Elwha and Glines Canyon dam removals: nearshore restoration and salmon recovery of the central Strait of Juan de Fuca

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Abstract

The nearshore of the central Strait of Juan de Fuca is a critical component to the marine ecosystem of Washington. The central Strait nearshore is largely defined by sediment processes which have been severely degraded by shoreline armoring and damming of the Elwha River. The removal of the Elwha and Glines Canyon Dams, scheduled to begin in 2009, will result in the transport and delivery of approximately 8 million cubic yards of sediment to the nearshore environment within approximately five years of dam removal, but this will provide for only partial restoration of nearshore ecosystem processes. This paper provides an overview of our approach to monitoring the nearshore response to removal of the Elwha River dams, with an emphasis on monitoring priorities and the strategy for defining additional restoration needs associated with salmon recovery.

Background

The Elwha River Ecosystem and Fisheries Restoration Act (Public Law 102-495, signed October 24, 1992 (106 Stat. 3173) provides for efforts to restore the fisheries and ecosystem of the Elwha River basin in Washington State via the removal of the Elwha and Glines Canyon Dams, which is deemed necessary for full restoration of the Elwha River ecosystem and fisheries. Dam removal on the Elwha River, scheduled to begin in 2009, will be the focus of the single largest river restoration action in the country. Within five years of the beginning of dam removal, approximately 8 million cubic yards of sand and silt will be delivered to the nearshore habitat. Within this timeframe it is estimated that 4.9-5.6 million cubic yards of fine material (silt and clay < 0.075 mm) and approximately 1.2- 2.7 mcy of course material (sand, gravel, cobble) will be delivered *(*Randle[1] pers comm.; Warrick and Gelfenbaum[2], USGS unpublished data*).*

Sediment loading and transport is a defining process of the Elwha nearshore habitat. The primary Elwha drift cell is estimated to be approximately 13 miles long and extend from the western portion of Freshwater Bay to the east tip of Ediz Hook (Figure 1; Clallam County 2004). The nearshore within this drift cell is defined by the area of tidal influence from the riparian zone to –30 m MLLW. It includes the lower estuary located at the river mouth, as well as the adjoining marine shorelines.

The Elwha nearshore is a complex ecosystem that exhibits high physical and biological variability within both geographic and temporal scales (Carter and VanBlaricom 1998; Shaffer 2000; VanBlaricom and Chambers 2003). It includes a river associated estuary, rocky, sandy, and bluff shorelines, kelp forests, and eelgrass beds (Figure 1). Numerous salmonid stocks, including Puget Sound Chinook, Hood Canal summer chum, bull trout, pink, coho, and steelhead depend on the Elwha nearshore. It is also used heavily by forage fish, a critical resource for salmon, for migration and spawning (Miller et al 1980; Shaffer 2000; 2004a)

