufficient level of statistical certainty is achieved. The initial goal of the (IMW) extrapolation exercise is to classify and group watersheds with similar physical, biological and anthropogenic impact characteristics in relation to the watersheds where intensive watershed monitoring will be conducted. Ultimately, the classification process will indicate the set of watersheds where the results from the IMW monitoring can be extrapolated, inform the design and distribution of future restoration and monitoring projects, and support the interpolation or imputation of data across regions of the state not monitored as intensively as the IMWs. [0]

This objective was described in terms of five sequential tasks in the 2004 Progress Report. These are listed below with timelines for completion.

Task 1 Describe immutable and human impacts characteristics of watersheds. Compilation of these base data layers was completed by November 1, 2004.

Task 2 Classification of watersheds using base layers. Completed December 1, 2004.

Task 3 Ordination of classified watersheds. Preliminary ordination runs done by Jan. 15, 2005. Refinements and improvements continue, with major reporting of progress on a quarterly basis through calendar year 2005.

Task 4 Testing and application of resulting predictive maps. Test of preliminary ordination runs to be completed by Feb. 1, 2005 and updated quarterly through calendar year 2005.

Task 5 Review, revision and expansion of approach Revised and updated project will be ready for peer review by Dec. 31, 2005.

The potential broad-scale utility of this work demands a rigorous peer review of its results and methodology. NOAA-Fisheries NWFSC is leading this component of the IMW project, and will make use of its existing peer review process, but will also include the Independent Science Panel or other technical review group, as requested. As a result of the technical review process, necessary modification and improvements will be implemented. In addition, NOAA-Fisheries is interested in applying a similar approach on a PNW region-wide basis. Therefore, when the methodologies have been sufficiently refined, the project will be extended to cover at least the three state area of Oregon, Washington and Idaho.

IMW COMPLEXES

The SRFB's IMW Program funding directly supports monitoring and research in three IMW complexes and the Skagit River estuary. The IMW complexes focus on coho salmon, steelhead and cutthroat trout in smaller watersheds and the Skagit project focuses on the effects of estuary restoration on ocean-type chinook salmon. Below we summarize the current fish production and spawner data and outline the restoration plan and monitoring planned for the next fiscal year. Detailed smolt and spawner data for the Hood Canal and Lower Columbia Complexes are included in Appendix A.

The three coho/steelhead/cutthroat IMW watershed complexes vary in physical characteristics, land use patterns, climate and relative abundance of the focal species (Table 3) as well as the length of the outmigrant monitoring record. The range in conditions will enhance our ability to extend our results to other watersheds and will provide an opportunity to address a wider range of factors contributing to habitat degradation than would be the case if all watersheds were similar.

Table 3. Characteristics of the three watershed complexes in western Washington.

	Straits of Juan De Fuca	Hood Canal	Lower Columbia
Watersheds	**West Twin East Twin Deep**	**Stavis Little Anderson Seabeck Big Beef**	**Germany Abernathy Mill**
Focal Species	**coho steelhead cutthroat**	**coho cutthroat steelhead**	**coho steelhead cutthroat (chum, chinook)**
Land Use	**forestry – private, state, and federal**	**urban, rural residential, forestry – private and state**	**forestry - private and state**
Total Area	**111 km^2**	**75 km^2**	**206 km^2**
Geology	**mixed sedimentary and metamorphic**	**glacial till**	**flow basalt w/ interbedded sandstone**
Precipitation	**190 cm**	**105 cm**	**160 cm**

Strait of Juan de Fuca

The watersheds in this complex (West Twin Creek, East Twin Creek, and Deep Creek) have been logged since the late 19th century. As a result, much of the wood that historically created pools and regulated the movement of sediment and organic matter in these watersheds had been depleted. Wood loss contributed to channel incision at some sites, isolating the floodplain and reducing access to off-channel habitats. In response to declines in habitat quality and in populations of native anadromous fish, the Lower Elwha Klallam Tribe has been actively attempting to restore fish populations. A restoration strategy, based on a watershed analysis (USFS 2002) was developed with the goal of reestablishing the dominant physical processes that control the identified limiting factors, including:

- Reduction in the rate of mass wasting to historical background rates
- Reestablishment of late successional, conifer-dominated riparian forests.
- Reintroduction of functional, high quality in-channel LWD.
- Restoration of off-channel habitats.

Of all the watershed complexes, this location offers the best opportunity for maintaining the integrity of control and treatment watersheds. The watersheds are almost completely owned by USFS, the Washington Department of Natural Resources, and one private forestry company (Figure 2). We have the cooperation of these organizations. Relatively little timber harvest or road construction will occur in these watersheds over the next decade. Therefore, interpreting any responses of the fish to the restoration treatments at the watershed scale will not be complicated by other activities that might affect habitat condition.

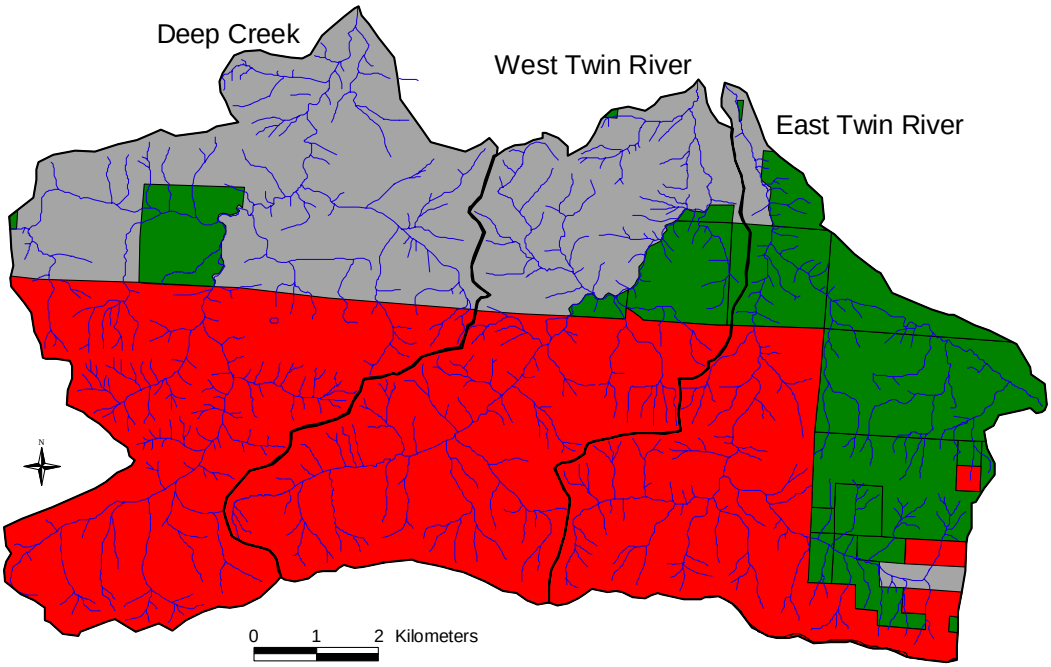

Figure 2. Deep Creek and Twin Rivers watersheds. USFS land is shown in red, Washington Department of Natural Resources in green, and private ownership in gray.

Fish Production

Populations of fall chum (*Oncorhynchus keta*), fall coho salmon (*Oncorhynchus kisutch*), winter steelhead (*Oncorhynchus mykiss*), and resident and anadromous cutthroat trout (*Oncorhynchus clarki*) utilize the Deep Creek and Twin Rivers watersheds (Table 4). Pacific lamprey (*Lampetra tridentata*) and sculpins *(Cottus sp.)* also are present in each drainage. Historical accounts mention chinook salmon (*Oncorhynchus tshawytscha*) in these watersheds but it is unclear if these were the results of hatchery outplants that occurred in the 1970's. Chinook salmon have not been observed in recent years.

