Elwha Research Planning Workshop

February 14-15, 2005

Summary Report

May 1, 2005

Compiled by Scott A. Stolnack[1], Robert J. Naiman[1] and Stephanie A. Harrington[2]

[1]University of Washington School of Aquatic and Fishery Sciences
Box 355020
Seattle, WA 98195-5020

[2]University of Washington Earth Initiative
Box 355351
Seattle, WA 98195-5351

Editorial Comments: sastol@u.washington.edu

Funding for the Elwha Research Planning workshop was provided by
the University of Washington Earth Initiative and the National Park Foundation.

Executive Summary

On February 14 and 15, 2005, over fifty scientists and educators gathered to draft an integrated, interdisciplinary science and education agenda in advance of the removal of two large dams on the Elwha River, Washington. Their efforts, guided by the work of five previous research and education workshops and participants' expertise in their fields, were to suggest priorities, implementation strategies, scheduling, and costs for research and education activities categorized into eight broad themes:

- Sediment, geomorphology and water quality
- Freshwater and riparian ecology
- Marine and nearshore ecology and processes
- Fish ecology
- Terrestrial and wildlife ecology
- Data sharing and management
- Social, cultural and economics
- Education and outreach

Recommendations were further divided into three time periods: before (2005 – 2008), during (2008 – 2011) and after dam removal (2011 – 2020). While some working groups discussed research needs up to twenty or thirty years after dam removal, the time horizon used for estimating costs of research programs (Appendix B) is limited to ten years after deconstruction of the dams.

The highest priority issues defined by the workshop participants were as follows:

- Determine key physical and biological processes regulating the structure, functioning, and dynamics of the freshwater and riparian systems
- Document baseline conditions in the coastal zone at the river mouth
- Monitor ecological processes in the coastal zone during dam deconstruction, and define the new dynamic equilibrium after project completion
- Quantify fish community responses to changes in habitat and community structure
- Understand the factors determining sediment distribution in the two reservoirs
- Quantify how the addition of fish to the upper Elwha provoke changes in the terrestrial ecosystem
- Establish an information management system to promote the flow of knowledge among researchers and the public
- Identify the social and cultural effects of the Elwha River restoration project on the Lower Elwha Klallam Tribe and other local and regional communities
- Develop an integrated educational curriculum across all grade levels linked to issues and concepts associated with the Elwha River restoration project, and engage citizens in all levels of the project to re-connect people with the landscape.

Deliverables include an improved understanding of physical and ecological processes directly influencing large-scale restoration and salmon recovery efforts, greater knowledge of the costs and benefits of large dam removal, an informed and engaged public, and detailed knowledge to guide present and future management actions.

The worksheets created by retreat participants (edited and reformatted for clarity) form the bulk of this document. Appendices contain rough estimates of costs, a list of retreat participants and affiliations, a compilation of existing or proposed research and education efforts focused on the Elwha River basin, and a glossary of acronyms.

Table of Contents

Introduction

The planned removal of the two Elwha River dams beginning in 2008 presents a rare opportunity to study the potentially profound physical, biological and sociocultural effects that could be experienced by restoring salmon runs and re-establishing natural physical processes. In preparation for removal of the dams, three technical workshops have been convened since 2001, numerous informal meetings have been held, and researchers are collecting data (Allaway 2004, CCMRC 2004, Randle et al. 2004, Schreiner and Winter 2004, Stolnack and Naiman 2005). At least a dozen agencies and institutions have – or are planning – a presence in the watershed (see Appendix C). A consortium has been assembled to coordinate research and education efforts

To clarify and prioritize the most pressing questions, a group of scientists and educators met on February 14-15, 2005 in Port Townsend, Washington, to draft an integrated, interdisciplinary science and education agenda. Their efforts were guided by the work of five previous research and education workshops and participants' expertise in their fields (Stolnack and Naiman 2005). Most, though not all, participants had experience in the Elwha watershed. Brought together by the University of Washington and the National Park Foundation, participants were asked to suggest priorities, implementation strategies, scheduling, and costs for research and education activities categorized into eight broad themes:

- Sediment, geomorphology and water quality
- Freshwater and riparian ecology
- Marine and nearshore ecology and processes
- Fish ecology
- Terrestrial and wildlife ecology
- Data sharing and management
- Social, cultural and economic
- Education and outreach

This report contains the text of their recommendations, edited and formatted for consistency and clarity. Appendices include a list of retreat participants and affiliations, cost estimates, a listing of existing or proposed research and education efforts in the Elwha River basin, and a glossary of acronyms used in this document.

1. Sediment, Geomorphology and Water Quality

1.1. Reservoir Sediment.

Objective: The reservoir sediment management objective is to induce the redistribution of sediment within the reservoir during drawdown and to erode that portion of sediment not expected to remain in the reservoir over the long term. This objective is intended to leave a majority of the sediment along the margins of the reservoir in a series of terraces that will be stable over the long term and to minimize the amount of sediment eroded from the reservoir area after dam removal. This would be accomplished by controlling the rate and increments of reservoir drawdown during the dam removal process.

Key Questions:

Erosion and Redistribution Processes

- What is the magnitude and timing of reservoir sediment erosion? How much of the reservoir sediment is transported past the dam during dam removal and during the years following dam removal?
- What is the dominant erosion process (e.g., headcut, flow and sediment transport capacity, lateral bank erosion)? How do large woody debris and coarse armor layers affect these processes?
- How does that rate and increment of reservoir drawdown affect the magnitude of lateral erosion and reservoir sediment redistribution?
- How much woody debris is present in the reservoir and how much would be transported to the downstream river channel?

Terrace Stability

- What are the factors influencing terrace slope stability (e.g., vegetation, bank slope, height, location relative to the active channel, geomorphic setting)?
- How does sediment terrace stability vary over time?
- Are there any chronic turbidity impacts to the downstream river channel caused by erosion of remaining reservoir sediments?
- Can reservoir sediment terrace stability be predicted, and used to guide re-vegetation management actions?

Deliverables: Detailed knowledge to guide sediment adaptive management program; scientific publications.

Observations/monitoring needs: (see implementation strategy).

Connection to other thematic activities: Direct linkages to vegetation establishment on the reservoir sediment terraces; downstream water quality concerns for water supply and the aquatic environment.

Probable participating organizations: U.S. Bureau of Reclamation; U.S. Geological Survey; National Park Service; Pacific Northwest National Laboratory; Lower Elwha Klallam Tribe; regional universities.

Implementation strategy:

1. Repeated topographic and bathymetric surveys, including large woody debris and geomorphic mapping.
2. Stream gauging at McDonald Bridge of discharge, stage, suspended sediment concentration, and bed load.
3. Stream gauging above Lake Mills of discharge, stage and suspended sediment concentration.
4. Time lapse ground and aerial photography.
5. Two-dimensional numerical model simulation of processes.
6. Linkage to vegetation monitoring of species, terrace level, moisture, water table, and succession.

Timeline: Measurements would begin just prior to dam removal and continue through the dam removal process and for 3 years following dam removal.

Possible sources of funding: National Science Foundation (NSF); U.S. Congress.

1.2. Downstream Channel and Floodplain Sediment Dynamics.

Objective: Maximize the benefits to habitat and minimize the impacts to infrastructure by controlling the rate of reservoir drawdown and dam removal.

Key Questions:

Sediment Aggradation and Channel Planform Evolution

- How does the rate of dam removal and reservoir drawdown affect sediment transport in the downstream river channel?
- What is the rate of sediment input, transport, storage, and delivery to the river mouth?
- What are the patterns, forms, processes, and rates of sediment deposition and erosion along the main channel, side channels, and flood plains (including bluff erosion)?
- What is the rate of woody debris input, transport, and retention?
- What are the interactions between channel/flood plain evolution, vegetation growth and succession, and large woody debris?
- How does high sediment concentration affect hydrodynamics and sediment transport (e.g., bulking factor, viscosity, particle fall velocity, roughness and hiding factor, and bed mobilization thickness)?

Water Quality

How do PH and the concentrations of iron, manganese, ammonium, and dissolved oxygen vary over time?

Deliverables: Detailed system knowledge to guide sediment adaptive management program; scientific publications.

Observations/monitoring needs: (see implementation strategy).

Existing efforts: This proposal has been coordinated with the Sediment Management and Monitoring Plan (Randle et al. 2004).

Connection to other thematic activities: This proposal has direct linkages to flood plain vegetation establishment and succession, riparian ecology, fish habitat, and to the sediment delivery to the near-shore marine environment.

Probable participating organizations: U.S. Bureau of Reclamation, U.S. Geological Survey, National Park Service, Pacific Northwest National Laboratory, Lower Elwha Klallam Tribe, Universities.

Implementation strategy:

1. Repeat LIDAR and bathymetric river surveys and geomorphic mapping.
2. Repeat floodplain cross section surveys in at least 10 cross sections.
3. Stream gauging near diversion structure of discharge, stage, suspended sediment concentration, and bed load.
4. Water quality measurements of iron, manganese, ammonium, dissolved oxygen, PH, and temperature.
5. Time lapse ground and aerial photography.
6. Two-dimensional numerical model simulation of processes.
7. Linkage to vegetation monitoring of species and succession.

Timeline: Measurements would begin just prior to dam removal and continue through the dam removal process and for 3 years following dam removal.

Possible sources of funding: National Science Foundation; U.S. Congress.

1.3. Ground Water and Surface Water Interactions.

Objective: Determine the effects of sediment deposition on the interactions between surface and ground water. This is important for the aquatic ecosystem and for municipal, domestic, and industrial water supply from wells.

Key question:

- How does sediment deposition along the channel and flood plains affect the flow through the hyporheic zone and the alluvial aquifer?

Deliverables: Detailed knowledge about the effects of coarse and fine sediment concentrations on the hydraulic conductivity of the river bed and the resulting effects on

fish habitat and groundwater exchange. This information would be presented in technical reports and scientific publications.

Observations/monitoring needs: (see implementation strategy).

Existing efforts: This proposal has been coordinated with the Sediment Management and Monitoring Plan (Randle et al. 2004).

Connection to other thematic activities: This proposal has direct linkages to fish habitat and to the alluvial aquifer on which local wells depend.

Probable participating organizations: U.S. Geological Survey, National Park Service, Pacific Northwest National Laboratory, Lower Elwha Klallam Tribe, universities.

Implementation strategy:

1. Install and measure 16 peizometers and temperature probes in the area of a study reach.
2. Conduct 10 conservative tracer tests before dam removal, during the initial fine sediment flush, during the coarse sediment flush, and after dam removal.
3. Collect freeze core bed-material samples from the study reach and near the Ranney well.
4. Numerical ground water modeling of study reach.

Timeline: Measurements would begin just prior to dam removal and continue through the dam removal process and for 3 years following dam removal.

Possible sources of funding: National Science Foundation; U.S. Congress.

2. Freshwater and riparian ecology

2.1. [Before Removal] Determine key physical and biological processes.

Key Question:

- What are the physical and biological processes that regulate the structure, functioning, and dynamics of freshwater and riparian systems of the Elwha River?

2.1.1. Develop a conceptual model of the key physical and biological processes (and their interactions) that regulate the structure, functioning, and dynamics of freshwater and riparian systems of the Elwha River.

Significance: Necessary to develop hypotheses of ecosystem responses to dam removal, to identify key monitoring parameters, and to make results portable to other locations and research problems.

Deliverables: Conceptual model (peer reviewed paper) advancing current state of knowledge of freshwater-riparian ecological interactions.

Observations/monitoring needs: Begin with a review of existing literature and supplement with appropriate data collected as part of Activity 3 (below).

Existing efforts: Completed workshops; some baseline data have been collected and are being analyzed.

Connection to other thematic activities: Physical processes, fish ecology, terrestrial & wildlife.

Probable participating organizations: National Park Service, Lower Elwha Klallam Tribe, NOAA Fisheries, U.S. Geological Survey, universities, Elwha Research Consortium.

Implementation strategy: Literature review, small working retreats or writing meetings; second meeting and revisions after field work.

Timeline: Six months for first iteration; completed (revised version) one year later. Should begin in mid 2005 for late 2006 completion.

Possible sources of funding: National Park Service, U.S. Geological Survey, Elwha consortium, NOAA Fisheries.

2.1.2. Quantify historical vegetation and channel dynamics based on interpretation of georeferenced historic maps/surveys and aerial photography.

Significance: Analysis of change over time requires understanding natural processes operating in the watershed both before and after the dams. This activity will provide baseline and historical information for analysis of historic and future changes in riparian vegetation and channel morphology.

Deliverables: Georeferenced maps and analysis of historic channel and vegetation dynamics (report, possible peer-reviewed publication).

Observations/monitoring needs: Historic; no monitoring.

Existing efforts (Appendix C): Beechie, Pollock, McHenry, Liermann, and Pess, "Alteration of channel and ecosystem dynamics downstream of Elwha dams" (See Appendix C); Pohl PhD dissertation?

Connection to other thematic activities: Physical processes and water quality.

Probable participating organizations: National Park Service, Lower Elwha Klallam Tribe, NOAA Fisheries, U.S. Geological Survey, universities, Elwha Research Consortium, NSF.

Implementation strategy: This activity must be done early so that other work can build on it.

Timeline: 2006; complete within first year of funding.

Possible sources of funding: National Park Service (NPS), POBS, NSF.

2.1.3. Describe aquatic and riparian systems.

This activity will refine our knowledge of fundamental linkages and dynamics in the conceptual model. Wherever possible, this sampling should also be implemented and documented such that it can be efficiently and appropriately used as baseline data for documenting post-dam removal changes. Activity includes development of sampling protocols.

Deliverables: Reports, presentations and publications detailing enhanced understanding of linkages and dynamics between aquatic and riparian systems.

Observations/monitoring needs:

a) Stable isotope signatures of multiple trophic levels.
b) Riparian species composition and stand structure, growth, productivity, leaf chemistry, and floodplain soil chemistry.
c) Water quality parameters (dissolved oxygen, temperature, pH, alkalinity, etc…).
d) Nutrient dynamics (N, P, C).

e) Invertebrate communities.
f) Primary productivity and communities.
g) Habitat mapping (side channel mapping, fish habitat, riparian classification).
h) Remote sensing (Hyperspectral, LIDAR).

Existing efforts (See Appendix C)**:**
a) Reisenbichler et al; Morley et al.
b) Shafroth et al; Beechie et al.
c) none
d) Reisenbichler et al., Morley et al.
e) Morley et al.
f) Lorang et al; Beechie et al., Pess et al., McHenry et al.
g) Lorang et al, Beechie et al., Wright et al.

Connection to other thematic activities: Sediment, fish, terrestrial ecology.

Probable participating organizations: National Park Service, Lower Elwha Klallam Tribe, NOAA Fisheries, U.S. Geological Survey, universities, Elwha Research Consortium.

Implementation strategy: Sample each of the above categories annually from 2004-2008. Dependent upon spatial framework, defined by sediment supply and presence/absence of anadromous fish.

SITE	SEDIMENT SUPPLY	FISH
Quinault (ref.)	Natural	Yes
Lower Elwha	Disconnected	Yes
Middle Elwha	Disconnected	No
Upper Elwha	Natural	No

Timeline: Sample each of the above categories annually from 2004-2008.

Possible sources of funding: National Park Service, Lower Elwha Klallam Tribe, NOAA Fisheries, U.S. Geological Survey, universities, Elwha Research Consortium, NSF.

2.2. [Before, during and after] Determine the freshwater and riparian responses to the reintroduction of salmon and marine-derived nutrients.

Key Question:

- How does the ecosystem respond to the reintroduction of salmon and marine-derived nutrients?

2.2.1. Use the conceptual model generated in Priority 1, A1 to formulate hypotheses related to responses of freshwater and riparian ecosystems to reintroduction of anadromous salmonids. This includes both bottom up (e.g., nutrient inputs) and top down (e.g., predation pressure) effects of returning salmon.

Deliverables: Document(s) with key hypotheses listed, elaborated.

Observations/monitoring needs: Conceptual model developed in Priority 1.

Existing efforts (Appendix C): Previous workshop reports. Pess et al, Morely et al., Reisenbichler et al.

Connection to other thematic activities: Physical processes, fish ecology, terrestrial ecology.

Probable participating organizations: National Park Service, Lower Elwha Klallam Tribe, NOAA Fisheries, U.S. Geological Survey, universities, Elwha Research Consortium, NGOs.

Implementation strategy: Consolidate information from existing workshops. Iterate following completion of conceptual model.

Timeline: Consolidation of information from workshops has largely been done in preparation for this workshop. Iteration could be done via e-mail as soon as a conceptual model is available for feedback. This should only take 1-2 months.

Possible sources of funding: National Park Service, Lower Elwha Klallam Tribe, NOAA Fisheries, U.S. Geological Survey, universities, Elwha Research Consortium, NSF.

Additional comments: Consolidation of information from previous workshops has largely been done in preparation for this workshop.

2.2.2. Develop methods, field protocols, and metrics necessary to detect responses at reach and watershed scales to the reintroduction of anadromous fish. Approaches should anticipate responses to marine-derived nutrient additions as well as aquatic food web changes at both reach and watershed scales.

Deliverables: Study plan, including sampling protocols for aquatic and terrestrial primary productivity, freshwater secondary productivity, biogeochemical cycling, and leaf litter. Sampling protocols should include both total nutrient concentrations and stable isotope ratios.

Observations/monitoring needs:

a) Stable isotope signatures of multiple trophic levels.

b) Riparian vegetation growth, productivity, leaf chemistry, and floodplain soil chemistry.
c) Water quality parameters (dissolved oxygen, temperature, pH, alkalinity, etc…).
d) Invertebrate communities.
e) Primary productivity and communities.
f) Habitat mapping (side channel mapping, fish habitat, riparian classification).
g) Remote sensing (Hyperspectral, LIDAR).

Existing efforts (Appendix C): Morley et al., Reisenbichler et al., Pess et al. The existing efforts principally cover aquatic invertebrates and fish. Research examining other aquatic and riparian components is not currently underway (to our knowledge).

Connection to other thematic activities: Fish ecology; terrestrial ecology; physical processes and water quality.

Probable participating organizations: National Park Service, Lower Elwha Klallam Tribe, NOAA Fisheries, U.S. Geological Survey, universities, Elwha Research Consortium.

Implementation strategy: Work through consortium and likely participating organizations to develop sampling strategy and agree on protocols. 1-2 day meeting among key participants.

Timeline: Before extensive data collection.

Possible sources of funding: Elwha Consortium.

2.2.3. Implement research and monitoring protocols to test hypotheses (above) and monitor freshwater and riparian responses to reintroduction of anadromous fish and marine-derived nutrients. Initially (1-5 yrs), this effort would require annual sampling to determine inter-annual and spatial variation. Long-term sampling frequency and intensity could be adjusted based upon initial results.

Deliverables: Multiple publications and contributions to Elwha Research Consortium databases. Reports to funding agencies and peer-reviewed publications. Presentations at scientific meetings and educational forums.

Observations/monitoring needs: (see additional comments)
a) Stable isotope signatures of multiple trophic levels. **
b) Riparian vegetation growth, productivity, leaf chemistry, and floodplain soil chemistry.
c) Water Quality (dissolved oxygen, temperature, pH, alkalinity, etc…). **
d) Invertebrate communities. **
e) Primary productivity and communities. **
f) Habitat mapping (side channel mapping, fish habitat, riparian classification). **
g) Remote sensing (Hyperspectral, LIDAR*).

Existing efforts (Appendix C): Morley et al., Reisenbichler et al., Pess et al. These existing efforts principally cover aquatic invertebrates and fish. Research examining other aquatic and riparian components is not currently underway (to our knowledge).

Connection to other thematic activities: Fish ecology; terrestrial & wildlife; physical processes and water quality

Probable participating organizations: National Park Service, Lower Elwha Klallam Tribe, NOAA Fisheries, U.S. Geological Survey, regional universities, Elwha Research Consortium, NGOs.

Implementation strategy: Prioritize potential metrics (observations/monitoring needs listed in a through g, above) to determine which will be intensively monitored vs. opportunistically/based upon availability of funds.

Timeline: Initial annual sampling (1-5 years); then sampling interval adjusted as necessary

Possible sources of funding: National Park Service, Lower Elwha Klallam Tribe, NOAA Fisheries, U.S. Geological Survey, universities, Elwha Research Consortium, NSF.

Additional comments:
* LIDAR is presumed to be funded through the physical processes and water quality theme.
** Personnel costs for data collection for observations a,c,d,e, and f are presumed to have been funded under Priority 3.

2.3. [Before, during and after] Determine the freshwater and riparian responses to changes in sediment and large woody debris supply and dynamics.

Key Question:

- What are the freshwater and riparian ecosystem responses to changes in sediment and large woody debris regimes?

2.3.1. Generate hypotheses and develop models related to responses of freshwater and riparian ecosystems to changes in sediment and wood supply and dynamics.

Deliverables: Document(s) with key hypotheses listed, elaborated.

Observations/monitoring needs: Conceptual model developed in Priority 1.

Existing efforts (Appendix C): Previous workshop reports. Pess et al., Beechie et al., Morely et al., Wright et al. (?), Shafroth et al.

