Understanding the Elwha:

A Strategy for Research and Education Programs on the Elwha River

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PREFACE

This report is in partial fulfillment of an agreement between Western Washington University and the National Park Service (Olympic National Park) to provide assistance in preparing an implementation plan for research and monitoring related to Elwha River restoration. The work was carried out under Task Agreement No. J9W88030025, administered through the Pacific Northwest Cooperative Ecosystem Studies Unit, under its Cooperative and Joint Venture Agreement CA9088A008.

The initial intent for this report, described in the Task Agreement, included the following elements of a research and monitoring implementation plan:

- Objectives;
- A model for the structure and functioning of the research and monitoring program;
- Subjects to be included;
- Participants;
- A general schedule;
- General funding requirements and options for funding; and,
- A strategy for establishing and funding the program.

As work on the project proceeded and the completion date was extended, understanding of what would be the most useful final product evolved. Final direction for the contents and emphasis of this report came from discussions in April 2004 with Brian Winter, Elwha Restoration Project manager for Olympic National Park and supervisor of this project, and with other Park staff.

The cooperation and assistance of Jerry Freilich, Research and Monitoring Coordinator for Olympic National Park, Brian Winter, and Cat Hoffman, Chief of the Natural Resources Division of the Park, in carrying out this project has been invaluable. Darryll Johnson, Research Coordinator of the PNW CESU, provided essential help in facilitating the administrative arrangements for the project.

The views expressed in this report are solely those of the author. Although the report is intended to be as useful as possible to Olympic National Park, the views expressed here are not necessarily those of the Park or its staff.

I. Introduction

This report outlines a strategy for Olympic National Park to pursue to try to ensure that comprehensive and coordinated long term research is carried out on the natural ecological systems of the Elwha River watershed. This program also should study the interactions of natural with human systems in the region, and be linked to an array of educational programs.

These major new programs of research and education are required to fulfill an urgent need and to take advantage of an unparalleled opportunity presented by the impending removal of two dams. The two Elwha dams have, for over 90 years, blocked anadromous fish from all but the lower five miles of what was once a major producer of numerous stocks of all five Pacific salmon species as well as steelhead.

The great majority of the Elwha watershed, however, lies within Olympic National Park and has undergone very little alteration. This sets up a massive ecological experiment, where the only significant disturbance for most of a natural watershed has been the absence of anadromous fish, and then the fish return. The understanding of ecosystem processes to be gained from tracking the ecosystem responses to this will be profound, and will illuminate major contemporary questions such as the role of marine-derived nutrients in salmon ecosystems, trophic web responses, processes of succession, and the influences of sediment and woody debris regimes on floodplain geomorphology. Further, the information gained on important management issues such as modes of salmon and habitat restoration and the effects of dam removal will be immensely valuable and widely applicable.

Removal of the dams is scheduled to begin in 2007, and very little time remains to obtain the baseline data that will be needed to track and understand change and ecosystem response. It is urgent that long term research and monitoring plans be developed – based on conceptual models and identification of research questions – and that collection of additional baseline data begins very soon.

The complexity of the needed research and monitoring program requires that a structure be in place to coordinate planning and activities among a network of researchers and educators. This will help ensure that all topics are adequately covered and that methods are compatible. A network coordination structure also can collect core monitoring data common to many topics, assist in fund raising, improve communication among participants and the efficiency of related projects, provide central data management services and facilitate data sharing, and potentially provide research facilities.

The strategy described in this report describes steps to be taken in the near term to help establish a network coordination structure and process. In the immediate future, Olympic National Park has a vital role to play as catalyst. Once in place and operating, the network is expected to be self-governing and self-perpetuating, and to raise funds for its own continuation.

II. Background to the Current Situation

Setting

The Elwha River is one of ten major rivers on the Olympic Peninsula of Washington State.[1] The river is 45 miles long. Its watershed covers 321 mi^2, fourth largest on the Peninsula; 83% of the watershed (267 mi^2) lies within Olympic National Park.

The Olympic Peninsula forms the western most northern corner of the lower 48 States, and is bordered by the Pacific Ocean to the west, the Strait of Juan de Fuca to the North, and Puget Sound to the east. The Peninsula is approximately 6,500 sq. mi. in area, 3,000 sq. mi. of which are the Olympic Mountains, rising to close to 8,000 ft. above sea level from the surrounding lowlands that are less than 500 ft in elevation.

Climate and local weather on the Olympic Peninsula are dominated by relatively mild and moist prevailing marine weather systems interacting with mountain topography. Strong east-west gradients in precipitation are present. The western part of the Peninsula has rainfall up to around 165 inches on average per year, with corresponding heavy mountain snowfall. By contrast, in parts of the rain shadow in the lee of the mountains on the eastern part of the Peninsula, annual rainfall can average around 20 inches or less. Precipitation in the Elwha watershed averages 60-80 inches per year, placing it in the moderate middle ground. Precipitation is highly seasonal, occurring mainly in winter and spring.

The Olympics are a generally dome-shaped block of mountains with long ridges separating river valleys radiating out from the central area. The Elwha flows northward from near the center of the Olympic Mountains to enter the Strait of Juan de Fuca west of the town of Port Angeles. Like the other major rivers in the region, it is relatively short, is steep in its upper reaches, and has high seasonal flows.

About 50% of the Olympic Mountains block is within Olympic National Park, and remains largely in a natural state. The 50% of the mountainous area outside the park, together with most of the lowlands, has been greatly altered by logging, residential and commercial development, and farming.

Natural vegetation and habitat types on the Peninsula range from lowland forest (rain forest on the western parts of the peninsula) from sea level up to approximately 1,500 or 2,000 ft. in elevation, including river valleys deep into the mountains, through montane and subalpine forest zones up to about 5,000 ft. elevation, up to an alpine zone that includes some glaciers. The natural forests are dominated by coniferous evergreen species including Douglas-fir, western hemlock, Sitka spruce, grand fir, and western red cedar, with silver fir, subalpine fir, mountain hemlock, Alaska cedar, and other species at higher elevations. Common deciduous trees include bigleaf maple, red alder, and black cottonwood. Forest understory species include salmonberry, salal, red elderberry, huckleberry, devil's club, willow, vine maple, and alder. Portions of the alpine region apparently were not glaciated during the last Ice Age and support several endemic herbaceous species of particular interest.

