How Much Habitat is Enough in the Lower Columbia River?

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Abstract

Native species in the lower Columbia River evolved under ecological conditions that existed for thousands of years previous to large-scale development that started in the late 1800's. As a result of conversion of native habitats to agriculture, industry and urban development, the lower Columbia has lost over 70% of vegetated tidal wetlands, 55% of forested uplands and 114,050 acres of native habitats overall since this time. Protecting remaining areas of native habitats and restoration of native habitats to recover historic habitat diversity should benefit native species, and resource management entities frequently target protecting historic native habitats as an end point for restoration actions or recovering native species. The difficult question that scientists and managers have been asking for many decades is "how much habitat is enough?" Many agencies use minimum viable population or population viability analyses to determine conservation targets for identified species (or focal species). If identifying these are not practical, entities often have to employ an approach that targets protecting or restoring a percentage of historic habitats. Quantities range widely from 10% to over 40%. Another method is using a point in time that represents reference conditions, such as in Tampa Bay, FL where managers target 1950's habitat coverage (represents an era before air conditioning and wide-spread urban development). We adapted an overall approach by R. Noss (2000) for the Klamath-Siskiyou Ecosystem and employed a technique employed by The Nature Conservancy for the southern Rocky Mountain ecoregion and the US Fish and Wildlife Service for the National Wildlife Refuges, based largely on the general species-areas curve in MacArthur and Wilson (1967), for protecting ecosystems (see Tear et al. 2005) for identifying the quantity of historic habitats we wish to recover. We have established voluntary numeric habitat coverage targets for the lower Columbia River ecosystem with the focus of protecting common species from becoming imperiled:

- No new net loss of native habitats as of 2009 (represents 50% loss, or 114,050 acres, since 1870)
- Recover 30% of historic extent for priority habitats by 2030 (restore 10, 382 acres); 40% of historic extent by 2050 (restore 22,480 acres) including:
  - *Representation* of priority habitats and rare, vulnerable communities
  - *Redundancy* by representing multiple examples of habitats within each region
  - *Resiliency* of communities to persist through disturbances by ensuring good quality, condition of habitats
- Other aspects, based on historic template:
  - Focus restoration of priority habitats in historic locations
  - Multiple large "reserves" and smaller patches that fill gaps, ensure corridors, increase connectivity
  - Identify minimum size criterion for larger reserves and minimum number of occurrences of habitats by region

We are working on a concurrent process for rare and threatened focal species and will integrate these targets into the natural habitat diversity targets once they are ready. Next steps for these targets include: 1) publication in refereed journal, 2)identifying a minimum size criterion for larger "reserves" and smaller patches of habitats, 3) identifying a minimum number of occurrences of habitats by region, 4) identifying gaps in habitats, key corridors for species, and 5) evaluating these targets to ensure they are protective of common species .

Introduction

The lower Columbia River is designated an "estuary of national significance", or one of 28 National Estuary Programs (NEPs); the entire Columbia Basin is also one of ten "Large Aquatic Ecosystems", similar to the Great Lakes, Chesapeake Bay, the Everglades and Puget Sound. All NEPs are required to work with regional stakeholders to identify issues facing the estuary and develop objectives and actions to address them. The region identified restoring *biological integrity* of the lower river ecosystem in 1999 as the ultimate goal of the NEP. More recently, the scientific community identified *historic habitat diversity* as one of four key ecological attributes that indicate whether we are meeting the goal of biological integrity (the other three are focal species, water quality, ecosystem processes). Historic habitat diversity was identified as an important attribute because native flora and fauna in the lower Columbia evolved under ecological conditions and habitats which persisted for thousands of years previous to changes resulting from large-scale development. Protection and restoration to recover native habitat mosaics should provide benefits to native fauna (Peterson and Turner 1994), including supporting resiliency in the face of climate change (Beechie et al. 2012). As encapsulated by Simenstad et al. (2000) restoration actions should be "grounded on the historic landscape template that influenced evolution of…species and metapopulations in that system". Resource managers in many areas have targeted natural habitat diversity as an end point for ecosystem restoration - preserving the best of what's left and recovering aspects of historic habitat diversity as the goal. To that end, the science community in the lower Columbia provided guidance and support for identifying resource-based, quantifiable conservation targets, including priority geographic areas for protection and restoration, to meet the goal of preserving historic habitat diversity.

