Occupancy and habitat use by larval lamprey in Bonneville and The Dalles pools and overview of standard sampling methods

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Larval Lamprey in Mainstem Columbia R.

Historically…

- **Anecdotal observations**
  - **At hydropower projects (JBS)**
    -‘browns’ and ‘silvers’
  - **As prey of avian predators**
  - **Parasitizing migratory fish (as juveniles)**
- **Juveniles migrating through to saltwater**
- **Larvae lost from tributary populations**

G. Kovalchuk, PSMFC

G. Kovalchuk, PSMFC

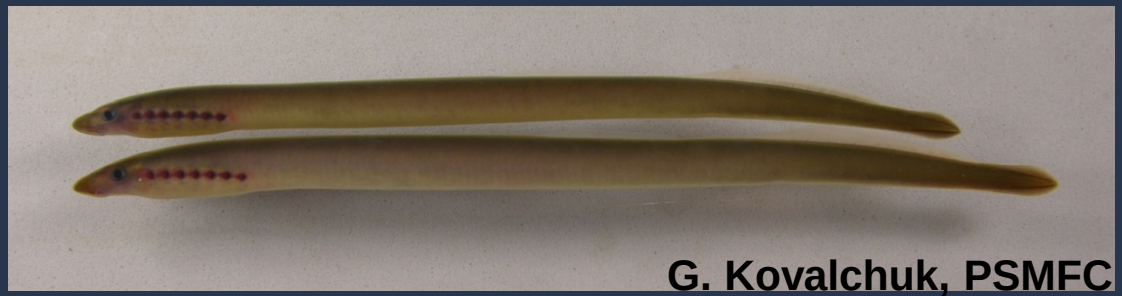
Zorich et al. 2011

Unknowns

- Larval lamprey utilizing/rearing in mainstem habitats
- Active vs. passive downstream movement
- Effects of hydrosystem operation on larval lamprey
  - Dewatering/stranding, downstream passage
- Recruitment
- Methods for quantitative sampling of patchy distribution in large rivers

Knowns

- Lamprey collected in BON reservoir – preliminary work in 2010-2011



Work history

- 2009 – Lower Willamette – Jolley et al. 2012, TAFS
- 2010 – BON pool, BON tailwater, Lower Columbia River
- 2011 – BON tailwater, BON tributary mouths and lower reaches
- 2012 – TDA pool, TDA tributary mouths
- 2013 – BON, TDA pools, trib mouths, shallow water strata

Evaluation of larval Pacific lamprey rearing in mainstem areas of the Columbia and Snake rivers impacted by dams

Broad objectives

- Evaluate whether mainstem pools are occupied by larval lamprey
- Evaluate strata-specific larval lamprey occupancy of mainstem pools
- Evaluate the size of larval lamprey rearing in pools

Tools and techniques

Question – Do larval lamprey occupy *XX* area?

Define sample area ('The Where')

1. Bonneville Reservoir (as a single strata)
2. The Dalles Reservoir (as a single strata)
3. Tributary mouths/deltas (within the pools)
4. Shallow water zone (influenced by pool elevation changes)