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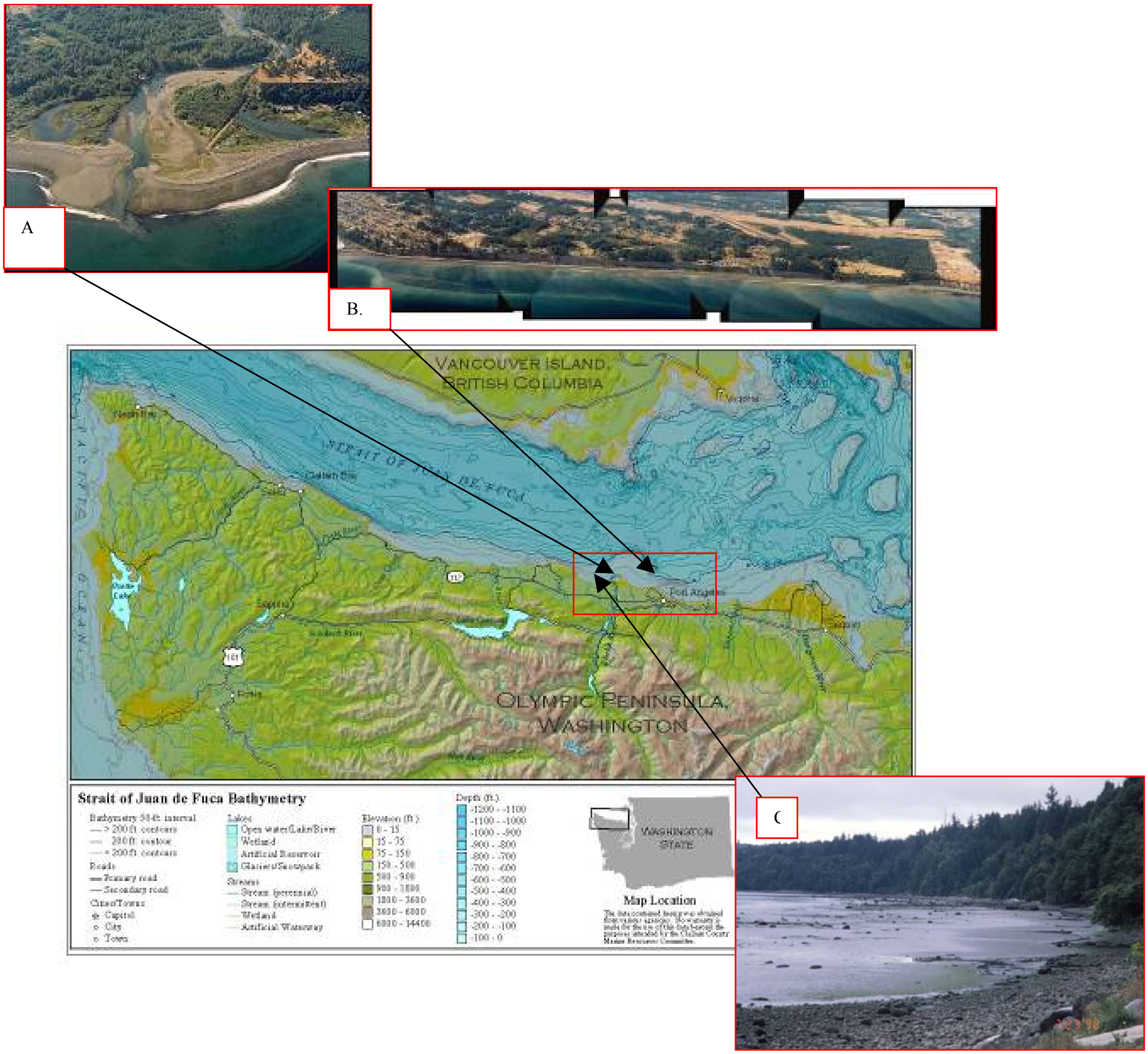

Figure 1. Strait of Juan de Fuca and Elwha nearshore (red box). A. Elwha river mouth; B. Armored Elwha bluffs shoreline (east of river mouth) to Ediz Hook, and; C. Freshwater Bay (west of river mouth).

The Elwha nearshore is limited by a number of anthropogenic features. Foremost is the chronic sediment starvation that has been occurring for over 90 years due in combination to the in river dams and a 9000' foot bulkhead installed in the 1940's along the feeder bluffs immediately east of the river. The estuary at the river mouth is significantly constricted due to a large dike installed along the west river mouth in the 1960's (Figures 2A and 2B).

Figure 2. Elwha nearshore limiting features: A. Bulkhead along feeder bluffs; B. Dike on west river mouth.

Dam removal will result in a partial restoration of the sediment processes shaping the Elwha nearshore by reestablishing the historic riverine sediment source. Nearshore habitat restoration that results from the restored sediment processes will be dependent on sediment delivery, including size, geographic area, and timing of sediment contribution (Shaffer and Crain 2004). Ecosystem monitoring of both physical and biological change over a long time period is necessary to evaluate and confirm ecosystem response, identify and alleviate unforeseen problems, and identify other restoration opportunities that can build upon the dam removal effort.

Framework for assessing nearshore restoration We are in the process of developing a framework strategy for measuring the restoration response for salmon in the nearshore (Figure 3). The two basic assumptions of the strategy are:

1. We will be able to detect restoration response to sediment changes in both habitat and fish use in the nearshore;
2. We are able to define historic nearshore habitat form and function

These two assumptions will be tested by a conceptual model in which we define restoration response by measuring habitat structure and fish use concurrently in habitats outside the restoration area but comparable to restored area, and within the restored drift cell. We will assess trends observed in habitat changes and fish use over time. Differences in trends will be analyzed to determine restoration response to sediment restoration.

