

Occupancy and distribution of larval Pacific lamprey: application of survey methods across multiple habitats and spatial scales

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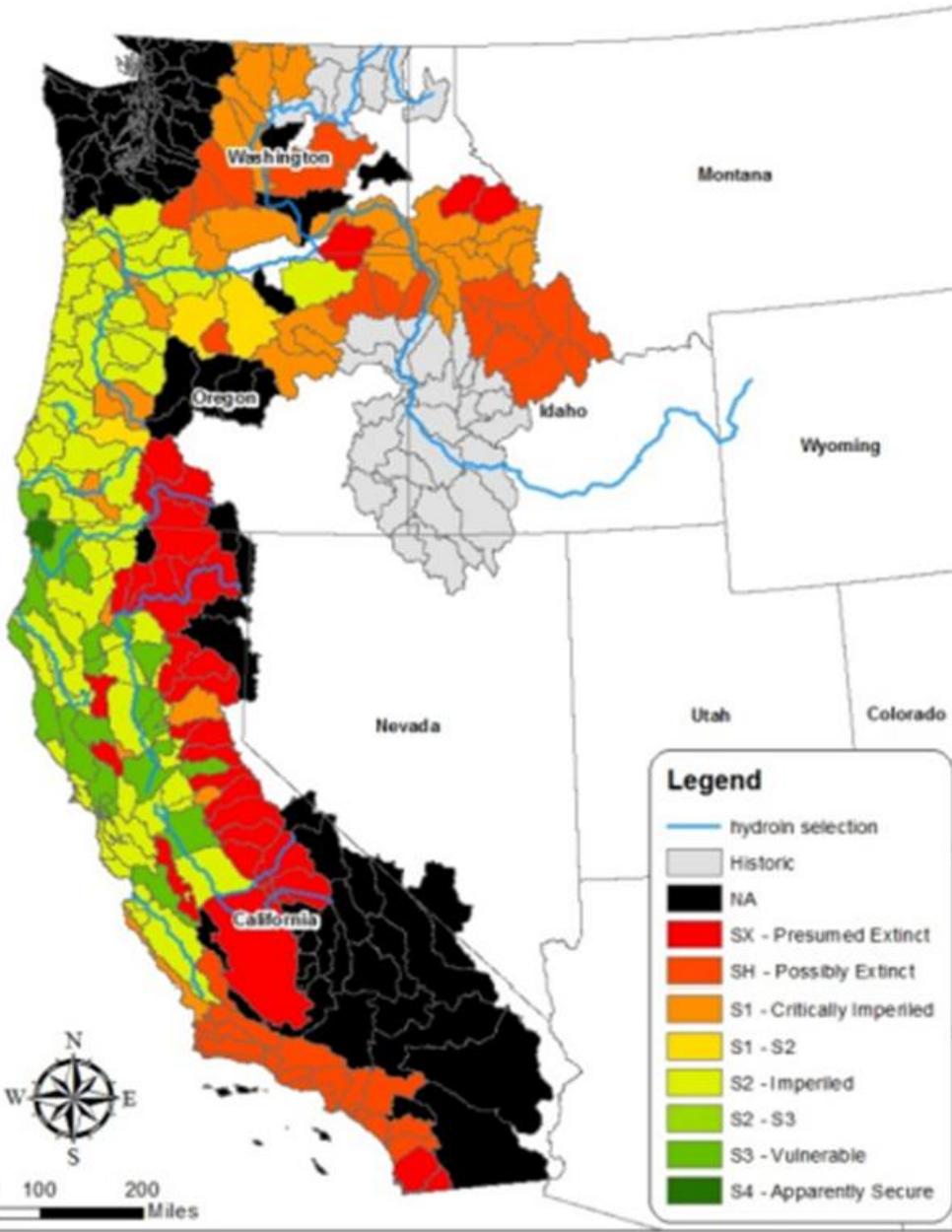


Overview

- Conservation concern
- Need for standard methods
- Sampling framework
- Application of technique
 - Different objectives
 - Different spatial scales