Connection to other thematic activities: Sediment, Elwha Project.

Probable participating organizations: National Park Service, Lower Elwha Klallam Tribe, NOAA Fisheries, U.S. Geological Survey, universities, Elwha Research Consortium, NGOs.

Implementation strategy: Consolidate information from existing workshops. Iterate following completion of conceptual model.

Timeline: Consolidation of information from workshops has largely been done in preparation for this workshop. Iteration could be done via e-mail as soon as a conceptual model is available for feedback. This should only take 1-2 months.

Possible sources of funding: National Park Service, Lower Elwha Klallam Tribe, NOAA Fisheries, U.S. Geological Survey, universities, Elwha Research Consortium, NSF.

Additional comments: Funding would only be required to compile and synthesize existing information and augment slightly following conceptual model review.

2.3.2. Develop sampling protocols to determine sediment and wood supply/dynamics stratified by the six reaches (upper, middle, lower, Quinault reference, and two reservoir "reaches.")

a. From conceptual model, determine reach stratification (upper, middle, lower, and two reservoir) and study site numbers and locations.
b. Develop wood budget protocols, including jam mapping and age determination, as well as wood recruitment and transport rates.
c. Document and resurvey riparian patch structure, composition and dynamics -- including recolonization/primary succession on new substrates, and secondary succession on existing surfaces, and community indices (richness, diversity, native/exotic, etc.).
d. Document and resurvey stream habitat abundance and condition, including (but not limited to) pool size and abundance, side channel creation, evolution and dynamics, and substrate size (surface and subsurface).
e. Document effect of restored connectivity on dispersal and establishment of water dispersed aquatic and terrestrial plants.

Deliverables: Protocols for characterizing wood budget and disturbance regime for each reach, habitat characterization of instream and riparian characteristics. Reports to funding agencies and peer-reviewed publications. Presentations at scientific meetings and educational forums.

Observations/monitoring needs: In-field observations and remote sensing data compiled in a GIS environment.

Existing efforts: Elwha Dam Removal Project adaptive management monitoring.

Connection to other thematic activities: Utilize methods and models developed by sediment group.

Probable participating organizations: National Park Service, Lower Elwha Klallam Tribe, NOAA Fisheries, U.S. Geological Survey, U.S. Bureau of Reclamation, universities, Elwha Research Consortium, NGOs.

Implementation strategy: TBD, see above under Activity 1.

Timeline: Some parameters/layers resurveyed every 1-3 years for at least 20 years following deconstruction.

Possible sources of funding: National Park Service, Lower Elwha Klallam Tribe, NOAA Fisheries, U.S. Geological Survey, universities, Elwha Research Consortium, NSF.

2.3.3. Implement research and monitoring protocols to test hypotheses and monitor freshwater and riparian responses to changes in sediment and wood supply and dynamics. Initially (1-5 yrs), this effort would require annual sampling to determine inter-annual and spatial variation. Long-term sampling frequency and intensity could be adjusted based upon initial results.

Deliverables: Multiple publications and contributions to Elwha Research Consortium databases, describing new knowledge of riparian-aquatic interactions.

Observations/monitoring needs:

a) Habitat mapping (side channel mapping, fish habitat, riparian classification).
b) Remote sensing (Hyperspectral, LIDAR).
c) Invertebrate communities.
d) Primary productivity and communities.
e) Fish communities.
f) Riparian communities.

Existing efforts (Appendix C): Morley et al., Reisenbichler et al., Pess et al. These existing efforts principally cover aquatic invertebrates and fish. For riparian vegetation, Shafroth et al.; Hauer, Lorang, Braatne; Ewing, Brown (w/in reservoir seedbanks, hydrochory).

Connection to other thematic activities: Fish ecology and biology; terrestrial & wildlife; physical processes and water quality; sediment.

Probable participating organizations: National Park Service, Lower Elwha Klallam Tribe, NOAA Fisheries, U.S. Geological Survey, universities, Elwha Research Consortium, NGOs.

Timeline: 2005-2025

Possible sources of funding: National Park Service, Lower Elwha Klallam Tribe, NOAA Fisheries, U.S. Geological Survey, universities, Elwha Research Consortium, NSF.

3. Marine and nearshore ecology and processes

Approach:
Generate and test predictions of hydrogeomorphic and ecological response trajectories in marine-nearshore ecosystems in scientific study area.

Basic Design:

1. Region of concern is estuary (tidal flood plain) to open marine waters, to 50 m depth.
2. Scientific study area is defined as western Freshwater Bay to eastern tip of Ediz Hook.
3. Comparative (reference) region is Clallam Bay to west, and eastern edge of Dungeness Bay.
4. Developed around strategy of predicting and assessing response trajectories between biota and hydrogeomorphic structure change in marine-nearshore.
5. Habitats defined: sandy subtidal (with and without eelgrass), subtidal boulders, subtidal gravel, gravel intertidal, sand intertidal, back barrier lagoons, tidal channels, emergent marsh wetlands, scrub-shrub wetlands, and uplands.
6. Comparison of Elwha study region to reference system(s) is fundamental to interpreting restoration "signal."
7. Focus is on adaptive learning; although adaptive management linked to marine-nearshore monitoring and studies may be feasible (e.g., influence rate of dam notching), we're realistically assuming that we will be generating assessments and developing/refining predictive capabilities for the *next* generation of dam removal/watershed restorations.

3.1. [Before] Document baselines in Elwha and reference system.

Key Questions:

1. What are the likely trajectories of geomorphic and ecological change in estuary and nearshore marine ecosystems that will result from dam removal?
2. Will the historic (pre-dam) structure of the Elwha estuary and adjacent nearshore marine shoreline serve as a predictable endpoint?
3. How does the historic and current estuary and nearshore marine geomorphology of the Elwha differ from other Strait of Juan de Fuca watersheds unaffected by dams?

3.1.1. Historical reconstruction of Elwha Delta, associated nearshore areas and reference systems.

Objectives: Reconstruct

1. Extent of subtidal delta;
2. Sediment distribution;
3. Extent of estuary, including estuarine wetlands;
4. Using current conditions, extrapolate historic biotic structure;

5. Historical and oral history of historic ecosystem structure and human use.

Deliverables:

1. Bathymetry map of subtidal delta (pre-dams) from H Sheets.
2. Using sediment cores, we can derive historic sediment distribution to overlay bathymetry.
3. Digitized, geo-referenced map of historical habitat conditions in intertidal and delta. Include reference locations.
4. Map of historic landforms along Straits including reference sites.
5. Maps of probable plant and animal associations (e.g., vegetation of estuarine wetlands) in nearshore. Include nesting sites, mammal haul outs, vegetation maps. Include riparian upland.
6. Chronology of human use. Report and timeline.
7. Chronology of historic harvests of nearshore and marine resources. Report and timeline.
8. Chronology of delta changes (multiple points over time). For example, position of river mouth using aerial photography, T/H sheets.
9. Substrate/habitat plant and animal associations at present.
10. Chronology of changes in shoreline of study areas.

Observations/monitoring needs: Historic bathymetry (depths of subtidal delta), historic sediment map of subtidal delta, probable historic habitats in intertidal and in delta (vegetation, channel shapes and locations). Location of historic landforms and positions of shoreline at multiple points in time. Typology of habitat types in marine/nearshore. Current biota/habitat associations, animal and plant associations (distribution, general abundance patterns). Infer animal communities under historic conditions from habitat maps and association data.

Existing efforts:

- PSNERP – developing historic habitat reconstruction methodology for Puget Sound. Developing habitat typology/classification.
- Rivers History Project, UW – helping to develop historic habitat methods and maps.
- Point No-Point Treaty Tribes – Generating historic map of Elwha delta. Mapping historic habitat conditions along nearshore in Straits.
- U.S. Geological Survey – Substrate/sediment maps of near Elwha.

Connection to other thematic activities: Integrate with Cultural Resources Group to define historic cultural use.

Probable participating organizations: UW, PSNERP, Point No-Point Tribes, Lower Elwha Klallam Tribe, U.S. Geological Survey.

Implementation strategy:

- Develop habitat classification/typology.
- Develop methodology for reconstructing historic habitat.

- Take sediment cores.
- Define historic habitat/landform structure in delta, nearshore.
- Sample plant and animals in different nearshore habitats to develop community structure and relative abundances.
- Compile oral histories.
- Develop and produce products.

Timeline: 3 years following the implementation strategy.

Possible sources of funding: U.S. Geological Survey; PSNERP.

3.1.2. Current conditions and habitat-biota associations.

Objectives:

1. Substrate mapping;
2. Bathymetry mapping;
3. Monitoring circulation and waves;
4. Modeling circulation, waves, and sediment transport/sedimentation;
5. Biological assemblage associations with habitat structure;
6. Remote sensing of suspended sediment plume distributions;
7. CODAR HF radar of nearshore surface currents;
8. Water chemistry (salinity, temperature, nutrients, turbidity/light attenuation);
9. Habitat mapping;
10. Geomorphology change prediction;
11. Behavior of visual feeding birds, marine mammals and fish to turbidity plumes.

Applied over variable space and time scales, including especially during high discharge events.

Deliverables:

1. Maps of estuary and shoreline geomorphology, substrate distribution, and bathymetry;
2. Remote sensing imagery during representative sediment transport events in nearshore-marine system;
3. Quantitative analysis of distinct biological assemblages (e.g., benthic infauna, epifauna, demersal fish, seabirds) with "hydrogeomorphic habitats;"
4. Models and model runs of representative estuarine-nearshore-marine circulation, sediment transport and sedimentation, and depictions of predicted geomorphic change;
5. Maps of water (chemistry) properties;
6. Description of bird, marine mammal and fish behavior as a function of turbidity, published scientific reports and journal papers, various media for public education.

Observations/monitoring needs: (1) benthos, fish and seabird sampling/observations to validate and refine existing MESA data, (2) "habitat structure" data corresponding to biological sampling, (3) CODAR HF data, (4) eelgrass and kelp distribution and relative abundance surveys, (5) targeted satellite acquisition of suspended sediment plume

'events', and (6) conduct habitat analyses of USGS videography for biological-habitat associations (using WDNR protocols).

Existing efforts: (1) on-going USGS circulation-sedimentation studies, (2) past MESA studies, (3) incidental, site-specific data on kelps, etc.

Connection to other thematic activities: (1) sediment, geomorphology and water quality, (2) data sharing and management, (3) education (and outreach).

Probable participating organizations: (1) U.S. Geological Survey, (2) Elwha research consortium, (3) WDNR, (4) NANOOS.

Implementation strategy:

1. Develop statistically structured sampling design of physical structure and biological associations based on estuarine and nearshore geomorphology/benthic structure;
2. Classify MESA and other data within that design;
3. Identify gaps in habitat-biota representation, and initiate sampling to fill gaps;
4. Conduct targeted, 'event-driven' observations and experiments around natural (pre-dam removal) suspended sediment plume distribution;
5. Synthesize predictions of physical change from estuary to nearshore extent of scientific study region;
6. Make predictions of biological response trajectories.

Timeline: Within pre-dam removal period.

Possible sources of funding: U.S. Geological Survey, National Science Foundation, NOAA, Washington Department of Fish and Wildlife.

Additional comments:

- Need consensus and coordination on reference system(s)
- Highly dependent on Sediment/Geomorphology/Water Quality group documentation of movement of sediments (sand and gravel, fines to lesser degree) through the system
- Need to establish uniform, adoptable system of "habitat" typology; link to PSNERP shoreline typology?
- Uniform suite of 'indicator' metrics, and common protocol
- A system for broad-scale observation and periodic remote sensing (bathyLiDAR, hyperspectral, satellite) should be established to support all elements of the program.

3.2. [Before] Conceptual model of marine-nearshore change.

Key Questions:

1. What is the degree of uncertainty associated with predictions of the rates and patterns of change in estuarine-nearshore ecosystems associated with dam removal?
2. How can a conceptual model be used to report the progress and outcome of the project to the public, funding agencies as well as the scientific community?
3. How will a conceptual model facilitate development and analysis of predictions that strengthen our ability to design future restoration projects?

3.2.1. Historic change analysis.

Objective: This activity describes and assesses the change from historic, undisturbed conditions of the estuary, nearshore and marine areas to present day conditions. The factors that would be included are: (1) geomorphic structure, (2) analysis of change factors, including those not associated with dams, (3) change in habitat and biota, (4) change in water quality (turbidity and nutrients) and food web, and, (5) change in primary production. This activity provides an understanding of what has changed, which assists in developing predictions of what processes and habitat conditions need to be re-established to fully restore the estuary-nearshore-marine area.

Deliverables: The primary product is a conceptual model describing the processes, habitats and biota changes caused by the dams as well as other factors. Specific products in this activity include (1) maps of historic and present day habitat distributions: (2) a report analyzing the major changes in habitat forming processes; (3) data on the abundances of major benthic and pelagic species historically and present day; (4) data on water property conditions historically and present day; (4) assessment of how these changes were driven by changes associated with damming the river; (5) assessment of non-dam related changes (e.g., climate, fisheries harvest, shoreline armoring) that may have affected the area; (6) a published manuscript on this change analysis which summarizes the changes, and the factors responsible for these changes.

Observations/monitoring needs: Maps of pre-dam elevation/bathymetry maps (T-sheets and H-sheets); current bathymetry and geomorphic maps; surface geology for pre-dam and present-day conditions; links of elevation-bathymetry and surface geology to habitat types and species; historical and pre-sent day water properties data. Water property monitoring before, during and after dam removal.

Existing efforts:

- USGS nearshore bathymetry and surface geology program.
- Point No Point analysis of historical T and H sheets.
- WDNR (M. Dethier) report on intertidal habitat types in Washington State.
- Thom and Hallum report on historical changes in habitats in Puget Sound.
- Battelle Marine Sciences Lab mapping of subtidal habitats.
- Fisheries harvest records.
- 1912 kelp maps.

- WDNR kelp monitoring program.
- WDNR eelgrass monitoring program.

Connection to other thematic activities:
- USGS geological processes research in river.
- Salmonid fisheries research by NOAA in the river.
- Hydrological modeling.
- Wildlife analysis.

Probable participating organizations: U.S. Geological Survey, UW, Peninsula College, Western Washington University Program at Peninsula College, Battelle/PNNL, WDFW, Lower Elwha Klallam Tribe.

Implementation strategy:
- Identify and gather historical data.
- Develop maps of historical data.
- Identify and compile pre-dam data.
- Examine data for gaps.
- Develop and implement studies to fill gaps.
- Conduct mapping and analyses.
- Develop model of processes and habitat changes.
- Produce publication.

Timeline:
- Identify and gather historical data - year 1.
- Develop maps of historical data – year 1.
- Identify and compile pre-day day – year 1.
- Examine data for gaps – year 1.
- Develop and implement studies to fill gaps – years 2-3.
- Conduct mapping and analyses – year 3.
- Develop model of processes and habitat changes – year 3.
- Produce publication – year 3.

Possible sources of funding: EPA, NSF, State of Washington, The Nature Conservancy, Department of Energy, NOAA, U.S. Geological Survey.

3.2.2. Develop predictions of results of restoration actions using the conceptual model developed in activity 3.2.1.

Objective: This includes identifying the uncertainty associated with predictions of the rates and patterns of change. Predicting the outcome provides a basis for judging the success of the project. Identifying uncertainties both admits that we are not sure about what will happen, and can help identify alternative actions to take to better meet the goals for the project. It is critical that the success of the project be reported to the public, funding agencies as well as the scientific community. Development and analysis of predictions strengthens our ability to design future restoration projects.

Deliverables:

- A model predicting spatial and temporal patterns of change in geomorphology, habitats and biota following dam removal.
- Predictions of several alternative short-term and long-term ecosystem state conditions.
- An assessment of the degree of uncertainty associated with these predictions.
- Recommendations for alternative actions to take in the event of reaching each one of the alternative states (i.e., no action, some corrective actions, change goal).
- A published manuscript describing the above.
- A web-based communication system to allow interested parties to access the publication as well as the data base and analysis used to develop the predictions.

Observations/monitoring needs: Model and analysis developed in Activity 1, Historic change analysis.

Existing efforts:

- Conceptual model by Puget Sound Nearshore Ecosystem Restoration Program (PSNERP).
- Conceptual model for nearshore assessment from Bainbridge Island (Williams et al.).
- Adaptive management framework for restoration projects (Thom 1997, 2000).
- Risk analysis associated with ecosystem restoration projects (Diefenderfer et al. 2004).

Connection to other thematic activities: USGS geological processes research in river; salmonid fisheries research by NOAA in the river; hydrological modeling.

Probable participating organizations: U.S. Geological Survey, UW, Peninsula College, Western Washington University Program at Peninsula College, Battelle/PNNL, WSDFW, Lower Elwha Klallam Tribe.

Implementation strategy:

- Develop final model of predictions.
- Develop alternative ecosystem states and times lines for development.
- Develop alternative actions based on alternative states.
- Develop plan for periodic assessment of state of the system.
- Publish manuscript.
- Develop web-based system.

Timeline: This activity should be completed in year 1 pre-dam removal.

Possible sources of funding: EPA, National Science Foundation, State of Washington, The Nature Conservancy, Department of Energy, NOAA, U.S. Geological Survey.

3.3. [During] Monitor short-term change.

Key Questions:

1. How do sediment transport and sedimentation processes change during the initial period during and immediately after dam removal?
2. What are the dominant physical and biological processes and structures affecting that change?
3. How do these changes compare to other (reference) estuarine-nearshore marine ecosystems in the region?

3.3.1. Monitor physical change.

Objectives:

1. Measure movement of suspended sediment plume (both surface and bottom plumes);
2. Continue bathymetry and substrate change measurements;
3. Monitor waves and currents;
4. Gather data to validate models.

Document at reference site(s), and consider and evaluate scales of influence beyond program area.

Deliverables: Research Papers – sediment dispersal processes and geomorphic change, extent distribution of turbid plume, oceanographic processes, estuarine processes.

Observations/monitoring needs: (1) Measurements of the physical forcing to the coastal system (river discharge, wind, waves, currents); (2) Benthic platforms to measure sediment transport along seabed; (3) remote sensing of the extent of the turbid surface plume; (4) CTD surveys of surface and bottom plumes during sediment discharge pulses; (5) Bathymetric and substrate monitoring of the nearshore and estuary, including "event response surveys" or cameras to capture high temporal variability; (6) monitor water and sediment dynamics in estuary and coastal lakes (7) coring of flood deposits; (8) 3-dimensional numerical modeling.

Existing efforts:

- Tribe – shoreface topographic surveys.
- USGS – process monitoring, bathymetric and substrate mapping, numerical modeling of coastal sediment transport.
- UW (Nittrouer & Ogston) – process monitoring, flood deposit coring (both proposed).
- Surfrider Foundation – photographic monitoring of river delta.

Connection to other thematic activities: Delivery of sediment (both timing and grain-size) and woody debris to delta is directly related to river sediment budget; coastal ecological response will be related to geomorphic change of estuary and nearshore, spatial/temporal distribution of the river turbidity plume, location and amount of sedimentation. Coastal ecological response (e.g., eelgrass) may produce geomorphic feedbacks.

Probable participating organizations: Lower Elwha Klallam Tribe, U.S. Geological Survey, UW, Battelle, Surfrider Foundation, local colleges.

Implementation strategy: Existing programs (Tribe, USGS) should work to develop team to characterize physical change monitoring plan. Team should be developed to supplement and fill gaps existing work plan.

Timeline: Observational and monitoring capabilities should be operational prior to the first pulse of sediment, i.e., before "first notch."

Possible sources of funding: NSF – Sediment dispersal processes and deposits; U.S. Geological Survey – Bureau research budget; NASA (remote sensing?)

3.3.2. Short-term biotic response.

Objectives: Investigate

1. Bird, marine mammal and fish behavioral response to turbidity plume;
2. Phytoplankton, seagrass and kelp productivity;
3. Benthic infauna changes;
4. Juvenile salmon estuarine residence time;
5. Nutrient concentration and distribution.

All to be collected in concert with physical monitoring (plume, larger sediment transport processes)

Deliverables:

Data, maps, and reports specific to restoration physical event.
Data, maps by season for duration of observed restoration physical event:

1. Key bird, marine mammal and fish distribution by season within project and comparative areas;
2. Data summarizing primary productivity phytoplankton;
3. Maps of macrovegetation distribution within project and comparative areas;
4. Juvenile salmon residence time within the estuary, nearshore within project area and comparative areas.

Not limited to physical event: Maps of nutrient concentrations, N, NP (inorganic and MDN) seasonally within project and comparative areas. At later stages of restoration response, define long term biological and physical monitoring.

Observations/monitoring needs:

Data, maps, by season, for the duration of the observed restoration physical event:
Key bird, marine mammal and fish distribution by season within project and comparative areas; primary productivity phytoplankton seasonally; maps of macrovegetation distribution within project and comparative areas; juvenile salmon residence time within the estuary, nearshore within project area and comparative areas; maps of nutrient concentrations, N, NP (inorganic and MDN) seasonally within project and comparative areas.

Not limited to physical event: Nutrient concentrations, N, NP (inorganic and MDN) seasonally within project and comparative areas.