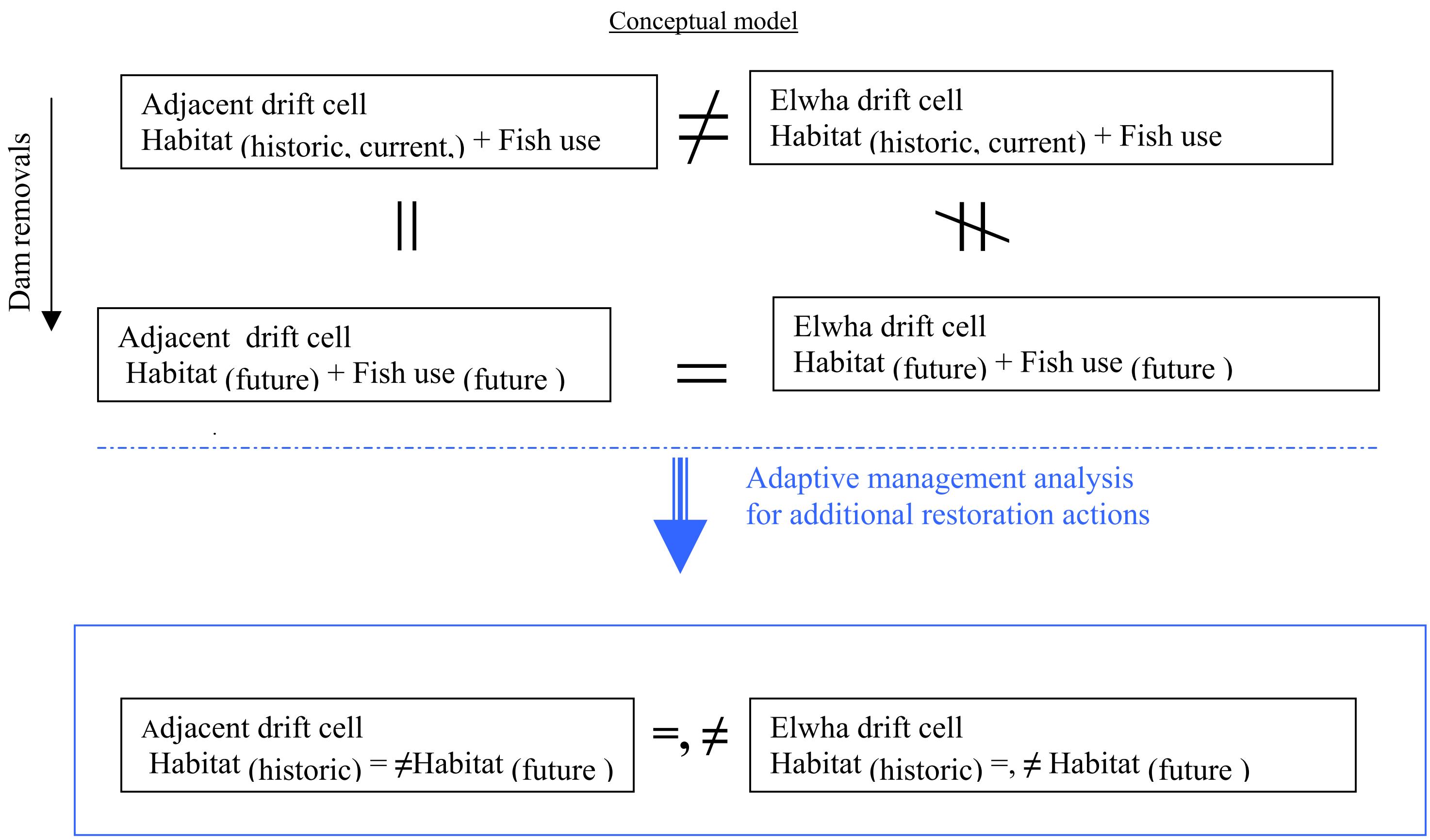

Figure 3. Conceptual model for defining nearshore restoration of Elwha. Blue line indicates possible management uses of information

There are two important components to defining nearshore response. Only by addressing both will we be able observe the response to dam removal and differentiate the nearshore response from natural nearshore habitat changes. They are:

1. Compare post dam removal nearshore resource and habitat function to pre-dam removal nearshore resource and habitat function;
2. Compare habitat function within Elwha nearshore to comparable nearshore outside of project area.

Once we have addressed these we may be able to use the results in an adaptive management context. If this is applied, a third component includes:

3. Compare predicted results to observed results

Specific metrics for these are:

A. Current fish use:
    1. The current fish use within the Elwha and comparable nearshore
    2. The current habitat structure and function within the Elwha and comparable nearshore
    3. The current functional linkages between fish use and habitat structure within the nearshore of the Elwha and comparable sites

Once these are defined we will compare the current functional linkages of Elwha nearshore to those of select comparable nearshore Strait sites.