Pacific Lamprey Nature Serve Rankings



Pacific lamprey conservation concern

- Population declining
- Extirpated from many areas
- Unique life-history
- Increased, on-the-ground work occurring

Standard Methods

Needs

- **Temporal/trend analyses**
- **Spatial analyses**
- **Rapid range description**
- **Maximize utility of data gathered from disparate sources/purpose**

Attributes

- **Efficiency**
- **Quantitative**
- **Statistically robust**
- **Flexible**
 - **Different objectives**
 - **Different spatial scales**

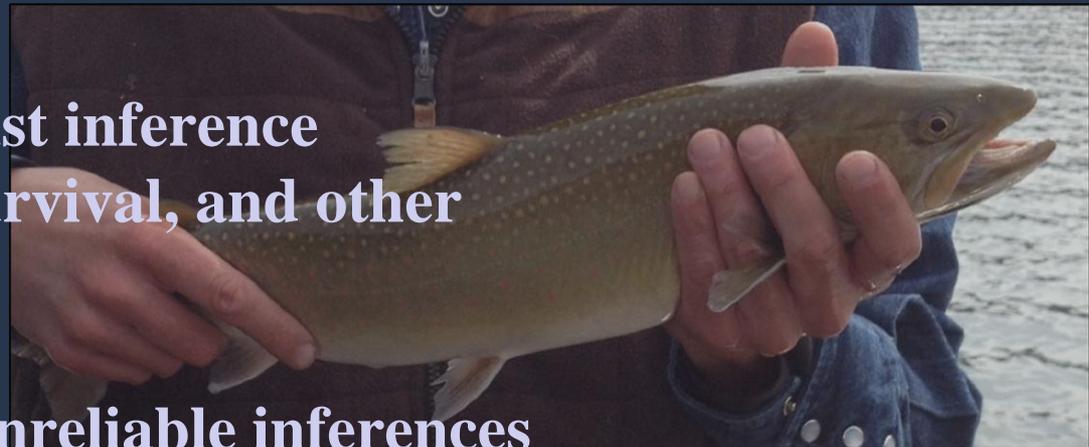
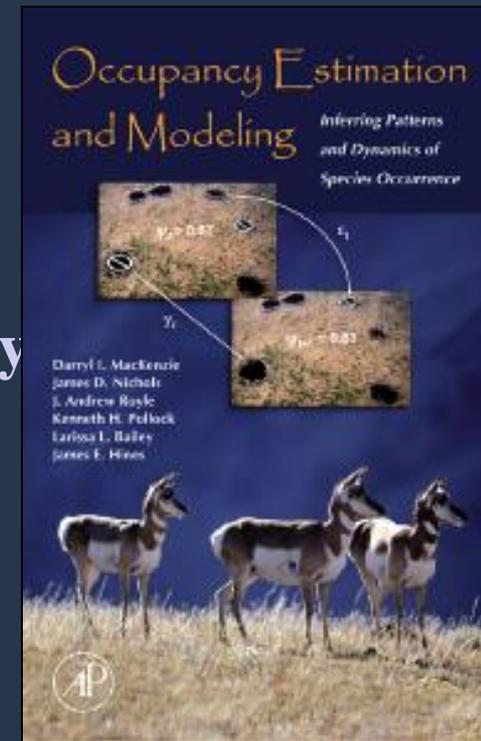
Occupancy: locations where a species is present

Why?

- Estimating changes in abundance or density is logistically impossible
- Species is cryptic, rare, and/or patchily distributed – requires less effort – efficient
- Surrogate for abundance