Existing efforts: (1) incidental, site-specific data on kelps, e.g., WDFW; (2) tribal sampling of juvenile salmon and baitfish.

Connection to other thematic activities: Strong integration with physical processes and fisheries groups. Correlation with cultural group. Work conducted in conjunction with education group.

Probable participating organizations: Lower Elwha Klallam Tribe, WDFW, NOAA, Clallam MRC, U Vic (VENUS), ONP, UW (NANOOS, School of Aquatic and Fisheries Science, School of Oceanography), USFWS.

Implementation strategy: Monitoring of physical process biological response should begin with sediment signal and continue until large sediment is determined to have stabilized (or moved through) the project area and dynamic equilibrium is achieved. Once sediment is deemed stabilized, long term monitoring will take over. For non-physical processes, monitoring will begin with initial dam removal and continue in perpetuity. Biological monitoring will be scaled to include regional and local response, and based on geomorphic classifications.

Timeline: Defined by sediment processes for those parameters linked to physical processes. For nutrient monitoring, transition from pre-dam removal monitoring and continue until system achieves dynamic equilibrium within the nutrient monitoring.

Possible sources of funding: Washington Sea Grant; NSF.

3.4. [During] Evaluate restoration predictions.

Key Questions:

1. Do changes in biological assemblages correspond to pre-dam removal predictions of their response to physical change?
2. Does recovery of key biological assemblages match predictions of recruitment and recolonization?

3.4.1. Evaluate physical change predictions.

Objectives:

1. Conduct comprehensive assessment of physical change in estuary and nearshore;
2. Compare near-field (estuary-delta) to far-field (beaches-spits east and west).

Deliverables: Summary Report - A thorough comparison of the restoration predictions and actual monitored change will provide invaluable information to refine predictive

techniques (both conceptual and numerical). These refined predictive techniques, in turn, will greatly enhance planning for future restoration and disaster responses activities.

Observations/monitoring needs: Results from detailed sediment budgets and physical process monitoring efforts; results from numerical modeling of oceanography and geomorphology.

Existing efforts:

- Tribe – shoreface topographic surveys.
- USGS – process monitoring, bathymetric and substrate mapping, numerical modeling of coastal sediment transport.
- UW (Nittrouer & Ogston) – process monitoring, flood deposit coring (both proposed).
- Surfrider Foundation – photographic monitoring of river delta.

Connection to other thematic activities: Delivery of sediment (both timing and grain-size) and woody debris to delta is directly related to river sediment budget; coastal ecological response will be related to geomorphic change of estuary and nearshore, spatial/temporal distribution of the river turbidity plume, location and amount of sedimentation. Coastal ecological response (e.g., eelgrass) may produce geomorphic feedbacks.

Probable participating organizations: Lower Elwha Klallam Tribe, U.S. Geological Survey, UW, Battelle, Surfrider Foundation, local colleges.

Implementation strategy: Conduct research workshops and conferences to present observational results, organize and compile all data collected, develop comparative metrics, and write summary report.

Timeline: Although evaluation will be ongoing with monitoring activities, results should be formally compiled following a critical period of monitoring and results have been produced (~1-year following major observational activities). Progress over series of interim updates, as system is transformed.

Possible sources of funding: NOAA Fisheries: NCEAS.

3.4.2. Evaluate biotic change predictions.

Objectives:

1. Assess biological assemblage structure at sites with varying levels of physical change;
2. Compare habitat-biotic assemblage associations to pre-dam removal;
3. Assess biotic recruitment patterns and rates.

Deliverables: Maps of the location and extent of ~11 different habitats will be generated at 1-year intervals for the same time each year (e.g. July) after dam removal. For each interval, descriptions of biotic assemblages (plants, invertebrates, vertebrates) will be

provided, based on sampling in each habitat. Comparisons over time will be made between the locations and extent of each habitat, and the biotic assemblages in them. For plants, invertebrates, and fish, measures of areal density, age structure, immigration, and emigration will indicate changes in recruitment and growth rates among sampling intervals.

Observations/monitoring needs: Monitoring during each sampling interval will focus on: (1) species composition, percent cover, and stand structure of terrestrial, wetland, and aquatic vascular plants and macroalgae, and microalgal biomass; (2) species composition and biomass of meiofaunal and macrofaunal invertebrates in benthic, epibenthic, and water-column communities; (3) species composition, numbers, and size structure of both adult and larval fish, (3) species composition, numbers, and behavior (roosting, feeding) of birds in aquatic and adjacent terrestrial habitats (e.g. shrub-scrub on ridges within wetlands), and (4) species composition and behavior (hauling out, feeding) of marine mammals (e.g. harbor seals, river otters, perhaps gray whales).

Factors affecting the community structure of benthic invertebrates, such as sediment grain size and organic matter content, will also be measured to help explain trajectories of community change over time in the same general habitat. Factors essential to macrophyte growth, such as soil texture, organic content, and nutrient content, will also be measured.

Understanding the nature and specificity of habitat dependencies requires data on the diets of consumers in different habitats. Diets of birds and fish will be determined by a combination of gut-content, fecal pellet, stable isotope, and fatty acid analyses.
To separate dam-removal effects from natural environmental variation, data collected at the Elwha site will also be collected at comparator sites without dam removal. For meaningful comparisons of similar habitats, these sites (estuaries) might differ for the ~11 major habitats recognized. For highly mobile birds, aerial surveys of larger areas will be needed to evaluate their distributional response to habitat availability in the Elwha nearshore.

Existing efforts: None. A proposal is pending to WDFW and the Elwha Tribe for surveys of nearshore habitat use by fish, to be conducted by WDFW and NMFS biologists. For some taxa (e.g., scoters and salmon), some comparable data are being collected at other sites during ongoing projects.

Connection to other thematic activities: The location and extent of the ~11 different habitats will be determined largely by the supply and redistribution of sediments by mainly physical forces. The abundance, distributions, size structure, and recruitment of fish will depend partly on fishery exploitation patterns. The Elwha Tribe is especially interested in harvestable shellfish populations, so results in that regard will be of strong public interest. Birds are perhaps the most visible and easily censused of affected organisms, so the potential for public interest and involvement is high.

Probable participating organizations: The NSF-funded REU program (Research Experience for Undergraduates) administered through Peninsula College and other local

schools could play an important role in sampling the biota. Although close supervision will be needed to ensure data quality and consistency, training for students and local residents (as from the Elwha Tribe) should allow strong public involvement. U.S. Geological Survey, USFWS, WDFW, NMFS, NPS, and various colleges and universities should be involved.

Implementation strategy: As the extent and location of the ~11 habitats is expected to change through time after dam removal, numbers and locations of samples at different time intervals must be based on maps of sediment and landform distributions generated by the cooperating physical scientists. Once sampling locations (via GPS) are determined, standard sampling procedures will be implemented for (1) plant and algal communities, (2) meiofaunal and macrofaunal invertebrates in benthic, epibenthic, and water-column communities; (3) both adult and larval fish, (4) birds in aquatic and adjacent terrestrial habitats, and (5) marine mammals (harbor seals, river otters, perhaps gray whales). Once sampling procedures are refined and standardized by scientists, students and the public can be incorporated into field work and laboratory processing of samples.

Timeline: Primary use of habitats by top consumers varies seasonally, e.g. mainly spring-summer for fish and fall-spring by waterbirds. The seasonal sampling scheme for different variables will vary depending on their functional role in supporting food web pathways of interest. More easily sampled components such as birds and mammals may be sampled monthly, whereas less easily sampled components such as epibenthic meiofauna may be sampled only in the spring. Regular samples will begin before the dam is removed to provide baseline data, and continued after dam removal until it appears that a dynamic equilibrium is reached. The period after dam removal until this equilibrium is reached is expected to vary appreciably among the ~11 major habitats.

Possible sources of funding: EPA, NPS, USFWS, NMFS, U.S. Geological Survey.

3.5. [After] Define new dynamic equilibrium in marine/ nearshore.

Key Questions:

1. Do estuarine and nearshore ecosystems structure and processes reach a definable ‘dynamic equilibrium state’ after the dominant sediment sources have moved through the system?
2. How long does will it take to achieve a dynamic equilibrium?
3. Do the biotic assemblages reach a dynamic equilibrium coincident with physical processes and structure?

3.5.1. Document restoration response in comparison to reference.

Objectives:

1. Sediment budgets,
2. Assemblage structure and relative abundance in characteristic habitats,
3. Biotic recruitment (e.g., infauna, kelp, eelgrass),

4. Indicator organisms (e.g., fish and bird diet).

The new "post-dam dynamic equilibrium" of these systems is expected to respond over different scales of space and time.

Deliverables: Papers – defining the transformation to the new "post-dam dynamic equilibrium" of the various nearshore and marine systems (sediment, habitat, specie, ecosystem, nutrients). For education and outreach, 3-D visualizations/animations of evolution of new dynamic equilibrium state

Observations/monitoring needs: Key metrics measured through the period of "post-dam dynamic equilibrium." These metrics include sediment budgets, water properties (turbidity, temperature), habitats, biotic species/community measures, and nutrient concentrations/loads.

Existing efforts:

- Tribe – shoreface topographic surveys.
- USGS – process monitoring, bathymetric and substrate mapping, numerical modeling of coastal sediment transport.
- UW (Nittrouer & Ogston) – process monitoring, flood deposit coring (both proposed).
- Surfrider Foundation – photographic monitoring of river delta.

Probable participating organizations: Lower Elwha Klallam Tribe, U.S. Geological Survey, UW, Battelle, Surfrider Foundation, local colleges.

Implementation strategy: Use sediment budgets and other (e.g., geomorphology) monitoring and studies to identify relative stabilization of sediment transport and estuarine/nearshore geomorphology. Initiate studies to document long-term variability in both physical processes/structure and development of biotic assemblages and ecosystem (e.g., food web) processes. Develop metrics of ecosystem state and dynamics that are responsive to development of dynamic ecosystem equilibrium.

Timeline: Staged dependent on response timing.

Possible sources of funding: NSF.

3.5.2. Evaluate long-term restoration in context of regional change.

Objectives: Evaluate

1. Sea level rise,
2. Climate change effects on freshwater discharge and sediment transport regionally,
3. Climate change effects in sea and wind waves,
4. Climate change effects on regional biological (e.g., fish, crab, seabirds) variability,
5. Fisheries harvest.

Restoration of the ecosystem must be judged in the context of its sustainability under changing conditions in the region and globe. Climate variation, natural disturbances (e.g., floods, earthquakes), and man-made alterations (e.g., fisheries harvest, pollution) can have significant impacts on the success of a restoration project. If the progress of a restoration project is to be evaluated objectively, these other forcing factors external to the project must be considered.

Deliverables: A system that compiles information and data that will be used in annual assessment of the progress of the restoration project.

Observations/monitoring needs:

- Update of sea level rise rates.
- Track sea annual sea level variations.
- Track climate change effects on freshwater discharge and sediment transport regionally.
- Track climate change in sea and wind waves.
- Track climate change on regional biological (e.g., fish, crab, seabirds) variability.
- Track fisheries harvest.

Existing efforts:

- NOAA sea level monitoring.
- Pacific Decadal Oscillation monitoring by UW-Climate Impacts Group.
- USGS wave tracking.
- NOAA and WSDFW fisheries harvest records.
- Tribal fisheries harvest records.

Connection to other thematic activities:

- Hydrological monitoring
- Wildlife monitoring
- Currents and wave monitoring
- Water properties monitoring

Probable participating organizations: U.S. Geological Survey, UW, Peninsula College, Western Washington University Program at Peninsula College, Battelle/PNNL, WSDFW, Lower Elwha Klallam Tribe.

Implementation strategy:
Update sea level rise rates.
Develop system to

- Track sea annual sea level variations.
- Track climate change effects on freshwater discharge and sediment transport regionally.
- Track climate change in sea and wind waves.
- Track climate change on regional biological (e.g., fish, crab, seabirds) variability.
- Track fisheries harvest.

- Conduct annual analysis of external factors.

Timeline:
Year 1 pre-dam removal: Update sea level rise rates.

Year 2 pre-dam removal: develop system to –

- Track sea annual sea level variations
- Track climate change effects on freshwater discharge and sediment transport regionally
- Track climate change in sea and wind waves
- Track climate change on regional biological (e.g., fish, crab, seabirds) variability
- Track fisheries harvest

Conduct annual analysis of external factors: annually through "during" and "after" phases.

Possible sources of funding: EPA, NSF, State of Washington, The Nature Conservancy, Department of Energy, NOAA, U.S. Geological Survey.

3.6. [After] Evaluate need and type of further research and restoration actions.

3.6.1. Evaluate physical changes.

Objective: Synthetic analysis of marine/nearshore ecosystem response in physical structure: Were predictions met? How did they vary? Why? Retrospective modeling of alternative restoration actions, responses and mechanisms of change. Assessment of need for future restoration actions.

Deliverables: Scientific Report/Papers – defining response of the various nearshore and marine systems (sediment, habitat, specie, ecosystem, nutrients) and suggesting new methods/techniques for prediction. Report will also suggest observational metrics to continue through the post-dam period to track continuing changes or evaluate the post-dam dynamic equilibrium.

Observations/monitoring needs: Results of the physical and biological observations.

Existing efforts: Lower Elwha Klallam Tribe, U.S. Geological Survey, UW.

Probable participating organizations: Lower Elwha Klallam Tribe, U.S. Geological Survey, UW, U of Wyoming, Battelle, Surfrider Foundation, local colleges.

Implementation strategy: Conduct synthesis workshops to summarize observational results, evaluate restoration actions, what metrics have worked or not, and write summary report/papers. A major element of an ultimate Elwha Restoration Conference that will synthesize outcome of science, education and outreach for all audiences.

Timeline: Results should be formally summarized and compiled following the major observational activities.

Possible sources of funding: NSF

3.6.2. Evaluate biotic change.

Objective: Synthetic analysis of marine/ nearshore ecosystem response in biotic structure: Were predictions met? How did they vary? Why? Retrospective modeling of alternative restoration actions, responses and mechanisms of change. Assessment of need for future restoration actions.

Deliverables:

- Quantitative analysis of restoration response relative to temporal (pre-during restoration event) and comparative areas. Analysis to include observed response of key biological parameters correlated with physical restoration (sediment) events.
- Synthesis of findings with key focus on determining the success in defining, and detailing, restoration response at a local and regional scale.
- Identify data gaps and additional restoration needs.
- Identify future long term monitoring. Future monitoring developed based on restoration response observed.

Observations/monitoring needs: Based on content and level of information from prior described activities.

Existing efforts: PSNERP nearshore ecosystem restoration planning efforts and products.

Connection to other thematic activities: Strong association with data management, physical processes, education, and cultural resources groups.

Probable participating organizations: Lower Elwha Klallam Tribe, Consortium (Peninsula College et al.), WDFW, NOAA, Clallam MRC, U Vic (VENUS), ONP, UW (NANOOS, School of Aquatic and Fisheries Sciences, School of Oceanography), USFWS.

Implementation strategy: Analysis will begin once dynamic equilibrium is achieved as detected in the "during" period restoration monitoring. This will be a major element of ultimate Elwha Restoration Conference that synthesizes outcome of science, education and outreach for all audiences.

Timeline: Long term post restoration biological monitoring will begin once dynamic equilibrium is achieved. Additional restoration actions may be implemented during restoration timeline as appropriate.

4. Fish ecology

Note: All activities are considered high priority and should be pursued concurrently.

4.1. Fish community response: Study design issues.

Key Question:

What are the strength and weaknesses of different study designs to evaluate the long-term fish community response to the removal of the Elwha River dams?

4.1.1. Long-term study design.

Objective: The Elwha Act of 1992 mandates the recovery of native anadromous salmonids to the Elwha River. The Elwha is a prime case study for the large-scale restoration of a watershed. This is essentially a huge experiment in ecology and evolution. Even small experiments require extensive planning; at the scale of an entire watershed, it is essential to establish a rigorous study plan if we are to learn anything informative about the biological effects of dam removal. Consequently, the first priority for establishing the effects of dam removal is a long-term study design.

A fish population response monitoring plan is currently in place that examines spatial and temporal scales, the concept of reference and treatment areas, and the identification of several metrics identifying species, life-stage, and productivity. This study design also identifies the need to separate natural and hatchery fish using both visual and genetic identification systems.

These concepts need to be operationally defined and implemented before, during, and after dam removal. Activity 1 would 1) link study design with specific questions, 2) identify appropriate population, diversity and mass balance metrics, and 3) define specific protocols to ensure implementation among all collaborators.

Deliverables:

1. Peer-reviewed study design or paper, possibly including modeling to identify the most appropriate methods or metrics;
2. List of protocols to be followed.

Observations/monitoring needs: None.

Existing efforts (see Appendix C):

Smith and Eaton
McHenry et al.
Pess et al.
Pess et al.
Reisenbichler et al.

Connection to other thematic activities: Sediment, riparian, estuarine, nearshore, and wildlife studies.

Probable participating organizations: Lower Elwha Klallam Tribe, NPS, WDFW, U.S. Geological Survey, NOAA Fisheries, the University of Washington, and the EPA.

Implementation strategy:

1. Finalize and peer-review monitoring plan;
2. Monitoring plan officially adopted by all collaborators as a guidance document;
3. Monitoring plan implemented.

Timeline:

2005. Draft document finalized and peer-reviewed.
2006. Monitoring plan directives implemented by collaborators.

Possible sources of funding: EPA, NOAA Fisheries, NPS, U.S. Geological Survey, NSF.

4.2. Fish community response: Direct effects of dam removal on fish populations.

Key Questions:

- What is the fish community response to dam removal in the Elwha River?
    - How does recolonization of newly opened habitat after dam removal effect fish community response?
    - What is the fish physiological, behavioral, and population response to a large-scale sediment disturbance?
    - How does a large-scale sediment disturbance alter fish habitat quantity and quality?

Objective: *Document the effects of dam removal on the fish community.* This project will investigate three general activities: recolonization of newly opened habitat, the immediate effects of sediment disturbance on fish, and the long-term effects of habitat change. These issues will be addressed within three units – the lower Elwha (below dams), the middle Elwha (area between dams), and the Upper Elwha (above dams) – over a 10-year time period post deconstruction.

4.2.1. Recolonization of newly opened habitat.

We will document the distribution, abundance, and productivity of the fish community, following the monitoring plan identified in Priority #1. This activity will focus on population responses in the middle and upper reaches of the Elwha. We will rely on complete marking of hatchery fish to distinguish natural colonization from anthropogenic supplementation. Pre-dam removal information will be critical to establish baseline conditions in these reaches.

4.2.2. Effects of sediment disturbance on fish.

This effort will focus on physiological, behavioral, and population responses to the sediment pulse during and following dam removal. Physiological effects include lethal and sub-lethal effects, behavioral effects include movements of adults or juveniles, and population effects include survival through particular life stages. This activity will focus on fish responses in the lower and middle reaches of the Elwha during and after dam removal. Pre-dam removal information will be important to establish baseline patterns.

4.2.3. Effects of habitat change on the fish community.

This effort will examine changes in habitat quantity, quality (e.g., embeddedness), and distribution in tributaries, mainstem, and floodplain channels, and their effects on fish. This activity will focus on the lower, middle, and upper Elwha, but the data generated will also allow us to evaluate how long term fluvial processes influence the shifting habitat mosaic on estuarine and nearshore fish communities.

Deliverables:

- Peer-reviewed empirical field studies.
- Life cycle models of population and community/ecosystem responses to dam removal and long-term habitat change.
- Quantitative information for adaptive management checkpoints.

Observations/monitoring needs:

- ACTIVITY 1 – Tagging studies, expanded juvenile and adult surveys.
- ACTIVITY 2 – Lab or hatchery to initiate initial studies.
- ACTIVITY 3 – Continued habitat monitoring over long time period (up to 20 years).

Existing efforts (see Appendix C):

Pess et al. (1)
Pess et al. (2)
McHenry et al.
Lorang et al.
Burke et al.
Konrad et al.
Konrad
Randle et al.

Baseline information:

1. Snorkel surveys of fish abundance and distribution in the lower, middle, and upper Elwha reach.
2. Spawner surveys and redd counts.
3. Outmigrant trapping March through June.
4. Surface trawling in nearshore areas associated with the Elwha.
5. Habitat surveys in lower, middle, and upper Elwha.
6. Collection of tissue samples of salmon and char for genetic and isotope analysis.

Connection to other thematic activities: Sediment, riparian, estuarine, nearshore, and wildlife studies.

Probable participating organizations: Lower Elwha Klallam Tribe, WDFW, U.S. Geological Survey, Peninsula College, and NOAA Fisheries.

Implementation strategy: See existing efforts.

Timeline:
Activity 1
2005-07

1. Continue collecting information on distributions and abundance of fish in lower and upper reaches. Continue conducting spawner surveys, and expand outmigrant trapping January-June.
2. Initiate beach seining of salmonids in the estuary and nearshore.
3. Initiate tagging studies of salmonids in all reaches to examine pre-dam removal movements.
4. Continue habitat mapping to establish pre-dam removal distribution of habitat types.
5. Initiate tagging studies of adult and juvenile fish to examine upstream and downstream movement, migration, and survival.
6. Evaluate tagging design for juveniles.