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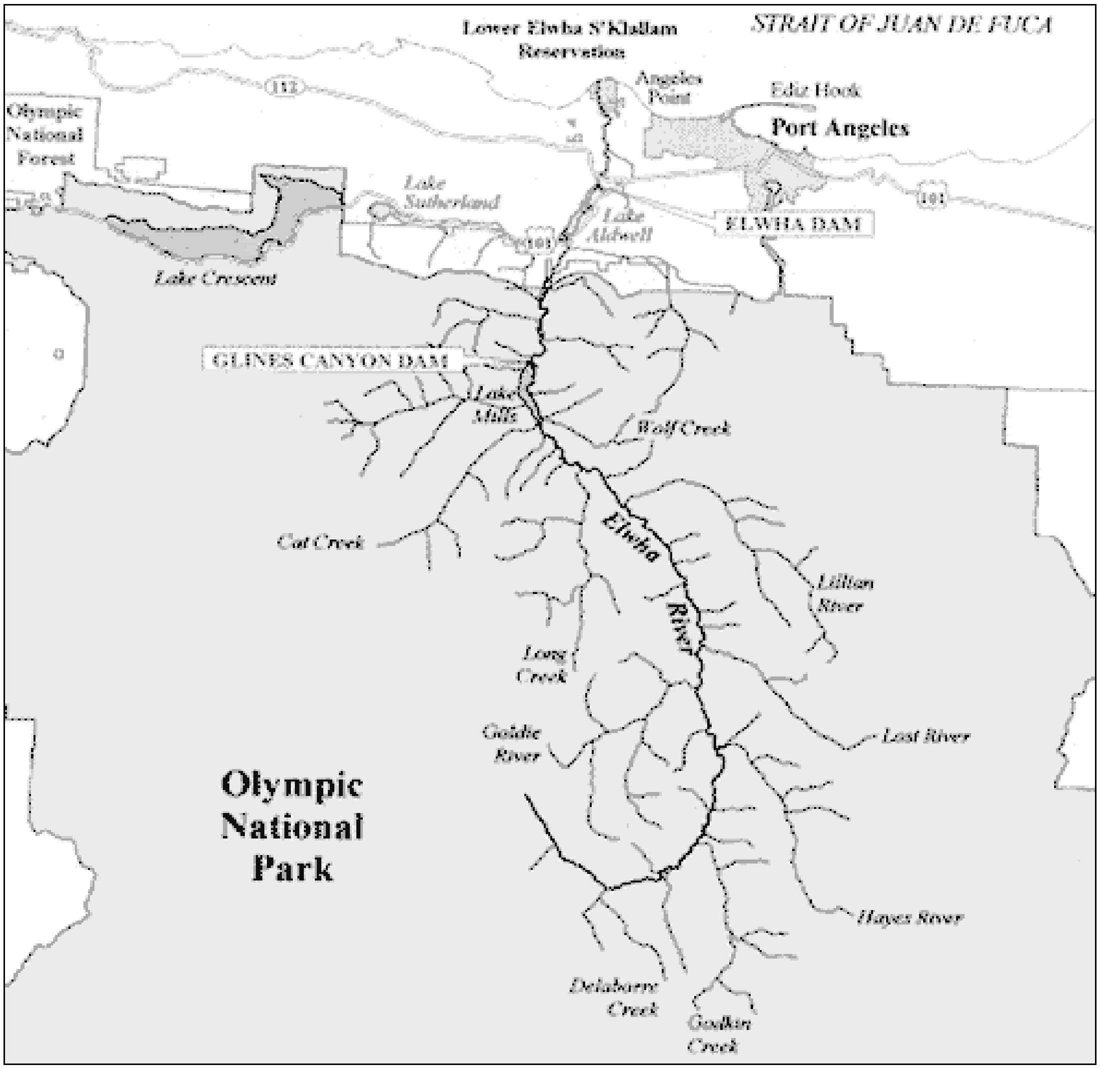
[1] Others are the Dungeness, Dosewallips, Duckabush, Skokomish, Quinault, Queets, Hoh, Bogachiel, and Sol Duc rivers.



Map 1. Elwha River. (Source: National Park Service)

Mammals utilizing these habitats include several thousand Roosevelt elk, native to the region and the largest terrestrial mammal on the Olympic Peninsula. Elk are most numerous on the west side; their principal habitat is the rain forest, but some move to higher elevations during summer and fall. Because of their numbers and size, elk help shape the structure of the forest through their browsing and grazing. Also present are Columbia black-tailed deer (native to the region and fairly common), mule deer (introduced and uncommon), mountain goats (introduced in the 1920s), mountain lions, black bears, coyotes, marmots, Douglas squirrel, raccoon, otters, weasels, fisher, mink and numerous others. Wolves formerly were common, but were extirpated early in the 1900s by hunters, farmers, and ranchers.

The region's combination of a marine environment and a diversity of habitats on land – from lowland river valleys and forests to alpine tundra – supports a rich avian fauna. Over 260 species of birds have been observed on the Olympic Peninsula.

Olympic Peninsula waters have historically supported abundant and diverse fish populations, notably salmon and other anadromous fish such as steelhead. All five species of Pacific salmon (chinook, coho, sockeye, pink, and chum) have been widespread. Resident freshwater fish include cutthroat, rainbow, and Eastern brook trout, as well as other species.

Regional Land Use

For thousands of years, the Klallam Indians and their ancestors have inhabited the Elwha River region and subsisted on the salmon runs and other resources of the watershed and the nearby marine environment. Today there are three recognized Klallam tribes -- the Lower Elwha Klallam, Jamestown S'Klallam, and Port Gamble Klallam.[2] The Lower Elwha Klallam Tribe's reservation occupies slightly more than 400 acres near the mouth of the Elwha River where it joins the Strait of Juan de Fuca.

European exploration of the region began by at least the late 16th century, and became more significant late in the 18th century with the expeditions of the Spaniard Juan Perez and the British explorers John Meares and, particularly, George Vancouver. Settlers moved onto the Olympic Peninsula around the time of the demarcation of the border between the United States and Canada in 1846 and the establishment of Washington Territory in 1853. Over the latter decades of the 19th century and into the early years of the 20th century, limited parts of the Peninsula's more fertile and accessible lowlands and river valleys were settled by farmers and ranchers. Hunting and fishing parties explored the foothills and valleys and penetrated deeper into the mountains. A couple of historical cabins built by outfitter guides and homesteaders still remain in the middle reaches of the valley of the Elwha within the National Park.

Exploration into the heart of the Olympics began in the late 19th century. Perhaps the first expedition into the mountains proper was an army exploration of the northeast Olympics in 1882 led by Lieutenant Joseph O'Neil. The Elwha River valley was the site for the epic struggles of the first successful crossing of the mountains: the Press Expedition (it was sponsored by the Seattle Press newspaper) toiled up the Elwha in the winter of 1889-1990 and, with great difficulty and discomfort, crossed through the mountains. That summer Lt. O'Neil led a more thorough exploration of the mountains and made the first east-west crossing. Mountain climbing on the peaks began late in the 19th century.

As the northern and eastern parts of the Olympic Peninsula became more settled and more accessible to people from Seattle and other towns on Puget Sound (the western side remained fairly inaccessible until the completion of Highway 101 around the Peninsula in the early 1930s), the salmon and steelhead of the Peninsula's rivers became famous among sport fishermen and women. Prominent among the rivers was the Elwha, fairly accessible and noted for the abundance, diversity, and size of its fish. The chinook salmon of the Elwha are thought to have been the largest on the Peninsula, reaching over 100 lbs in weight.

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[2] Other Tribes of the Olympic Peninsula include the Hoh, Makah, Quileute, Quinault, and Skokomish Indian Tribes.