Capture probability

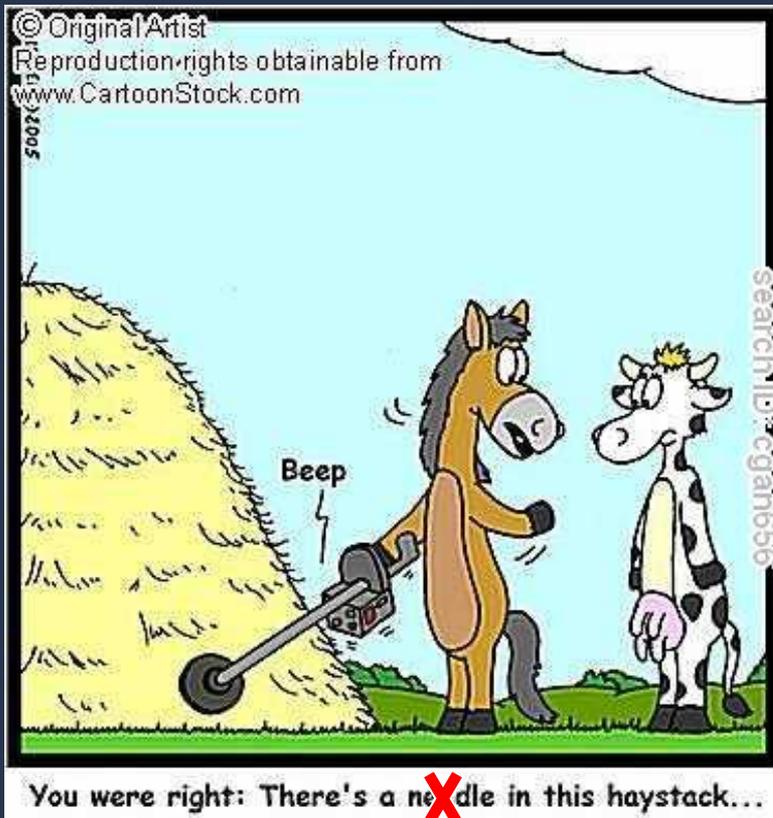
- key for making robust inference about abundance, survival, and other parameters
- Ignoring produces unreliable inferences



The problem of **Detection Probability**

Important concept!

- Present is present; but what is truly absent and how much confidence do you have?



"lamprey"

		Actual	
		Present	Absent
Sample	Present	Occupied	Error 'Incorrect Identification'
	Absent	Error 'Non-detection'	Unoccupied

Sample framework for an occupancy-based approach

1. What is the question?
2. What is your “universe”?
 - lake? river? HUC4? county ?
3. Where will you look?
 - entire lake? entire stream? 1 m² quad? 50-m reach of stream?
4. How do you select your sampling units?
5. How hard to you look? Or when do you stop?
6. What is your confidence in the result?

GRTS Procedure (Generalized Random Tessellated Stratified)

- EPA/EMAP approach (Stevens and Olsen 2004)
- Can be multiple dimensions
- For random samples of size n , the n samples will be spatially balanced (“spread out”)
 - the procedure uses reverse hierarchical ordering to achieve the spatial balance
- Additional samples can be added – doesn’t compromise the spatial balance
 - landowner denial, dry sites, ship anchored at the site