2008 – Dam removal.

1. Evaluate the distribution and abundance of returning tagged salmonids to the Elwha and neighboring watersheds.
2. Begin evaluation of tagging study design.

2009-25
Continue field studies initiated before dam removal.

Activity 2
2006-07

1. Establish baseline sediment conditions. This includes embeddedness, percent fines in gravels, and suspended sediment levels.
2. Initiate studies at hatchery to evaluate physiological and behavioral effects of suspended sediment on adults and juveniles.

2008 – Dam removal.

1. Measure sediment metrics.
2. Adults – utilize radio tagging technology to monitor fish movement and survival patterns. In addition, quantify physiological performance and stress response of captured individuals.
3. Eggs – evaluate egg survival using egg boxes.
4. Juveniles – utilize PIT tagging technology to monitor fish movement and survival patterns.

2009-25: Continue sediment monitoring and tagging studies to evaluate the long-term effects of sediment disturbance.

Activity 3
2006-25: Continue habitat surveys

Possible sources of funding:

- Congressional line item for federal agency work or consortium.
- State funding for some survey work, although such support would likely be small. Consider lobbying for special state appropriation.
- Foundations for infrastructure.
- Pacific salmon commission.

4.3. Correlated Effects of Fish Community Response.

Key Question:

- How do correlated effects such as wild/hatchery interaction, resident/anadromous interaction, exotic species, marine survival, and climate variability effect fish community response to the removal of the Elwha River dams?

Objective: Correlated effects include issues within and outside the watershed that will influence fish community response to dam removal. These include: 1) wild/hatchery fish interactions, 2) resident/anadromous interactions, 3) exotic species interactions, and 4) marine survival/climate variability. These secondary effects could compromise/effect the success of the overall restoration effort and disguise the true effects of dam removal. For example, resident rainbow trout might preclude steelhead recovery through competition or hybridization, or they might facilitate restoration by serving as the progenitors of a well adapted gene pool.

Deliverables:

1. Wild/hatchery fish interactions
   a) Identify the relative contribution of hatchery and wild stocks to restoration for each species.
   b) Identify the relative contribution of fish with various life history phenotypes (i.e. run timing, spawn timing).
   c) Evaluate the relative efficacy of alternative outplanting life history stages (hatchery strategies-unfed fry, fed fry, smolts)

2. Resident/anadromous interactions
   a) Identify the relative contribution of resident/anadromous gene pools of *O. mykiss*, *Salvelinus* spp. and *O. nerka* to produce Natural Origin Recruits (NORS).
   b) Understand the partitioning of freshwater habitat and food resources between these two forms (juveniles; mate selection and outbreeding depression).

c) Test for outbreeding depression by making experimental crosses of resident and anadromous *O. mykiss*.

3. Exotic species interactions
   a) Document the distribution of exotic species and evaluate their risk to the overall restoration effort to serve as a basis for action through adaptive management.
   b) Determine the consequences of inaction on recovery (monitor impacts on restoration).
   c) Monitor for the transmission of diseases novel to resident populations above the dams.
   d) Marine survival/climate variability

   Link to UW Ocean/Climate researchers to evaluate large scale correlations of ocean conditions and salmon recovery.

Observations/monitoring needs:

- Activity 1 – Long-term tagging/behavioral/survival studies of juveniles and adults.
- Activity 2 – Long-term tagging/behavioral/genetic studies of juveniles and adults to compare relative success of different breeding strategies.
- Activity 3 – Continued distribution and abundance monitoring over long time period (up to 20 years).
- Activity 4 – Coded wire tag and acoustic studies to gain better understanding of marine survival

Existing efforts (see Appendix C): Winans and Meyers; McHenry and Elofson; House and Mumford; Burke et al.

1a/1b/2a) NOAA Fisheries has initiated baseline genetic sampling of Elwha River stocks in cooperation with USGS and Lower Elwha Klallam Tribe.

3a) Some existing information collected by Lower Elwha Klallam Tribe/NPS/USGS
3c) See above.

4a) Need more Elwha specific effort?
4b) Some monitoring occurring for coho, chinook; needs to be evaluated for sufficiency.

Connection to other thematic activities: Riparian, estuarine & nearshore, and wildlife studies.

Probable participating organizations: Lower Elwha Klallam Tribe, WDFW, U.S. Geological Survey, Peninsula College, and NOAA Fisheries.

Implementation strategy:
1a/1b/1c) Apply GSI methodology and/or pedigree analysis to genetic baseline and juvenile/adult gene frequencies to evaluate genetic contribution from source populations. Conduct power analysis and demonstrate feasibility of methodology.

2a/2b) Same as 1.
2c) Conduct controlled experiment using appropriate stocks most likely to be involved in recolonization/recovery.

3) Mixture of compilation of existing data supplemented by field observation in previously unsampled habitats.

4) Implement tagging strategies to monitor marine survival and distinguish hatchery fish.

Timeline:
1a/2a) Baseline must be established NOW! (and throughout the project).
1b) Need to characterize life history traits of existing lower river populations prior to dam removal. Track over time. Compile and synthesize data to relate spawning time and temperature regime in various Olympic Peninsula/PNW watersheds.
1c) Occurs following dam removal; however, planning among diverse agencies needs to happen soon.

2c) Conduct experimental work prior to reintroduction of steelhead to upper river.

3a/3b) Conduct surveys and syntheses prior to dam removal (next 2 years); adaptive management will determine extent of effort pending results. If no action, need to monitor potential impacts post-removal.
3c) Conduct baseline surveys now (prior to dam removal), repeat surveys at decadal(?) intervals.

4) Establish and continue through entire project.

Possible sources of funding:
1. Congressional line item for federal agency work or consortium.
2. State funding for some survey work, although such support would likely be small. Consider lobbying for special state appropriation.
3. Foundations for infrastructure.
4. Pacific salmon commission.

Additional comments: Budget estimates (Appendix B) are very uncertain.

5. Terrestrial and wildlife ecology

Note: As of May 2005, priorities, specific activities, timelines and implementation strategies for terrestrial and wildlife ecology issues remain to be elaborated.

Overview
Dam removal in the Elwha River is a quintessential opportunity to study the development of a fully functional, interactive ecosystem, by monitoring the strength of emerging connections between the aquatic and terrestrial ecosystem components as fish re-colonize the system and terrestrial vegetation re-colonizes the former reservoir regions.

Key Questions:

1. To what degree will the addition of salmon, versus the physical change in terrestrial habitat, force change in the system?
2. Are nutrients limiting in the system – to what degree will the addition of marine-derived nutrients impact aquatic and terrestrial primary production?
3. Is food (energy) limiting – to what degree will the addition of salmon alter food web dynamics via "top-down" vs. "bottom-up" effects?
    a. via predation/scavenging on the adult fish
    b. via predation on the smolts
    c. via predation on eggs and fry

Deliverables:
A clear understanding of how changes in the fisheries resource provoke changes in the ecosystems dependent on that resource, clarifying key linkages involving predation and scavenging as well as nutrient additions.

Observations/monitoring needs: From nutrient chemistry to top predators, sampling schemes must be spatio-temporally coordinated such that ecosystem transfers (nutrients, energy) can be captured. However, within each functional component (e.g., fish, aquatic insects, meso-predators, etc.), the spatial scale of sampling will depend on the biology of the organism (e.g., home range).

1. Fish sampling: carcass counts; smolt production; size distribution of resident fish
2. Nutrient budgeting: a mass balance differencing
3. Densities, movement rates, tissue sampling of nutrient vectors (meso & macro-predators; choose indicator species)
4. Primary productivity (choose indicators)
5. Population demography and growth rates of meso & macro-predators (choose indicator species)
6. Population demography and growth rates of herbivores (choose indicator species)

Existing efforts (Appendix C): Brown; Happe and Jenkins; Jenkins et al.; Shafroth et al.; Morley et al.; Reisenbichler et al.; Lorang et al.; Freilich; Pess et al.

Connection to other thematic activities: Physical processes, fish ecology, aquatic and riparian ecology.

Probable participating organizations: National Park Service, NOAA Fisheries, U.S. Geological Survey, universities, Elwha Research Consortium, NGOs.

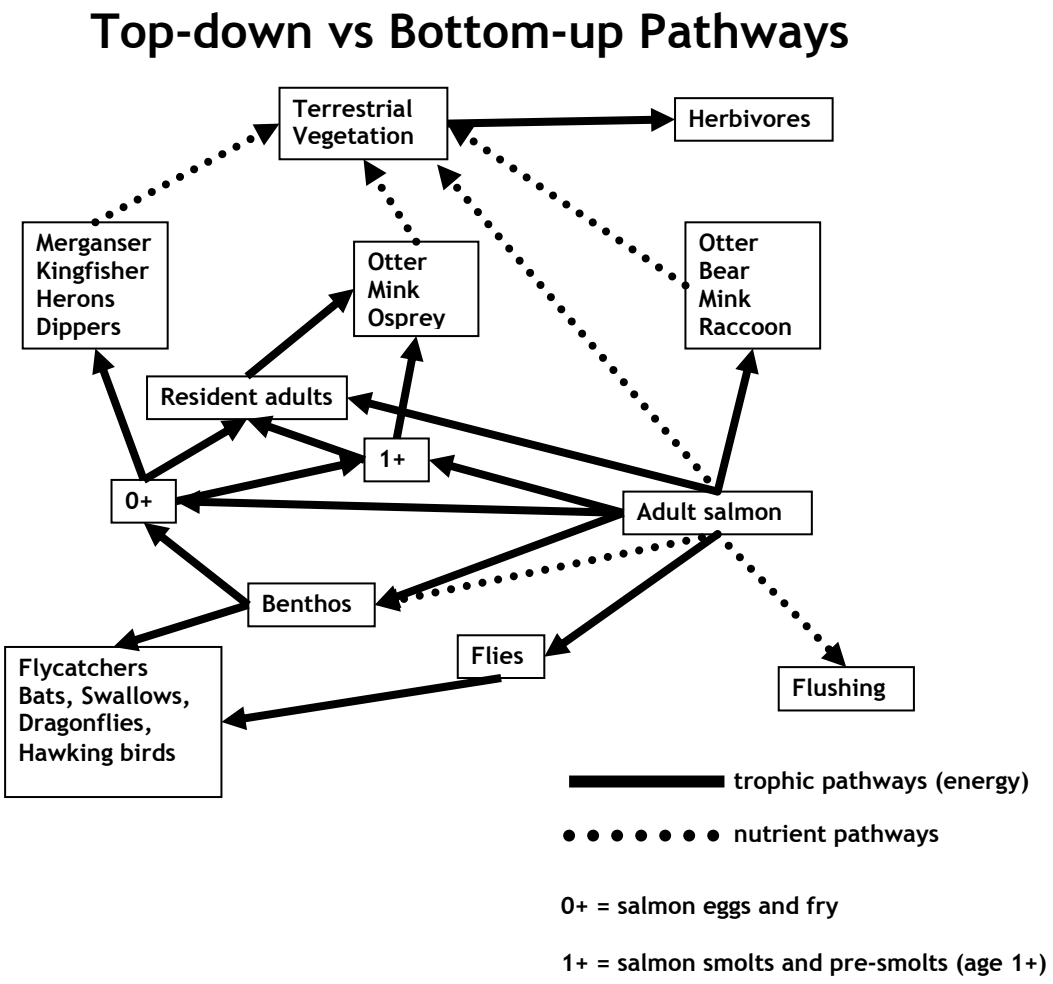
Possible sources of funding: National Park Service, NOAA Fisheries, U.S. Geological Survey, universities, Elwha Research Consortium, NSF.

Additional comments: A key concept emerging from the working group was the potential for different salmon life history stages to affect animal species (and trophic guilds) unequally. For example, mergansers and dippers may be strongly affected by the abundance of salmon eggs and fry populations, while otters and mink may be more affected by pre-smolt juveniles and smolts. In addition, the size of insect hatches may be influenced by the quantity and distribution of salmon carcasses, which could disproportionately affect insectivorous birds and other species (see Figure 1).

Different reaches are predicted to experience relatively different sizes of trophic effects; these differences can be exploited for investigating interactions between fish and other organisms in the watershed.

Costs are highly variable depending upon the number of organisms and trophic guilds studied; this range is represented in the cost estimates presented in Appendix B. Connections to aquatic productivity, fish and riparian ecology studies will have a large effect on the final budget.

Figure 1. Trophic and nutrient pathways postulated by the Terrestrial/Wildlife working group.



6. Data sharing and management

6.1. [Near-term] Establish an Information Management Organization.

6.1.1. Assemble Project Oversight Board.

Objective: An Information Management (IM) Project Oversight Board is needed to oversee the establishment and implementation of the activities to follow for the short term, mid term and long term efforts.

Deliverables:

1. Selection of Project Oversight Board members.
2. Definition of roles and responsibilities of IM Coordinator.
3. Information Management Project Scope and Charter.
4. Performance evaluation of IM efforts.

Existing efforts: Initially made up of Feb. 14-15 participants and others working in Information Management areas such as the UW, IRICC, Federal, State, Tribal, and non-profit organizations.

Connection to other thematic activities: 6.1.2 (Hire an IM coordinator); 6.2 (Requirements gathering, project plan and budget of alternatives).

Probable participating organizations: Technical staff from participating organizations, members of user community.

Implementation strategy: Start with minimal volunteered services.

Timeline: Already started with Feb. 14/15, 2005 workshop participants; other partners should be contacted for potential participation.

Possible sources of funding: In-kind contribution of cooperating agencies.

Additional comments: Most organizations fail to consider the long term life cycle requirements of data/applications/systems and the need for a project oversight board to continue to support these efforts at an ongoing strategic level with principal users and management.

6.1.2. Hire an Information Management Coordinator.

Objective: Hire an Information Management Coordinator who can adapt through feedback from the project community, since *a single point person to coordinate all activities is the most critical factor for ensuring success*. Job requirements: Experience with community building a must. Requires travel to meet data providers individually to build trust and assess best technology for the building of prototypical data clearinghouse. Strong vision in terms of likely successful data provision forms and data retrieval interfaces a must as education of providers and users will be critical and first impression

significant to obtaining buy-in and trust. Must understand significance of knowledge engineering to successful use of community data clearinghouses.

Observations/monitoring needs: Interaction with Information Management Oversight Board.

Existing efforts: Groupware industry success case studies (e.g., oceans.us.org).

Connection to other thematic activities: Support of project goals that can be improved via community interaction and shared data sets.

Probable participating organizations: Those named as members of the Project Oversight Board (above), including National Park Service.

Implementation strategy: Exhaustive search for ideal candidate; educate oversight board as to the criticality of job requirements. Once found, hire ASAP.

Timeline: Hire ASAP upon identification of a worthy candidate, two year funding for iterative phase to full operational plan.

Possible sources of funding: 15% tariff on funded research; government organizations looking for guidance on information sharing during critical environmental reclamation projects.

Additional comments: Success of system is highly dependent on success of this information management coordinator.

6.1.3. Assemble Project Implementation Team.

Objective: An Information Management Project Implementation Team is needed to implement the information management system. This will ensure that the system gets the attention needed to succeed. The role of this team is to assist and support IM Coordinator to implement all aspects of Priority 2 activities.

Deliverables: Definition of roles and responsibilities of IM Project Team.

Existing efforts: Initially made up of Feb. 14-15 workshop participants to facilitate initial efforts, and others working in Information Management areas such as the UW, IRICC, Federal, State, Tribal, and non-profit organizations.

Connection to other thematic activities: Activity 2 (Hire an IM coordinator); PRIORITY 2 (Requirements gathering, project plan and budget of alternatives).

Probable participating organizations: Technical staff from all participating organizations.

Implementation strategy: Start with volunteered services, adapt to funding levels and expand as money is available meeting bi-weekly initially to monthly. Assign tasks to core team members.

Timeline: Already started with Feb. 14/15 team; staff up as funding is available in the next 3 to 6 months.

Possible sources of funding: In-kind contribution of cooperating agencies.

Additional comments: IM Project Core Team members can be rotated if there are many members.

6.2. [Near-term] Requirements gathering – Develop a project plan and budget for alternative short- and long-term strategies.

6.2.1. Build consensus and awareness of user community, memoranda of understanding to explicitly identify information community involvement as critical mass of participants is critical to the success of information management endeavors.

Deliverables: Memoranda of understanding (MOUs) signed by each project community member who will provide data on beta test usefulness.

Observations/monitoring needs: Tally of the number of memos signed. Are key participants on board?

Existing efforts: Boilerplate text drawn from similar data sharing agreements.

Connection to other thematic activities: Key to empowering information management coordinator, and providing a baseline vision among the community of what's reasonable to develop.

Probable participating organizations: Workshop participants and others.

Implementation strategy: One-on-one negotiation of agreements between IM Coordinator and representatives from each cooperating organization.

Timeline: Approximately 9 months to obtain all desired MOUs.

Possible sources of funding: Part of IM Coordinator's salary; same as hiring activity.

Additional comments: Agreements are key to inform the planning efforts.

6.2.2. Develop clearinghouse of links to abstracts provided by the user community. This is an early, motivational deliverable that will provide the

user community with a better picture of what the system ultimately developed by the IM team might provide.

Deliverables: Prototype of clearinghouse with placeholders representing eventual links to be developed.

Observations/monitoring needs: Usability of the prototype for the community.

Existing efforts: Many similar models can be found on the Web.

Connection to other thematic activities: Forging connections via data vision for data sharing.

Probable participating organizations: All workshop participants (and others).

Implementation strategy: Highly iterative design via community one-on-one sessions, actively pursuing feedback at each step.

Timeline: Concurrent with Information Management Coordinator's tenure.

Possible sources of funding: Bundled with Information Manager Coordinator's funding.

Additional comments: Clearinghouse is the most likely path to satisfactory success.

6.2.3. Inventory existing data formats, protocols, and standards being used by partners and members of the user community. Educate the user community on what types of data are going to be exchanged, and where possible come to a consensus on data exchange formats.

Deliverables: Summary report of data standards and conventions, with recommendations. Methods to convert non-standard data.

Observations/monitoring needs: Not applicable except in the sense that a collaborative tool would be crucial for communicating in this stage.

Existing efforts: Information Management Coordinator will work with partner agencies to see what inventories might have been accomplished.

Connection to other thematic activities: Activity 1 and 2 above.

Probable participating organizations: Those of user group, plus NPS and representatives of other agencies to ensure that standards are compatible.

Implementation strategy: For maximum buy-in by members of the scientific community, the formats and standards for data exchange should be driven by conventions already in use elsewhere.

Timeline: Primarily during design phase, though there is recognition that this is a cyclic process that can continue into operation and maintenance phases.

Possible sources of funding: Part of salary of coordinator and team in-kind (or salaried) efforts.

6.3. [Mid-term] Implement the recommended prototype system(s) based on positive feedback from user community.

6.3.1. Data Quality assurances/stewardship.

Objective: The data need to be well documented and in a form that is usable by the community. There has to be someone in charge of the data to ensure that it is correct and stays current (Provider).

Deliverables: Data that is well documented and usable.

Probable participating organizations: All data providers.

Implementation strategy: Good communication with user community.

Timeline: Continuous throughout Operational and Maintenance phase.

Possible sources of funding: % of projects.

6.4. [Mid-term] Build up production system infrastructure to support operations. Make sure the necessary staffing and infrastructure are in place to support the system that was developed during earlier phases.

6.4.1. Make sure that the necessary hardware/software/networking and staffing are in place to support the system that was developed in the earlier phases.

Deliverables: Properly functioning system.

Timeline: From the changeover from prototype to production throughout the life of the project.

6.5. [Long-term] Develop mechanisms for customer-driven performance evaluation (i.e., adaptive management, changing needs and technology).

(Note: this activity not elaborated by working group.)

7. Social, cultural and economic

Overview:
The Elwha Ecosystem Restoration Project offers a unique opportunity to gain a better understanding of how a large-scale river restoration project benefits an American Indian Tribe that has been linked to that ecosystem from time immemorial; and how restoration will influence local and regional communities and their relationships with each other and the environment. This human element of the ecosystem is often a critical factor in overall success of and public support for restoration. Among the many possible social science research projects, the most important immediate and long term needs include: socio-cultural impacts on the Lower Elwha Klallam Tribe; local and regional economic impacts; public attitudes and perceptions; and changes in patterns of fishing and other resource activities.

7.1. Identify the social and cultural effects of the Elwha River restoration project on the Lower Elwha Klallam Tribe.

Key Question:

Within the context of the unique relationship of the Lower Elwha Klallam Tribe to the Elwha River and its watershed – what social and cultural impacts will the Elwha River restoration project have on the Tribe?

Objective: The Elwha River restoration project is of paramount importance to the Lower Elwha Klallam Tribe's social, spiritual, cultural, and economic identity. The Tribe's fisheries were secured by the Treaty of Point-No-Point in 1855, yet fish passage on this important river system has been blocked since 1912. Sacred sites and former habitation and resource acquisition sites that have been inundated by the two reservoirs will once again become accessible. There will be opportunities for revitalized Tribal connections to important aspects of their culture long impacted by the dams and reservoirs. This project will address the social and cultural effects of river restoration upon the Tribe, and will be directed by the Tribe in consultation with the Park Service as necessary.