Table 4. Status of salmonid stocks in the Deep/Twins Watershed.

Species	Race	Production	Stock origin	Stock status (WDF et al. 1993)	Stock status (McHenry et al. 1996)
Chum	Fall	Wild	Native	Healthy	Critical
Coho	Fall	Wild	Mixed	Depressed	Stable
Steelhead	Winter	Wild	Unresolved	Healthy	Depressed

Strait of Juan de Fuca stocks of coho salmon have been depressed for several decades and reached their lowest levels on record in the early to mid-1990s. The Pacific Fisheries

Management Council reviewed the status of coho populations in the Strait of Juan de Fuca (SJF) region and concluded that none of the 48 independent drainages in this region supported healthy coho stocks. The study concluded that SJF coho populations as a whole are negatively impacted by low freshwater survival, low marine survival rates and high marine interception rates.

Sporadic spawning ground surveys by WDFW in Deep Creek from 1950 to 1970 reported counts as high as 206 fish/mile (330 fish/km). Repeatable surveys of index areas have been conducted in Deep Creek and Sadie Creek (E Twin tributary) since 1984 by WDFW. These index areas provide an indication of trends, but cannot be reliably expanded into an estimate of watershed-level spawner abundance. Significant efforts have been made since 1998 to improve estimates of total spawning salmon abundance in Deep Creek and East and West Twin rivers. A habitat based system of spawning ground surveys was initiated in 1997 involving WDFW and the Makah and Lower Elwha Klallam Tribes. A random stratified sampling system of available habitat types was instituted. This new system enables estimation of total escapement for each of the three watersheds in this complex (Figure 3). Relative escapement to each individual watershed has been consistent for four of the five years from 1997 through 2002 with Deep Creek supporting the highest number of spawning coho followed by West Twin then the East Twin River. Deep Creek exhibited a decline in spawner abundance relative to the other two watersheds in 2002.

Formal steelhead escapement surveys were only initiated in 1998 limiting the ability to determine long-term trends in watershed escapement (Figure 4). However, the data from 1998 through 2003 suggests that the relative abundance of adult steelhead among the three watersheds is consistent. This stock is currently managed for wild production and no hatchery outplants have been released in the Deep/Twin complex since the early 1980's. Winter steelhead adults enter the watershed beginning in December and continue through May. Spawning occurs in February through early June.

Smolt trapping was initiated by the Elwha Klallam Tribe in Deep Creek in 1998 and in the East and West Twin Rivers in 2001. Traps, consisting of a fence weir and live box, capture the entire population of emigrating smolts. Trapping begins in late April and continues through mid-June with peak outmigration in late May. Data collected to date are in Figures 5 and 6. As with the adult counts, interannual variation in smolt production appears consistent among the three watersheds.

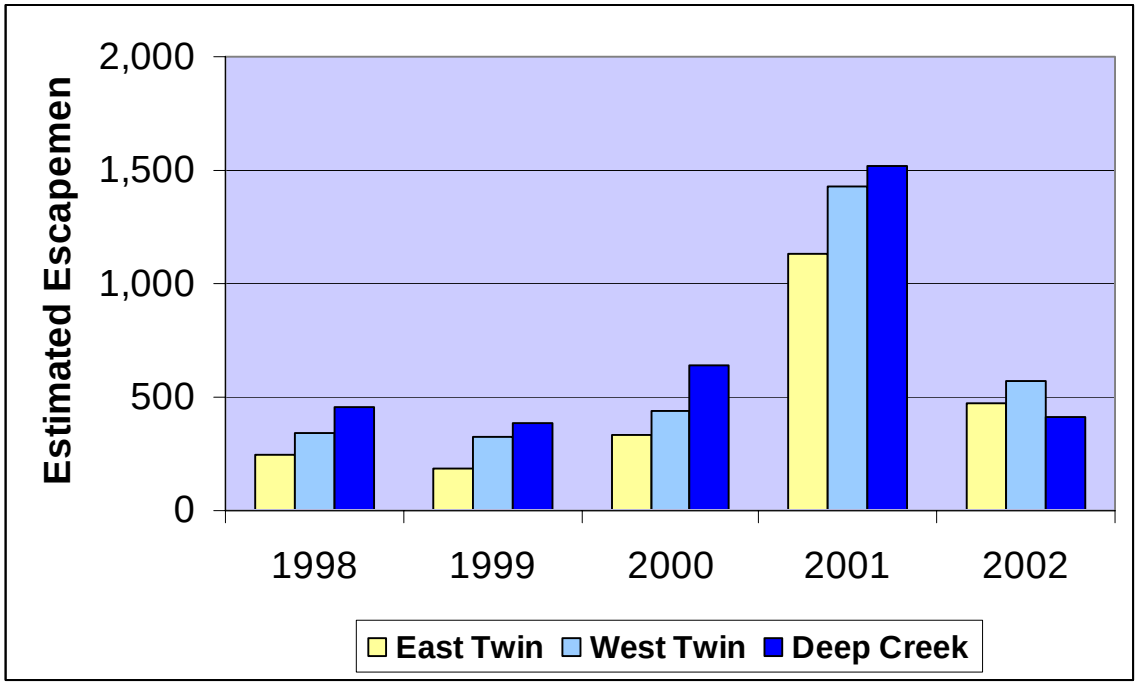

Figure 3. Coho salmon escapement to Deep Creek and East Twin and West Twin Rivers, 1998-2002.

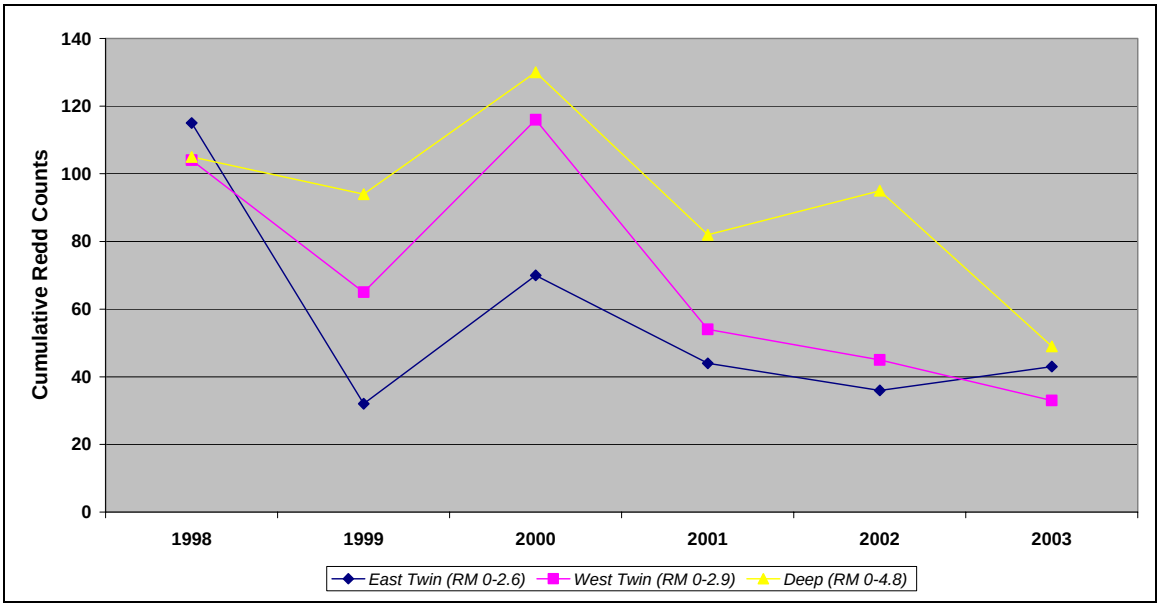

Figure 4. Steelhead escapement to Deep/Twin Rivers, 1995-2004.