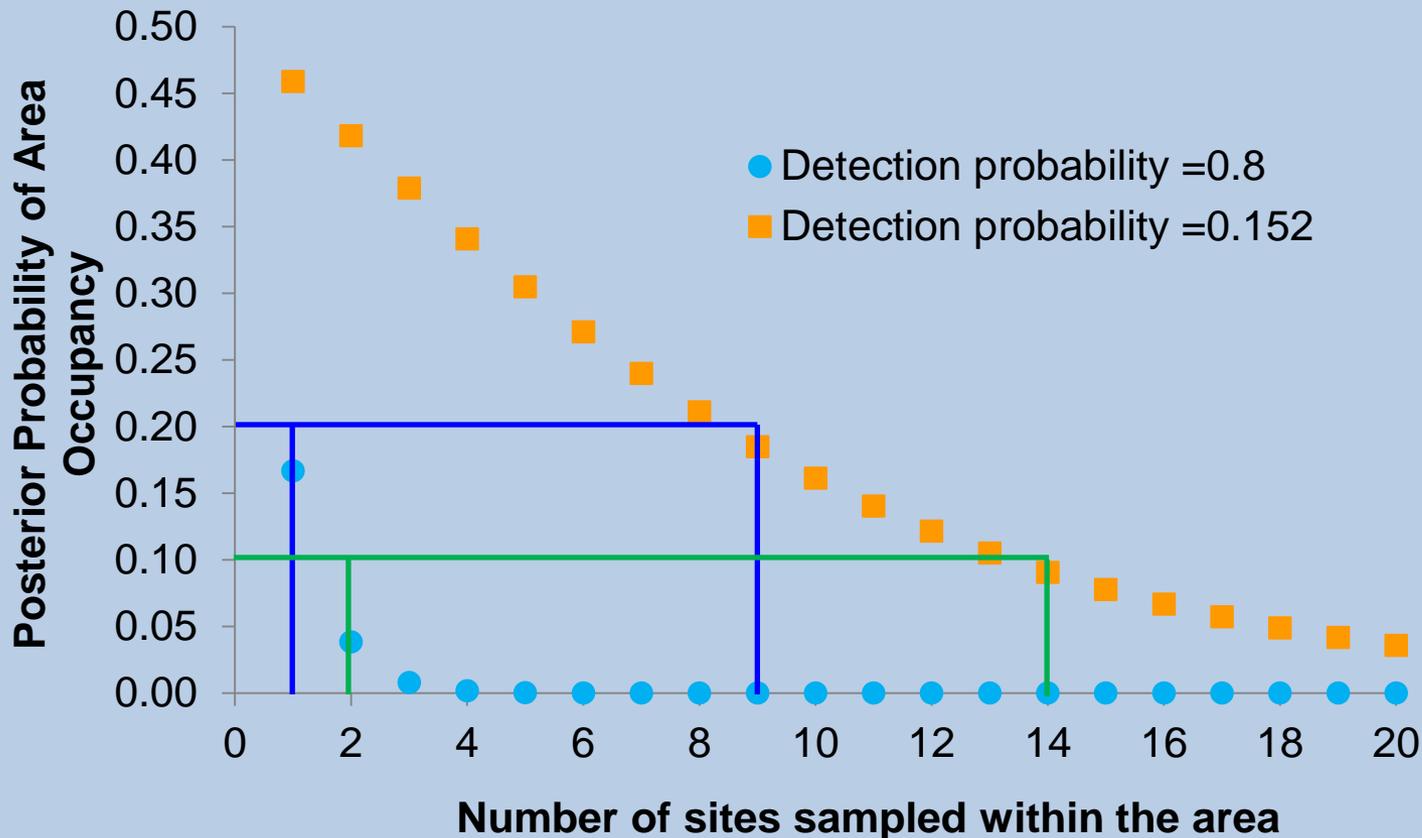
How many sites to sample?

- **Purpose:** to make a probabilistic statement about occupancy relative to non-detection
- **Steps:**
 - Select an appropriate detection probability (can be difficult)
 - Plug estimate into Peterson and Dunham (2001) model to identify how many random sites you need to sample
 - Sample those sites until you detect that it is occupied
 - If no detection, make the final probabilistic statement, given your assumptions: **“Given that detection probability is 0.7, we are 90% certain that the area of interest is unoccupied”**
- **Value:** make a probabilistic statement about occupancy, relative to false absence, if you do not detect presence

Example

Two detection probabilities

- 0.8
- 0.152



80% probability
that the area is
unoccupied
(20% probability
it is occupied)

90% probability
that the area is
unoccupied
(10% probability
that it is
occupied)