Deliverables: Social and cultural impact assessments.

Observations/monitoring needs: Monitoring of site emergence and restoration; collection of information of Native American use of the Elwha River basin and related resources (fish, wildlife, plants, etc.).

Existing efforts: Tribal fisheries information; programmatic agreement for cultural resources; National Park Service/ Lower Elwha Klallam Tribe archeological surveys and ethnographic research.

Connection to other thematic activities: Data Management; Education.

Probable participating organizations: Lower Elwha Klallam Tribe, Olympic National Park.

Implementation strategy: Gather baseline socio-cultural and natural resource use information; track changes in Tribe's use of Elwha River resources and visitation; write social and cultural impact assessment.

Timeline: Consultation with the Tribe and baseline information gathering to begin immediately. Data and information collection to commence immediately and continue for 25 years after dam removal.

Possible sources of funding: Federal and state funding.

7.2. Assess the economic impacts of the Elwha River dam removal and restoration project.

Key Questions:

What are the economic gains and losses causally related to large dam removals and major river restoration projects?
What is the magnitude of those gains and losses?
When, over the course of the project, do the gains and losses materialize?
Which constituencies are the primary economic beneficiaries and which suffer economic losses?
Where, geographically, are the gains and losses realized?
How many people benefit; how many are adversely effected?

Objective: This study should examine costs and benefits, impact distribution, employment, income; effects on social and biological capital; and non-market values. Specific economic sectors to be evaluated include: fisheries, tourism/recreation, dam deconstruction activities (e.g., planning, demolition); ecosystem restoration; education; tribal economics.

Significance: Provides information to inform other dam removal/large-scale restoration efforts; essential information for determining cost-effectiveness of project; enables identification of cost and benefit distribution geographically and across economic sectors.

Deliverables: Several reports capturing and analyzing economic data and information covering the following activities: fisheries, tourism/recreation, deconstruction, restoration, and education.

Observations/monitoring needs: Collection of economic data; tourist surveys; angler surveys; recreationalist surveys; tracking of deconstruction and restoration employment.

Existing efforts: EIS, Elwha Klallam economic development information; EDC records, state tourism department, Visitor and Convention Bureau, Port Angeles Chamber of Commerce, park visitor use data, concession operators; WDFW surveys.

Connection to other thematic activities: Education, Data Management.

Probable participating organizations: City of Port Angeles, Visitor and Convention Bureau, Clallam County, Olympic National Park, Elwha Klallam Tribe; WDFW; universities; OPI; NGOs.

Implementation strategy: Find and evaluate other dam removal economic studies; scope analysis; collect baseline information; collect data.

Timeline:
Immediately: scope and design study; collect baseline data and information
Ongoing: collect data and information
5 years post-removal: report
10 years post-removal: report
25 years post-removal: report.

Possible sources of funding: Federal, State, Clallam County, Jefferson County, Lower Elwha Klallam Tribe, City of Port Angeles, Visitor and Convention Bureau; private foundations interested in rural economic development and sustainable economies.

Additional comments: A lot of existing data can be used for this project. Clear incentive for funding project because of political interest in economic development.

7.3. Track the evolution of community/interest group perceptions and attitudes.

Key Questions:

- How do community perceptions/attitudes change over the course of a large restoration project?
- How quickly do they change and in response to what developments?
- What information and public engagement efforts are most helpful in building public support?
- What are the primary concerns that need to be addressed?
- How is public perception of dams changed by dam removal and restoration of a free-flowing river?

7.3.1. Identify group perceptions and attitudes.

Objective: This study is intended to ascertain community and interest/identity group perceptions and attitudes regarding removal of the Elwha dams and restoration of the watershed to determine how the perceptions and attitudes change over time as the project progresses.

Significance: The study will identify primary concerns and desired outcomes to inform education efforts; information gathered will inform other dam removal and large-scale ecosystem restoration efforts; if public and interest group perceptions are largely favorable, should help in obtaining funding for such projects

Deliverables: Description of qualitative and quantitative analysis of how perceptions and attitudes changed over time; conceptual model.

Observations/monitoring needs: Before, during, after measurements of perceptions/ attitudes.

Existing efforts: EIS scoping open house.

Connection to other thematic activities: Education, Data Management.

Probable participating organizations: NPS, UW, Lower Elwha Klallam Tribe, survey research group, WWU, other universities, or RFP process.

Implementation strategy: Review info generated in previous dam removal processes; gather information through surveys, focus groups, and other effective means; obtain info based on geographic (local, regional, national?) areas interest/identity groups.

Timeline: 1 survey ASAP, 1 survey immediately after removal; 1 survey 10, 20 and 30 years after removal.

Possible sources of funding: Requires agency funding due to long-term nature of project. Grants; NPCA, foundations, news media.

7.4. Identify the impacts of the Elwha restoration project on species, amounts and management of tribal/ sport/ commercial fisheries.

Key Questions:

- What is the impact of dam removal and subsequent restoration activities on fisheries?
- How quickly can fisheries be reestablished that target populations from above the dams?
- How does participation in fisheries change as restoration takes place?
- What types of fisheries are appropriate during specific stages of recovery?

Objective: A primary motivation for the Elwha restoration is the reinstatement of fisheries. In order to understand the impact of dam removal and ecosystem restoration on fisheries, it is necessary to research and document human fishing patterns (including tribal, sport, and commercial sectors) as they develop and change in response to ecosystem change.

The research should include saltwater fishes in the sedimentation zone, anadromous fishes, freshwater fishes in the river and connected lakes, and shellfishes in the estuarine and nearshore areas. While it is not possible at the present time to have a targeted fishery for ESA listed chinook salmon, other species of salmon and steelhead and other fish [including brook trout invasives] are fished. The availability of these species will clearly be affected by dam removal. In addition, the species composition and distribution of marine fish and shellfish is likely to change with alterations in patterns of sediment deposition. This may affect the species supported in the near and offshore, impacting harvesting practices. Research on management approaches and how they change is also relevant.

Significance: This research will allow us to understand changing human behavior in response to changing ecosystem conditions and management approaches. This information is important in evaluating and describing the success or lack of success of this historic restoration. It may also be important for predicting the effects of dam removals in other areas.

Deliverables: List of species harvested, amounts harvested, timing and gear use in fishing, types of participants in harvesting and consumption, management strategies. For each of the following time periods: Historic pre-dam, post-dam construction, current, post-dam removal (several times) until ecosystem stabilization.

Observations/monitoring needs: Harvest data and consumption data from observation, creel surveys and/or participant reporting.

Existing efforts: Commercial fish ticket reporting. NWIFC subsistence harvest data, NPS Project EIS and nearshore study of traditional uses. US vs. Washington U&A documentation, MMS OCS studies.

Connection to other thematic activities: Fish Ecology, Wildlife, Sediment.

Probable participating organizations: NWIFC, WDFW, NOAA Fisheries, National Park Service, Lower Elwha Klallam Tribe, sport commercial fishers, NGOs.

Implementation strategy: First step is to perform retrospective study of patterns of use and management in Elwha River associated/influenced ecosystem in freshwater and nearshore (review existing information). Design and implement the documentation of current patterns of use and management. Second, at regular intervals (to be determined), repeat survey to monitor changes in patterns of use and management.

Timeline: 2005-2006 perform step one. Repeat survey every 3 years [2009-2010/ 2013-2014/ 2017-2018/ 2021-2022 and as necessary thereafter].

Possible sources of funding: Due to project related nature of approach and need to document effects of restoration project implementation over time, agency funding would be most beneficial.

Additional comments: This could be extended to other taxa, i.e., hunting of birds, marine mammals, and land mammals, and gathering of plants in the area.

8. Education and outreach

Note: The items listed below are not in a priority ranking. Rather, all initiatives should be integrated and, thus, should be moving forward in parallel.

8.1. Develop Scaleable K-12 curriculum.

Objective: Develop a comprehensive, interdisciplinary, integrated curriculum, that is scaleable for K-12th grade and for available time, and that focuses on the Elwha River watershed, the dam deconstruction, and the ecological restoration.

8.1.1. Develop and implement a formal Elwha River curriculum to be made available for, and would actually be used by, K-12 schools in Western Washington.

This would involve developing educational programs and curriculum that link to the Washington State Essential Academic Learning Requirements (EALRs) and to success indicators associated with the Washington Assessment of Student Learning (WASL). The programs would be linked to different science/technology objectives, socioeconomic objectives, and specific research projects associated with the Elwha project. This project will support the enhancement of science, math, and technology education; help students develop an enhanced sense of place in the Pacific Northwest; provide public school students with an understanding of the ecosystems in which they live, and of ecological restoration in general; and raise the public awareness and appreciation of the Elwha River watershed, the deconstruction project, the restoration of the habitat, and the socioeconomic issues associated with the project.

Deliverables:

- An integrated curriculum for K-12, connecting the EALRs and the Elwha restoration project.
- Enhanced field and other hands-on experiences for students linked to active research projects.
- Pedagogical research opportunities.
- Improvement in student WASL scores.
- Development of new curricular materials such as: a dynamic timeline describing the natural and cultural history of the watershed from pre-historic into the future; a scale model of the Elwha River to show before, during, and after deconstruction; web-based interactive curricula that can be exported outside our immediate area.

Implementation Strategy:
Establish a consortium composed of curriculum design and delivery experts and discipline-specific scientists and educators to identify the various curricular development and research opportunities; write grants to secure funding to achieve development, implementation and distribution of the new curriculum.

Existing efforts:

- Lower Elwha Klallam Tribe presentations to out of town groups OMSI- Salmon Camp (10 native students), UW classes regarding Native American History and Law School, developing Klallam Language/Culture curriculum for 4th and 8th grade in addition to 2 years of Klallam Language/Culture at Port Angeles High School.
- Olympic Park Institute has begun implementation of an Elwha-based field science education program for middle and high school students. As part of a 5-day field science experience, students conduct inquiry-based study of the watershed while collecting data that will be compiled to assist in ecosystem monitoring efforts.
- American Rivers is producing a cd-rom containing educational materials such as historic and current photos, overviews of conservation and restoration activities, and movie clips from a digital landscape model depicting current and future conditions in the Elwha River valley.
- Olympic National Park is producing three products that will provide introductory materials for educators and Elwha education partners, including a multi-disciplinary inquiry based student activities and introductory PowerPoint presentation developed in a curriculum workshop of educators, curriculum and resource specialists; the compilation of digital images and graphics; and the production of educational web pages incorporating both the created curriculum and images.
- Peninsula College is mapping links between K-12 courses and post-secondary programs in science and natural resources for eventual use in tying Elwha programming into existing programming.

8.1.2. Develop Teacher-training opportunities that are linked to the Elwha River watershed issues and research projects.

This would involve developing new teacher-training modules that are intimately linked to the Elwha River ecosystems, the deconstruction project, and the ecological restoration activities and research projects. The teachers would be working directly with agency scientists and higher education faculty who would be working on research projects. Modules would be created for "clock-hour"-types of professional development opportunities for school faculty. There would also be 2 and 4-year degree programs for potential elementary, middle, and high school educators that would be delivered in partnership between 2 and 4-year schools. Both professional development and degree programs would be delivered using lab, field, lecture, and web-based instructional strategies. This activity would help assure an increased chance for success of Activity 1, as the teachers delivering the new curriculum will be trained using the Elwha project as the focal point.

Deliverables:

- Professional development modules and short courses, linked to the Elwha project and research activities, for school teachers to acquire training and clock hours to help them advance in their careers.
- Two- and four-year degree programming for potential educators that are linked to the Elwha project and research activities.

- K-12 faculty with an enhanced understanding of the Elwha project and watershed, ecology, and ecological restoration

Implementation Strategy:

- Establish a consortium composed of discipline-specific scientists and educators, education-based faculty at universities and colleges, NGO representatives, and K-12 faculty to develop the professional development modules.
- Establish a consortium composed of discipline-specific scientists and educators, education-based faculty at universities and colleges to develop new curriculum in college and university education programs to link with the Elwha project and research activities.

Existing efforts:

Olympic Park Institute conducts training in inquiry-based learning methods for teachers of grades 4-12, with a focus on the Elwha watershed.

8.2. Help to create a citizenry that is informed about and engaged in ecology and ecological restoration, especially as it pertains to the Elwha project.

8.2.1. Inform/educate/update resource providers and decision-makers.

This activity will provide the ability to assure that local state legislators, federal congressional members, community leaders, and representatives from granting agencies and foundations are initially informed and then receive periodic updates concerning the Elwha project, its enormity, the research and educational projects, the interdisciplinarity of these projects, and the benefits the projects will have for various constituencies. This activity will raise the awareness of the various leaders concerning the project; help instill in them a positive perspective on the project; demonstrate to them the economic value of changing community values (i.e., increases in tourism, educational opportunities, fisheries, etc.); help create well-informed decision-makers; and enhance potential funding opportunities.

Deliverables:

- Production and distribution of "white papers" initially providing an understanding of the history of the Elwha River and the various issues, leading to a discussion of where we are today, what is about to happen and its implications, and the educational and research activities and their potential benefits.
- Production and distribution of annual updates on the project and the associated activities, with a particular focus on the benefits to the community and region.
- Development of journal review articles in such venues as Science, Bioscience, National Geographic, and Scientific American.
- Develop book(s) on the project in conjunction with UW Press, including related symposia.
- Educate decision-makers through on-site tours or presentations in Washington, DC.

Implementation Strategy:

- The NSF-funded RCN Consortium would create the white papers (including the updates) and identify the distribution list.
- The RCN Consortium would coordinate a collaboration of appropriate scientists and educators, and facilitate the development of various Elwha Project scientific review articles.
- The NGOs are currently building public support through outreach to local, regional, and national audiences; hence, strengthening ties with NGOs to encourage public understanding of dam removal as a river restoration strategy.
- Incorporate effective communication/interpretation strategies into graduate, undergraduate, and teacher training programs.

Existing efforts:

- Lower Elwha Klallam Tribe lobbies in Washington, DC regarding tribal funding for projects connected with dam removal, and presents to agencies to request their support for funding efforts or to bring them up to date on the project from the tribal perspective.
- NPCA and American Rivers are coordinating the PERE (Partnership for Elwha Restoration and Education) – a partnership of tribal, conservation, government, and education groups. PERE is producing a traveling display for community outreach at regional events, such as the Salmon Homecoming and Lavender Festival.
- NPCA produced, and will update, a "driving brochure" of the Elwha River Restoration Project for park visitors. The brochure is currently distributed at the park, chamber of commerce, and Elwha fish hatchery.
- NPCA works with Congressional appropriators (including Rep. Dicks and Sen. Murray), Park Service and White House officials to ensure stable funding for the project and the park itself. American Rivers also participates in this arena.
- American Rivers is highlighting the potential of dam removal as a river restoration tool among funders, its membership, and the broader public nationwide using its newsletter, website, and presentations at regional conferences.
- Olympic National Park Resource Education Division is producing a newsletter to share information regarding current Elwha education efforts.

8.2.2. Involve/engage citizens in scientific and educational activities associated with the Elwha project and research activities.

This activity would advance the strategy of informal science education (ISE) for all groups of citizens. By doing so, this would increase the typical layperson's awareness of the sense of place in the Pacific Northwest, and their awareness and understanding of ecology, natural resources and ecological restoration (as well as the socioeconomic implications associated with restoration). This would include development of ISE grants and projects, a new Visitor/Interpretive Center, and a web-based virtual museum that would all eventually lead to collaborations with national museums (Smithsonian,

Academy of Sciences, etc.) that would further advance the awareness and understanding of ecology, natural resources and ecological restoration to a national level of prominence.

Deliverables:

- Bring a consortium together to develop a NSF ISE grant and other funding/foundation proposals.
- Have the consortium develop citizen science educational projects linked to the on-going research and educational projects on the Elwha.
- Design/develop a traveling exhibit that describes the Elwha River watershed, the deconstruction project, the education and research projects, and how people can get involved.
- Develop an interactive web-based virtual museum of historic information, plans for activities, results and projections for the future.
- Develop an Elwha Project Visitors Center/Interpretive Center.
- Develop strategies to collaborate with other national-level museums to establish links and displays nation-wide.

Implementation Strategies:

- Establish a consortium to identify the citizen science and funding opportunities.
- Use the RCN Consortium and other networking connections to establish links with other national museums and develop strategies for developing nationwide opportunities.
- Develop very clear links between the various websites (ONP, OPI, other NGOs, RCN, etc.) and strategies for making these available/readily accessible to the public.
- Form a RCN Consortium (and others?) Task Force to investigate design/structural needs for a new Interpretive Center, and funding opportunities.
- Incorporate effective communication/interpretation strategies into graduate, undergraduate, and teacher training programs.
- Develop consistent "messaging" in responding to media, community and legislative inquiries about the Elwha, such as a clearinghouse, Public Information Office coordinated by the RCN, etc.

Existing efforts:

- Lower Elwha Klallam Tribe presentations to out of town groups OMSI- Salmon Camp (10 native students); UW classes regarding Native American History and Law School.
- NPCA is launching a community volunteer revegetation project with Olympic National Park – generating in 2005 some 800 hours of volunteer work removing invasive plants, and involving community members (Scout groups, churches, businesses) in hands-on education about the project.
- Olympic National Park is planning and designing an overlook with exhibits at the Elwha Dam to provide visitors with Elwha Project information particularly for the dam deconstruction timeframe when other public access is restricted.

- Olympic National Park to design and fabricate exhibitry at the Glines Canyon Dam and associated powerhouse to interpret the historic significance of the dams.
- Peninsula College coordinating NSF Informal Science Education proposal to plan, design and fabricate exhibits for Fiero Marine Center and two visitor centers in Olympic National Park – Olympic National Park Visitor Center and Hurricane Ridge Visitor Center.
- Peninsula College has coordinated meetings regarding potential citizen science programs in region.
- Olympic National Park is coordinating the publication of a book focused on the cultural history of the Elwha ecosystem.

8.3. Develop/deliver undergraduate and graduate programming associated with the Elwha River watershed, the dam deconstruction, and the ecological restoration.

8.3.1. Develop a comprehensive, interdisciplinary, integrated undergraduate curriculum that is scaleable across lower and upper division students, students with variable backgrounds and in various majors, and can be delivered at variable levels of depth and breadth.

The curriculum will contain field, lab, lecture, and web-based activities that are aligned with other existing programs and with existing and developing Elwha Project research and educational activities. This will link undergraduate students from numerous science and social science majors and from education degree programs to the Elwha project educational and research activities. Students will be involved in research projects, new and modified existing courses, and service learning opportunities. The program will link students in a multi-tiered manner as participating students will serve as mentors to other undergraduate and public school students, and will be involved in other outreach activities. The time frame for any project work on the Elwha River will be variable from a single week of lab/field work within a course to an entire year of research work.

Deliverables: A consortium will be brought together (via the RCN Consortium?) to write grants and secure other funding to implement the activities below.

- Teaching and curriculum development/delivery-
    - New courses will be developed and existing ones modified and delivered at various institutions that link to the Elwha Project;
    - Links will be made to the NSF funded REU research courses;
    - Service learning opportunities will be developed and delivered that link students to both the project and the community;
    - Distance learning strategies and curriculum will be developed and delivered by various institutions;
    - Summer sessions will be developed with course and research opportunities offered;
- Research projects-

  - Projects will be developed that are linked to the ongoing and developing research activities on the Elwha River watershed, using the different agency scientists and higher education faculty as mentors;
  - Projects and students will be linked to the NSF funded REU project;
  - Projects will be of variable length, depth, and foci;
  - Students will present their work at annual conferences/workshops, such as the Peninsula College REU conference and the NW Chapter of Society for Ecological Restoration in student sessions.
- International linkages-

  Courses and projects in environmental science, natural resource management, and ecological restoration will link to international opportunities. For example, through international exchanges, students and faculty could work with students and faculty from China on the impacts of dams and their deconstruction. Students and faculty could work in Costa Rica on the proposed new biological corridor to characterize existing habitats and project impacts of restoring the variably managed ones. International workshops and short courses could be held in Western Washington that focus on ecological restoration.
- Inter-institutional partnerships-
  - Ecological restoration curriculum could be linked and delivered between institutions, that involves sharing of courses, field/lab experiences and equipment, and human resources;
  - Links will be established between those working on the Elwha research and educational projects and the WA Center for Education and Innovation's "Curriculum for the Bioregion" project.
- A task force will be formed that investigates the feasibility and funding sources for a new multi-agency Elwha Project research/education facility to include lab, lecture and living space. Proposals will be written in support of this initiative.

Implementation Strategies:

- Develop partnerships between agencies working on the Elwha Project and higher education faculty for the purposes of linking scientists and educators together on research projects and for curriculum development and grant writing, making use of the abilities/contacts of the RCN Consortium.
- Make links between the above groups and WA Center for Education and Innovation and the NW Chapter of Society for Ecological Restoration (and other appropriate societies).