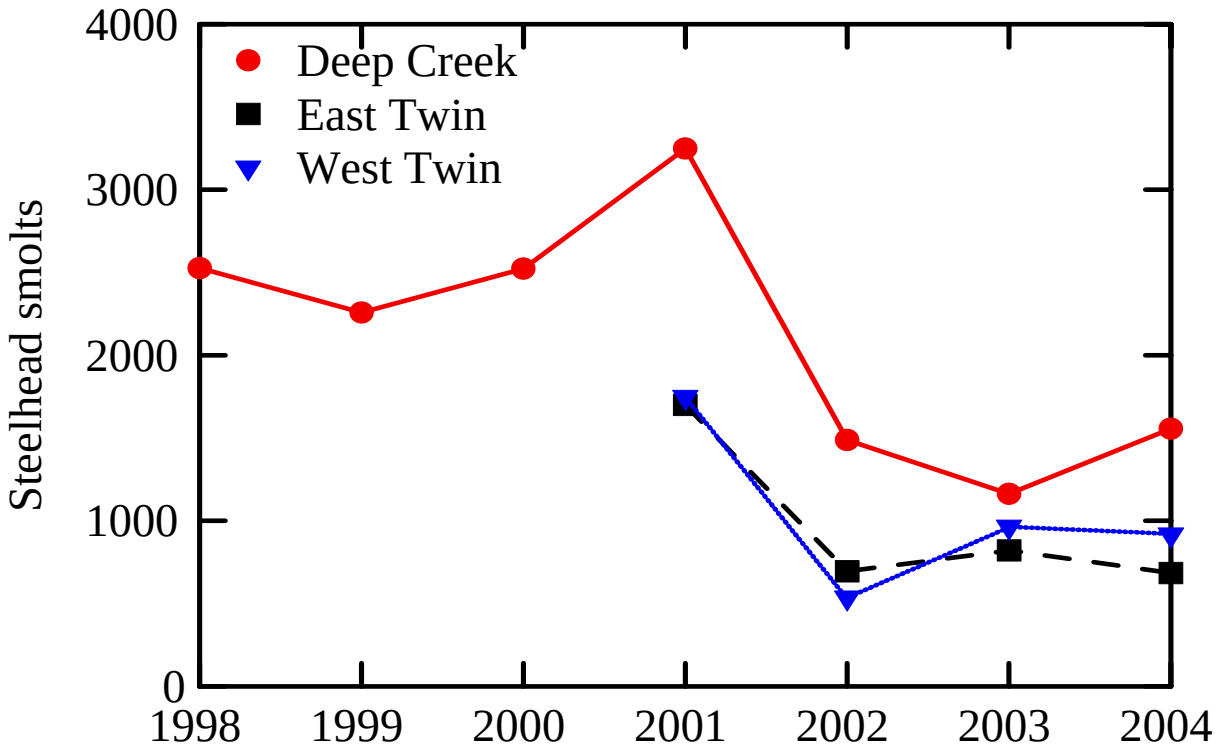

Figure 5. Steelhead smolt production from Deep/Twin Rivers, 1998-2004.

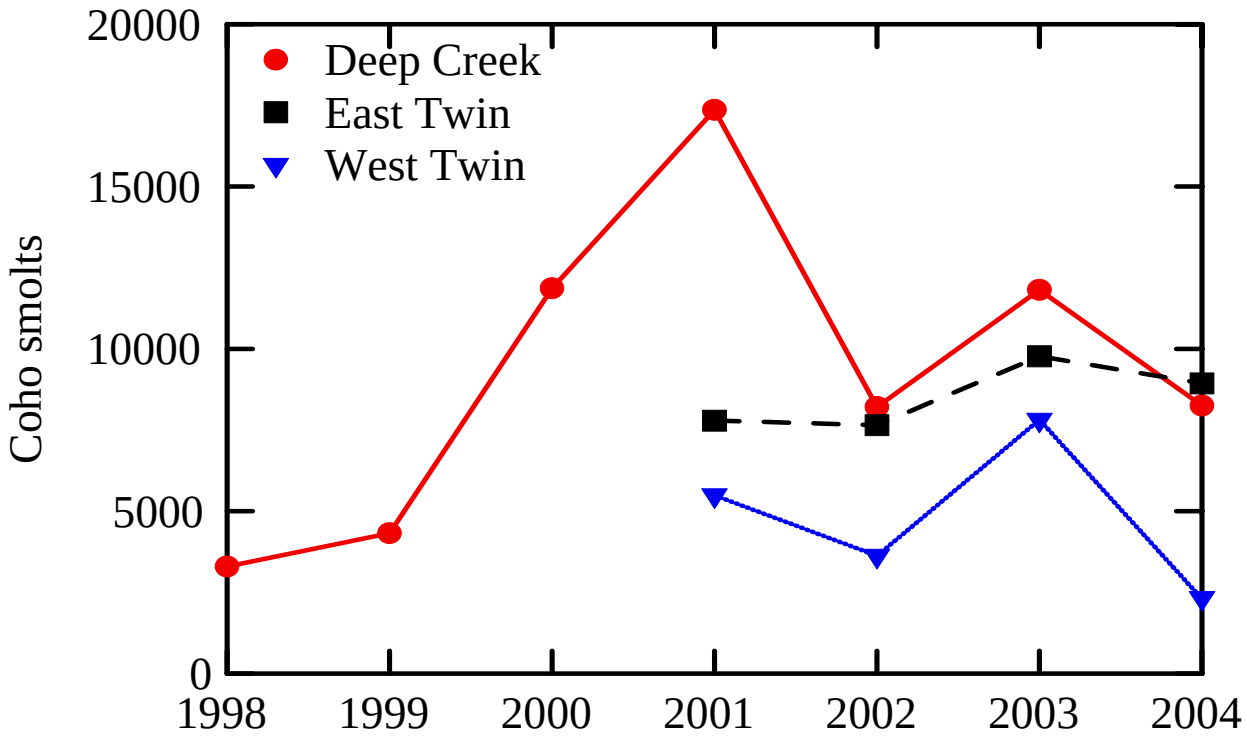

Figure 6. Coho smolt outmigration from Deep/Twin Rivers, 1998-2004.

Restoration

Restoration efforts in Deep Creek were initiated in 1997 by the Elwha Klallam Tribe and have continued through 2004 (Table 5). Tribal efforts have focused upon reestablishment of late successional, conifer-dominated riparian forests, reintroduction of functional, high quality in-channel LWD, and restoration of off-channel habitats.

Several factors were identified that contributed to the degradation of conditions in Deep Creek and this understanding helped guide the deployment of restoration projects. Above RM 1.3, the 1990 dam-break flood resulted in severe scour of the bed and the almost complete loss of in-channel LWD. Conversely, below RM 1.3, the impacts were primarily associated with sediment aggradation (pool filling, widening) which created very unstable channel conditions. Because of the channel instability observed below RM 1.3, restoration activities were initiated above this point (RM 1.3 to 4.0). LWD was placed in an attempt to convert this plane-bed reach into a forced pool-riffle reach. Over 1,000 individual pieces of LWD have been used in the following configurations: log revetments (2), engineered log jams (2), rock weirs (17), constructed log jams (59), deflectors (19), log weirs (13), and rock/log structures (12). In 2004 restoration activities focused on the lower reaches of Deep Creek (RM 0 to 1.8) and 17 locations have been identified for installation of large, complex logjams. To date, 3.0 miles of Deep Creek and 0.5 mile of Gibson Creek, a tributary, have received in-stream restoration treatments (Table 6), while riparian vegetation improvements have been conducted on 2.5 miles of riparian forest. An additional four off-channel habitat projects have been implemented.

