Wildlife responses and roles in Elwha ecosystem restoration

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Project Purpose

Elwha ecosystem restoration involved the largest and most comprehensively studied dam removals in history. Wildlife have received more study than any comparable dam removal or restoration project, but several wildlife research needs remain. In particular, there are knowledge gaps about several wildlife taxa and uncertainties about many wildlife restoration roles. This study is intended to help meet some of these research needs.

Background and Need

Ecosystem restoration involving large dam removal spans large spatial extents and long time scales. Presentations in this session describe restoration planning, coordination, and ongoing progress associated with removal of two large dams on the Elwha River. Success in the unprecedented scope and scale of Elwha ecosystem restoration has resulted from collaboration among many people and organizations, representing diverse interests and expertise. Success also has been facilitated by integrating components and processes of the ecosystem itself in restoration planning and practice. Wildlife represent important ecosystem components and mediate many important ecosystem processes. Some taxa and wildlife functions have been well-studied, but others are poorly understood. In the years since Elwha dam removals, wildlife colonization of exposed reservoir beds has been rapid, dominated by early successional and mobile species. Detecting early wildlife responses depended on baseline inventories prior to dam removal, followed by monitoring during and after dam removal. Wildlife also perform important restoration functions, and contribute to all nine attributes defining restored ecosystems. This early in Elwha restoration, conspicuous wildlife functions include native seed dispersal to restoration sites, herbivore effects on revegetation, and organic matter dispersal to nutrient-poor sediments. In future decades, diverse wildlife also will help restore terrestrial-aquatic connections by dispersing nutrients from increasing salmon runs to riparian and terrestrial areas. Each of these wildlife roles is influenced by spatial distributions of pre-dam structural legacies and structures placed during active restoration efforts, particularly large woody debris. By placing these structures in locations and configurations that support wildlife functions, restoration planning and practice more effectively integrate wildlife in restoration. Benefits include increasing the rate of restoration progress and direction restoration along desirable trajectories. In this way, the collaborative interdisciplinary approach in Elwha restoration can be expanded in future restoration projects to encompass active collaboration with wildlife (McCaffery et al. *in press*).

Project Questions and Hypotheses

In 2018, this project will focus on five wildlife taxa and ecosystem functions corresponding to Elwha research needs. Most data collection will be conducted by student research assistants, under direct supervision of the PI. Similarly, data analysis will involve close interaction between student researchers and the PI. Focal taxa, functions, and questions may be adapted in future years contingent upon 2018 results, restoration progress, and access constraints. Driving questions and hypotheses for each are listed below.

(1) Species: terrestrial insects.
Question: how do early successional vegetation affect abundances, composition, and species richness of terrestrial insects?

Hypotheses:

If terrestrial insects are limited by plant productivity and structural diversity, then insect abundance and species richness will be greater in vegetation growing on reservoir bed fine sediments because fine sediments support the most rapidly growing dense woody vegetation with greater structural complexity than sparse vegetation on coarse sediments.

If terrestrial insects are limited plant defensive compounds, then then insect species richness will be greater in vegetation growing on coarse sediments, where plant diversity is greater and plant defenses are reduced by nutrient and moisture stress.

(2) Ungulate browse selection.

Question: does large woody debris partially shield early successional plants from ungulate browsing?

Hypotheses:

If large woody debris (LWD) reduces ungulate access to early successional plants, then browsing intensity will be greatest on plants distant from LWD, intermediate on plants adjacent to one log, and least on plants fully enclosed by LWD.

If LWD reduces protects plants from ungulate browsing, then species gradients in browse intensity will be larger in plants distant from LWD than plants enclosed by LWD, because LWD reduces ungulate access to preferred plant species.

(3) Beaver browse selection.

Question: which factor(s) most strongly determines plants selected by beavers?

Hypotheses:

If beavers select plants to maximize foraging efficiency, beaver browse will be most frequent in dense stands of woody plants. Alternatively, beaver browse will occur disproportionately on larger stem diameters.

If nutritional content is most important to beavers, then beaver browse will be concentrated on particular plant species, regardless of vegetation density or other factors.

If predation risk or exposure limits beaver foraging, then beaver browse will be inversely related to distance from active river channels.

(4) Amphibian and wetland distributions.

Questions: How has Elwha restoration affected amphibian and wetland distributions?

How have amphibian distributions in Elwha habitats changed since the pre-dam removal baseline established by Jenkins et al. (2015)?

How do early successional wetlands in the Mills reservoir bed compare in structure and amphibian composition with more mature wetlands in Geyser Valley?

Hypotheses:

If wetland capacity to support amphibians increases with time and wetland plant establishment, then amphibians will be more diverse and abundant in Geyser Valley than in wetlands on the Mills reservoir bed.

If wetland establishment and amphibian distributions are limited most strongly by dispersal from source populations, then wetland plant and amphibian species richness will be greater in Geyser Valley than in wetlands on the Mills reservoir bed.

(5) River-dependent birds: Harlequin duck (*Histrionicus histrionicus*), Spotted Sandpiper (*Acitis macularius*), Common Merganser (*Mergus merganser*), American Dipper (*Cinclus mexicanus*), and Belted Kingfisher (*Megaceryle alcyon*).