Example 1: White Salmon River Basin

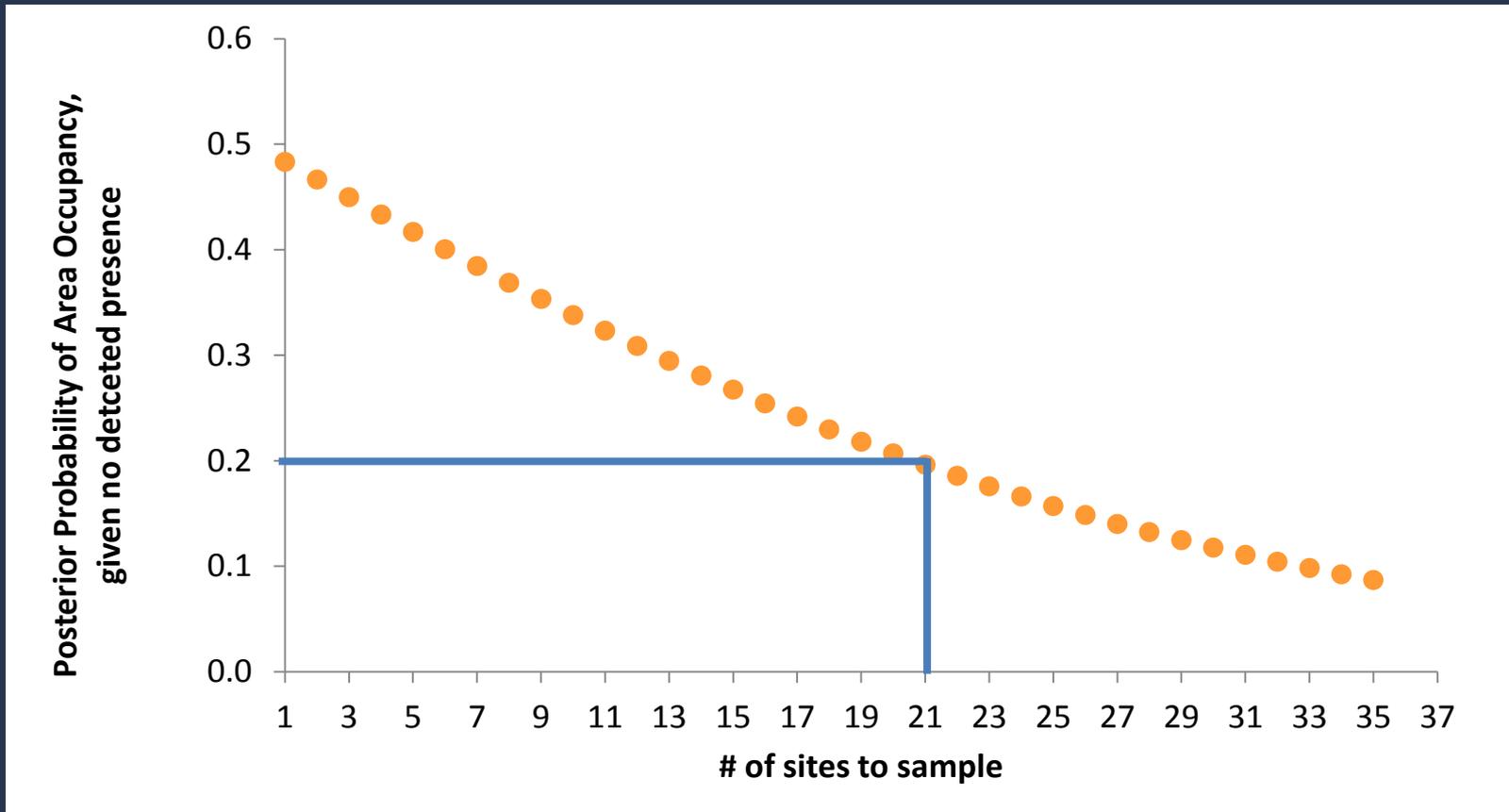
Question: Distribution within basin prior to, and after, removal of Condit Dam

- Fine-scale - 3rd order watershed
- Effort – 21 reaches; later reduced to 6 based on estimated detection probability in Trout Lake Creek



How many sites in the White Salmon?