The Elwha supported 10 distinct runs of anadromous fish: the five pacific salmon species -- coho, pink, chum, sockeye, and chinook (both spring and summer/fall runs) -- as well as winter and summer runs of steelhead, sea-run cutthroat trout, and native char. These runs totaled hundreds of thousands of fish.

Federal protection for the Olympic Mountains was recommended as early as the late 19th century, by such people as the army's Lt. O'Neil and Judge James Wickersham (later active in mountain exploration in Alaska). An Olympic Forest Reserve was established in 1897, including the mountains and also land out to the ocean. Reduced in size to exclude some timber lands, this was designated the Olympic National Forest in 1907. President Theodore Roosevelt created Mount Olympus National Monument in 1909 within the National Forest, encompassing 615,000 acres centered on the mountains, with the particular purpose of protecting elk populations. This area was reduced in half during World War I, and transferred to the National Park Service in 1933.

Olympic National Park was established in 1938, covering 648,000 acres. Later additions have brought the total Park area to almost 900,000 acres. It encompasses the heart of the mountains, but it also includes lowland rainforest and river corridors, and lands along the Pacific Ocean on the west side of the Peninsula (these were added to the park in 1953). Some of the eastern mountains were excluded from the Park but later were protected through creation of National Forest Wilderness in 1984.

Nearly 95% of Olympic National Park was designated as Wilderness in 1988. The Park was designated an International Biosphere Reserve in 1976, and a World Heritage Site in 1981.

Olympic National Forest generally surrounds and abuts the Park on its north, east, and south sides. Washington State lands, most managed by the state Department of Natural Resources (DNR), adjoin the Park on much of its west side. Both National Forest and DNR lands generally occupy lower elevations that support better timber. Some blocks of private forest lands also occur in these regions.

The relative inaccessibility of land that now lies within the National Park and the lesser value of its timber, together with the fairly early designation of protected status, combined to protect those forested areas from logging. As a result, the vegetation within most of the Park – including the great majority of the Elwha watershed – remains in its natural state.

Meanwhile, the legacy of over a century of settlement and resource exploitation – roads, towns, dispersed houses, reduced wildlife and fish populations, clear cuts, networks of logging roads, and so on – has significantly affected ecological processes outside the Park. Close approximations to natural conditions and processes on the Olympic Peninsula persist mainly within the National Park: the upper watersheds of the Elwha and the other major rivers. Even there, natural processes can be affected in major ways by developments outside the park, particularly lower down on the rivers.

Building the Dams

Interest in damming the Elwha River for electric power generation began within a few decades of expanded settlement of the region. A Canadian entrepreneur named Thomas Aldwell began purchasing land along the lower Elwha in 1889, and by 1908 he had consolidated enough land for a dam in the narrowest gorge and a reservoir above it. Aldwell gained financing from George Glines, and in 1910 established the Olympic Power and Development Company. They constructed the Elwha Dam 4.9 miles from the river mouth, starting in 1910 and finishing in 1913. The dam forms Lake Aldwell above it. The dam is approximately 105 ft. high and 405 ft. long at its top; Lake Aldwell is 2.5 mi. long.

As a result of the dam, the Elwha River was blocked to fish migration at the dam from 1911. Although dams such as this were legally required to provide for passage of migrating fish, the Elwha Dam was constructed without any fish ladder or other provision for fish passage. A hatchery was built at the dam to compensate, but it was unsuccessful and closed in 1922.[3]

A second dam, Glines Canyon Dam, was constructed for additional power generation about 13 miles upriver from the mouth between 1925 and 1927. It forms Lake Mills. Glines Canyon Dam is 210 ft. high and 270 ft. wide at the top; Lake Mills is 2.8 mi. long.

The Glines Canyon Dam, too, lacks any provision for fish passage. Ownership of the dam and associated land remained in private hands until recently, but most of the land under Lake Mills was incorporated into Olympic National Park in 1940.

Power from the Elwha Dam initially served Port Angeles, Sequim, and the Bremerton Navy Yard. Since 1920, all the power from both dams has supplied the pulp and paper mills in Port Angeles.

Effects of the Dams

Anadromous fish such as salmon and steelhead have been limited to the lower 4.9 miles of the Elwha River and tributaries for over 90 years. The size of each of the anadromous runs has drastically shrunk. At least one stock – sockeye – may be extinct; two other stocks – pink salmon and spring chinook – have only very few individuals left.

The ecological effects of the absence of anadromous fish in the watershed above the lower dam are profound. Spawning runs of the size the Elwha supported before the dams were built would have carried vast amounts of marine-derived nutrients to the upper reaches of the watershed, where they were distributed into riparian and aquatic habitats and became vital constituents of food webs and nutrient pathways throughout the entire ecosystem.

[3] Two fish production facilities were built on the lower Elwha in the mid-1970s. The Lower Elwha Klallam Tribe operates a hatchery producing coho, chinook, and steelhead on its land near the mouth of the river. The Washington State Department of Fish and Wildlife operates a fish rearing channel 2.8 mi. upriver from the mouth.

The dams and reservoirs also have radically affected the size and distribution of sediments in the lower Elwha and in the near shore marine environment. The lower river (between the two dams and below the lower dam) has been starved of small size sediments that have been trapped in the reservoirs. Approximately 4 million cubic yards of sediments have accumulated in Lake Aldwell, and 13.8 million cubic yards in the upper reservoir, Lake Mills.

About 5.3 miles of river lie beneath the two reservoirs, and 684 acres of former riverine and lowland habitat. The shrinkage in habitat and reduction in nutrients are thought to have caused declines in as many as 22 species of mammals and birds. These species include carnivores that eat fish such as bald eagles and river otter and herbivores that use riverine shelter habitat such as Roosevelt elk and black-tailed deer, but also other species.

Because of the reduction in small sediments in the lower river, the shrunken area of spawning habitat has been further degraded. The river's estuary also has had reduced sediment inputs and consequent erosion, as have near shore areas along the Strait of Juan de Fuca east of the Elwha, the direction of prevailing currents. Sediment discharge from the Elwha is thought to have been reduced by about 280,000 cubic yards annually. Intertidal and subtidal zones now consist primarily of large cobbles instead of sand. The shoreline -- including Ediz Hook, which forms the harbor at Port Angeles -- is eroding and steepening. Other effects also are present in the lower river: the interruption of normal floodplain dynamics, for example, and a shortage of large woody debris.

Other Land Use in the Watershed

As the northern Olympic Peninsula developed through the 20th century, other changes came to the Elwha Watershed outside the National Park. Private houses have been built near the river, including in the floodplain. Two fish production facilities are near the river. On the Lower Elwha Klallam Reservation near the mouth of the river, numerous houses, Tribal facilities, and extensive roads and septic and water supply facilities have been built at a low elevation. Dikes have been constructed to protect some of these developments from flooding.