Tools and techniques

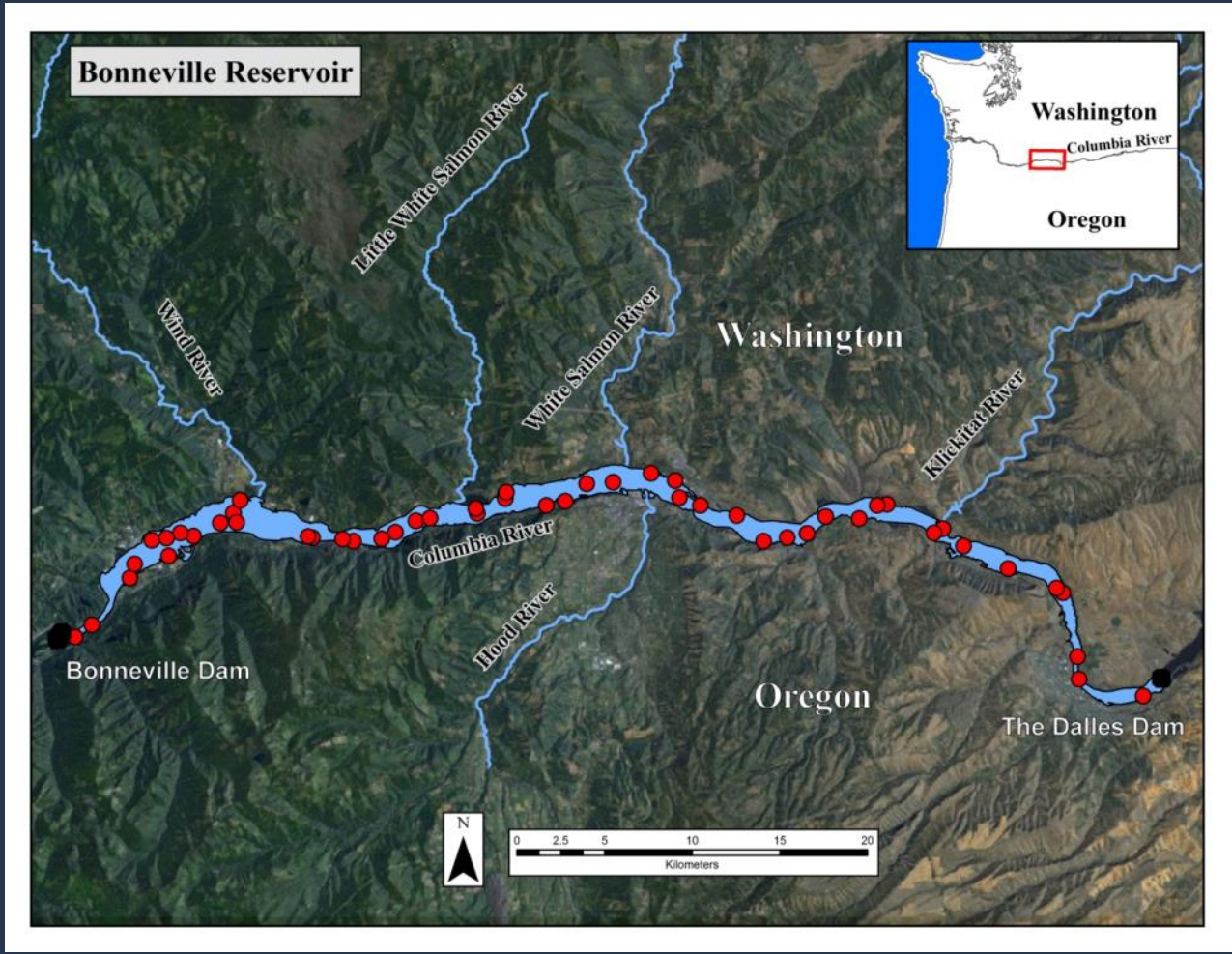
From: Jolley *et al*. 2012, Occupancy and Detection of Larval Pacific Lampreys and *Lampetra* spp. in a Large River: the Lower Willamette River

1) **The How: Sampling – deepwater electrofishing technology**
2) **The Where: Random, spatially balanced site selection = quantitative unbiased sample framework**
   - **GRTS approach: generalized random tessellation stratified**
3) **The Effort: Reach specific detection probability – guidance for sampling effort, given level of certainty**
   - **34 sample quads = >90% certainty when 0 detected**