Restoration efforts in the East Twin River were initiated in 1998, when an off-channel rearing pond was constructed on private property near river mile 1.0 (km 1.6). Large scale LWD reintroductions were initiated in 2002 by the Elwha Klallam Tribe through a Salmon Funding Recovery Board grant. In the summer of 2002 over 450 metric tons of large LWD was placed with a helicopter into Sadie Creek at forty sites in river mile 0-2.0 (km 0.0-3.2) and at 30 sites in the East Twin River in river mile 2.0-3.0 (km 3.2-4.8). These efforts were followed in 2003 with ground-based placement at an additional 35 sites in the East Twin at river mile 1.2-2.0 (km 2.0 and 3.2).

Table 5. Summary of in-channel restoration activities conducted on Deep Creek, 1997 to 2004.

Year Constructed	Number of Structures	
	Deep Cr	East Twin R
1997	40	
1998	53	
1998	7*	
1999		1
2000	25	
2002	25	70
2003		35
2004	17	

*sponsored by Clallam Conservation District

During December of 1999, the north Olympic Peninsula was struck by an intense rainstorm that generated a 120-year flood on the nearby Hoko River. Of the 100 structures constructed through 1999, only 14 failed. All structures that failed were located in Deep Creek in the upper treatment area near the West Fork Deep Creek. The channel at this location is severely confined by its valley. In addition, half of the structures that failed were built by hand crews in reaches inaccessible to heavy equipment, which limited the size of the logs that could be placed in the channel. These failures were taken into consideration when designing later projects.

Restoration projects for 2005-06 include:

- The replacement of a culvert blocking fish passage to a portion of Sadie Creek will be implemented in 2005 (funded by SRFB) and will provide an excellent opportunity to quantify the salmon recolonization rates and patterns. We will be conducting population estimates above and below each of the four culverts to establish baseline conditions. After culvert replacement we will conduct both adult and juvenile salmonid surveys to identify the distribution and abundance of colonizers over the next several years. The methods used to monitor the culverts will be compatible with those used by the SRFB in their effectiveness monitoring.

- Increased rate of mass wasting caused by poorly constructed mid-slope roads was identified in the watershed analysis (USFS 2002). Road maintenance and abandonment plans were developed in 1999-2001 for hazardous road segments within the watersheds. A plan to decommission the mid-slope portion of this road will be forthcoming in 2005.

- Additional LWD placement projects for Deep Creek and East Twin River will be submitted for funding in 2005.

Research and monitoring

In 2003, the US EPA provided funding for a PIT tag study in the East Twin River on the Olympic Peninsula. This study focuses on the habitat-specific movement and over winter survival of juvenile coho, cutthroat trout and rainbow trout/steelhead. In August and

September of that year, approximately 1,200 juveniles were PIT tagged in the East Twin River and Sadie Creek, one of its major tributaries. Snorkel surveys were performed to provide density estimates and to search for tagged fish. Tagged fish were interrogated *in situ* with an underwater PIT tag antenna, which allows us to determine movement between habitats by individual fish. In the spring of 2004, we recaptured 52 tagged smolts, for a recapture rate of just over 4%. One explanation for this poor return could be the channel-changing flood event that occurred in October 2003; just a few weeks after tagging was completed.

In 2004, the East Twin River, West Twin River, and Deep Creek were included in the Intensively Monitored Watershed program. Because a PIT tagging project was already in progress on the East Twin River, the decision was made to tag more fish (3,500) in the East Twin River and to begin PIT tagging (300) in the West Twin. In the fall of 2004, permanent PIT tag antenna systems were installed in the East Twin and West Twin Rivers to monitor tagged fish year round. We discovered that juvenile coho and trout were leaving one watershed and moving upstream into the other, which entails entering the Strait of Juan de Fuca, moving approximately 400 meters from one stream mouth to the other, and then ascending the streams to the antenna arrays. It was also discovered that there was a large emigration of tagged coho and trout over a short period of time in the fall. Preliminary analysis shows that nearly as many tagged fish left the stream in the fall as were captured in the smolt trap this spring.

A permanent PIT tag reader was installed at Sadie Creek in early April approximately 3.4 kilometers above the confluence with the East Twin River. Two sets of antennae, separated by approximately 40 meters to provide information on direction (upstream or downstream) of fish movement, were installed 200 meters above the smolt trap.

In the fall of 2005, there will be a substantial increase in tagging effort in the West Twin River to mirror the effort in the East Twin River. The goal is to tag 3,500 juvenile trout and coho in each watershed, which will provide a much larger database to assess the differences in growth, survival, and outmigration timing between the control and treatment watersheds. Tags will be distributed throughout the watersheds to determine the survival differences between reach types and to try to determine the influence of restoration efforts on juvenile over winter survival.

Hood Canal Complex

Land use in the four watersheds in this complex range from urban and residential in Little Anderson Creek to almost entirely forestry in Stavis Creek, where a substantial proportion of the watershed is managed by the Washington Department of Natural Resources. In Little Anderson Creek, lack of wood and off-channel habitat has been identified as likely factors constraining fish production (Table 6). Seabeck Creek displays evidence of channel incision in many locations and significant amounts of sediment deposition in other channel segments. The incision in this watershed may actually be contributing to low summer flows by reducing groundwater storage. Big Beef Creek has a small impoundment that impacts water temperature downstream and provides habitat for various warm water fishes that may prey on coho and steelhead smolts.

Because we expect continued residential development in all basins, but especially in Little Anderson Creek and Big Beef Creek, this complex offers the best opportunity to evaluate the impact of urban and residential development on our ability to increase salmon production with restoration efforts. These watersheds also offer the advantage of being quite small making it possible to treat a significant proportion of the channel network relatively easily. However, social, logistical and financial constraints may preclude the implementation of some restoration measures (e.g., improved stormwater control, reducing the effects of the impoundment on Big Beef Creek).

Table 6. Primary production constraints are listed by IMW basin**.**

Constraint	L Anderson	Big Beef	Seabeck	Stavis
Low summer flow	X	X	X	X
Fall spawner flows		X		X
Predation by exotics		X		
High water temp		X		
Sediment input	X	X	X	X
Lack of LWD	X	X	X	X