Within the Park, roads and foot trails penetrate parts of the watershed, and a few administrative and recreational facilities have been built. A paved road extending south from Hwy. 101 follows the river to Glines Canyon Dam, and continues up hill to the west, ending at a trailhead for backcountry hiking with connecting trails to Lake Crescent and the Sol Duc River, and to a hot spring. A dirt road off the Elwha River road continues east of Lake Mills to the Whiskey Bend trailhead, which gives access to hiking along the middle valley of the Elwha, to a connecting trail to Hurricane Ridge, and to a long through trail to Lake Quinault.

Two road-accessible campgrounds have been developed along the river. A boat ramp provides access for recreational boating on Lake Mills. Recreational fishing occurs on both the lake and the river. Commercial rafting companies as well as private individuals do whitewater boating on stretches of the Elwha. A park ranger station and maintenance facilities also are located along the Elwha River road.

III. Future of the Elwha Watershed

The Elwha River forms the largest watershed in Olympic National Park. It constitutes 19% of the total land area of the Park. Restoration of natural ecological conditions and processes in the Elwha watershed will be of major importance not only for the salmon and other wildlife there, and restoration of natural conditions in the river floodplain and the marine ecosystem, but also for the whole of the Olympic Peninsula.

Removal of the Dams

As the electrical power from the dams declined in importance in the last quarter of the 20th century (by the early 1990s, the dams were providing only 38% of one pulp and paper mill's power in Port Angeles), and appreciation of the values of a natural ecosystem on the Elwha grew, interest in removing the dams increased. The Glines Canyon dam originally was licensed by the Federal Power Commission in 1926 for a period of 50 years, and received annual renewals after that original license ran out in 1976. The Elwha Dam never was licensed. Renewal of the Glines Canyon license grew increasingly contentious. Issues included the presence of a dam in a National Park, impacts of the dams on salmon and other aspects of natural ecosystems, the inadequacy of mitigation of these impacts and the high cost of providing sufficient mitigation, and the relatively low value of the dams for power generation, particularly with alternative sources available, for instance from the Bonneville Power Administration.

To resolve the controversies, Congress enacted the Elwha River Ecosystem and Fisheries Restoration Act of 1992 (PL102-495). This law provides for "…the full restoration of the Elwha River ecosystem and native anadromous fisheries ..." The Department of Interior determined in 1995 that removal of both dams was required for full restoration. A total of close to $183 million has been authorized to pay for acquisition and removal of the dams, mitigation of impacts of dam removal on water supplies[4] and other infrastructure, including protection for the Tribal and state fish facilities, and for restoration. Scientific research and monitoring beyond the limited needs for restoration (for example, determining the size of current and future fish populations, and the most effective way to revegetate the drained reservoirs) was not funded under the Restoration Act.

The dams have been bought by the federal government, and planning is well underway for their removal and for various mitigation and restoration measures. Removal of the dams is now scheduled to begin in 2007. Current plans call for removing both dams at approximately the same time and allowing trapped sediments to wash down the river as quickly as possible. Removal will extend over perhaps two years, with activities suspended for periods when spawning fish return to the lower river in order to allow sediments to clear.

[4] The Elwha supplies water to some municipal and industrial users in Port Angeles, and to the Dry Creek Water Association and the Elwha Place Homeowners' Association.

Dam removal will open up to salmon over 70 miles of what is considered prime river and tributary spawning and rearing habitat. Project planners estimate that approximately 390,000 salmon and steelhead will return to spawn annually within about 30 years, compared with the approximately 4,000 wild salmon that now spawn each year below the lower dam.

Science and Research

It is a remarkable accomplishment for all who were involved that the public policy decision was made to remove the dams and the funding was made available. This will be the largest dam removal anywhere, and the most complete restoration of a wild salmon river.

Beyond this, however, the removal of the Elwha dams also opens a remarkable opportunity to gain knowledge and understanding of the ecological processes operating in a wild salmon watershed and the methods of restoring a salmon ecosystem. The Elwha presents an unprecedented and unparalleled setting for both basic and applied ecological research, largely because the preservation of most of the watershed in a natural state provides a monumental natural experiment: almost the only natural condition that has been altered is the presence of anadromous fish. Tracking the effects of the restoration of salmon will provide exceedingly valuable information on the structure and functioning of natural ecosystems of this kind, and on ways to restore them.

Issues of dam removal, salmon recovery, and more broadly ecosystem restoration are widespread and increasing, both in the United States and elsewhere around the Pacific Rim. Virtually nowhere else is there a comparable opportunity to gain ecosystem-wide information with such applicability to salmon restoration. The Elwha also affords outstanding opportunities for experimental work on fundamental ecological topics involving nutrients and trophic webs, colonization and succession, aquatic and riverine habitats, and fluvial processes. A comprehensive, long term research and monitoring program can provide invaluable understanding of the impacts of dam removal on salmon recovery, the influences of salmon on their freshwater ecosystems, and the methods of recovery. Baseline and then continuing studies also will enable development of predictive models of ecosystem response to stream and other physical changes following dam removal.

The scientific implications of removal of the Elwha dams – including those that extend far beyond the immediate needs for restoration of this particular watershed -- are well appreciated by researchers and managers in the National Park Service (NPS), the US Geological Survey (USGS), other resource management agencies, universities, the Tribes, and advocacy groups concerned about salmon and natural ecosystems. [5]

Over the last few years, several workshops have been convened by NPS and others to bring together specialists and identify research needs and priorities. Innumerable discussions

[5] The high interest in the Elwha as a "Living Laboratory" and in monitoring changes in the ecosystem was recognized early in dam removal planning. Department of the Interior *et al.*, 1994, p. xvi.

among individuals also have occurred to organize and try to coordinate research activities. Since no funding from the Restoration Project is available for research beyond the identified limited needs of Elwha restoration, these workshops and discussions invariably have included concerns about finding funding for the needed research.

The first of the major workshops, held in August 2001, focused on sediment management and monitoring. It produced a draft sediment management plan.[6] Workshop participants emphasized the importance of coordinating research and monitoring programs for both physical and biological aspects of the ecosystem. A workshop on biological monitoring and research was convened by NPS and USGS in March 2003. The results of that workshop are available through the compiled notes of working groups on research pertaining to vegetation, fish, birds, mammals, and invertebrates. A third workshop, focusing on the marine environment, was held in March 2004. The results of that workshop have not been available by the time of preparation of this report.

Identification of research needs typically has started from the foundation of past or current research, and gaps in that research or in existing knowledge of the ecosystem. Generally, major research questions or hypotheses that could be addressed are then identified, sometimes with priorities and identification of linkages with other research questions. Particular types of data needed and specific research methods or protocols are sometimes also identified. Importantly, these often include baseline data to be gathered before the dams are removed, and monitoring that will be needed over time.

This report compiles in Appendix I major research needs identified by workshop participants and gleaned from notes of discussions and from research proposal documents.[7] This does not represent a comprehensive inventory of all topics and suggested methods, but it is indicative of the type and scope of topics and includes many of the main subjects that have been identified by researchers knowledgeable about the Elwha, salmon, and related ecosystem studies.