Bonneville Reservoir: Site Selection

GRTS Framework

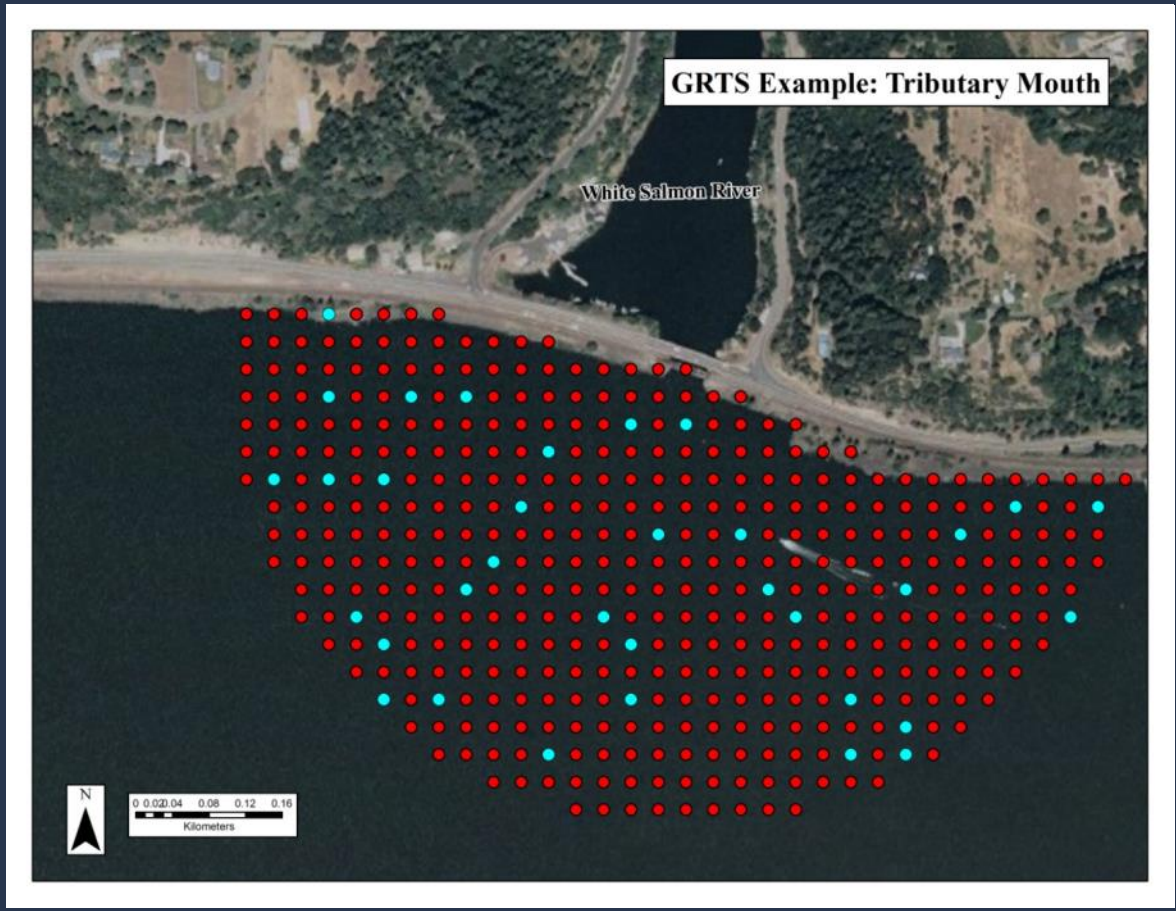
1. 30x30 m quads (90,200)
2. UTM center points
3. GRTS script in Program R
   - Numerically ordered
   - Random
   - Spatially balanced
4. N = 34 quadrats