Existing efforts:

- Lower Elwha Klallam Tribe hosts interns from higher education programs when requested.
- Several courses at Peninsula College and WWU Huxley College-Olympic Peninsula have used the Elwha project as a focal point or as a portion of a course.
- Undergraduate research courses focused on the Elwha at Peninsula College will start Spring Quarter 2005.

8.3.2. Develop a comprehensive, interdisciplinary, integrated graduate curriculum that is scaleable across masters and PhD students, students with variable backgrounds and in various fields, and can be delivered at variable levels of depth and breadth.

- Graduate students should be trained and involved in skillfully delivering all aspects of this education plan; the Elwha Project represents a unique opportunity to create a new generation of researchers who can communicate their technical work effectively to diverse audiences.
- Engage interdisciplinary teams of graduate students in designing interpretation strategies to bring scholarly and technical aspects of the Elwha project to diverse audiences.
- Use the Elwha Project as a case study in team-based interdisciplinary graduate curricula in fields such as Conservation Biology, Environmental Management, Public Affairs, Communications, Information Science, Environmental Anthropology, Environmental Education, and Interdisciplinary and Policy Dimensions of Earth Sciences.

Existing Efforts:

- Lower Elwha Klallam Tribe hosts interns from higher education programs when requested.
- The UW Program on the Environment currently has interdisciplinary graduate certificate programs in Environmental Management; Interdisciplinary and Policy Dimensions of Earth Sciences; and is now developing a new program on Conservation of Living Systems.
- Graduate students at UW are involved in delivering the curriculum in the UW's tri-campus Restoration Ecology Network.

8.4. Develop mechanisms, strategies and protocols for systematically and efficiently making the World Wide Web a resource for accurate, updated information about the Elwha Dam removal and Elwha River restoration.

8.4.1. Coordinate links among Elwha education and research websites.

Implementation Strategies:

1. Identify people responsible for website content for various aspects of the project;
2. Establish an ongoing, informal e-working group to ensure that coordination happens in a way that is useful to various external and internal constituencies. Consider using the Everglades restoration websites as a model.

8.4.2. Develop a central Elwha River Restoration project website that is a portal for all online information about the Elwha.

Ensure that people find this site using search terms such as "Elwha dam removal," "Elwha restoration," and others. Link clearly to all other sites of project partners, and also include the Allaway summary document, new "Elwha White Papers," the document from the current retreat, and other key project documents.

Implementation Strategies:

1. The RCN Consortium will facilitate the above activity;
2. Continue to explore innovative ways that technology can assist collaborative information sharing;
3. National Parks Conservation Association has translation of the science for the public as one of its main goals.

Existing Efforts:

- Lower Elwha Klallam Tribe has tribal website with Elwha River Restoration section.
- NPCA has small website on Elwha Restoration, and is considering hosting a larger consortium site for NGOs.
- American Rivers has a specific Elwha Restoration page on its national website with numerous downloadable educational and press materials, and is considering hosting a listserve updating interested members of the public on the Elwha project.
- American Rivers and NPCA are pursuing in-depth media coverage of the Elwha project by magazines, newspaper special features, the History Channel, etc.
- The UW has an award-winning tri-campus program offering an undergraduate certificate in Ecological Restoration. The UW Restoration Ecology Network (UW-REN) runs a Capstone Program in which students from multiple fields on the three UW campuses work on authentic restoration projects for real Washington State clients.

Timeline: Anticipate education needs based on research and recovery at various stages of the project.

Connections to other thematic activities: Every priority listed above is tied to the work of every other working group. We should not lose sight of these connections as we move into the future. We should create mechanisms for ongoing, bilateral information sharing.

References

Allaway, J. 2004. Understanding the Elwha: a strategy for research and education programs on the Elwha River. Huxley College of the Environment, Western Washington University, Port Angeles, WA. Report prepared for Olympic National Park.

Clallam County Marine Resources Committee [CCMRC]. 2004. Technical workshop on nearshore restoration in the central Strait of Juan de Fuca. Prepared for CCMRC by Triangle Associates, Seattle, WA. [Accessed January 28, 2005] http://www.clallammrc.org/CCMRC/Workshop%20CSJ.pdf

Randle, T. J., J. Bountry, B. Jackson, and G. Smillie. 2004. Elwha river restoration draft sediment monitoring and management plan. U.S. Department of the Interior, Bureau of Reclamation and National Park Service, Port Angeles, WA. [September 10, 2004 draft].

Schreiner, E. G., and B. D. Winter. 2004. Restoration of the Elwha River ecosystem, research and monitoring questions: March 18-19, 2003 (Draft). Port Angeles, WA. [January, 2005 draft].

Stolnack, S.A. and Naiman, R.J. 2005. Summary of research and education activities in the Elwha River watershed and adjacent coastal zone. University of Washington. 54p.

Appendix A: Retreat participants

Steve Acker
Supervisory Botanist
Olympic National Park
600 East Park Avenue
Port Angeles, WA 98362
360-565-3073
steve_acker@nps.gov

Jim Allaway
Academic Program Director
Huxley College Program on the Peninsula
Huxley College of the Environment
MS 9085
Western Washington University
Bellingham, WA 98225
360-417-6521
jim.allaway@wwu.edu

Katherine Baril
Director
WSU Jefferson County Extension
201 W. Patison
Port Hadlock, WA 98339
360-379-5610 x202
kbaril@wsu.edu

Dwight Barry
Professor of Environmental Science and
Director of Environmental Science and Resource Management
The Center of Excellence
Peninsula College
1502 East Lauridsen Blvd
Port Angeles, WA 98362
360-417-6586
dwightb@pcadmin.ctc.edu

Tim Beechie
Science Coordinator, Watershed Program
Northwest Fisheries Science Center
2725 Montlake Blvd. East
Seattle, WA 98112-2097
206-860-3409
tim.beechie@noaa.gov

John Boetsch
Ecologist/Data Manager
Olympic National Park
600 East Park Avenue
Port Angeles, WA 98362
360-565-3064
john_boetsch@nps.gov

Bruce Campbell
Research Scientist
Human Interface Technology Lab
University of Washington
Box 352142
Seattle, WA 98195-2142
206-543-5380
bdc@hitl.washington.edu

Betsy Carlson
Outreach and Education Specialist
Olympic National Park
3002 Mt Angeles Road
Port Angeles, WA 98362
360-565-3146
betsy_carlson@nps.gov

Jeff Duda
Ecologist
USGS Biological Resources Division
Western Fisheries Research Center
6505 Northeast 65th Street
Seattle, WA 98115
206-526-6282 x233
jeff_duda@usgs.gov

Bill Eaton
Senior Vice President
Peninsula College
1502 East Lauridsen Blvd
Port Angeles, WA 98362
360-417-6246
bille@pcadmin.ctc.edu

Robert Elofson
Tribal River Restoration Liaison
Lower Elwha Klallam Tribe
2851 Lower Elwha Road
Port Angeles, WA 98363
360-452-8471 x39
relofson@elwha.nsn.us

David Fluharty
Associate Professor
School of Marine Affairs
University of Washington
3703 Brooklyn Ave NE
Seattle, WA 98105-6715
206-685-2518
fluharty@u.washington.edu

Ross Freeman
Conservation Policy Advocate
American Rivers, NW Office
4005 20th Ave West, Suite 221
Seattle, WA 98199
206-213-0330 x16
rfreeman@americanrivers.org

Jerry Freilich
Research & Monitoring Coordinator
Olympic National Park
600 East Park Avenue
Port Angeles, WA 98362
360-565-3082
jerry_freilich@nps.gov

Kurt Fresh
Research Fishery Biologist
Northwest Fisheries Science Center
2725 Montlake Blvd E.
Seattle, WA 98112-2097
206-860-6793
kurt.fresh@noaa.gov

Correigh Greene
Northwest Fisheries Science Center
2725 Montlake Blvd. East
Seattle, WA 98112-2097
206-860-5611
correigh.greene@noaa.gov

Stephanie Harrington
Executive Director
UW Earth Initiative
University of Washington
Box 355351
Seattle, WA 98195-5351
206-543-0878
stephah@u.washington.edu

Cat Hoffman
Chief of Natural Resource Management
Olympic National Park
600 East Park Avenue
Port Angeles, WA 98362
360-565-3060
cat_hoffman@nps.gov

Tracey Hosselkus
Education Director
Lower Elwha Klallam Tribe
3080 Lower Elwha Rd.
Port Angeles, WA 98363
360-452-8471 x218
thosselkus@elwha.nsn.us

Gay Hunter
Museum Curator
Olympic National Park
600 East Park Avenue
Port Angeles, WA 98362
360-565-3056
gay_hunter@nps.gov

Karen James
Cultural Anthropologist
13797 Silven Avenue NE
Bainbridge Island, WA 98110
206-842-5983
heiki@msn.com

Randy Johnson
Biologist
WA Department of Fish and Wildlife
Port Angeles, WA
360-417-3301
johnsraj@dfw.wa.gov

Richard Kang
Salmon Data Management Team Leader
Northwest Fisheries Science Center
2725 Montlake Blvd. East
Seattle, WA 98112-2097
206-860-6786
richard.kang@noaa.gov

Chris Konrad
Research Hydrologist
U.S. Geological Survey
1201 Pacific Ave, Suite 600
Tacoma, WA 98402
253-428-3600 x2634
cpkonrad@usgs.gov

Jim Lovvorn
Professor
Department of Zoology & Physiology
University of Wyoming
Laramie, WY 82071
307-766-6100
lovvorn@uwyo.edu

Tom Martin
Hydrologist/Water Resources Engineer
Pacific Northwest National Laboratory
Marine Sciences Operations
1529 West Sequim Bay Road
Sequim, WA 98382
360-681-4590
thomas.martin@pnl.gov

Rob Masonis
NW Regional Director
American Rivers
4005 20th Ave West
Suite 221
Seattle, WA 98199
206-213-0330 x12
rmasonis@amrivers.org

Mike McHenry
Fisheries Habitat Manager
Lower Elwha Klallam Tribe
2851 Lower Elwha Road
Port Angeles, WA 98363
360-457-4012 x14
mchenry@elwha.nsn.us

Colin MacLaren
Student
Geosciences
Oregon State University
104 Wilkinson Hall
Corvallis, OR 97331-5506
maclarec@onid.orst.edu

Mike Messenger
Information Systems Manager
NW Indian Fisheries Commission
6730 Martin Way E
Olympia, WA 98516
360-438-1181 x321
mmessenger@nwifc.org

Dave Montgomery
Professor
Earth and Space Sciences
University of Washington
Box 351310
Seattle, WA 98195-1310
206-685-2560
dave@ess.washington.edu

Robert J. Naiman
Professor
School of Aquatic and Fishery Sciences
University of Washington
Box 355020
Seattle, WA 98195-5020
206-685-2025
naiman@u.washington.edu

Julia Parrish
Associate Professor
School of Aquatic and Fishery Sciences
University of Washington
Box 355020
Seattle, WA 98195-5020
206-221-5787
jparrish@u.washington.edu

George Pess
Stream Ecologist
Northwest Fisheries Science Center
2725 Montlake Blvd. East
Seattle, WA 98112-2097
206-860-3450
george.pess@noaa.gov

Tim Randle
Manager
Sedimentation and River Hydraulics Group
Bureau of Reclamation
P.O. Box 25007
Denver, CO 80225-0007
303-445-2557
trandle@do.usbr.gov

Reg Reisenbichler
Research Fishery Biologist
Western Fisheries Research Center
U.S. Geological Survey
6505 NE 65th St
Seattle, WA 98115
206-526-6282
reg_reisenbichler@usgs.gov

John Richardson
Associate Professor
Forest Sciences Department
University of British Columbia
3002-2424 Main Mall
Vancouver, BC V6T 1Z4
CANADA
604-822-6586
john.richardson@ubc.ca

Scott Schaffer
Executive Director
Olympic Park Institute
111 Barnes Point Road
Port Angeles, WA 98963
360-928-3720 x19
sschaffer@yni.org

Ed Schreiner
Research Biologist
U.S. Geological Survey
Forest and Rangeland Ecosystem Science Center
Olympic Field Station
600 East Park Avenue
Port Angeles, WA 98362
360-565-3044
ed_schreiner@usgs.gov

David Secord
Co-Director
Program on the Environment
University of Washington
Box 352802
Seattle, WA 98195-2802
206-221-6140
dave@u.washington.edu

Jennifer Sepez
Anthropologist
Alaska Fisheries Science Center
NOAA Fisheries
7600 Sand Point Way N.E.,
Building 4
Seattle, WA 98115
206-526-6546
jennifer.sepez@noaa.gov

Anne Shaffer
Area Marine Habitat Biologist
Washington Department of Fish and Wildlife
332 East 5th St., Suite 100
Port Angeles, WA 98362
360-457-2634
shaffjas@dfw.wa.gov

Pat Shafroth
Research Scientist
U.S. Geological Survey
Fort Collins Science Center
2150 Centre Avenue, Bldg C
Fort Collins, CO 80526-8118
970-226-9327
pat_shafroth@usgs.gov

Charles (Si) Simenstad
Research Associate Professor
School of Aquatic and Fishery Sciences
University of Washington
Box 355020
Seattle, WA 98195-5020
206-543-7185
simenstd@u.washington.edu

Peter Skidmore
Aquatic Ecologist
The Nature Conservancy
217 Pine St., Suite 1100
Seattle, WA 98101
206-442-1840
pskidmore@tnc.org

Kathy Steichen
Assistant Chief of Resource Education
Olympic National Park
600 East Park Avenue
Port Angeles, WA 98362
360-565-3133
kathy_steichen@nps.gov

Greg Stewart
Department of Geosciences
Oregon State University
104 Wilkinson Hall
Corvallis, OR 97331
541-750-7345
gregory.stewart@oregonstate.edu

Scott Stolnack
School of Aquatic and Fishery Sciences
University of Washington
Box 355020
Seattle, WA 98195-5020
206-221-5406
sastol@u.washington.edu

Ron Thom
Staff Scientist and Manager
Coastal Assessment and Restoration Team
Marine Sciences Laboratory
Pacific Northwest National Laboratory
1529 W. Sequim Bay Road
Sequim, WA 98383
360-681-3657
ron.thom@pnl.gov

Steve Todd
Habitat Biologist
Point No-Point Treaty Council
7999 Salish Lane
Kingston, WA 98346
360-297-6526
stodd@pnptc.org

Josh Walter
Elwha Restoration Project Organizer
National Parks Conservation Association
313-A 1st Ave. S.
Seattle, WA 98104
206-903-1444 x26
jwalter@npca.org

Jonathan Warrick
Research Geologist
Pacific Science Center
U.S. Geological Survey
400 Natural Bridges Drive
Santa Cruz, CA 95060
831-427-4793
jwarrick@usgs.gov

Heather Weiner
Director, NW Region
National Parks Conservation
Association
313-A 1st Ave. S.
Seattle, WA 98104
206-903-1444 x21
hweiner@npca.org

Gary Winans
Research Geneticist
Northwest Fisheries Science Center
2725 Montlake Blvd. East
Seattle, WA 98112-2097
206-860-3265
gary.winans@noaa.gov

Brian Winter
Elwha Project Manager
Olympic National Park
826 E Front Street, Suite A
Port Angeles, WA 98362
360-565-1323
Brian_Winter@nps.gov

Jacilee Wray
Anthropologist
National Park Service North Coast
and Cascades Network
600 East Park Ave.
Port Angeles, WA 98362
360-565-3051
jacilee_wray@nps.gov

Rob Young
Associate Professor
Department of Geosciences
Western Carolina University
Cullowhee, NC 27823
828-227-3822
ryoung@wcu.edu

Appendix B: Estimates of project costs

Note: The following cost estimates are rough projections only, and do not account for economies of scale, overlaps among working groups, synergistic opportunities, or other factors. Costs were extracted from the original worksheets provided by individual working groups.

Priority		Before	During	After
	Sediment/Geomorphology/Water Quality			
1	**Maximize sediment redistribution**			
1.1	repeated topographic and bathymetric surveys (reservoirs)	720,000	480,000	0
1.2	stream gaging at McDonald bridge (6 years)	100,000	300,000	200,000
1.3	stream gaging above Lake Mills (6 years)	50,000	150,000	100,000
1.4	time-lapse photography (aerial and ground) (7 years)	80,000	75,000	50,000
1.5	2-D modeling and simulation of reservoir processes	150,000	50,000	0
2	**Channel and floodplain sediment dynamics**			
2.1	repeat LIDAR and bathymetric river surveys (7 years)	300,000	450,000	300,000
2.2	floodplain cross section surveys and mapping (7 years)	30,000	45,000	30,000
2.3	stream gaging near water diversion structure (6 years)	100,000	300,000	200,000
2.4	water quality measurements (DO, PH, temp, Fe, etc) (6 years)	25,000	75,000	50,000
2.5	time-lapse web & stereo cameras (aerial photos etc in 1.4)	20,000	0	0
2.6	2-D modeling and simulation of channel/flood plain processes	100,000	750,000	25,000
3	**Ground water and surface water interactions**			
3.1	install and monitor 16 peizometers and temp probes	400,000	0	0
3.2	10 conservative tracer tests before, during (X2), after	200,000	400,000	200,000
3.3	collect freeze-core bed material samples	120,000	0	0
3.4	numerical ground water modeling of study reach	400,000	0	0
	Totals	2,795,000	2,400,000	1,155,000

	Data sharing and management			
1 (before)	**Establish information management organization**			
1.1	travel for oversight board and implementation team	10,000	15,000	50,000
1.2	information management coordinator, travel, workstation	200,000	300,000	1,000,000
2 (before)	**Develop project plan and budget alternatives**			
2.1	develop data clearinghouse links and collaborative tool	60,000	30,000	70,000
2.1	inventory existing data (software and other minor expenses)	12,000	0	0
1 (during)	**Implement prototype systems**			
1.1	data quality assurance/stewardship	Assessed % of projects (depends on system design)		
1.2	build up production system infrastructure	(depends on system design)		
1 (after)	**system maintenance**			
	Totals	282,000	345,000	1,120,000

		Before	During	After
	Education and outreach			
1	**Develop & implement comprehensive K-12 curriculum**			
1.1	Develop & implement curriculum			
	formal curriculum development	800,000	0	0
	assessment and evaluation	200,000	0	0
	implementation and distribution	1,300,000	0	0
1.2	develop teacher training opportunities	250,000	0	0
2	**Community outreach & education**			
2.1	inform/educate resource providers and decision-makers	50,000		
2.2	involve/engage citizens in sci/ed activities	0		
2.2a	establish citizen science consortium	30,000		
2.2b	establish links w/ museums & nationwide opportunities	50,000		
2.2c	develop strategies and links betw. various websites	100,000	150,000	
2.2d	investigate design/needs for new interpretive center	3,500,000		
2.2e	incorp. communication/interp strategies into ed programs	600,000	900,000	1,500,000
2.2f	develop information clearinghouse	400,000	600,000	1,000,000
3	**Undergrad/grad curriculum programming**			
3.1	develop comprehensive undergad curriculum	480,000	720,000	
3.2	develop comprehensive grad curriculum	600,000	900,000	
4	**Develop web-based information resources & protocols**			
4.1	coordinate links among education and research websites			
4.2	Elwha River Restoration project website (webmaster)	200,000	300,000	500,000
	Totals	8,560,000	3,570,000	3,000,000

	Sociocultural			
1	**Gauge community perceptions and attitudes**	200,000	0	200,000
2	**Assess economic impacts: before, after removal**	400,000	400,000	400,000
3	**Elwha tribe social and cultural impact assessments**	250,000	150,000	150,000
4	**Sport/commercial fisheries impacts**	200,000	100,000	300,000
	Totals	1,050,000	650,000	1,050,000

		Before	During	After
	Fish biology and ecology			
1A	**Fish community response: study design**			
1A.1	finalize and adopt monitoring plan	10,200	16,882	73,036
1B	**Document direct effects of project on fish populations**	1,813,000	1,665,436	7,205,314
1B.1	recolonization: fish tagging, surveys			
1B.2	sediment effects: physiological, behavioral, pop'n response			
1B.3	effects of fish habitat changes on fish community			
1C	**Document correlated effects of fish community response**			
1C.1	investigate wild/hatchery fish interactions	1,000,000	1,500,000	5,000,000
1C.2	investigate resident/anadromous interactions			
1C.2a	genetic analysis	300,000	150,000	0
1C.2b	In-situ and/or experimental manipulations	300,000	150,000	0
1C.2c	lab/field experiments: eval egg to adult survival	560,000	840,000	1,960,000
1C.3	investigate exotic species interactions			
1C.3a	survey to refine distribution information	150,000	0	0
1C.3b	synthesize existing information to model risks	150,000	0	0
1C.3c	monitor for disease transmission among populations	500,000	750,000	500,000
1C.4	marine survival/climate variability			3,000,000
	Totals	4,783,200	5,072,318	17,138,351

	Marine/Nearshore			
	Document baselines			
1.1 (before)	historical reconstruction of delta, nearshore, reference	600,000	300,000	0
1.2 (before)	current conditions and habitat-biota associations	3,000,000	1,500,000	0
	Develop conceptual models of change			
2.1 (before)	develop conceptual model of historic change	1,500,000	750,000	0
2.2 (before)	develop predictions of ecosystem change	500,000	0	0
	Monitor short-term change			
1.1 (during)	monitor physical change	1,000,000	3,000,000	0
1.2 (during)	monitor biotic response	1,280,000	1,920,000	3,200,000
	Evaluate restoration predictions			
2.1 (during)	evaluate physical change predictions	0	800,000	2,000,000
2.2 (during)	evaluate biotic change predictions	1,300,000	1,950,000	0
	Define new dynamic equilibrium			
1.1 (after)	document restoration response compared to reference	0	0	1,200,000
1.2 (after)	evaluate long-term resto. -- context of regional change	700,000	1,500,000	2,500,000
	Evaluate further research/restoration needs and actions			
2.1 (after)	evaluation and synthesis (physical)	0	0	400,000
2.2 (after)	evaluation and synthesis (biotic)	0	0	1,920,000
	Totals	9,880,000	11,720,000	11,220,000

		Before	During	After
	Freshwater and Riparian			
1	**Determine key physical and biological processes**			
1.1	develop conceptual model	45,000	0	0
1.2	quantify historical vegetation and channel dynamics	150,000	0	0
1.3	develop baseline sampling protocols	726,000	726,000	0
2	**Determine responses to salmon reintroduction**			
2.1	form hypotheses re. responses to salmon reintroduction	10,000	0	0
2.2	develop sampling protocols for community response	50,000	0	0
2.3	implement sampling protocols to test hypotheses	830,000	830,000	2,075,000
3	**Determine responses to sediment and wood dynamics**			
3.1	generate hypotheses	10,000	0	0
3.2	develop sampling protocols	25,000	0	0
3.3	implement sampling protocols to test hypotheses	1,060,000	1,060,000	2,650,000
	Totals	2,906,000	2,616,000	4,725,000

	Terrestrial and Wildlife			
	Note: Costs are highly variable depending upon the number of organisms and trophic guilds studied. Connections to aquatic productivity, fish and riparian ecology studies will have a large effect on the final budget. Studies of individual groups of organisms or trophic guilds would range approximately 100K-230K/yr plus 100K-200K/yr for nutrient budgets.	2,000,000	3,000,000	10,000,000

Note: all costs are rough projections only

Overall Totals:	35,256,200	29,373,318	47,008,351

Project Grand Total over 15 years: $111,637,869

Appendix C: Existing efforts -- active and planned/proposed research in the Elwha River watershed and nearshore areas

The following section briefly presents current and planned research activities in the Elwha River watershed and nearshore area. This information has been updated from Appendix A of Stolnack and Naiman (2005), "Summary of Research and Education Activities in the Elwha River Watershed and Adjacent Coastal Zone," and is included here to link to the 'existing efforts' sections in the present report.