Some of the major basic and applied research questions are the following:

- What is the role of marine-derived nutrients in aquatic and riverine zones and in the whole trophic webs of salmon ecosystems? How will productivity change, at various levels? How will the trophic structure of the ecosystem change?
- How will the return of salmonids affect populations of predator and prey species?
- What is the process and rate of recolonization of suitable habitats by anadromous fish?
- What is the process and rate of adaptation of the river channel and floodplain morphology to return of natural sediment loads and woody debris inputs? How and when can a dynamic equilibrium be reached?

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[6] Randle *et al.*, 2003.
[7] Many of the topics have been identified by multiple sources, and some are combined and rearranged here.

- How will populations of terrestrial mammals and birds respond to vegetation change in the riverine zone and in the former reservoirs?
- What will be the physical responses of the Elwha River estuary and down-current near shore areas to changes in sediment discharges? What will be the responses of and changes in biotic communities in the marine environment?
- How effective is recovery of salmonids by natural processes vs. outplanting of hatchery-origin fish?
- What will be the competition or predation between anadromous and resident fish?
- Can kokanee in a lake re-establish a run of sockeye?
- What will be the short-term and long-term effects of rapid sediment flushing on invertebrate and fish populations, and on aquatic habitats?
- What will be the patterns and the processes of vegetation colonization and succession in the former reservoir areas and in the more dynamic floodplain?
- What methods of vegetation restoration are most effective?

The importance of obtaining baseline data (before removal of the dams begins) on those parameters necessary to answer these research questions, and continuing monitoring of these parameters for a long enough time to understand ecosystem response (decades, for many of the questions), can hardly be overemphasized. It is urgent to prepare a long term research plan, identify the data needed, and – within the next couple of years – gather the essential baseline data.

A small number of research projects are either completed or underway in the Elwha watershed. Participants in the wildlife workshop identified past and current research in their fields; these projects are listed in Appendix II. In addition, several researchers are working on projects in other parts of the Park that involve developing methods that will be applicable in the Elwha – for example, on small mammals, carnivores, a national lynx survey, interactions of bears and salmon, and sampling requirements and costs for long term wildlife monitoring.

Since work on this current project began in August 2003, interest in conducting research on the broader ecological implications of dam removal has grown greatly among agency and academic scientists. Several individual scientists have contacted research authorities at the Park within the past few months with inquiries or plans for research on specific aspects – for example, nutrient pathways, habitat utilization by fish, and characterization of vegetation and the floodplain by remote sensing -- but with the rationale for the studies set within the context of the bigger picture of long term ecosystem response to dam removal. Some of these projects are listed in Appendix III.

Even more promising is the increasing interest in achieving coordination among research projects and in designing a comprehensive long term research program. The Park has received several inquiries about establishing such a program. Perhaps most significantly, a handful of researchers based in agencies or universities have began the actual work of coordination: contacting colleagues, convening meetings to plan coordination, preparing lists of research questions, priorities, and methods. Park staff have been central in stimulating and helping organize these coordination efforts.

Among the planned research projects, and the organizations and individuals involved in the beginnings of coordination efforts, are those identified in Appendix III. Many of these people likely will be among the core group involved in initial stages of establishing a coordinated research and education network, as discussed in the next section.

Some ecologists also see Elwha research as an important component of a larger program to understand, protect, and restore natural salmon ecosystems on the entire Olympic Peninsula, or – more broadly yet – around the entire Pacific Rim (northern California to Kamchatka). In this larger context, comprehensive research on the Elwha can be an early step in building a much wider and more encompassing research program. This perspective matches the interests of Olympic National Park, too, in long term and Park-wide ecological understanding and scientific monitoring.

Understanding the response of social systems to change in the Elwha watershed, and the interactions of human with natural systems, is an additional aspect of research on the Elwha that is receiving increasing recognition. The Elwha – its water, fish, wilderness – are directly and indirectly linked to numerous aspects of human activity in the region. How those human systems react and adapt to change in the Elwha, and how they interact with natural systems, are fields of enquiry that must be included in a comprehensive ecological research program. Both basic research on human/natural system interactions, and research aimed at applied environmental-management aspects such as dam removal and salmon restoration, are needed. Moreover, both basic and applied research have the promise of returning important findings, since the magnitude of change in natural systems caused by dam removal can be expected to be mirrored in many ways in the linked changes in human systems.

Education

Dam removal also presents a tremendous opportunity for multifaceted programs of education focused on ecosystem recovery. Educational programs will be valuable at many levels: among the adult community on the northern Peninsula, at all the public school grades, in the community colleges, for bachelor-level degree programs, and for graduate student courses and research. Students will be able to follow change in the watershed through the years. They will be able to participate in and contribute to actual research. They will be able to learn about fundamental ecology and also applied aspects such as restoration, and with a greater sense of relevance to their lives because it is in their backyard.

Developing educational programs is part of the mission of the Park and those academic institutions that are also home to much of the research expertise being directed at the Elwha. Thus, linking research with education is a logical approach, and promises to enhance both fields of activity.

Work to date on educational program involving the Elwha includes the following:

- Re-establishment of a joint environmental studies degree program by Huxley College of Western Washington University and Peninsula College; this program will use the Elwha as a cross-cutting case study.
- Several initiatives by Peninsula College to involve students in research activities and develop additional programs.
- On-going programs of the Olympic Park Institute, and development and fund raising for additional programs.
- Grant applications led by Peninsula College to fund expanded programs of community education, college-level research and courses, and job skills training.

IV. A Strategy for Research and Education

The fundamental need for research and monitoring in the Elwha watershed is to have a comprehensive coordinated program established soon, and to have that program maintained over the long term.

A comprehensive program is required because of the ecosystem-wide responses and linkages that will follow dam removal, the importance of the basic ecological information that will be produced, and the applicability of the knowledge gained to dam removal, salmon restoration, and watershed management efforts elsewhere. Coordination of the program is needed to help ensure that it proceeds in a timely way and efficiently, that all important topics are covered, and that methods and formats are compatible and conducive to expanded understanding of the whole ecosystem. Getting the research program underway without delay – particularly identifying needed baseline data and mounting data collection efforts – is urgent because of the very few seasons available for research before dam removal begins. Maintaining the research program and particularly monitoring over a long period – probably for decades, until a status of dynamic equilibrium is reached in important ecosystem components – will be required to observe the full course of ecosystem responses.

Similarly, a wide-ranging education program linked to research on the Elwha also is needed, both so that the knowledge gained can be most fully distributed through society, and for practical assistance in carrying out monitoring and research tasks. Initiation of the education program logically should occur at the same time as establishment of the research program.

As discussed in the previous section, individual researchers are directing considerable interest at various aspects of the Elwha ecosystem, and important efforts have begun to coordinate research efforts among some scientists. Likewise, educators at several levels are developing programs on the Elwha.