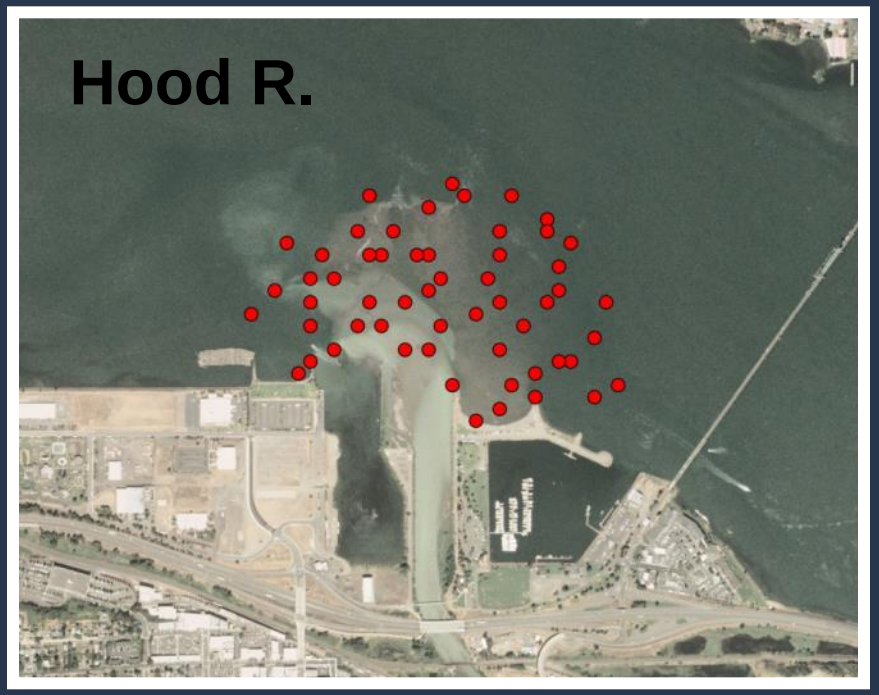


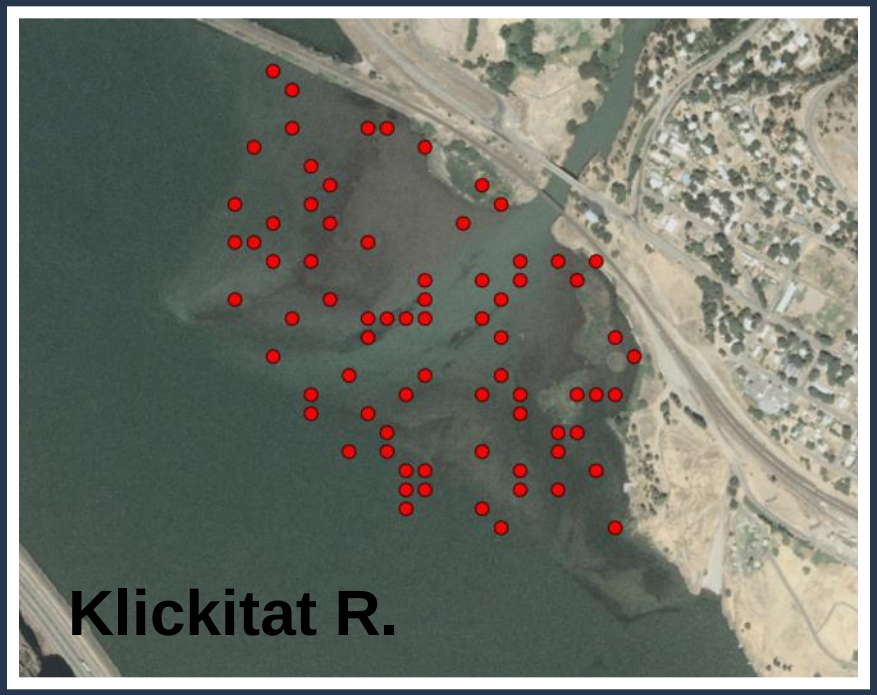
Tributary Mouth: Site Selection

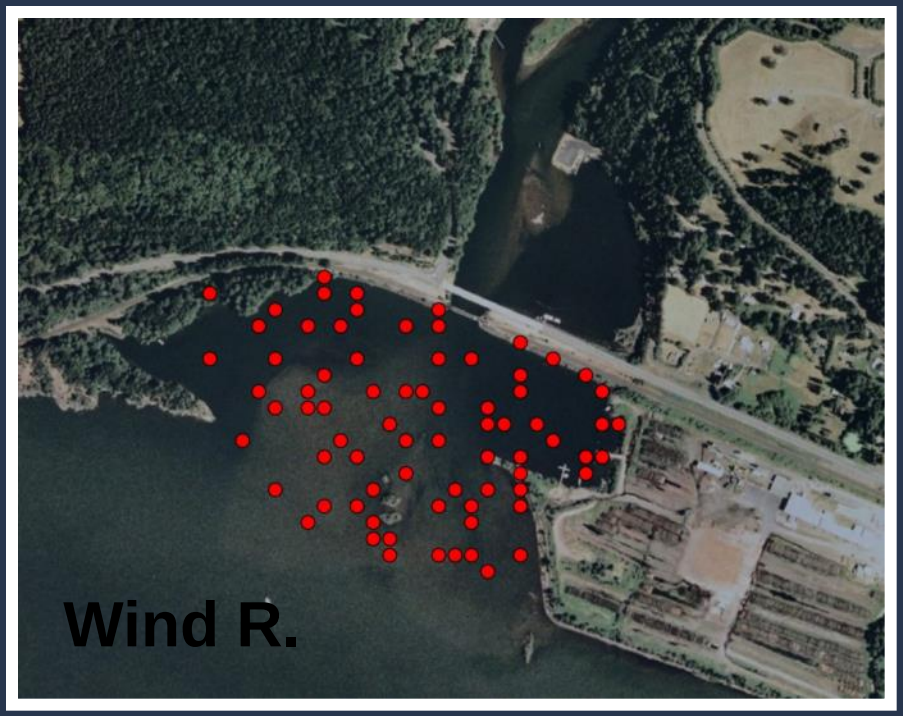
GRTS Framework