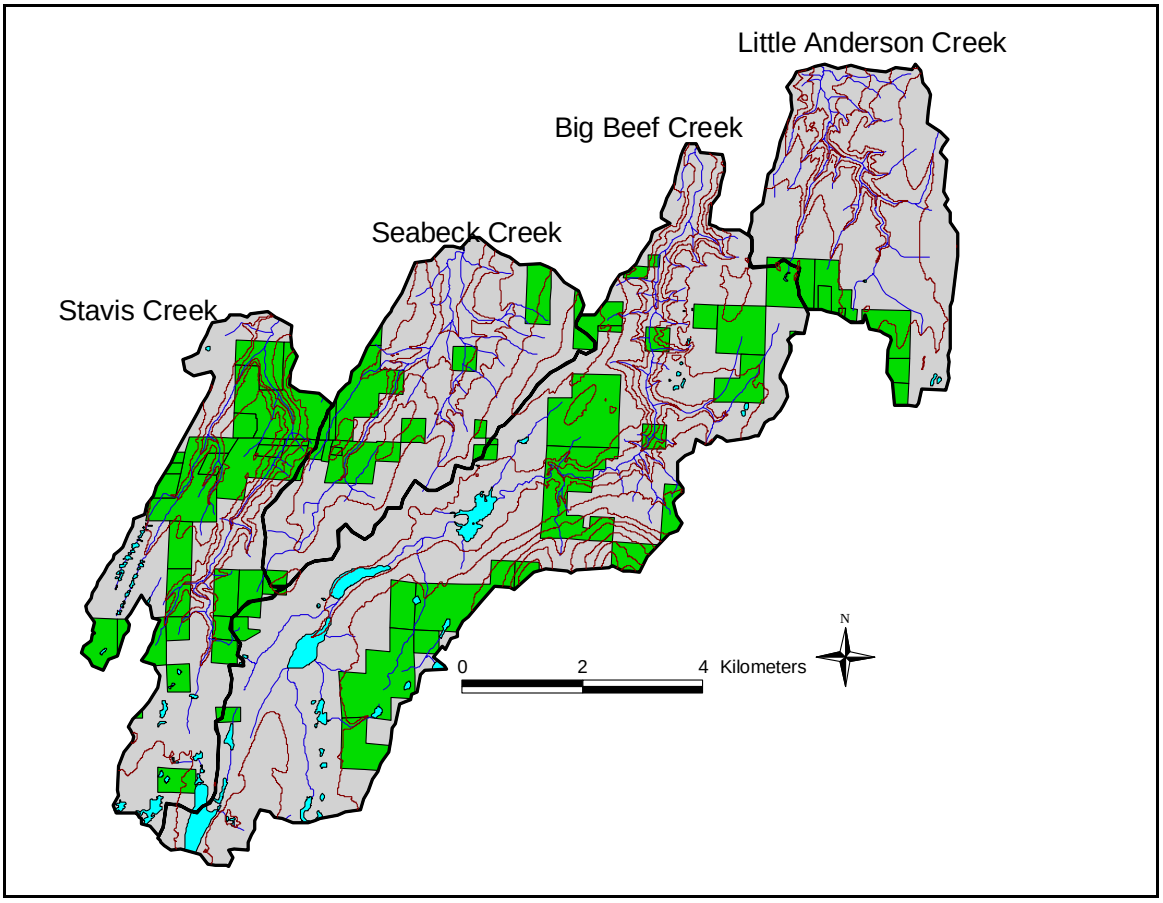

Figure 7. Hood Canal IMW Complex. Washington Department of Natural Resources land is green. Lakes and wetlands are blue.

Fish production

Naturally produced salmonids from the Hood Canal Complex include coho salmon, fall chum salmon, cutthroat trout, and a small population of steelhead. Efforts are being made to establish a naturally-produced population of summer chum in Big Beef Creek.

Because returning adults must pass through the weir, accurate spawner counts are available for Big Beef Creek since 1976 (Table 8). In 2003 the IMW began weekly November-December spawner counts on reaches known to support anadromous fishes in all four basins. Additional surveys were conducted on stream reaches where there was a question about access for coho salmon or steelhead in 2004 in order to develop a comprehensive understanding of the extent of spawner distribution in these four watersheds. The improved knowledge on spawner distribution will be used to improve the accuracy of escapement estimates in future spawner surveys.

Smolt counts began in Big Beef Creek in 1978 and 1992 or 93 in the other streams (Table 7; Figures 8-11). Coho smolt production ranges from the hundreds per year in Little Anderson

Creek to tens of thousands per year in Big Beef Creek. Steelhead production is relatively low in all basins.

Table 7. Period of record and data collected at each smolt trap.

Smolt trap	Watershed analysis?	Juveniles		Adults	
		Since	Species	Since	Species
Anderson Cr	Yes, 1998	1992	coho	-	
Big Beef Cr	Yes, 1998	1978	coho, cutthroat, steelhead	1976	chinook, chum, coho
Seabeck Cr	Yes, 1998	1993	coho	-	
Stavis Cr	Yes, 1998	1993	coho	-	

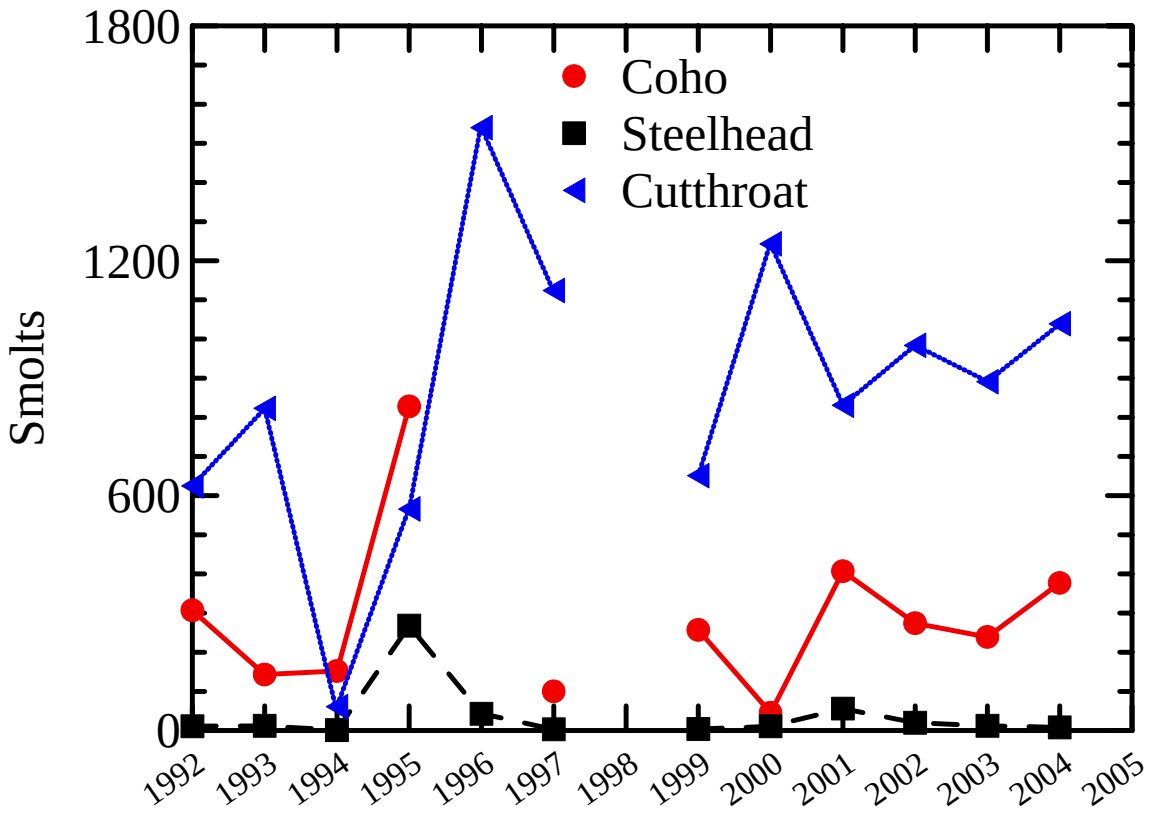

Figure 8. Annual production of coho, steelhead, and cutthroat smolts from Little Anderson Creek.