We followed the recommended principles in Tear et al. (2005) for setting credible numeric targets. These recommendations include:

1. ***Use best available science**, defined as:*
   - Underlying reasoning is scientifically valid
   - Theory or technique can be (or has been) tested
   - Subjected to peer review and publication
   - Known or potential error rate and existence of standards
   - Attracted widespread acceptance within relevant scientific community
2. ***Evaluate multiple alternatives***
3. ***Set targets for short (1-25 years) and longer time periods***
   - Population viability analyses often use 95% probability of persistence for>100 years
4. ***Incorporate the "three R's":***
   - ***Representation*** – capture some of everything
   - ***Redundancy*** – reduce level of risk from losing representative components of targets by multiple representations
   - ***Resilience*** – ensure ability to persist through disturbances through quality, conditions, and size of reserves

We also adopted the Tear et al. (2005) recommendation to follow the scientific method: 1) follow a transparent process that can be challenged or refuted by evidence; 2) our assumptions should be clearly documented; 3) our uncertainties should be documented and 4) the targets and methods should be subjected to peer review. Additionally, for our targets to be adopted by the science community, we felt it was important to first *separate science from feasibility*: that is, the targets be ecologically based, driven by science and insulated from political or social pressures initially. To reach the lofty goal identified for the NEP of *biological integrity,* the targets also need to be comparably lofty.

Notably, we anticipate future changes to the targets. It will be important to assess the conditions of the ecosystem and how they change with implementation of the targets, answer key uncertainties and determine if the targets or actions need adapting. If new information indicates that the targets will not meet the overall vision and goals of the program (i.e., biological integrity), we will need to change the targets and our actions accordingly.

Approach

There are several general approaches to use as a basis for setting quantifiable or geographic conservation targets:

- **Reference site conditions:** analogous undeveloped ecosystem
- **Regulatory threshold:** e.g., water quality "not-to-exceed" thresholds or type-for-type replacement in mitigation
- **Biodiversity "hot spots":** large number of endemic species not found elsewhere
- **Resource – based:**

1. **Single species -** identify population goals (e.g., minimum viable population, population viability analyses), then identify habitat needs to meet population goals as basis for targets
2. **Multiple species -** similar to #1, but identify focal or target species, population goals for that species and habitat needs
3. **Ecosystems** - protect a percentage of historic habitat extent, which is assumed protective of species using those habitats, if sufficient. Examples:
   Pre-large scale development or some period where data exists for ecosystem (e.g., Tampa Bay 1950's habitat coverage)
   12% on national scale (WCED 1987); 10% on national scale (IUCN 1993)
   30% – 42% based on evidence-based approaches (e.g., species-area curves [MacArthur and Wilson 1967]) (as cited in Tear et al. 2005)

In the case of the lower Columbia, where the first two approaches are not suitable, we chose to use a multi-pronged approach to identify conservation targets, with preserving "ecosystems" (or percentage of historic native habitats), diversity "hot spots", and focal species, the latter two approaches to follow the first when information becomes available. Similar to layers of a cake, when conservation targets for focal species and biodiversity "hot spots" are identified in the future, we will overlay them on the "ecosystem" targets.

Step 1 - In 2011, we evaluated change in land cover over roughly the past 140 years for the lower Columbia River by comparing digital GIS representations of late 1800's maps (Office of Coast topographic sheets, and General Land Office survey maps) with 2010 land cover data (see Estuary Partnership 2012). The evaluation was conducted for the historical floodplain of the tidally influenced, lower 146 miles of river. We documented a total loss of 114,050 acres of native habitats over this time period: 68 – 70% loss of vegetated tidal wetlands and 55% of forested uplands were the most notable losses. The majority of loss of these habitats was due to conversion of land for agriculture and urban development. Also significant was conversion of tidal wetlands to non-tidal wetlands.

The Science Work Group then identified which habitats should be considered a priority for protection into the future in order to recover or protect what's left of natural habitat diversity. The Science Work Group considered the following concepts in their review of the historic habitat change analysis results:

- Large patterns of loss/change by river reach, by region and by entire lower river
- Dramatic losses of individual habitats
- Proportion of historic habitat coverage (ratio of coverage in relation to other habitats) in comparison to current proportion
- Geographic distribution historically versus current (whether habitats have shifted upstream/downstream).

Approach (continued)

The Science Work Group identified those habitats that represented >10% of the historic cover for an individual river reach. For those, the Science Work Group prioritized habitats that suffered significant decreases in coverage (i.e., >25% loss in coverage), and further prioritized the habitats by severity of loss (i.e., the greater % loss, the higher the ranking). The Science Work Group gave even greater weight to those habitats if there was a total loss or very little remaining habitat, as shown in the 2010 land cover dataset. Finally, the Science Work Group reviewed "rare" habitats (i.e., those habitats that had <10% cover for an individual river reach), and prioritized those habitats that suffered significant relative decreases (e.g., shrub scrub). Based on these considerations, the Science Work Group identified the habitats as priority by Hydrogeomorphic Reach (Table 1).