Clearly, these developments are significant steps towards establishing the comprehensive, coordinated, long-term research and education program that is needed. However, several essential ingredients are lacking. These include:

- A mechanism to ensure continuation of efforts over a period of years (current coordination depends on the interests of individual scientists, and thus is vulnerable to changing assignments or budgets);
- Dedication of significant time and effort (currently, key participants are carving out time for coordination and planning from their already overly-busy work commitments);
- Funding to provide that time commitment;
- A central point of contact and information (several individuals – notably Jerry Freilich and Brian Winter at Olympic National Park – are filling that role out of necessity, but it does not seem likely to be sustainable as a major part of their responsibilities over the long term, especially as the need expands);
- Commitments by the range of institutions that will be required; and,
- Agreed-on terms of coordination and cooperation that accomplish the objectives of the research and education program while respecting the interests of individual participants and institutions.

A funded structure to help establish, coordinate, and support a network of research and education participants would seem to be the most effective approach. Initially this probably could consist simply of a funded coordinator, based probably at a university, and support for meetings, travel, communications, publishing, and other activities involved in establishing the network and planning the programs (developing conceptual models, identifying research questions and priorities, defining research time frames and shared protocols, and so on). Funding for some baseline data collection also likely would be needed. In the longer term, funding would be required for continuing core monitoring activates, data management, publishing, and research support services – including possibly a research station.

The strategy outlined below is suggested as an approach for Olympic National Park to pursue to try to ensure that such a network structure is established. The role of the Park is seen as central to the effort, but more that of a catalyst than an implementer. As it has been doing, the Park can try to help obtain initial funding and stimulate the establishment of a network. The continuing role of the Park will be as a key participant in the network – along with universities, agencies, tribes, and other parties.

A Plan to Establish A Comprehensive Research and Monitoring Program

A. Goal

Ensure that comprehensive long-term research on ecological systems and the interaction of human and natural systems is carried out on the Elwha River watershed, together with linked programs of education at all levels.

B. Strategy

Provide leadership to establish a network of cooperating institutions and other participants to carry out the research, monitoring, and educational programs. Assist in obtaining funding to provide coordination for this network, and to facilitate the research and educational programs. Continue to participate in the network, and take a major role in helping to guide its development.

Key participants in the research and education network will include:

- Olympic National Park
- Universities: Huxley College of the Environment at Western Washington University; University of Washington; Flathead Lake Biological Station at University of Montana; Oregon State University; University of Oregon;
- US Geological Survey.
- Lower Elwha Klallam Tribe.
- others to be identified.

Activities/Functions of the network

- Governance:
  - Establish and regularly convene a steering committee
  - Expand the network as needed to include additional participants
- Develop and maintain a long term research and monitoring plan:
  - Develop conceptual models as a foundation for identifying research questions
  - Identify research and monitoring needs (research questions/hypotheses)
  - Set research and monitoring priorities
  - Coordinate timing and schedules for research and monitoring
  - Maintain quality control and review
  - Establish common research protocols for widest use of results by research community
- Facilitate research
  - Establish system for storage and sharing of common data
  - Eventually, provide basic logistical facilities and support services for researchers (need and feasibility to be determined)
- Carry out limited research and monitoring programs to gather core data for the long term program and to gather data urgently needed in the near term as a baseline before dam removal begins
- Raise funds for core activities (coordination, core research and monitoring, data management, logistical assistance)

Staff

- Coordinator
- Administrative assistant (contingent on funding for support services)
- Data/information technology specialist (contingent on funding for support services)

Facilities: Research station (need and feasibility to be determined)

C. Objectives

1. Establish preliminary steering committee: June 2004.

2. Obtain funding for network coordination: bridge funding June 2004; longer term funding Sept. 2004.
3. Identify key research monitoring questions and priorities: August 2004.
4. Establish procedures for preliminary research coordination: August 2004.
5. Obtain funding for needed core monitoring and base-line research: Dec. 2004
6. Begin needed core monitoring and base-line research: Jan. 2005.

D. Steps to Achieve Objectives

<u>Steps for Objective 1</u> (Establish initial steering committee: June 2004)

1. Identify potential participants, from current researchers, participants in workshops, local stakeholders, regional universities, established scientists in relevant fields, potential funding organizations,
2. Winnow list of potential participants to short list of key participants for initial committee, based on importance to planning, contribution, availability, experience, influence.
3. Contact individuals, determine interest and availability.
4. Convene meetings to establish committee.

<u>Steps for Objective 2</u> (Obtain funding for network coordination: bridge funding June 2004; longer term funding Sept. 2004)

1. Estimate near term and longer term funding needs.
2. Identify potential sources of funding.
3. Prepare background information and project rationale.
4. Research and prepare grant applications and other funding requests.
5. As a strategy, seek small-scale bridge funding for near term support, while preparing requests for longer term support.

<u>Steps for Objective 3</u> (Identify key research monitoring questions and priorities: August 2004)

1. Review questions identified by workshop participants, other past and present research and proposals, coordination efforts underway.
2. Identify any additional research questions or topics in-house.
3. Organize questions and topics.
4. Begin to formulate ecosystem and human/natural systems models.
5. Circulate preliminary questions, priorities, and models to initial steering committee.
6. Receive feedback.
7. Refine.
8. Circulate revisions to committee.
9. Consider and finalize (at committee meeting, or among sub-groups).

<u>Steps for Objective 4</u> (Establish procedures for preliminary research coordination: August 2004)

1. Identify coordination needed for comprehensive research/monitoring program.
2. Identify additional procedures needed beyond existing ONP procedures.
3. Design needed coordination.

4. Circulate to steering committee.
5. Receive feedback.
6. Refine.
7. Circulate revisions.
8. Consider and finalize (forum to be decided).

Steps for Objective 5: (Obtain funding for core monitoring and base-line research: Dec. 2004)
1. Review and compare identified research needs against ongoing and planned research.
2. Identify gaps in needed research (needed research not currently underway or planned).
3. Identify core research and monitoring needs (research and monitoring needs that are central to systems models and key research questions, and that are not covered by existing or planned research).
4. Set priorities and time schedules for needed core research and monitoring data.
5. Develop budgets and work schedules for 1-2 years
6. Identify personnel to do the research, plan work programs.
7. Identify potential funding sources.
8. Prepare and submit funding proposals.

Steps for Objective 6: (Begin needed core monitoring and base-line research: Jan. 2005)
1. Match research priorities and schedules to funding available.
2. Begin needed core monitoring and research.
3. Expand monitoring/research data collection as additional funding is obtained.

V. Conclusion

Staff of Olympic National Park, with contributions under this present project and collaboration by individual researchers and educators, already have essential tasks underway to begin to carry out this strategy. These tasks include stimulating coordination, planning research and education programs, and seeking funding.

Over the past several months, these efforts have widely publicized the importance and urgency of ecosystem-wide research and monitoring on the Elwha within scientific and agency circles, often in combination with efforts to identify possible sources of funding. Several grant applications have been prepared, and major grant proposals are in preparation. Numerous individual discussions and group meetings have been conducted pressing the need for a coordinated program. Some of these contacts have evolved into the beginnings of actual coordination, as noted above. Partners are being lined up for an initial steering committee. Interest in the educational elements of the program has grown, and several educators are actively planning their participation.