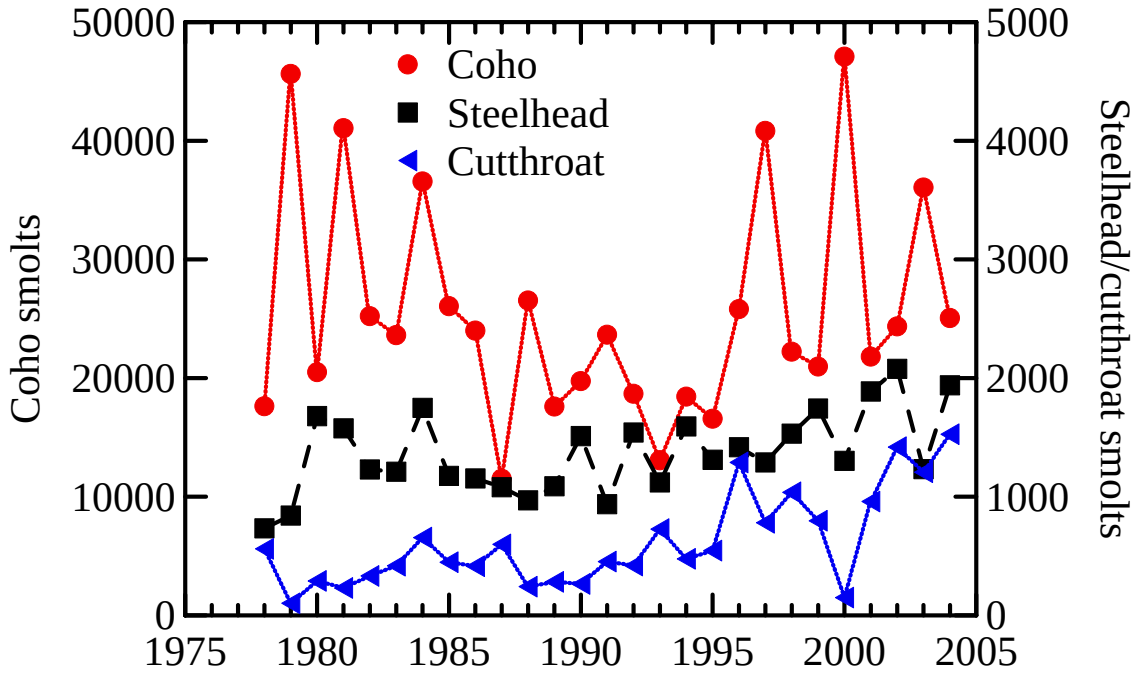

Figure 9. Big Beef Creek coho, steelhead, and cutthroat smolt production.

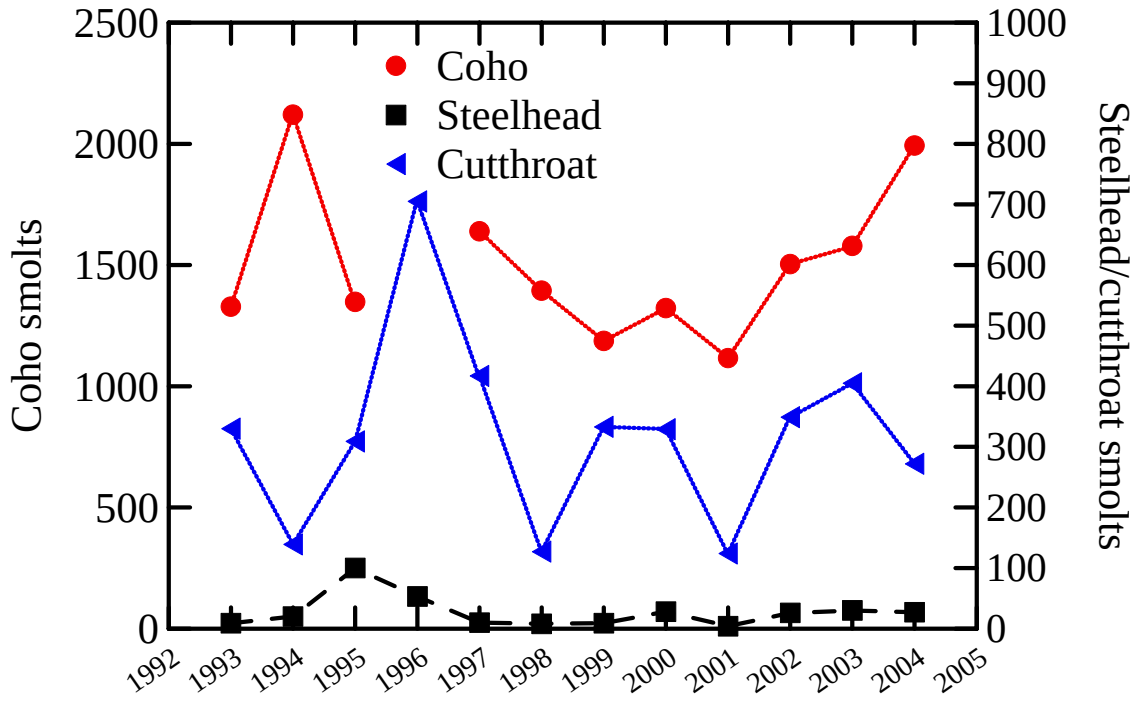

Figure 10. Wild coho, steelhead, and cutthroat smolt production from Seabeck Creek.

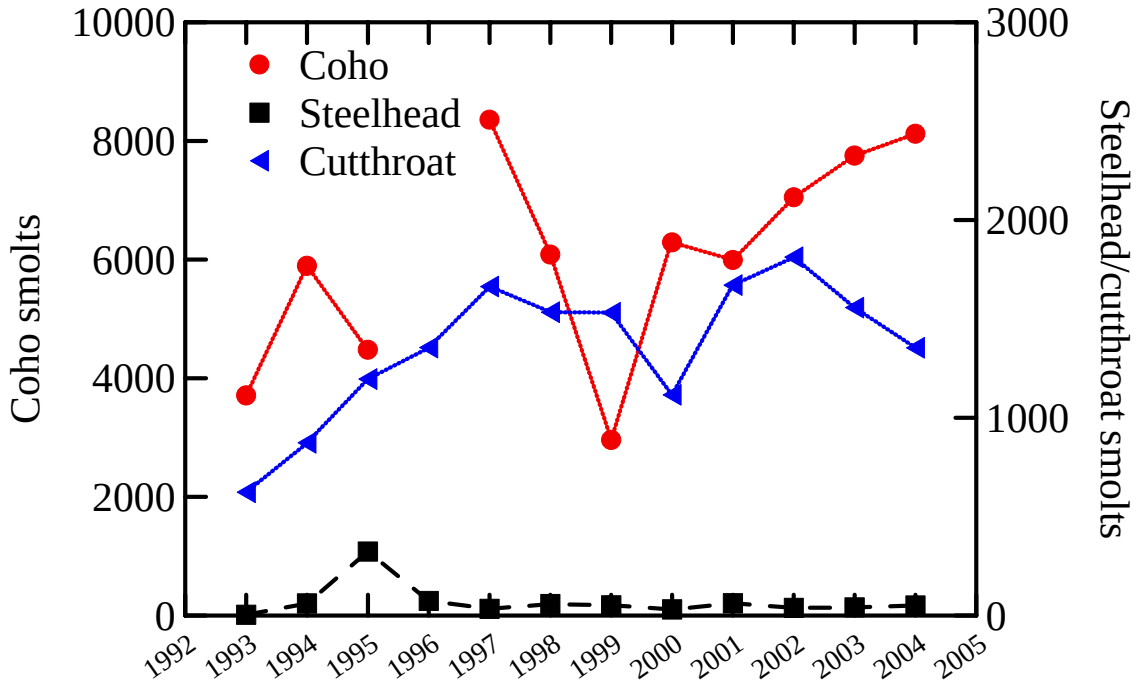

Figure 11. Stavis Creek wild coho, steelhead, and cutthroat smolt production.

Restoration Projects

Two restoration projects are currently being implemented in this complex. The first is funded by a Landowner Incentive Program grant to the Hood Canal Salmon Enhancement Group to restore the reach of Little Anderson Creek just below Anderson Hill Road. Initially the project includes moving a farm outbuilding from the floodplain followed by enhancement of in-channel habitat. Actions taken in the channel will depend upon a reach assessment being conducted later this summer.