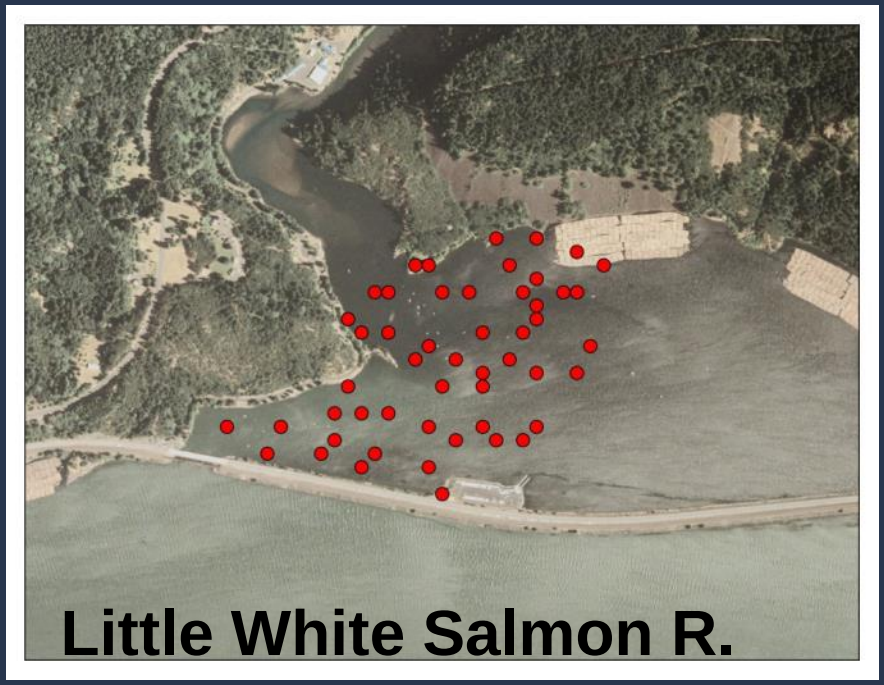
1. Selected from BON GRTS points
2. 500 m radius from confluence
3. N = 34




Hood R.


Klickitat R.

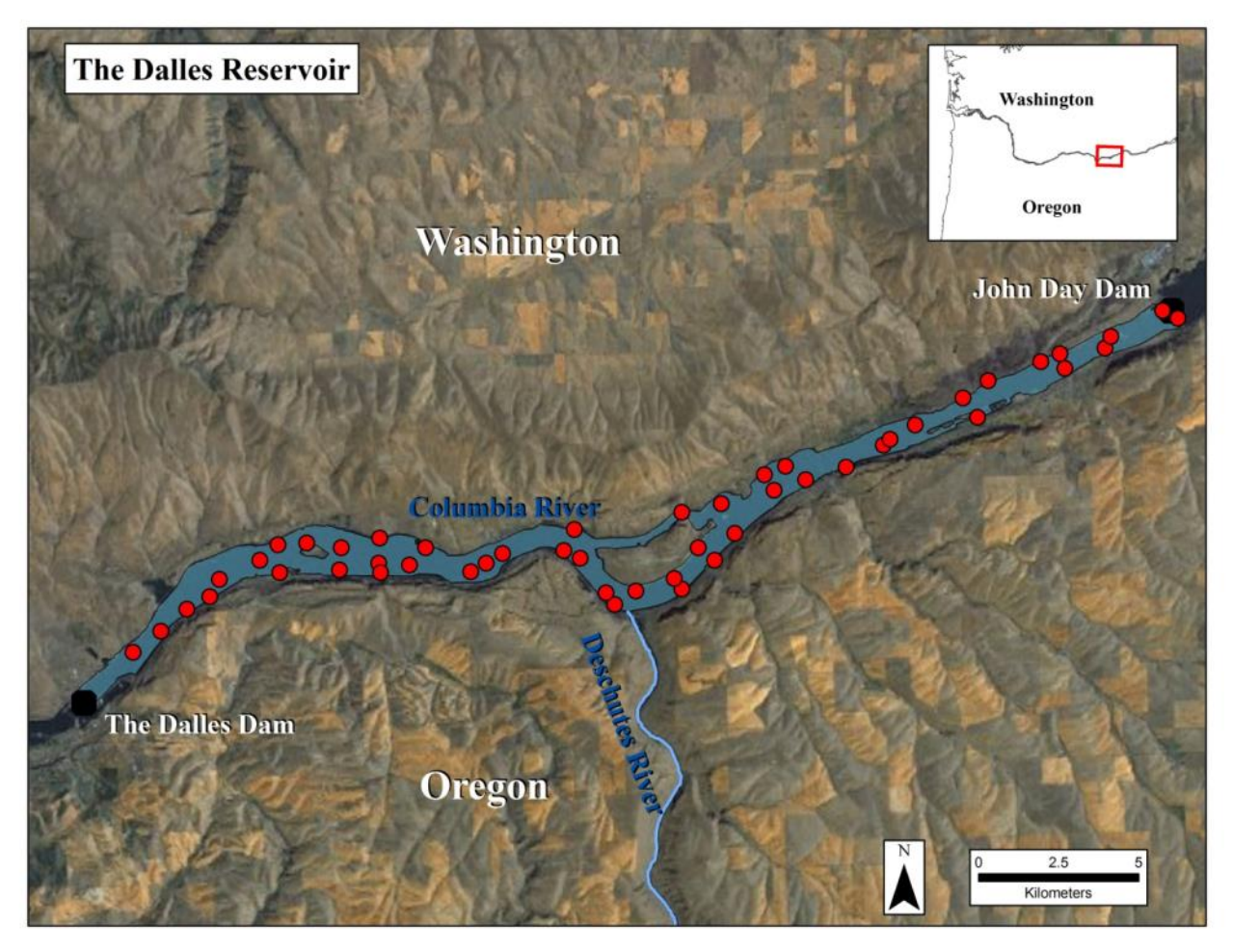

Wind R.