- Conservative detection probability of 0.065
- 80% confidence of non-occupancy, if presence not detected
- Peterson and Dunham (2001) model suggests 21 sites

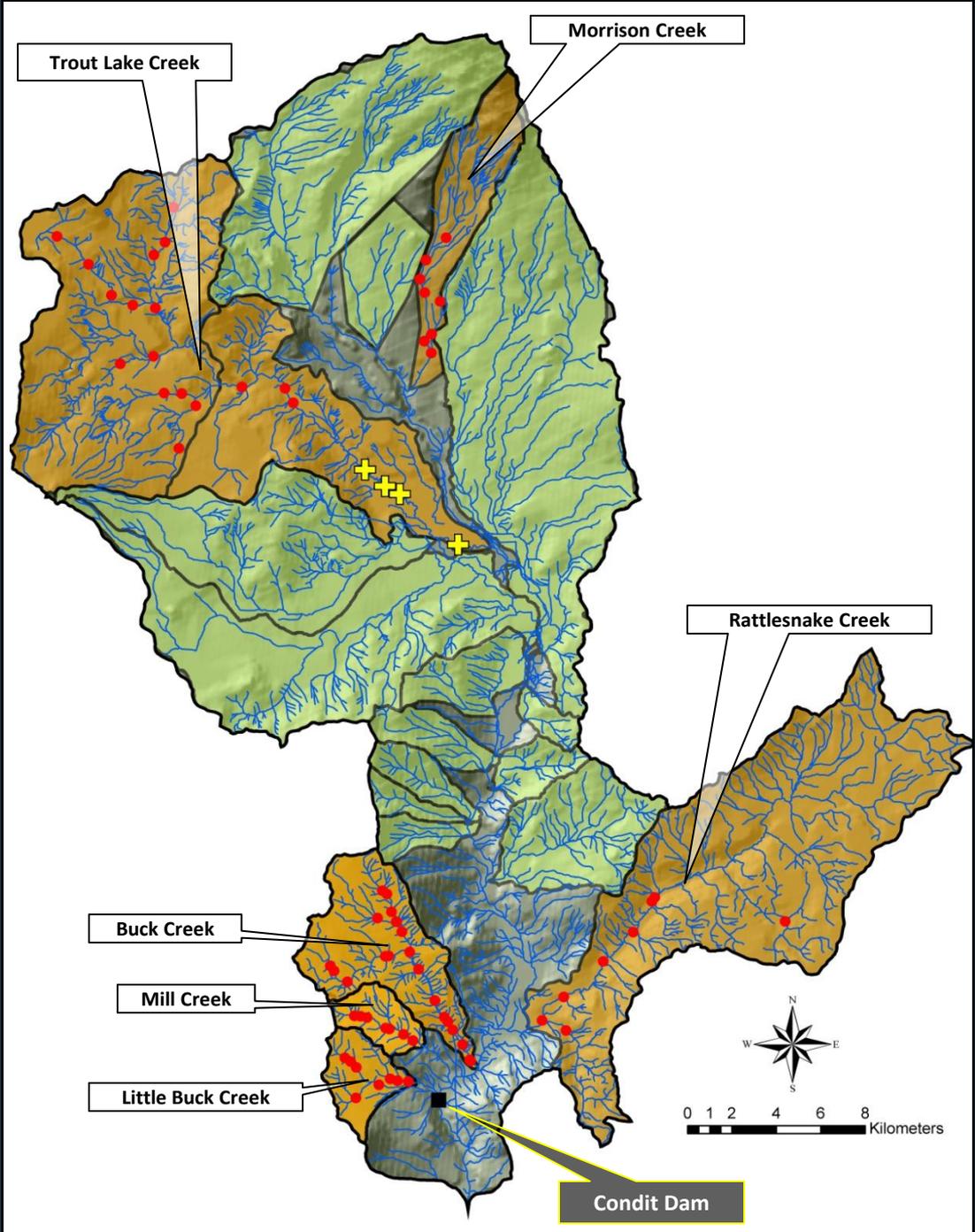


Results

- Lampreys captured in 1 of 6 watershed units

Watershed Unit	Total # Reaches Surveyed	Western Brook Lamprey	
		# Reaches Lamprey Detected 	# Reaches Lamprey Not Detected 
Trout Lake Creek	21	4	17
Buck Creek	21	0	21
Rattlesnake Creek	8	0	8
Little Buck Creek	8	0	8
Mill Creek	7	0	7
Morrison Creek	8	0	8

- Greatly reduced sampling effort based on the GRTS sampling method



White Salmon River - Conclusions

An unprecedented opportunity to study Pacific lamprey recolonization of a river basin.