Sources of information include electronic mail surveys and telephone calls directed at investigators from various agencies and institutions known to be involved in the Elwha River dam removal project (e.g., NOAA Fisheries, U.S. Geological Survey, U.S. Bureau of Reclamation, Olympic National Park, University of Washington, etc), reports from the three technical workshops focused on the Elwha River dam removal project, and queries to the Olympic National Park research coordinator.

Research is categorized as either physical processes and water quality, marine and nearshore, terrestrial and wildlife, freshwater and riparian, fish ecology, sociocultural, education, or data sharing and management.

Consortium Organization

Title: RCN: Elwha Research Consortium

Principal Investigators: Smith (WWU, Huxley College; PI), Eaton (Peninsula College; co-PI)

Description: This RCN grant supports a core research consortium studying effects of removing two dams on the Elwha River on Washington's Olympic Peninsula. This grant supports coordination of a growing number of scientists to examine the return of salmon species; the fate of large woody debris; hydrology, sediments and water quality; the role of marine derived nutrients in forest food webs; control of invasive species; and other potential topics. The core of the consortium will establish by-laws, coordinate work of teams in the field, and establish the experimental designs for the inter-connecting studies. The Elwha is a model system for dam removal demonstrating ecological processes under ideal conditions. Results from the Elwha will inform the world on the potentials and pitfalls of dam removal for river restoration.

Expected Products: This grant will allow local educational institutions, the Elwha Tribe, and government agencies to coordinate the wide range of research afforded by this unique opportunity. It will: provide administrative staff; support the development of conceptual models; coordinate the various interlocking research efforts; allow scientists to meet; and support data infrastructure. Core participants will write a charter ensuring a level playing field for all researchers, encouraging participation, and enhancing funding opportunities for all

Schedule: Project to begin Spring 2005 and last through September 2010

Link for additional information: bille@pcadmin.ctc.edu; Bradley.Smith@wwu.edu

Physical processes and water quality

Title: Channel morphodynamics and sediment management during the removal of the Glines Canyon Dam from the Elwha River, Washington State, USA: drawdown experiments and physical modeling

Principal investigators: Bromley, Grant, Thorne

Description: A scaled physical model of Lake Mills and Glines Canyon Dam was built and used to run a series of dam removal experiments. The aim of the modelling exercise was to test hypotheses regarding the behaviour of the Lake Mills delta sediments in response to different magnitudes of dam removal.

Expected products: PhD dissertation and substantial report to the US Bureau of Reclamation. These items will provide a detailed explanation of the morphodynamic response of a delta incising and prograding into a reservoir that still retains significant storage space. A conceptual model will be developed to summarise this behaviour, which will expand on the existing channel evolution models.

Schedule: Planned completion September 2005.

Link for additional information: http://www.fsl.orst.edu/wpg/

Title: Effects of suspended sediment on water quality and aquatic habitat in the Elwha River

Principal investigators: Konrad

Description: 1-dimensional, sediment transport model to assess the effects of dam removal on suspended sediment concentration and particle-size distribution of the riverbed

Expected products: Journal paper.

Schedule: 2004-2006

Link for additional information: http://wa.water.usgs.gov/projects/elwha/summary.htm

Title: Real-time analysis of suspended sediment in the Elwha River

Principal investigators: Konrad, Melis, Rubin

Description: Developing an instrument for monitoring suspended sediment concentration and particle-size distribution based on laser diffraction. The instrument will have an automatic dilution system so that it can analyze over a relatively unlimited range of sediment concentrations

Expected products: Sediment analyzer.

Schedule: 2004-2005

Link for additional information: cpkonrad@usgs.gov.

Marine and nearshore

Title: Juvenile Salmon in the Nearshore Ecosystems of the Strait of Juan de Fuca

Principal investigators: Shaffer, Ward, Crain, Winter, Fresh, Lear

Description: The Strait of Juan de Fuca ecosystem connects the protected waters of Puget Sound with the ocean ecosystem. The nearshore portion of the Strait potentially serves as a major migratory route for salmon juveniles leaving Puget Sound. Within the Central Strait, nearshore sediment processes have been degraded due to reductions in sediment inputs resulting from shoreline armoring and damming of the Elwha River. It is projected that the removal of the Elwha and Glines Canyon dams, scheduled to begin in 2008, will result in the transport and delivery of approximately 8 million cubic yards of sediment to the nearshore environment within five years of dam removal. Implications of this increased sediment input on nearshore habitats and the biota that use these habitats, such as salmon, are unclear. Project will define fish use of habitats within the central Strait of Juan de Fuca nearshore, including species, populations, and life history strategies of juvenile salmon and forage fish.

Expected products: T.B.D.

Schedule: Anticipated begin spring 2005 for up to 3 years.

Link for additional information: shaffjas@dfw.wa.gov

Title: Photographic monitoring of the central straits shoreline

Principal investigators: Ian Miller, Surfrider Foundation

Description: Aerial and ground-level digital photographic monitoring of shoreline before and after dam removal from Freshwater Bay to Ediz Hook.

Expected products:

Schedule: First overflight planned for January 2005

Link for additional information: imiller@surfrider.org

Title: Historical changes in the Strait estuaries and nearshore, Neah Bay to Discovery Bay

Principal investigators: Todd, Collins

Description: Use historical sources to reconstruct physical landscape and major habitat types from ~1850 to early 1900s.

Expected products:

Schedule: Expected completion July 2005.

Link for additional information: stodd@pnptc.org

Title: Effects of Elwha dam removal on nearshore habitats

Principal investigators: Warrick. Gelfenbaum

Description: Part of "Coastal Habitats in Puget Sound" project, USGS Coast and Marine Geology Program: 1) Nearshore and beach surveys at over 100 beach cross sections to be repeated twice yearly during dam removal; 2) shelf substrate and habitat mapping using swath sonar, video, and grain-size sampling; 3) deploy acoustic sensors (W 05) to measure water circulation and waves offshore of river delta; 4) numerical (hydrodynamic) modeling of Strait and river mouth.

Expected products:

Schedule: Funded through FY 04 and 05

Link for additional information: jwarrick@usgs.gov

Subject to funding renewal
Title: Beach profile monitoring of the Elwha River delta coast

Principal investigators: Beirne, Ward, Johannessen

Description: Contract with Coastal Geologic Services Inc to survey beach profiles at 7 locations on coastline.

Expected products: Tribe plans to increase number of profiles and area surveyed

Schedule:

Link for additional information: beirne@elwha.nsn.us

Proposed
Title: Elwha River dam removal and the Venus Cable: a unique experiment in marine sediment dispersal

Principal investigators: Nittrouer, Ogston

Description: The removal in 2007 of dams from the Elwha River (north coast of Olympic peninsula) will provide relatively predictable sediment discharges that are expected to reach concentrations >50 g/l (US Department of Interior, 1996). The possible presence of the VENUS cabled observatory in 2005 at the mouth of the Elwha River would provide a unique opportunity to observe and respond to gravity flows (fluid muds and hyperpycnal flows) and to investigate their dynamics and impacts. Not only would this be valuable for basic scientific purposes, but it would be an extraordinary opportunity for applied purposes – to document the fate in the marine environment of sediment discharged by dam removal, and to understand the processes responsible.

Expected products:

Schedule: 2005-2010

Link for additional information: nittrouer@ess.washington.edu

Proposed
Title: Nearshore restoration of the Elwha dam removals: sediment fate and beach restoration

Principal investigators: Shaffer, Beirne

Description: Modeling support for linking physical and biological functions of the nearshore

Expected products:

Schedule:

Link for additional information: shaffjas@dfw.wa.gov

Terrestrial and wildlife

Title: Surficial geology map for Elwha drainage

Principal investigators: J. Riedel, J. Probala and S. Dorsch

Description: Surficial geology is one of the 12 basic inventories targeted by the Natural Resource Challenge. A program developed at North Cascades National Park is designed to meet this need by mapping of 30 different surficial geology/landforms units, ranging from alluvial fans and floodplains to landslides and glacial moraines. Our approach is focused on depositional features that are mapped on 1;24,000 scale base maps using LIDAR, 1:12,000 scale stereo photos, and field verification. Work on the Elwha was initiated in 2003 and will continue through 2005, with the valley below Elkhorn nearing completion.

Expected products: GIS data layer of surficial geology units (landforms). Inventory of all landslides including several dozen characteristics of each feature. Inventory report summarizing results, with brief discussion.

Schedule: Summer 2004 = field verify landforms in lower valley main stem Elwha; Winter 2004-05 = digitize landforms of lower Elwha below Elkhorn; Summer 2005 = field check landforms in upper Elwha valley and initiate mapping in other watersheds; mapping will continue through 2011 before Olympic Park is completed.

Link for additional information: jon_riedel@nps.gov

Title: Land cover/ land use classification using very high resolution (4m multispectral) satellite imagery of the lower Elwha watershed

Principal investigators: Steinmaus, Miller

Description:

Expected products: GIS dataset and map for Elwha tribe.

Schedule: Unknown.

Link for additional information: karen.steinmaus@pnl.gov

Title: The Sediments of the Elwha River: A Preliminary Study of the Affects of Dam Removal

Principal investigators: Mussman, Zabrowski (UW)

Description: Removal of the two Elwha River dams has been proposed as a method for restoring endangered anadromous salmon to the Elwha River. However, the removal of the dams affects not only aquatic biota, but also the riparian habitats associated with river margins and floodplains. If the sediment is not stabilized, excessive amounts could erode downstream causing turbid waters and health threats to salmon. When the dams are removed, it is estimated that half of the reservoir sediment will erode downstream and the remaining sediment remain in situ. Concerns regarding the remaining sediments include infestation with invasive plants, wind and water erosion, and cracking. This proposal would address these concerns by conducting experiments on the sediment to predict erosivity and prescribe mulches or amendments that could prevent erosion and reduce establishment of invasive species. In addition, soil ecosystem development on glacial lake

sediments in the Elwha area will be examined to predict long-term soil development and ecosystem succession. This proposal will directly address two of the network's emphasis areas: 1) monitoring ecosystem health and establishing baseline data and reference points and 3) ecological restoration. There are three main goals proposed to address these emphasis areas. The first goal is to establish a reference ecosystem by describing soils developed on old glacial lake terraces and the vegetation that has grown on them. The second goal is to perform experiments on sediments to study treatments for erosion prevention. The third goal is to sample areas around the two reservoirs to be used as N-15 baseline data.

Expected products:

Schedule: Start in 2005

Link for additional information: zabow@u.washington.edu

Title: Soil survey of lower Elwha drainage within Olympic NP

Principal investigators: coordinated by NPS national soil scientist Pete Biggam

Description:

Expected products:

Schedule: probable start in 2007

Link for additional information: pete_biggam@nps.gov

Title: Seed bank in the sediment of lakes to be drained

Principal investigators: Smith, Ewing (UW)

Description: Sediment samples will be taken from various areas of the lake. Seed banks will be germinated. Vegetation sampling will be done in the riparian or upslope zone that is currently unflooded. Seed bank representation and existing vegetation will be compared.

Expected products: Inventory of germinable seeds in lake sediment. Composition of existing vegetation communities. Suggestions for use of seed bank in restoration.

Schedule: Will start this spring and be finished in the fall of 2006

Link for additional information: joshuacs@u.washington.edu

Title: The effects of dams on diversity and invasibility of riparian plant communities in Olympic National Park, Washington

Principal investigator: Rebecca Brown, Eastern Washington University

Description: The influence of dams on riparian areas is poorly understood, despite the fact that there are over two million dams in the United States. Riparian areas represent uniquely connected ecosystems that are strongly influenced by flooding. This connectivity, particularly in the form of flood-borne seed dispersal, contributes to the role that riparian areas play as "hotspots" for plant diversity and as corridors for the spread of invasive plant species. Dams, by altering this connectivity, may negatively affect the diversity of riparian plant species. The presence of dams on the Elwha River in Olympic National Park has created a unique "experimental perturbation" that modifies the flood regime and alters downstream seed transport compared to pristine upstream (or "control") reaches. Studies of riparian vegetation, soil seed banks, and seed dispersal on the

dammed Elwha will reveal patterns in seed supply, diversity and invasibility related to the dam. The Glines Canyon dam on the Elwha River is scheduled for removal in 2008 and will be one of the largest dam removals in the world. A sediment study in the reservoir will evaluate its role as a hidden seed bank of native and invasive species that may affect restoration efforts when the dam is removed. In addition, my studies will provide a unique ecological baseline for predicting (and subsequently testing) riparian responses to the dam removal.

Expected Products:

Schedule:

Link for additional information: rbrown@mail.ewu.edu

Title: Monitoring of the rare plant, *Cimicifuga elata*

Principal investigators: Schreiner

Description:

Expected products:

Schedule:

Link for additional information: ed_schreiner@usgs.gov

Title: Baseline monitoring of black bear seasonal distribution in the Elwha Valley prior to dam removal

Principal investigators: Happe, Jenkins

Description:

Expected products:

Schedule:

Link for additional information: patti_happe@nps.gov

Proposed
Title: Responses of streamside wildlife communities to salmon restoration

Principal investigators: Jenkins, Happe, Adams, Perakis

Description:

Expected products:

Schedule:

Link for additional information: kurt_jenkins@usgs.gov

Freshwater and riparian

Title: Baseline monitoring of floodplain vegetation and geomorphology prior to dam removal, Elwha River, Olympic National Park

Principal investigators: Shafroth, Braatne, Hartt

Description: We have collected baseline data on vascular plant communities along 15 permanent cross-valley transects along the Elwha River. We located five transects above both dams on the Elwha (in Geyser Valley), five transects between the two dams, and five below both dams. Vegetation measurements included line intercept (woody vegetation), point intercept (herbaceous vegetation), nested quadrat sampling (tree, shrub, herbaceous, woody seedlings) within different vegetation patches, and stand age determination within patches. These measurements will yield data on species richness, abundance (cover, density, basal area), vegetation dynamics (age classes, woody seedlings), and tree growth. Physical environmental measurements included topographic surveying of transects/plots and surficial soil texture, which will be complemented by stage-discharge modeling done by the Bureau of Reclamation. These data will be initially interpreted in the context of effects of the dams on riparian vegetation. Following dam removal, transects will be resampled over time to enable evaluation of the effects of dam removal. Finally, our measurements of woody vegetation composition will be linked to broader scale vegetation classifications that are being undertaken by R. Hauer and J. Braatne.

Expected products: MS thesis; Project report to Olympic National Park; 1-2 peer reviewed publications

Schedule: Hartt's thesis will be completed for Spring or Summer 2005 graduation; final report to Olympic Natl. Park will be completed by Summer or Fall 2005; first peer-reviewed publication will be submitted by Summer or Fall 2005

Link for additional information: pat_shafroth@usgs.gov

Comments: We are seeking funding to resample herbaceous vegetation and woody seedling dynamics for as many years as possible prior to dam removal. At this point, we don't anticipate having funding to resample in summer 2005, however. We are open to collaboration with other investigators interested in using our permanent transects as sites for other measurements (e.g., nutrient dynamics to relate to tree growth or vegetation composition changes post-dam removal).

Title: Consequences of a natural dam-break flood for geomorphology and vegetation on the Elwha River, Washington, U.S.A.

Principal investigators: Acker, Beechie, Shafroth

Description: To use unmanipulated ecosystems as models for riparian restoration, it is important to identify the roles of various disturbance mechanisms in structuring riparian forests. As part of the preparation for dam removal and riparian restoration on the Elwha River in Washington state, we examined a 0.5 km long debris fan on a wilderness reach of the river to determine whether geomorphic and vegetation patterns could be attributed to a natural dam-break flood in 1967. We identified five major surfaces within the fan, three of which date to the dam-break flood based on tree ages. Two surfaces closer to the present channel of the river were created by more recent disturbances. The surfaces created by the 1967 flood vary in height from 4 m above the present channel to essentially level with the channel, and vary in surface texture from boulders to sand and silt. Consistent differences in tree species composition and stem density between the five surfaces generally do not correspond to differences in surface age. The heterogeneity of riparian forests in this one portion of a presumed "reference ecosystem" for riparian restoration is due to both the diversity of environments generated by the 1967 flood and repeated disturbances since then.

Expected products: Manuscript for submission to peer-reviewed journal; poster presented at Ecological Society of America annual meeting, 2004

Schedule: Expect to submit manuscript in spring 2005

Link for additional information: steve_acker@nps.gov

Title: Pre-dam removal monitoring on the Elwha River Basin: establishing baseline conditions for primary and secondary productivity

Principal investigators: Morley, Coe, Duda, McHenry, Kiffney, Pess, and Beechie

Description: In order to effectively evaluate the potential effects of dam removal on primary and secondary productivity in the Elwha River Basin, a coordinated data-collection effort is needed for establishing pre-dam removal conditions. Building on earlier monitoring work conducted by the Lower Elwha Tribe and the USGS in the mid-90's, we began collecting baseline data in the summer of 2004. In order to sample mainstem, tributary, and side channel habitats below, between, and above the dams, data collection was coordinated amongst NOAA, the USGS, and the Lower Elwha Klallam Tribe. The focus of this first year of data collection was on standardizing data collection protocols, collecting a representative number of samples from varied habitats, and on establishing long-term monitoring locations. Along with physical habitat characterization, at each of our monitoring sites we collected benthic invertebrates, periphyton, and water chemistry samples. Based on this collaborative research effort, we will determine adequate sample size, appropriate spatial distribution of samples sites (lateral and longitudinal), and refine sampling protocols as necessary for ongoing dam removal monitoring.

Expected products: Peer-reviewed papers

Schedule: Continue sampling for 3 to 5 five years after dam removal

Link for additional information:
http://www.nwfsc.noaa.gov/research/divisions/ec/wpg/index.cfm

Title: Documenting current stream productivity and fish populations prior to dam removal in the Elwha River: Setting the stage for long-term monitoring of ecosystem responses. [also listed in "Fish Ecology and Biology," below]

Principal investigators: Reisenbichler, Petersen, Duda and Connolly

Description: Collection of baseline stable isotope levels for aquatic species including periphyton, macroinvertebrates, and fish from the upper, middle, and lower Elwha. Analyze and archive O. mykiss DNA throughout the watershed, including tributaries. Develop protocols for fish sampling to determine community composition and production.

Expected products: 1) Baseline values of marine derived nutrients in aquatic food webs. 2) Genetic characteristics of O. mykiss and archived tissue collection for future studies 3) Community composition of fish populations from index reaches in the middle and upper Elwha from electroshocking and snorkeling surveys.