B. Post dam removal fish use:

1. The short- and long-term nearshore use by targeted fish species post dam removal in nearshore of Elwha and comparable areas
2. The short and long term nearshore habitat structure response to dam removal within Elwha nearshore and comparable nearshore areas

Nearshore restoration (in terms of nearshore habitat function response) specific to dam removal is then defined by comparing the structure and function trends observed within the Elwha drift cell and comparable sites outside the drift cell during both pre- and post- dam removals time periods. Adaptive management steps may also be defined by comparing predicted habitat conditions (based on historic information) to observed habitat conditions and identifying areas of additional restoration need for areas that do not meet predicted goals.

General Methodology

The geographic area for this work includes: 1) The primary sediment drift cell of the Elwha nearshore which is approximately 13 miles long and extends from Observatory Point to Port Angeles Harbor (Clallam County 2004; Schwartz 1972), and; 2) Comparable nearshore outside the immediate influence of river restoration. Combined, the study area extends approximately 35 miles from Dungeness Spit and bluffs to Crescent Bay (Figure 4).

Physical monitoring will consist of extensive aerial surveys, along with side scan sonar and field beach mapping (currently being conducted by the Lower Elwha Tribe and USGS). Beach mapping is to include the substrate type, as well as beach elevation and profile. Annual mapping efforts will be conducted over a period of at least ten years, and will incorporate both the area in the immediate vicinity of the Elwha River, as well as control sites of Dungeness spit and bluffs and Crescent Bay.

Monitoring of the rebuilding and recolonization of the nearshore fishery resource will include the standard fish use survey techniques of beach seines, snorkel, and dive surveys. Monitoring will be based on geomorphic classification of habitats as described by McBride and Beamer (2004). Sampling will be implemented using a stratified random sampling design. Strata will include tidally influenced estuaries associated with the Elwha River mouth, sandy intertidal beaches, over and understory kelp beds, eelgrass beds, and shallow subtidal unvegetated habitats. The evaluation of nearshore habitat use will further focus on juvenile salmon migration, adult salmon migration, juvenile and adult forage fish migration, and adult forage fish spawning.

Function of these habitats for fisheries will be defined by documenting the biological communities of each habitat type, and focus on function of habitats for forage fish spawning, juvenile salmon and forage fish migration. Methods for defining function will include mapping for forage fish spawning, and seines for fish migration.

Sampling sites. Specific sites for sampling are listed in Tables 1 and 2. Once habitat geomorphic and functional parameters are satisfied the sites will be chosen based on historic sampling areas (Miller et al 1980; , USFWS 1994, Shaffer 2000, Carter and VanBlaricom 1998).
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Sampling timeline Sampling is anticipated to be categorized in a temporal context of: pre-, during, and post dam removals, and will be continued until the nearshore response of restored in river sediment processes are deemed complete. Given the extreme seasonal variability in the physical and biological habitats of the central Strait, and quick delivery of sediment to the nearshore once restoration begins, monitoring will need to occur frequently, and begin as soon as possible. Physical habitat and sediment mapping is underway. Habitat mapping has partially begun. Monitoring for habitat function should begin as soon as possible. Fish migration sampling should occur at a minimum of monthly, and during early spring and summer months, preferably weekly. Sampling should also coincide as much as possible with sediment movement. Due to large variability intrinsic to the central Strait nearshore and the temporal nature of the nearshore restoration that may occur, longer term monitoring should be applied. Pilot fish use sampling will begin in April 2005. Full scale sampling for salmon use is anticipated to begin next year, dependant on funding.

Linkages of Elwha nearshore work with larger cross regional assessment and recovery efforts: Specific to salmon recovery, at the 2004 session of the Pacific Estuarine Research Society (PERS) regional salmon managers and researchers convened to identify the top priorities for understanding and restoring salmon in the nearshore. The group identified a cross regional assessment of salmon use of the nearshore as a top priority for salmon recovery in the nearshore (Shaffer 2005). Beamer and Fresh (2005) have subsequently developed a large cross regional assessment of fish use of marine environments, anticipated for funding in 2005-2006. The Elwha nearshore restoration and salmon recovery framework is incorporated into the Straits portion of this larger regional assessment.