- Do Pacific lamprey return to the White Salmon River?
- How long until they return?
- How many return?
- Where do they go in the basin and why?

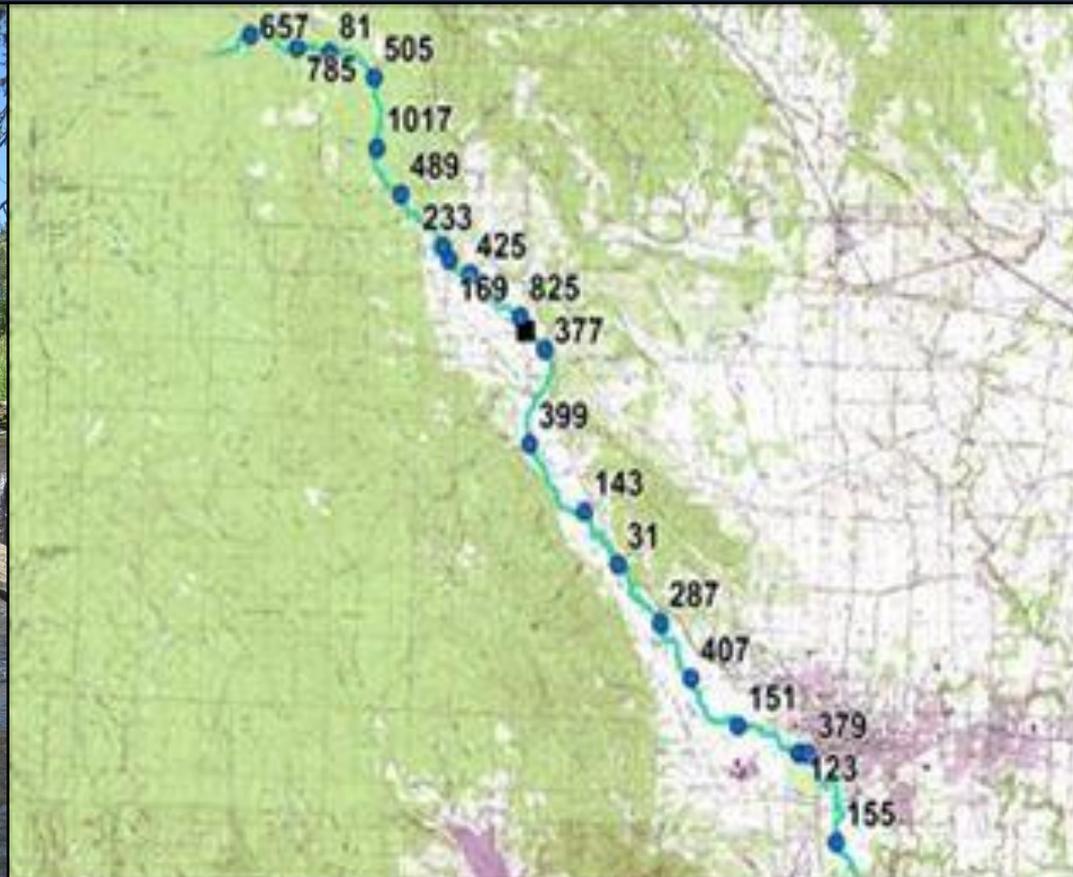
- WBL occupied above dam indicating habitat suitability above
- Occupancy approach allows site comparison through time; follow-up surveys underway



Example 2: Balm Grove Dam/Gales Creek

Question: Occupancy above and below questioned passage barrier

- Fine-scale; 3rd order basin
- Effort – 6 reaches above and below Balm Grove Dam



Results

Below Dam

- All reaches occupied with both species of lamprey
- Signs of Pacific lamprey redds



Above Dam

- Only western brook lamprey
- Despite abundant habitat, no signs of Pacific lamprey redds
- Mounting evidence that Balm Grove Dam is a barrier to adult Pacific lamprey