The suitability of the strategy suggested here has been tested in numerous discussions over the course of this project, and appears – in present circumstances – to be practical and appropriate. However, constraints and opportunities for the Elwha research and education program are likely to continue to evolve, and implementation of the strategy is likely to continue to require flexibility.

Perhaps the biggest obstacle is funding. Ironically, the public policy success of obtaining funding for dam removal, which created this tremendous research opportunity, impedes efforts to fund the research to take advantage of the opportunity. For example, several recent efforts by the Park and others to obtain even small amounts for research programs have been rebuffed on the grounds that the Elwha Restoration Project is richly financed. Even when the common misconception that Project funding covers ecosystem research is corrected (in fact, it covers only limited research and monitoring considered necessary to re-establish fish and restore the reservoirs), the $183 million figure remains an obstacle. The more accurate way to perceive the relationship would seem to be that the large $183 million investment can not have its full benefits – for salmon or ecosystems, or for society's management of watersheds – unless a relatively very small additional amount is spent to understand and learn from the dam removal action.

Several important participants are beginning to actively develop parts of this strategy, and interest continues to grow among agency and university scientists. Key among participants is Olympic National Park; its efforts have been critical in moving preparations along to their present state. It is hoped that the analysis and strategy presented here will contribute to the success of continuing efforts by the Park and others to establish a comprehensive, coordinated, long term research and education program on the Elwha River ecosystem.

Appendix I. Identified Research Questions and Methods

Table I-A. Research Questions and Methods: Fish

Hypotheses
• Aquatic production for the whole river system will be greater after dam removal.
• Productivity is highest in the lower river.
• Productivity in the middle and upper river is limited by N, P, and C.
• Recovery of anadromous runs to the upper river will increase N, P, and C in the ecosystem, with marine-derived nutrients.
• Marine-derived nutrients are more [less] important than terrestrial-derived (allocthonous) nutrients in a major wild salmon ecosystem.
• Resident rainbow trout in the upper river will compete with returning steelhead.
• Brook trout will not pose a threat to native char.
• A wild run of sockeye can be re-established from the existing stock of Lake Sutherland kokanee.
• Hatchery-origin and wild fish will not interbreed.
• Hatchery-origin will not out-compete wild fish for scarce resources such as spawning habitat.
• Recolonization and restoration of fish populations can occur solely with natural strays.
• Recolonization and restoration of fish populations will occur more quickly with restocking.
• There is currently no reproduction of Chinook in the lower river; all returning Chinook are of hatchery origin.
• Mammalian or avian predators will not limit fish productivity.
• Different species of fish will recolonize the upper river at different rates.
• Natural barriers will have a differential effect on recolonization of the upper river by different species.
• Upper basin tributaries will be of differing importance for different fish species.
• Recovery of salmonids in side channels with large woody debris (LWD) will be more rapid than in channels without LWD.
• Atlantic salmon will not invade the Elwha, or, if they do, they will not interbreed with indigenous fish or compete with them to the extent of interfering with recovery.
• Life history patterns of anadromous fish below the dams will not be different after dam removal.
• The spatial and temporal distribution of habitats below the two dams will change in response to sediment, LWD, and river flow fluxes.
• These changed habitats will provide more habitat for particular life history stages of anadromous fish.
• The sources, amount, and fate of LWD will change after dam removal, including as a result of changing lateral channel migration.
• Sediment pulses in the river after dam removal and before floodplain equilibrium will not be excessively detrimental to fish recovery.
• If macroinvertebrate populations are destroyed locally by flushing of stored sediments after dam removal, those populations will recover.
• The Elwha estuary and the near shore environment of the Strait of Juan de Fuca will have greater

productivity and provide better habitat for rearing and migration of juvenile salmonids after dam removal.
Monitoring Data Needed
• Distribution of fish species.
• Relative abundance of fish species.
• Life history patterns of fish.
• Seasonal distributions and habitat utilization of fish.
• Distribution and changes in key types of fish habitat.
• Composition, distribution, abundance, biomass, and trophic webs of aquatic invertebrate communities and populations.
• Water temperature, chemistry, sediments, flow.
Baseline Data
• Present values of these parameters before removal of dams.
• Chemical signature for each tributary and each reach of the river.
• Characterization of physical parameters for each tributary and reach of the river (temperature, sediments, LWD, etc.)
• Genetic characterization of hatchery and wild population for all salmonid species.
Research/Monitoring Methods and Approaches
• Isotopic analysis
• Radio telemetry
• Trapping
• Otolith microchemistry
• Mark/recapture
• Snorkeling surveys
• Spawning surveys
• Remote sensing floodplain and habitat characterization (hyper-spectral imagery coupled with acoustic doppler processing).
• Reference/control sites developed from basic physical and biological parameters.
• Identify keystone species in trophic webs (e.g., among macroinvertebrates)
• Genetic marking of all hatchery-origin fish used in restoration

Table I-B. Research Questions and Methods: Vegetation

Hypotheses
Sediments and Wood
• Reservoir sediments contain abundant large wood that will be mobilized after dam removal and help to shape aquatic and riparian habitats.
• The topography of the de-watered reservoirs will change dramatically as dams are gradually removed and delta deposits are distributed throughout former pool areas. After dam removal is complete, most topographic change will occur within the river's meander zone.
• De-watering of sediments in the newly exposed upland areas will require two to three years, with the rate modified by sediment texture and insolation as determined by topography.
Natural Succession
• Differences between the several reaches of the river (below the dams, between the dams, above the dams) will converge in terms of the formation of stable floodplain surfaces where accumulations of large wood deflect flows and facilitate deposition of fine sediments. Woody vegetation will persist only where such stable surfaces are formed.
• Herbivory by native ungulates and microtine rodents will decrease the density and growth of woody vegetation colonizing floodplains.
• Cover and density of colonizing vascular plants will be greatest on substrates of optimal texture (sandy loam?).
• Marine-derived nutrients will be transferred to riparian and upland vegetation by return of anadromous fish.
Restoration
• Due to geomorphic instability and seed rain from surrounding vegetation, planting is no more effective for ecosystem restoration than not planting.
• Fertilization and/or irrigation will increase growth of restoration plantings and alter relative dominance of plant species.
• Restoration plantings will be most effective in sediments of optimal texture.
• Exotic plant species will be less abundant in areas planted to promote ecosystem restoration.
• The post-restoration trajectory of vegetation will be toward an equilibrium frequency distribution characteristic of the natural state of the Elwha River ecosystem. As this occurs there will be an increase in topographic complexity, and an increase in vegetation, soil and habitat heterogeneity.
• Other watersheds on the Peninsula can be used to model drivers/inputs such as rainfall, vegetation, and terrain. This model could then be used to predict the expected equilibrium frequency distribution for the restored sections of the Elwha. The upper, undisturbed reaches of the Elwha can be used to test the predictive capability of such a model for the Elwha system.
Monitoring Data Needed
• Vegetation type
• Stem density
• Canopy height
• Species diversity
• Large woody debris
• Stream channel geometry and morphology
• Flood frequency, duration, extent