Little White Salmon R.

The Dalles Reservoir: Site Selection

GRTS Framework

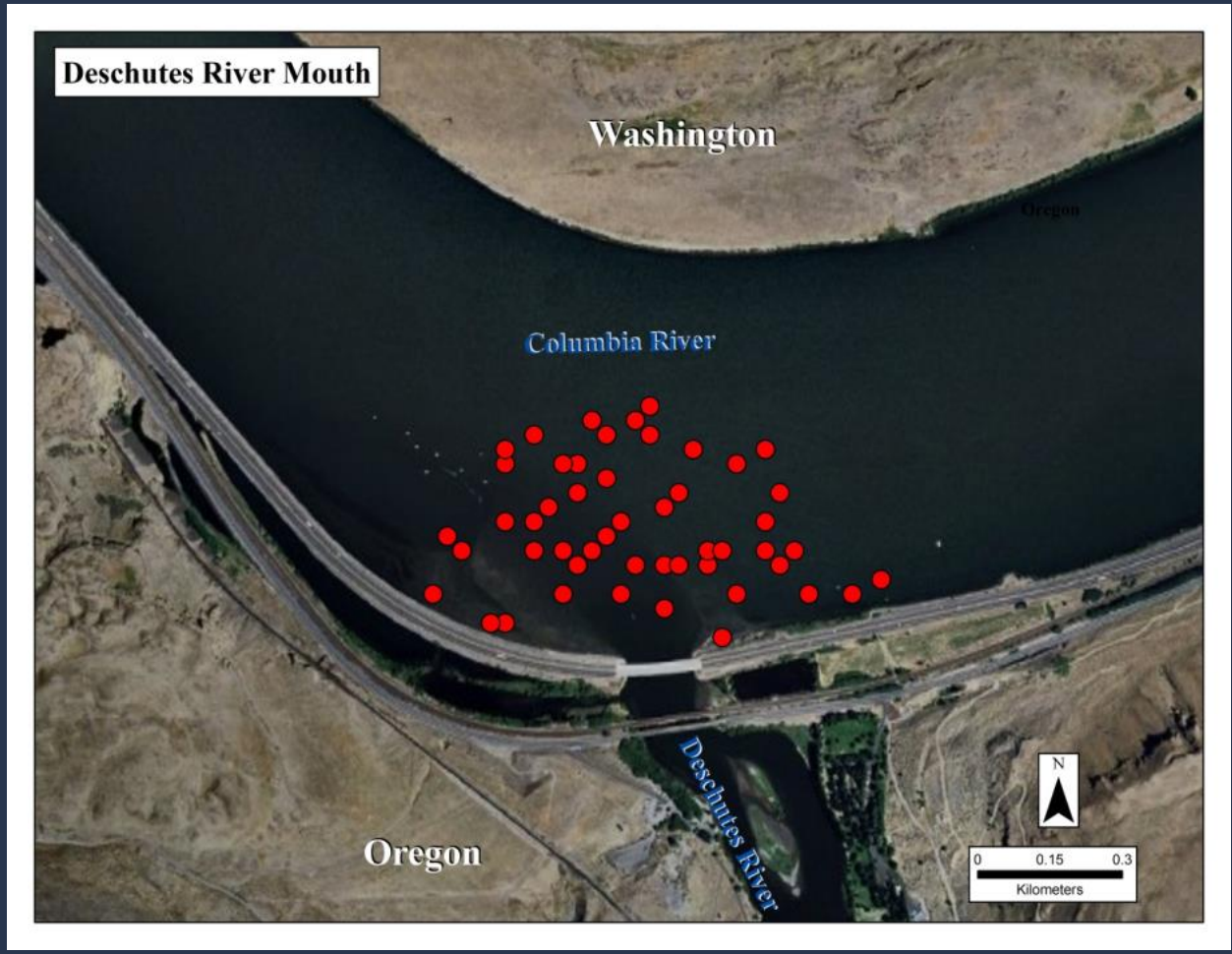
1. **30x30 m quads (41,574)**
2. **N = 34**