The second project, Anderson Landing Preserve (http://www.kitsapgov.com/parks/pdfs/parks%20pdfs/web_anderson.pdf), is owned by Kitsap County and encompasses 68 acres of land bordering the lower 0.7 km of Little Anderson Creek. The stream channel is unstable and has obviously meandered across the valley bottom, as several old channels are visible. Although the current habitat condition is relatively poor, beavers have been present at his site since at least 2004 and the dam building and tree felling has had a noticeable beneficial effect on habitat. We propose to leave the area to stabilize and recover naturally rather than deliberately manipulating the channel. .

Other restoration projects are in the planning stages and are listed below:

- LWD placement in Little Anderson Creek above Anderson Hill Rd
- Riparian vegetation restoration on mainstem and tributary in Anderson Landing Park
- Several fish passage barriers on Seabeck Creek
- LWD placement in incised channel segments below Height Center Rd

Research and Monitoring

Although the suspected limiting factors in Hood Canal, sediment and lack of LWD, are similar to the Straits, the causes are more complex and will require more effort to determine the solutions. Sediment deposition in the lower end of all watersheds is apparent and the sources are likely bank erosion and incision of stream channels in the upper watershed. In the more developed watersheds, these conditions may be exacerbated by high peak stream flows as storm runoff from impervious surfaces is directed into the channel system rather than percolating into the groundwater. Stream channel incision occurs in all basins but is especially widespread in Seabeck Creek. There is anecdotal evidence that summer flows in this system are much lower than historically, possibly a product of the channel incision. Before proposing widespread instream habitat restoration, we will examine the likely causes of channel incision, sources of sediment and changes in flow.

In 2005 we will focus on:

- the relationship between summer low flow and available rearing habitat.
- Spawner and redd distribution as a function fall flows
- Peak and minimum stream flows in the system as a function of development and road density

Lower Columbia Complex

The Lower Columbia Complex is comprised of Mill, Abernathy, and Germany Creeks, located within the Elochoman WRIA (25), in Cowlitz and Wahkiakum Counties, Washington. Most of the complex is owned by Washington Department of Natural Resources (DNR) and industrial forest landowners small landowners have holdings scattered throughout the lower end of all three basins. Residential development is light, although projected to increase substantially within WRIA 25 by 2020, and concentrated along public roads in the lower portion of the three basins. Some agriculture occurs in the lower end of Abernathy Creek and Germany Creek.

Of the three complexes, the Lower Columbia Complex provides the best opportunity to assess the effect of commercial forest management on aquatic habitat and fish. Lack of large wood in the channels, reduction in off-channel habitat, and alterations in sediment delivery and transport are likely to be factors that have influenced habitat conditions in these watersheds (Table 8).

Table 8. Constraints to smolt production

Factors limiting smolt production
low habitat diversity
poor channel stability
poor riparian function
reduced floodplain function
altered streamflow
high stream temperature
excess sediment input

Many of these production constraints are correlated and can be attributed to clearing of riparian vegetation for agriculture or timber harvest, road construction in the floodplains, sediment input from forest roads and mass wasting, and direct manipulation of the stream channel.

Fish Production

Historically, escapement estimates were limited to chinook salmon and steelhead in the watershed in this complex (using the index reach method). We expanded these surveys in 2004-2005 to include chum and coho salmon and extended them throughout the known anadromous zone. This intensified procedure will enable us to assess spawner and redd distribution and to estimate total numbers.

Smolt traps are located within a kilometer of the stream mouths (Figure 12). Smolt monitoring has been conducted in the Lower Columbia Complex since 2001 (Table 9). The low level of coho production in the Lower Columbia Complex may relate to the higher stream gradients, poor habitat condition, or even to low coho escapements, which were not measured until last year. Wild steelhead smolt production per square kilometer of watershed averaged 20 in Mill Creek, 108 in Abernathy Creek, and 130 in Germany Creek. These levels are much higher than are observed in Stavis Creek, a stream in the Hood Canal complex, over the same two years (4 steelhead smolts/km^2). The pattern of land use in Stavis Creek is similar to that of the Lower Columbia watersheds but Stavis Creek is a much smaller and lower gradient stream.

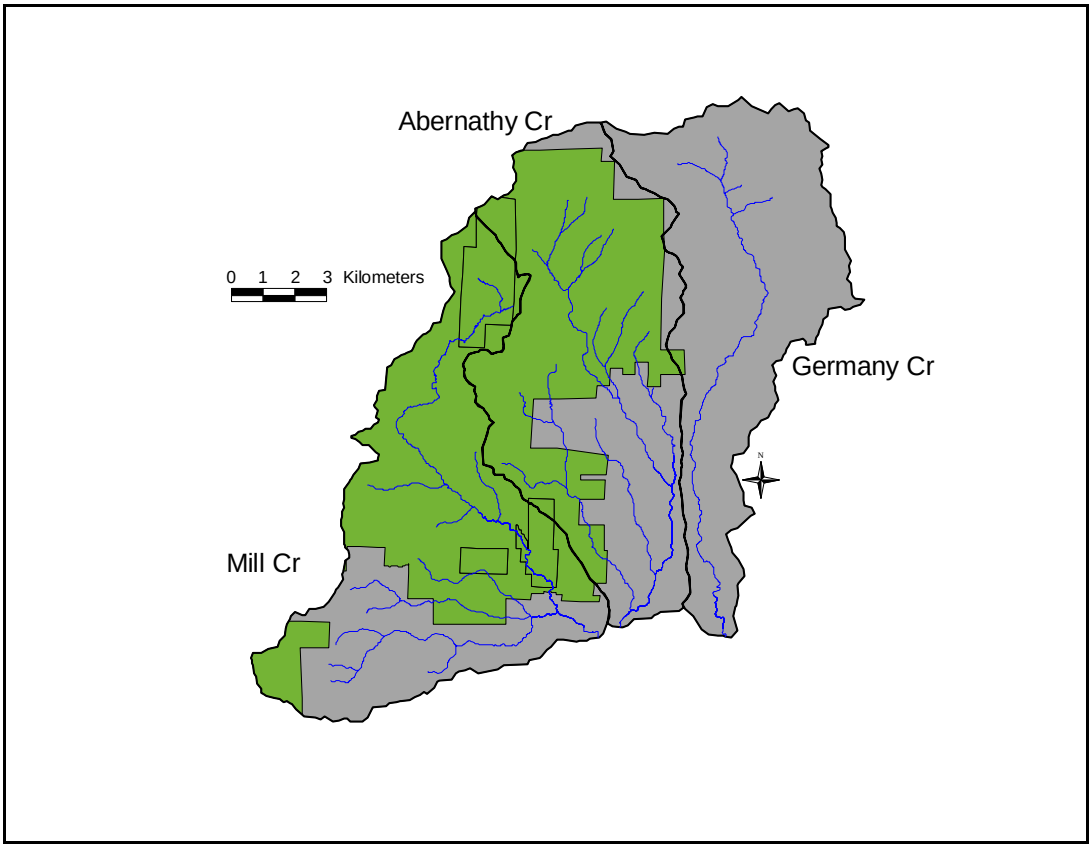

Figure 12. Lower Columbia IMW Complex. Land managed by the Washington Department of Natural Resources is shaded green.