Questions: How have river-dependent bird distributions changed since Elwha dam removals?

Which habitat factors determine have river-dependent bird distributions?

Hypotheses: If river-dependent birds are limited primarily by fish abundance and influx of marine-derived nutrients (MDN), then their abundances will have increased relative to counts obtained by Blackie (2002) prior to Elwha dam removals.

If habitat availability is more limiting than fish and MDN abundance, then increases in Spotted Sandpiper in former reservoir habitats will greater than changes in other river-dependent birds, because Spotted Sandpiper habitat has increased more than that used by other species.

Field Sampling Sites and Methods

All field methods will be non-invasive and non-destructive. No samples will be removed from field sites. No permanent plot or site markers will be used. The following study areas and methods will be used in 2018, listed by wildlife focal species.

(1) Terrestrial insects. Study areas: Aldwell and Mills reservoir beds.

Sampling design: transect-based systematic sampling with random starting point. East-West oriented transects will be established at 100 meter intervals, extending from the forest edge to nearest river active channel. Sampling will occur at 10 meter intervals along each transect.

Methods: sweep net sampling along early successional vegetation. All insects will be released unharmed at capture sites after identification. Vegetative cover will be estimated using spherical densitometers and visual estimates.

(2) Ungulate browse selection. Study areas: Mills reservoir bed and Geyser Valley floodplain.

Sampling design: stratified random sampling in areas of abundant LWD. Three strata will be sampled equally: plots distant from LWD, plots adjacent to LWD on one side, and plots fully enclosed by LWD.

Methods: visual observation of browse intensity, measured as fraction of plants browsed and fraction of stems browsed on each plant, consistent with Sager-Fradkin et al. (2013).

(3) Beaver browse selection. Study areas: Aldwell and Mills reservoir beds.

Sampling design: for practical reasons, sampling will be restricted to areas with abundant beaver sign.

Within beaver activity areas, randomly sited 2 m^2 plots will be delineated using portable quadrat frames.

Methods: visual observation of recently browsed and unbrowsed plants, recording plant species, stem density, stem diameter, and distance from nearest active river channel.

(4) Amphibian and wetland distributions. Study areas: Mills reservoir bed and Geyser Valley floodplain.

Sampling design: due to limited wetland extent, all safely accessible wetlands will be sampled.

Methods: amphibian perimeter searches, visual and GPS delineation of wetland boundaries, visual identification of wetland plants, plant density estimates using portable 1 m^2 quadrat frames.

(5) River-dependent birds. Study areas: Aldwell and Mills reservoir beds, middle reach (Park boundary to Glines Canyon), Geyser Valley, river reaches near Elkhorn.

Sampling design: work will include as many reaches sampled by Blackie (2002) as time and access limitations allow.

Methods: avian transect counts along river reaches following methodology in Blackie (2002). Riverbank characteristics will be rated categorically using visual observation.

Analytical Methodology

(1) Terrestrial insects. Relationships between insect abundance, species richness, and vegetative cover will be analyzed using linear and nonlinear regression. Insect species composition will be compared between fine and coarse sediment sites using cluster analysis.

(2) Ungulate browse selection. Protective effects of LWD and potential interactions with plant species and distance from LWD will be evaluated using 3-factor analysis of variance.

(3) Beaver browse selection. Beaver selection relative to plant species and stem diameter will be analyzed using resource selection functions (McDonald et al. 2012). Selection relative to stem density and distance from water will be quantified using regression models. Relative importance of each factor and factor combination will be determined using information theoretic methods (Burnham and Anderson 2002).

(4) Amphibian and wetland distributions. Following Jenkins et al. (2015), amphibian abundance indicies will be derived from detections per unit of sampling effort. Cluster analysis will be used to compare species composition between Mills and Geyser Valley wetlands for both amphibians and wetland plants. In the future, Bayesian occupancy models may be used to describe amphibian distributions, following Jenkins et al. (2015). In that case, pre-dam removal results reported in Jenkins et al. (2015) would be used as Elwha-specific prior distributions.

(5) River-dependent birds. Following Blackie (2002), reach-specific detection densities for each species will be calculated by dividing number of detections by surveyed reach distance. These densities will be compared with pre-dam removal values in Blackie (2002) using a Wilcoxon paired-sample test, because count data usually deviate from normality. Species-specific habitat selection will be evaluated using resource selection functions and logistic regression (McDonald et al. 2012).

Anticipated Results and Interpretation

Results of work proposed here will fill knowledge gaps about poorly studied taxa (terrestrial insects), evaluate early wildlife responses to Elwha restoration compared to pre-dam removal baselines (amphibians and river-dependent birds), and provide information about plant selection by browsers that affect revegetation success (beavers, ungulates). Each sub-project is designed to avoid duplication of other Elwha wildlife research projects, but rather complement those efforts. These results may support adaptive components of Elwha restoration (e.g., Chenoweth et al. 2011). They also will provide valuable information about several wildlife taxa and restoration roles that are absent from the dam removal restoration literature (McCaffery et al. *in press*).

References

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