Example 3: Mainstem Columbia River with dam influence

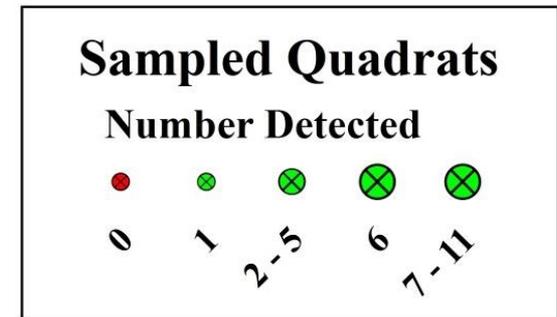
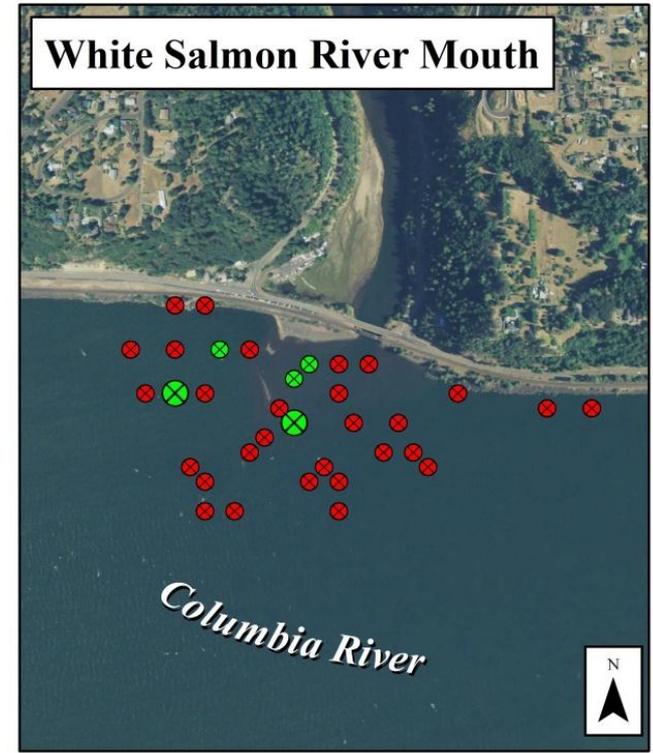
Question: Occupancy of pools and shallow, tributary “delta” areas (might be influenced by water level fluctuations)

- Scale 30m² quadrats within pools and river mouths
- Effort – 34 quads doubled from 17 from Willy work



Results

- All areas occupied
- Baseline information established
- Realistic DP – refine the model – more efficient sampling
- Venue for comparison/inference
- Occupancy related to abundance → areas of habitat importance emerging?



Year	Reach	<i>d</i>	Pacific lamprey	Western brook lamprey	Unid
2012	Klickitat mouth	0.12	3	0	2
	White Salmon mouth	0.03	1	0	0
	Wind River mouth	0.29	6	15	16
	Lower Klickitat	0.03	1	0	0
	Lower White Salmon	0.09	0	4	0
	Lower Wind	0.24	4	10	1
	The Dalles Pool	0.00	0	0	0
	Deschutes mouth	0.00	0	0	0
2013	Deschutes mouth	0.09	5	0	2
	Klickitat mouth	0.15	4	1	1
	Wind mouth	0.18	4	11	1
	White Salmon mouth	0.15	3	4	0
	Little White Salmon mouth	0.09	0	4	0
	Bonneville pool	0.03	2	0	0
	The Dalles pool	0.00	0	0	0

Sample Units

- Example – occupancy sampling in one subbasin → informs occupancy within the basin → informs occupancy within the HUC4 → informs occupancy within the RMU → informs occupancy within the range



Summary

- **Technique greatly increases sampling efficiency**
- **Occupancy framework can be applied to ANY scale**
- **Choice of unit needs to be anchored by your goals and objectives**
- **Results will be scale specific....but can be nested within larger scale/units informing a regional-scale bottom-up approach**

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