Table 9. Data collected in Lower Columbia complex

Lower Columbia Complex				
Smolt trap	*Watershed analysis?*	*Juveniles*		*Adults*
		Since	*Species*	*Species*
Mill Cr Abernathy Cr Germany Cr	No	2001	chinook, coho, cutthroat, steelhead	chinook, steelhead coho

Restoration Projects

Two restoration projects are currently underway in this complex. One on lower Abernathy Creek will restore riparian vegetation. The other is a project being implemented in conjunction with a land acquisition on lower Germany Creek. Several off channel ponds will be reconnected with the channel at this site and one or more chum salmon spawning channels will be built. We are working with the Columbia Land Trust, Washington Trout, and the SRFB-funded project monitoring team to develop and coordinate our monitoring efforts on

this project and incorporate the results into the overall IMW framework. The restoration project design should be complete by late summer 2005 with monitoring beginning soon after.

Other restoration projects for 2005 are being evaluated based on a draft prioritized list from the Lower Columbia Fish Recovery Board. These include:

- restore floodplain (riparian planting, fencing, connectivity)
- instream LWD or boulder placement
- restore off channel habitat

Skagit River Estuary

A study plan has been prepared by the SRSC, NWFSC, and United States Geological Survey as a supplement to the The Skagit Chinook Recovery Plan (Beamer, et al. 2005). It is available at the SRSC web site (http://www.skagitcoop.org/). This plan is summarized below.

Juvenile ocean-type Chinook salmon are well known for utilizing tidal deltas, "pocket estuaries" (nearshore lagoons and marshes), and other estuarine habitats for rearing during outmigration (Reimers 1973, Healey 1980, Beamer et al 2003). Several studies have linked population responses to availability of estuary habitat, either by examining return rates of groups of fish given access to different habitat zones (Levings et al. 1989) or by comparing survival rates of fish from populations with varying levels of estuary habitat degradation (Magnusson and Hilborn 2003). These studies support the hypothesis that estuarine habitat is vital for juvenile chinook salmon. However, these necessarily coarse-scale studies have ignored how large-scale estuarine habitat restoration affects population characteristics. These issues may be critical to understand how to best restore chinook salmon populations, as many estuaries within Puget Sound and elsewhere have been lost to agriculture and urbanization. For example, the Duwamish River has lost more than 99% of its tidal delta habitat (Simenstad et al 1982), while the Skagit River, which contains the largest tidal delta in Puget Sound, has lost 80-90% of its habitat area (Collins et al. 2003).

In 1994 the Skagit River tribes initiated field studies to evaluate wild Skagit Chinook fish-habitat relationships for population recovery purposes. The studies were developed in the context of a lifecycle model framework that includes discrete life stages and habitats for multiple juvenile life history types of ocean-type Chinook salmon. Field studies include: (1) identification of juvenile life history types, (2) inventories of current and historic habitat conditions, and (3) fish use patterns for freshwater, estuarine delta, and Skagit Bay near shore life stages. Results after a decade of study show: (1) a strong negative relationship of peak flow during incubation with egg-fry survival, (2) a large historical loss of delta estuarine habitat (3) a high percentage of wild juvenile Chinook utilize delta estuarine habitat for extended rearing, (4) evidence for density dependence in the delta and possibly freshwater habitat areas, (5) density-dependent effects on movement by individual migrants, and (6) strong seasonal preferences in nearshore habitat utilization. The results of the field studies lead independently to a solid biological rationale for a suite of recovery actions that would benefit specific juvenile life history types. However, it is critical to understand how Chinook salmon populations respond to recovery actions, to be able to extend these results to other

estuaries within Puget Sound and elsewhere that have been lost to agriculture and urbanization.

The goal of this project is to understand changes in population characteristics (primarily abundance, productivity, and life history diversity) of wild Chinook salmon in response to reconnection and restoration of estuarine habitat. Researchers have developed a plan to do this via long-term interagency monitoring in the Skagit River watershed involving sampling of outmigrants at Mt Vernon (WA Department of Fish and Wildlife, WDFW), fyke trapping of fish rearing in the tidal delta (Skagit River System Cooperative, SRSC), beach seining of nearshore habitats in Skagit Bay (SRSC), and townetting of offshore areas in Skagit Bay (Northwest Fisheries Science Center, NWFSC). This program provides us a system-wide analysis of patterns of abundance and life history diversity across the migration season. These efforts, in combination with site-specific efforts to examine effectiveness of several large-scale estuary restoration projects, will allow us to evaluate the role of estuary restoration for the recovering Chinook salmon population in the Skagit River.

Specific tasks funded through the IMW include:

Fyke trapping in the tidal delta (SRSC). 10 sites will be monitored biweekly from February through July. This monitoring includes sites on the North and South Forks of the Skagit River, and effectiveness monitoring of Deepwater Slough. Additional sites may be added to accommodate effectiveness monitoring of Wylie Slough.

Beach seining of nearshore sites in Skagit Bay (SRSC). 28 sites will be monitored biweekly from February through September. This monitoring includes sites contiguous to the North and South Forks of the Skagit as well as pocket estuaries.

Townetting of offshore sites in Skagit Bay (NWFSC). 12 sites will be monitored monthly from April to October. This monitoring includes sites contiguous to the North and South Forks of the Skagit and pocket estuaries, as well as sites adjacent to the exit points from Skagit Bay to Puget Sound (Crescent Harbor, Deception Pass).

Mark-recapture studies, analyses of life history diversity (NWFSC). NWFSC will extend monitoring efforts by

- conducting mark-recapture studies on the North and South Forks of the Skagit (up to 8 sites)
- conducting an acoustic tagging study of marked fish in Skagit Bay
- analyzing existing collections for differences in diet and life history diversity among sites and life stages.

<u>Restoration projects</u>

This project capitalizes on four estuary restoration efforts either already completed or to be completed within the next four years along the South Fork of the Skagit River: Deepwater Slough (completed in 2000), Wiley Slough (in progress), Milltown Island (proposed), and Fisher Slough (proposed). These restoration projects involve dike removal and restoration of habitat forming processes such as riverine and tidal inundation. In total these projects will result in restoration and reconnection of 637 acres of wetlands, and therefore will greatly improve habitat availability for juvenile Chinook salmon.

BUDGET SUMMARY

We estimate that the IMW program will be underspent for the 03-05 biennium (FYs 2004 and 2005) by approximately $428,000 of the $1.74 million allocated. This was due to:

- greater than anticipated in kind contribution from the Lower Elwha Klallam Tribe and WDFW Habitat division;
- delay in purchasing continuous turbidity sensors to allow time to evaluate a recently released laser-based sensor;
- cost savings by incorporating the flow and water quality monitoring into existing monitoring programs at the Dept of Ecology
- delay in developing GIS-based database until after the first year of data collection.
- contracts for the SRSC and NWFSC run from February through December 2005 so that only a portion will be spent by the end of the current fiscal year.

We have requested that the unspent funds be reallocated to the next biennium so that we can complete the installation of the basic monitoring equipment and implement the reach-scale and subbasin scale monitoring, as planned. This will result in a 'bulge' in spending for FYs 2006 and 2007, but we anticipate returning to our 'normal' annual budget of $1.19 million by FY 2008.

The IMW program has coordinated with and contributed to ongoing monitoring and research efforts by the Lower Elwha Klallam Tribe, WDFW, NWFSC, and the SRSC (Table 10). In addition, several IMW cooperators have committed substantial in kind support of staff time to the monitoring effort and to program oversight. This coordination with existing monitoring and in kind support comprise a substantial contribution to the IMW program.

Table 10. Estimated in-kind contributions toward oversight and monitoring and cost of the additional monitoring efforts within the IMW complexes with which we are coordinating.

IWM collaborator	In kind FY2006	Existing monitoring
WDOE	$53,000	
WDFW	$87,000	$200,000
NWFSC	$58,000	$200,000
Elwha Klallam	$24,500	$90,000
Weyerhaeuser	$78,900	
Skagit R Sys Coop		$158,000
Total	**$301,400**	**$648,000**

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APPENDIX A