Schedule: FY04 & FY05

Link for additional information: reg_reisenbichler@usgs.gov

Title: Collect remote sensing information on terrestrial and aquatic variables and compare to habitat data collected from traditional methods in same areas.

Principal investigators: Lorang, Hauer, McHenry, and Pess

Description: Utilize new technology (hyperspectral imagery and Acoustic Doppler Processing) to expand our current habitat inventory in the Elwha, as well as increase its overall accuracy and repeatability. We will compare differences in the accuracy, precision, repeatability, and cost between remote sensing and traditional habitat survey techniques and in order to help make such efforts more efficient.

Expected products: Peer-reviewed paper.

Schedule: Continue work 5 to 10 years after dam removal.

Link for additional information: mark.lorang@umontana.edu

Title: Develop reference site data for monitoring biological integrity and water quality of streams

Principal investigators: Freilich

Description:

Expected products:

Schedule:

Link for additional information: jerry_freilich@nps.gov

Title: Alteration of channel and ecosystem dynamics downstream of Elwha dams

Principal investigators: Beechie, Pollock, McHenry, Liermann, and Pess

Description: Reduced sediment supply to the lower Elwha River since construction of the first Elwha dam in 1912 has caused river entrenchment and decreased channel movement. To understand how these changes alter the spatial and temporal dynamics of the river-floodplain ecosystem, we combine data for erosion and formation of floodplain surfaces, successional patterns of floodplain vegetation, and responses of riverine fauna to the shifting suite of habitat types. We first develop a matrix of transition probabilities that describes the spatial and temporal dynamics of habitat patches in the river-floodplain system. Field surveys of morphological and biotic attributes of different patch types are then used to infer spatial and temporal variations in aquatic communities based on the transition matrix, and to predict how the floodplain ecosystem will respond to dam removal. Monitoring will continue after dam removal to test our predictions.

Expected products: Peer-reviewed papers

Schedule: 2003 till ? Continue work 5 to 10 years after dam removal.

Link for additional information:
http://www.nwfsc.noaa.gov/research/divisions/ec/wpg/index.cfm

Fish ecology and biology

Title: Biological monitoring of engineered logjams (ELJs) in the Lower Elwha River below the dams

Principal investigators: Pess, McHenry, Coe, Liermann, Kloehn, Bennett, and Peters

Description: Juvenile and adult salmonid and non-salmonid seasonal snorkel surveys began in 2000 in reaches with and without ELJs in the Lower Elwha River. We also conduct an annual fish census below the dams. We plan to continue seasonal surveys and the summer fish census through 2005. Primary and secondary productivity sampling began in 2002 in reaches with and without ELJs in the Lower Elwha. Within treatment reaches, sampling occurred both on the ELJ structures and in habitats directly influenced by the presence of ELJs.

Expected products: Peer-reviewed papers

Schedule: 2000 till 2005

Link for additional information:
http://www.nwfsc.noaa.gov/research/divisions/ec/wpg/index.cfm

Title: Collecting and creating baseline genetics on salmonids in the Elwha River

Principal investigators: Winans and Meyers

Description: In 2004, we began sampling Chinook, steelhead/rainbow trout, and chum salmon in the Elwha watershed in conjunction with the Lower Elwha-Klallam Tribe, USGS, WDFW, and NPS. Extensive sampling of resident rainbow trout was begun in the middle and upper portions of the river that included nonlethal collections for DNA analysis and, in some cases, photographs for morphometric evaluations. We are in the process of statistically analyzing preliminary DNA-based genetic data for a subset of the steelhead/rainbow trout samples and a Chinook salmon collection, as well as morphological data for middle and lower river steelhead/rainbow trout collections. The power of these data rely on thorough geographic coverage as well as temporal representation of the variability. In 2005, then, we will continue to sample the above species as well as coho, pink, and sockeye salmon, and kokanee in conjunction with the above agencies. Emphasis will be on obtaining samples of late-spawning (wild) steelhead and early-returning Chinook salmon; and collecting and analyzing genetic and morphological data (where possible) for all species in light of existing genetic and phenetic data sets.

Expected products: Peer-reviewed papers.

Schedule: Continue work 5 to 10 years after dam removal.

Link for additional information:
http://www.nwfsc.noaa.gov/research/divisions/ec/wpg/index.cfm

Title: Predicting salmonid response to the removal of the Elwha River dams

Principal investigators: Pess, McHenry, and Beechie

Description: The Elwha River dams have disconnected the upper and lower Elwha watershed for over 90 years. This has resulted in a disruption to upstream salmonid migration and a "loss" of 90% of the salmonid habitat. The dams have also interrupted the downstream movement of both sediment and wood, leading to such inputs being dominated by local sources (e.g., bank erosion and avulsions). The current salmon habitat, as well as salmonid abundance and distribution, reflects these changes. Current salmonid populations (several of which are hatchery-dominated) are either dramatically smaller than estimated historical population or extirpated. Nevertheless, salmonid populations do persist below the dams in part because channel incision has not been significant, and floodplain habitats remain an important component of the Elwha River ecosystem. Dam removal will (1) reconnect upstream habitats increasing salmonid carrying capacity, and (2) allow the downstream movement of sediment and wood leading to long-term aquatic habitat improvements. Both large-scale changes will allow salmonid populations to rebuild on a

watershed-scale. We hypothesize that the salmonid recolonization will be concentrated in several large alluvial valleys in the Middle and Upper Elwha.

Expected products: Peer-reviewed paper to be submitted Feb 2005.

Schedule: 2001 till ? Continue work 5 to 10 years after dam removal.

Link for additional information:
http://www.nwfsc.noaa.gov/research/divisions/ec/wpg/index.cfm

Title: Documenting current stream productivity and fish populations prior to dam removal in the Elwha River: Setting the stage for long-term monitoring of ecosystem responses. [also listed in "Freshwater and Riparian," above]

Principal investigators: Reisenbichler, Petersen, Duda and Connolly

Description: Collection of baseline stable isotope levels for aquatic species including periphyton, macroinvertebrates, and fish from the upper, middle, and lower Elwha. Analyze and archive O. mykiss DNA throughout the watershed, including tributaries. Develop protocols for fish sampling to determine community composition and production.

Expected products: 1) Baseline values of marine derived nutrients in aquatic food webs. 2) Genetic characteristics of O. mykiss and archived tissue collection for future studies 3) Community composition of fish populations from index reaches in the middle and upper Elwha from electroshocking and snorkeling surveys.

Schedule: FY04 & FY05

Link for additional information: reg_reisenbichler@usgs.gov

Title: Monitoring coho, Chinook and steelhead smolts captured in smolt trap on Lower Elwha

Principal investigators: Mumford and House

Description: General fish health monitoring of outgoing smolts captured in a trap on lower end of Elwha River will take place annually in an effort to collect baseline information on pathogenic bacteria, parasites and viruses in the fish populations. The sampling will be approached in a manner consistent with the National Wild Fish Health survey, with routine screening of 60 fish per species for specific viral, parasitic and bacterial pathogens.

Sampling will take place in collaboration with Dr. Walt Dickhoff (NOAA, Montlake), who is studying several aspects of the reproductive physiology. Additionally, toxicology could potentially be done on the same fish.

Expected products: Determine if there is a change in the pathogens detected in surveys of outmigrating smolts before and after dam removal.

Schedule: The trap will be in place from mid-March through mid-June. Sample will start in 2005.

Link for additional information: http://wildfishsurvey.fws.gov/

Title: Monitoring Lake Sutherland kokanee for IHNV and *Parvicapsula minibicornus* prior to and following dam removal and the natural colonization of sockeye

Principal investigators: House and Mumford

Description: There have been historical accounts of kokanee in Lake Sutherland prior to the construction of the Elwha dam in 1911, as well as records of hatchery kokanee released into the lake from various sources from 1933 to 1964. There is no health history from fish in Lake Sutherland available. Currently the kokanee in Lake Sutherland have been isolated from anadromous fish, and therefore marine pathogens since 1911. With the removal of the dams in 2008 and renewed access for anadromous fish, it is anticipated that a sockeye run will return to Lake Sutherland. We will sample spawning kokanee adults prior to and following dam removal (as well as returning sockeye) and monitor the populations for pathogens, including Infectious Hematopoetic Necrosis Virus (IHNV) and *Parvicapsula minibicornus*, to which these species are known to be especially susceptible.

Gary Winans (NOAA, Montlake) is conducting a genetic evaluation of Lake Sutherland kokanee and sockeye with a comparison to other regional stocks, and we will coordinate sampling as much as possible, with the assistance of the Lower Elwha Tribe.

Expected products: To provide fish health data on Kokanee in Lake Sutherland prior to and after dam removal; these fish may be at higher risk of infection with the re-introduction of anadromous fish. The fish health sampling will be done with an emphasis on detection of IHNV and *Parvicapsula minibicornus*.

Schedule: Expect to begin sampling November 2005 as fish are spawning, and sample annually.

Link for additional information: mhouse@nwifc.org

Proposed

Title: Coho Salmon Spawning Distribution in the Lower Elwha River prior to Dam Removal: Implications for Recolonization after Dam Removal

Principal investigators: Burke, Frick, McHenry, and Pess

Description: Prior to the construction of the Elwha and Glines Canyon Dams, the Elwha River supported large populations of all major native west coast species of Pacific salmonids (Oncorhynchus spp.). Currently, these populations are depressed, supported primarily by hatcheries, or extinct. Removal of these two dams, scheduled for 2008 to 2010, will provide salmon and other species access to 79 km of pristine spawning habitat (Gregory et al. 2002). Current spawning habitat use by coho salmon (O. kisutch) below Elwha Dam is unknown, yet coho, heavily supplemented by hatchery outplants, are the most abundant salmonid species below the dams (McHenry et al. 2000). Coho have also been documented as being one of the initial salmonid colonizers in newly opened habitats, regardless of whether the barriers are natural or artificial (Milner et al. 2001, Pess et al. 2003). Thus, understanding how coho salmon use existing spawning habitat will be critical to predicting and evaluating the effects of dam removal on species distribution and abundance. Our objectives include: 1) establishment of optimal placement of radiotelemetry receivers for adult salmon monitoring in the lower Elwha River, 2) quantification of movement patterns of adult coho salmon prior to spawning, and 3) determination of the number and spatial extent of coho salmon spawning areas in the Elwha River and estimation of selectivity by comparing characteristics of spawning habitat with those of available habitat.

Expected products: Peer-review papers.

Schedule: 2005 till ?

Link for additional information: Brian.Burke@noaa.gov

Title: Smolt Outmigration Monitoring in the Elwha River

Principal investigators: McHenry and M. Elofson

Description: Natural production of all salmonid species in the Elwha River is poorly understood. Most stocks are either supported by hatchery production, dramatically depressed or extirpated. Our objectives include: 1) quantify numbers and species of salmonids produced in the Elwha River before during and after dam removal, and 2) monitor changes in the proportion of naturally produced and hatchery produced Chinook and coho salmon, as well as steelhead.

We propose a multi-year project that will likely run the length of the Elwha restoration project through recovery (2005-2030). Pre-dam removal smolt production will be measured using two rotary screw traps fished at different locations in the Elwha River below Elwha Dam. This method, because of relatively low capture rates in large rivers, requires an estimation of trap efficiency, typically through the use of mark-recapture studies. To accomplish these objectives we propose to use two rotary screw traps to collect and estimate population size on the Elwha River. An 8' rotary screw trap will be fished at river mile 1.0 in the downstream end of the Hunt Road Channel (largest west side channel). A 5' rotary screw trap will be simultaneously fished at river mile 2.5 (outlet of Spruce hole). The smaller trap will be used to collect fish for marking to be used in a continuous mark-recapture study to evaluate the trap efficiency of the 8' screw trap. All coho, steelhead, and Chinook salmon smolts larger than 55 mm captured at the upstream site will be anaesthetized in (MS-222) weighed and measured, and given a unique mark. While there are numerous marking techniques available, many have limitations in that they are expensive, slow, and difficult to read or may cause unacceptably high rates of mortality. We anticipate the need to experiment between marking techniques in order to find the best method for the Elwha. Traps will be fished annually during the period from March 1 to July 31.

Expected products:

Schedule: 2005 till ?

Link for additional information: mchenry@elwha.nsn.us

Sociocultural

Title: Cultural resource inventories related to Elwha project

Principal investigators: Contact Paul Gleeson, Olympic National Park

Description: Requirement in EIS.

Expected products: 1) cultural landscape inventory; 2) historic structures inventory; 3) HABS/HAER studies of two dams; 4) historic context statements; 5) historical archeology research design; 6) pre-historical archeology research design; 7) archeological resources inventory; 8) ethnographic study; 9) inventory of archival resources; 10) historical assessment of Elwha River fisheries; 11) genealogical studies of Lower Elwha Klallam Tribe; 12) ethno-historic study of non-native settlements; 13) interpretive plan – Elwha and Glines Canyon dams

Schedule:

Link for additional information: Paul_Gleeson@nps.gov

Education

Title: An integrated approach to restoration of anadromous salmonids and their habitat in the Elwha River following dam removal

Principal investigators: Contact Nancy Wright, University of Idaho

Description: Train Tribe staff to acquire and evaluate physical, ecological, and socioeconomic datasets for lower Elwha River, estuary, and nearshore area; develop GIS tools; develop and apply characterization of parameters for long-term resource management by Tribe.

Expected products:

Schedule: March 2005 through March 2007.

Link for additional information: nwright@uidaho.edu

Title: Extreme Makeover: The Elwha River Edition

Principal investigators: O'Keefe

Description: Course to be taught at Olympic Park Institute on river ecology and restoration of the Elwha River. The course will include field tours and lectures. This project will be placed in the context of other dam removal projects.

Expected products: 3 day course for a general audience.

Schedule: To be presented Oct 7-9, 2005**.**

Link for additional information: okeefe@u.washington.edu

Title: Field science program focused on Elwha watershed

Principal investigators: Olympic Park Institute

Description: Pilot project involving local schools in data collection.

Expected products:

Schedule:

Link for additional information: sschaffer@yni.org

Title: Elwha exotic plant removal volunteer work weekends (not final title)

Investigators: Dan Campbell, National Park Exotic removal team, Josh Walter, NPCA organizer

Description: NPCA will be working with the park to coordinate local volunteers and to help curb the exotics in the two Elwha campgrounds and the area around the upper dam. The work weekends will run monthly from March through September or October depending on their success.

Expected products: Education of local volunteers on the Elwha restoration project, better control of exotics in the area.

Schedule: Planning and recruiting volunteers through March 2005. March through Sept.-Oct.2005 field work.

Link for additional information: jwalter@NPCA.ORG

Proposed
Title: Summer science education: Elwha restoration

Principal investigators: Young

Description: NSF proposal for science education program focusing on tribal kids

Expected products:

Schedule:

Link for additional information: ryoung@wcu.edu

Title: REU Site—An Undergraduate Research Program on the Elwha Dam Removal and Restoration Project in Washington State

Principal Investigator: Eaton (Peninsula College; PI), Allaway (WWU, Huxley College; co-PI)

Description: NSF proposal for both PC and Huxley College program at PC students will be involved with scientists from PC, Huxley College, Olympic National Park, USGS Biological Resources Division, NOAA Fisheries, and Lower Elwha Klallam Tribe in a year-long research course (Fall through Summer Quarter) that includes over 100 hours of course activities and 400 hours of research on the Elwha system, working as full participating members of the consortium. The research projects will focus on analysis of a variety of parameters in the Elwha ecosystems throughout the year, identifying mechanisms and indicators of changes in population distribution and abundance; predicting changes in these populations due to dam removal; and providing information on the effects of dam removal and restoration projects for use worldwide. The 16 students per year will include four students from the tribal communities in PC's district enrolled in either a two or 4-year science program at PC; four PC students in the sciences; four students in the Huxley College program at PC; and four students from other rural college districts.

Expected Products: In addition to being trained in a variety of areas of study in natural resources management and ecology, students will present their results to the regional scientific and public communities at an annual REU Public Workshop, and at national undergraduate research conferences (i.e., CUR and NCUR conferences); scientist mentors and students will produce scientific publications, and protocols for long-term ecosystem monitoring that will be documented and made available in technical report format and on the National Parks in the North Coast and Cascades Network (NCCN), and PC Center for Excellence websites.

Schedule: Project to begin Fall 2005 and last through September 2009

Link for additional information: bille@pcadmin.ctc.edu

Proposed
Title: ATE—A Technical Experiences Program on the Elwha Dam Removal and Restoration Project in Washington State

Principal Investigator: Eaton (Peninsula College; PI), Allaway (WWU, Huxley College; co-PI), Dwight Barry (Peninsula College; co-PI), Brian Hauge (Peninsula College; co-PI)

Description: The purpose of this ATE Project is to develop a new regional community college student technical experiences program at PC for students in the Natural Resource-related fields, using the Elwha ecosystems as focal points for the project. This program would provide advanced skills training and job preparation for students to help them enter into the workforce or transfer to baccalaureate programs for the last two years of technician training, and provide a significant regional recruitment tool to attract and retain students to help address a developing workforce gap. The grant would sponsor nine students from the tribal communities in PC's district, twelve PC students in the sciences, and nine students from other rural districts in the state in the two-course sequence involving 60 hours of classroom activities and 180 hours of research on the Elwha ecosystems. There will also be sponsorships for five students in the Huxley College BA and BS programs at PC to conduct research during the year, and for 5 high school faculty and 5 college students for a 10 week summer projects program.

Expected Products: Students will be trained in a variety of areas of study in natural resources management and ecology, and prepared for entry into jobs or upper division programs at universities. In addition, students will present their results to the regional scientific and public communities, and at national undergraduate research conferences (i.e., CUR and NCUR conferences). Scientist mentors and students will produce scientific publications, as well as technical reports and protocols that will be made available in technical report format and on the National Parks in the North Coast and Cascades Network (NCCN), and PC AETCE websites.

Schedule: Project to begin Fall 2005 and last through September 2008

Link for additional information: bille@pcadmin.ctc.edu

Proposed
Title: ATE—A Technical Experiences Program on the Elwha Dam Removal and Restoration Project in Washington State

Principal Investigator: Eaton (Peninsula College; PI), Allaway (WWU, Huxley College; co-PI), Dwight Barry (Peninsula College; co-PI), Brian Hauge (Peninsula College; co-PI), Freilich (Olympic National Park)

Description: This is a four year grant project that will provide advanced training for undergraduate science students by development of an undergraduate student research and data collection program at PC to study the Elwha River system ; and in so doing, provide baseline data on the ecosystem's biotic community and chemical conditions and trends prior to before and after dam removal in order to help address several specific hypotheses and questions associated with the impacts of dam removal; The research students will be involved in writing all reports, final protocols, website material, developing any presentations, and any other products resulting from this work. The Scientific Team members will serve as mentors and editors for all student writing and presentation preparation efforts.

Expected Products: 20 students will be enrolled in PC and Huxley College at PC specific research courses. These will included 15 funded students (5 from PC, 5 from Huxley, and 5 from the Lower Elwha Tribe). Students will participate in the research projects associated with the Elwha Research Consortium. The research students will be involved in writing all reports, final protocols, website material, developing any presentations, and any other products resulting from this work. Students will also make presentations at local, regional and national.

Schedule: Project to begin Fall 2005 and last through September 2009

Link for additional information: bille@pcadmin.ctc.edu

Appendix D: Acronyms used in this document

CODAR HF Coastal radar High Frequency
CTD Conductivity, Temperature, Depth
EALR Essential Academic Learning Requirements
EIS Environmental Impact Statement
IRICC Interorganizational Resource Information Coordinating Council
ISE Informal Science Education
IM Information Management
IRICC Inter-organizational Resource Information Coordinating Council
LEKT Lower Elwha Klallam Tribe
LIDAR Light Detection and Ranging
MDN Marine Derived Nutrients
MESA Marine Ecosystems Analysis
MMS OCS Minerals Management Service Outer Continental Shelf
MOU Memorandum of Understanding
NCEAS National Center for Ecological Analysis and Synthesis
NANOOS Northwest Association of Networked Ocean Observing Systems
NMFS National Marine Fishery Service
NOAA National Oceanic and Atmospheric Agency
NPCA National Park Conservation Association
NPS National Park Service
NRPP Natural Resource Preservation Program
NSF National Science Foundation
NWIFC Northwest Indian Fisheries Commission
OMSI Oregon Museum of Science and Industry
OPI Olympic Peninsula Institute
PERE Partnership for Elwha Restoration and Education
PNNL Pacific Northwest National Laboratory
POBS Park Oriented Biological Support
PSNERP Puget Sound Nearshore Ecosystem Restoration Program
RCN Research Consortium Network
REU Research Experience for Undergraduates
OMSI Oregon Museum of Science and Industry
ONP Olympic National Park
USFWS U.S. Fish and Wildlife Service
U&A Usual and Accustomed
USGS U.S. Geological Survey
UW University of Washington
UW-REN University of Washington – Restoration Ecology Network
VENUS Victoria Experimental Network Under the Sea
WDFW Washington Department of Fish and Wildlife
WDNR Washington Department of Natural Resources
WWU Western Washington University