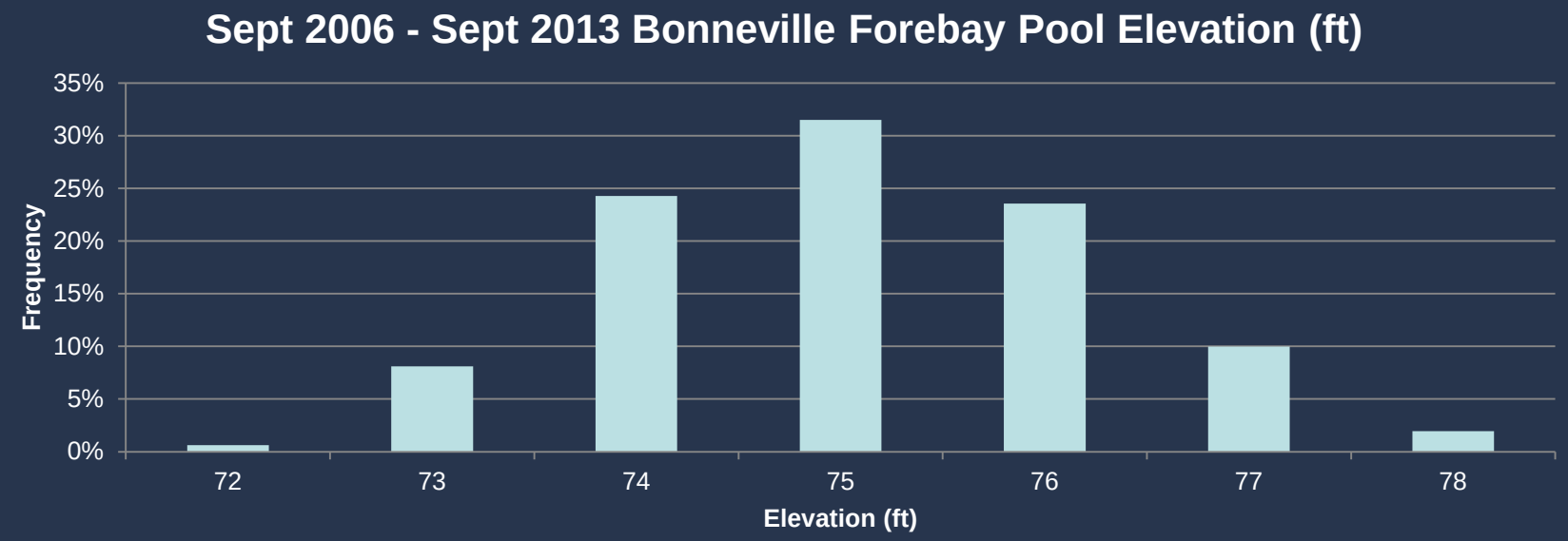
Deschutes Mouth: Site Selection

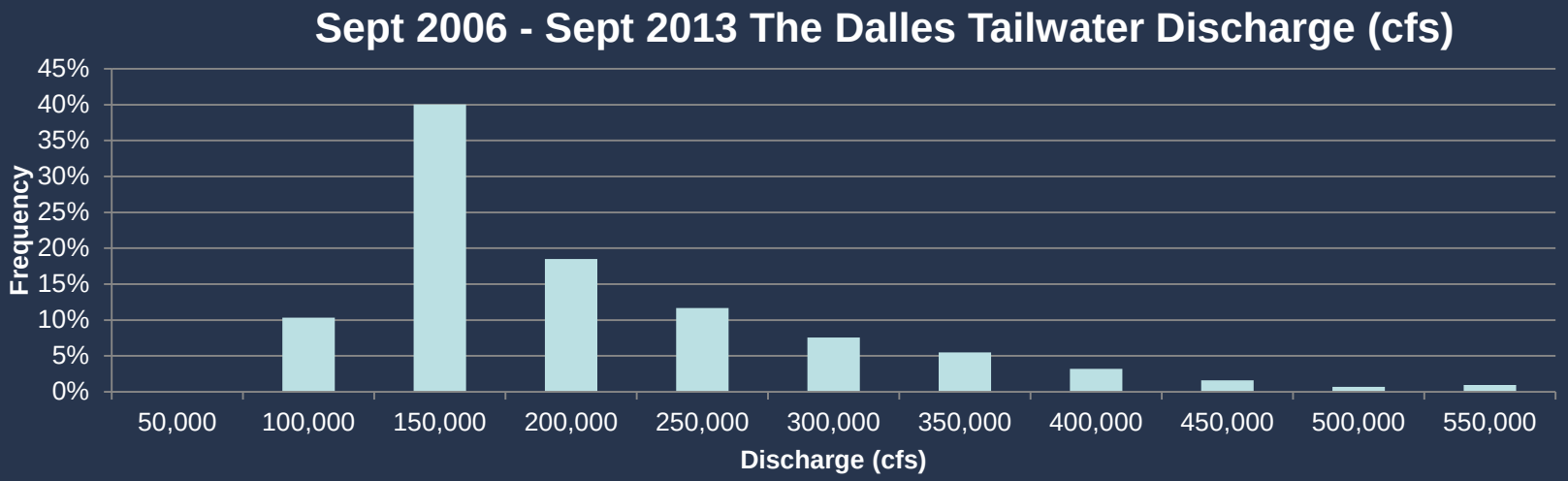