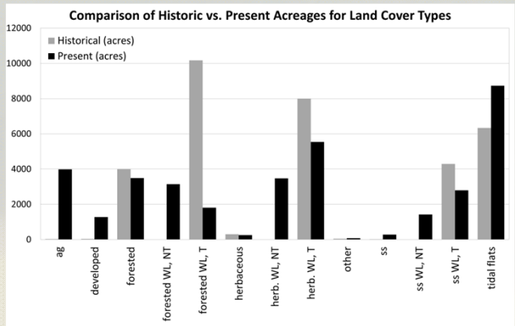

Figure 1. Comparison of historic vs. current habitat coverage for Reach B
(from Estuary Partnership 2012)

Reach	Priority Habitats			
	1	2	3	4
A	herbaceous tidal wetland	wooded tidal wetland		
B	wooded tidal wetland	herbaceous tidal wetland		
C	wooded tidal wetland	herbaceous tidal wetland		
D	herbaceous tidal wetland	wooded tidal wetland	forested	herbaceous
E	herbaceous	forested	shrub-scrub	herbaceous tidal wetland
F	forested	herbaceous	herbaceous wetland	shrub-scrub
G	forested	herbaceous	herbaceous wetland	
H	wooded wetland			

Table 1. Priority habitats (in order) by Hydrogeomorphic Reach

Step 2 - In 2013, we evaluated establishing "ecosystem" targets using a method similar to the approach used in the Tampa Bay region - based on historic habitat coverage and restoring the historic ratio of habitats. Over several months of discussions with the Science Work Group, we concluded that this first approach lacked scientific rigor, was insufficiently protective and was impractical over the entire study area (see Science Work Group presentations June, August, November 2013).

In late 2013, we chose another method that closely resembles an approach focusing on "ecosystems" used by The Nature Conservancy (TNC) for the Southern Rocky Mountain Ecoregion and explored by the US Fish and Wildlife Service for the National Wildlife Refuges (see Tear et al. 2005 for more information). In this case, TNC evaluated targets of 10% and 30% of ecosystem historic extent, with the 30% based on the mathematical relationship between habitat area and the number of species an area can support, or the "species-area curve" from MacArthur and Wilson (1967). TNC researchers evaluated these targets to determine if they were protective of the ecoregion's more common species (i.e., to prevent species from imperilment rather than recovering imperiled species). TNC applied a "Coarse-filter/Fine-filter approach":

- Coarse filter –representation of all native ecosystem types and communities
- Fine filter – add areas for rare and vulnerable species that are inadequately represented by coarse filter

To capture the three R's, TNC defined the following:

- For *resiliency*, a minimum size criterion for each ecosystem type
- For *representation* and *redundancy*, a target number of occurrences for each ecosystem type, stratified by region

TNC determined the 30% target was protective of common species because: 1) additional habitat exists outside the reserve network; 2) species and communities tend to occur across multiple ecoregions; and 3) published thresholds generally suggest the number of discrete locations where common species occur was met with the 30% target.

The Science Work Group recommended we follow a similar process and evaluate whether recovering over 30% historic extent target is protective of common species and put us on the trajectory of protecting biological integrity. Rare, threatened and endangered species would require species-specific conservation targets that will be developed separately.

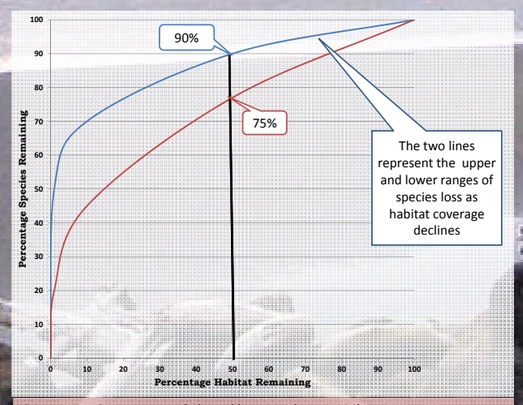

Figure 2. Species area curve (adapted by A.P. Dobson, 1996)

Results – Approved Habitat Coverage Targets

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***Results in average of 60% of historic native habitat coverage (range is 46-88%, depending on reach)**
****Requires restoring an average 3,306 acres every 5 years**

Next Steps

1. **Undergo independent peer review and publication in refereed journal.**
2. **Identify minimum size criterion for larger "reserves" and small patches of habitats**
3. **Identify minimum number of occurrences of habitats by region**
4. **Identify gaps in habitats, key corridors**
5. **Track implementation of targets and monitor effectiveness of targets in reaching goal** (i.e., *restoring biological integrity*)
6. **Develop targets for focal species, biodiversity "hot spots" and compare to these targets**

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