Table 1. Geomorphic habitat classification (each may include biological habitat structure of kelp and eelgrass beds, and support habitat function of forage fish spawning, juvenile salmon and forage fish migration, and shellfish resource).

Site	Sandy shore	Spit	Rocky Shore	Tidally influenced river	Pocket Estuary	Stable bluff	Eroding bluff
Salt Creek river and estuary				X	X		
Elwha River and estuary)				X	X		
Pysht river and estuary				X			
Crescent Beach	X						
Freshwater Bay shoreline			X				
Elwha Bluffs							X
Dungeness bluffs						X	
Ediz Hook		X					
Dungeness Spit		X					

Table 2. Habitat function monitoring by geomorphic habitat type

Fuction	Sandy shore (including unvegetated,and eelgrass bed)	Spit (unvegetated shallow subtidal)	Rocky Shore	Tidally influenced river	Pocket Estuary	Stable bluff	Eroding bluff
Forage fish spawning	X	X		X	X	X	X
Forage fish migration	X	X	X	X	X	X	X
Juvenile salmon migration	X	X	X	X	X	X	X

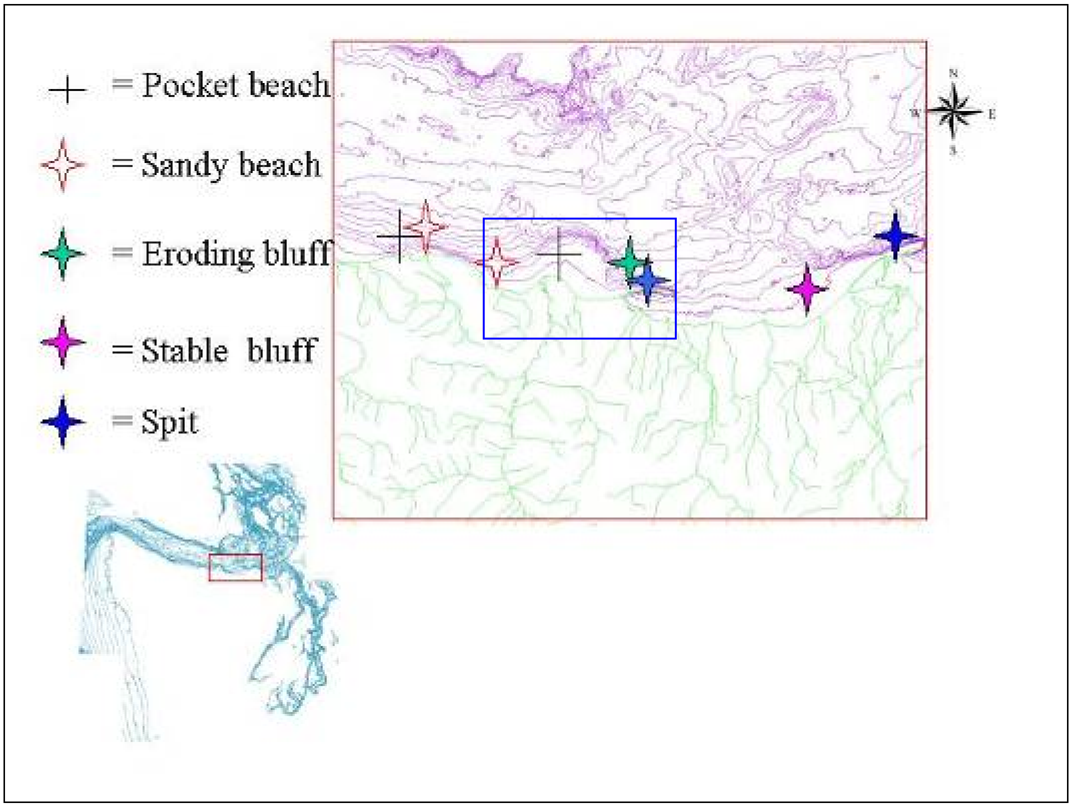

Figure 4. Map of geographic area of biological monitoring by geomorphic type. Blue box denotes Elwha drift cell.

Conclusions

The upcoming Elwha restoration event is a unique opportunity to partially restore a significantly degraded nearshore as well as understand how restoration processes in the nearshore are linked to restoration in the rest of the watershed. The work will be a large collaborative effort. The high variability in the Elwha nearshore and rapidly advancing dam removal schedule dictate this nearshore evaluation effort begin immediately if we are to realize our full information and restoration potential.

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