• Stream flow
• Water table elevations
• Sediment soil texture
• Water temperature
• Water chemistry parameters (dissolved organic carbon, N, P) in relation to development and maturation of vegetation.
• Nutrients (C, N) in vegetation
Baseline Data
• Isotopic signatures (soils, vegetation, water), in the Elwha and other watersheds
• Distribution of vegetation types
• Floodplain topography
• Stream and water table levels
Research/Monitoring Methods and Approaches
• Various plot designs
• Remote sensing characterization
• Experimental addition/manipulation of nutrients
• Comparisons with other watersheds on Peninsula
• Long term monitoring and studies
• Control studies of competitive hierarchies among species in recovering systems
• Isolation of potential sources of nutrients (fish, alder, upland litter, soil C+N, atmospheric deposition)

Table I-C. Research Questions and Methods: Wildlife

<u>Hypotheses</u>
As a major influx of nutrients is returned to this system in the form of anadromous fish, there will be a restructuring of trophic pathways with a cascading effect (increases in particular populations at certain trophic levels).
In turn, increased use of marine-derived nutrients by animal populations will result in greater transport of marine nutrients into upland terrestrial ecosystems.
<u>Examples of related hypotheses for particular species or groups:</u>
<u>Bears</u>
• There will be a change in population distribution, as bears increase their use of riparian areas.
• Bear population will increase.
• Increased bear population will result in an increase in predation on neonatal elk and deer.
• Increased predation will decrease deer and elk populations.
• Decreased deer and elk populations will change understory vegetation composition & biomass (from a decrease in herbivory).
<u>Corvids</u>
• Population of corvids will increase due to increased scavenging opportunities
• Increased corvid population will increase predation on breeding bird populations
<u>Macroinvertebrates</u>
• An increase in available nutrients from salmon carcasses will change the diversity and abundance of macroinvertebrates in the river system.
• If populations of macroinvertebrates increase, an increase in avian predators of aquatic insects will occur. (e.g. harlequins, dippers, willow flycatchers, swallows, or mammalian predators such as water shrews) .
As fluvial processes are restored to the lower reaches of the river (below Rica canyon) physical and vegetative changes will affect wildlife communities.
<u>Examples of related hypotheses for particular species or groups:</u>
• Beaver and muskrat distribution and abundance will change.
• Abundance of toads and red-legged frogs (and possibly long-toed, northwest salamander or snakes) will increase.
• Increased availability of early seral plant communities will result in increase in populations of early seral dependent birds (e.g., willow flycatchers)
• Elk and deer population distribution will change as elk habitat increases (currently, elk are dominant in the upper river and deer are dominant in downstream reaches).
• An increase in elk will intensify browsing pressure on plant restoration.
• Populations of Townsend's vole and mountain beaver will increase due to a large quantity of herbaceous plants in recovering lakebeds, and in turn will adversely affect restoration of woody plant species.
<u>Monitoring Data Needed</u>
• Relative abundance of species with strong interactions with salmon: bear, otter, osprey, eagles, mink, corvids.
• Use of fish by these species.

• Use of nutrients that could be marine-derived.
• Direct and indirect effects of changes in bear distribution and abundance: effects of bear predation on recovery of salmon; effects of bear predation on deer and elk population; changes in deer/elk herbivory, or understory structure/composition.
• Relative abundance and distribution of aquatic species that may benefit from changes in stream channel characteristics (e.g., beaver, toads, red-legged frogs).
• Relative abundance and distribution of breeding birds, small mammals, and elk and deer that are expected to change in response to changing successional dynamics related to changes in fluvial processes.
• Changes in macroinvertebrate populations, and changes in dependent avian species (harlequins, dippers, willow flycatchers, swallows) and mammalian predators such as water shrews).
Baseline Data
Baseline values for these parameters prior to dam removal.
Research/Monitoring Methods and Approaches
• Field surveys and remote telemetry
• Isotopic analysis
• DNA analysis
• Comparative studies in other Peninsula watersheds.

Appendix II. Past and Current Research

Table I. Past or Current Wildlife Research in the Elwha Area

Breeding bird inventory, 2002, 2003.
Annual breeding bird transect (Hurricane Ridge to Altaire Campground on the Elwha).
Study of river dependent birds (2 years), from river mouth to above dams. Repeatable protocol developed for monitoring riverine bird species (however, comparable information for other areas of Park is not available).
Recent population and distribution studies of black-tailed deer (trail based transect over 4 years, trail-based compared to random transect 1 year).
Inventory of amphibians in early 1990s, mostly in off-channel habitats.
Study of terrestrial amphibians, 2001, 2002.
Small mammal survey (1 trapping grid in upland site, 8 nights per year, 3 years).
Current monitoring study of black bears: home range, movement, habitat use (especially riparian vs. subalpine). Five bears radio-collared, to be followed for 1-2 years. A goal is to develop protocols for bear monitoring.
Survey of bats (6 Douglas-fir stands, 6 nights per season, 3 seasons).
Survey of carnivores (camera traps, 2 sample sites, 1 year.
Unsuccessful attempt to locate fisher.
Unsuccessful attempt to count elk.

Appendix III. Planned Research Projects and Participants in Coordination

Table III-A. Planned Research Projects

Predicting ecosystem response to the removal of the Elwha River dams.	*Principle Investigators*: George Pess, Tim Beechie, Peter Kiffney, Gary Winans (National Oceanic and Atmospheric Administration (NOAA), Northwest Fisheries Science Center); Mike McHenry (Lower Elwha Tribe); Ric Hauer (University of Montana, Flathead Lake Biological Station).
Baseline monitoring of floodplain vegetation and geomorphology prior to dam removal, Elwha River.	*Principal Investigators:* Patrick Shafroth,(USGS, Midcontinent Ecological Science Center); Jeffrey Braatne (University of Idaho); Timothy Beechie (National Marine Fisheries Service (NMFS)).
Transport of suspended sediment and its effect on aquatic habitat in the Elwha River.	*Principal investigator:* C.P Konrad (USGS).
Develop reference site data for monitoring biological integrity and water quality of Streams.	*Principal investigators:* Jerry Freilich, Reed Glesne (National Park Service).
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.	*Project Leaders/Principal Investigators:* Reg Reisenbichler, Jeff Duda (USGS, Western Fisheries Research Center); James Peterson, Patrick Connolly (USGS, Columbia River Research Laboratory).

Table III-B. Organizations and Individuals Participating in Early Coordination Efforts

Olympic National Park	Jerry Freilich, Cat Hoffman, Brian Winter, Sam Brenkman, others
Western Washington University, Huxley College of the Environment	Brad Smith, Jim Allaway
Lower Elwha Klallam Tribe	Mike McHenry,
NOAA/Fisheries	George Pess, Tim Beechie, Peter Kiffney,
USGS	Reg Reisenbichler, Pat Connolly, Andrea Woodward, Jeff Duda, Ian Jezorek, Brady Allen, Kyle Martens
Peninsula College	Bill Eaton
Olympic Park Institute	Scott Schaffer
University of Montana, Flathead Lake Biological Station	Jack Stanford, Ric Hauer

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