GRTS Framework

1. 500m radius from confluence
2. N = 34

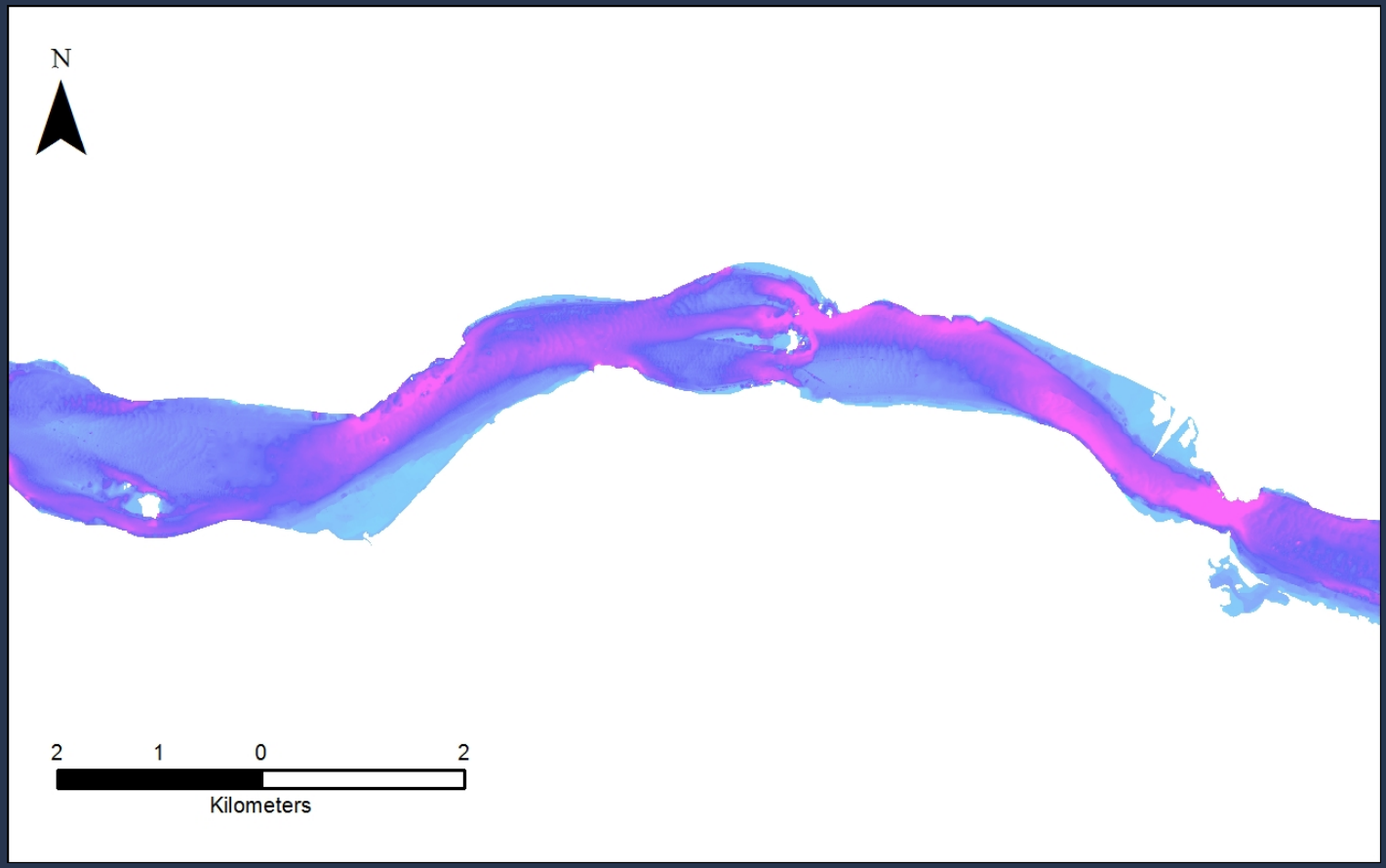


Shallow Water Strata





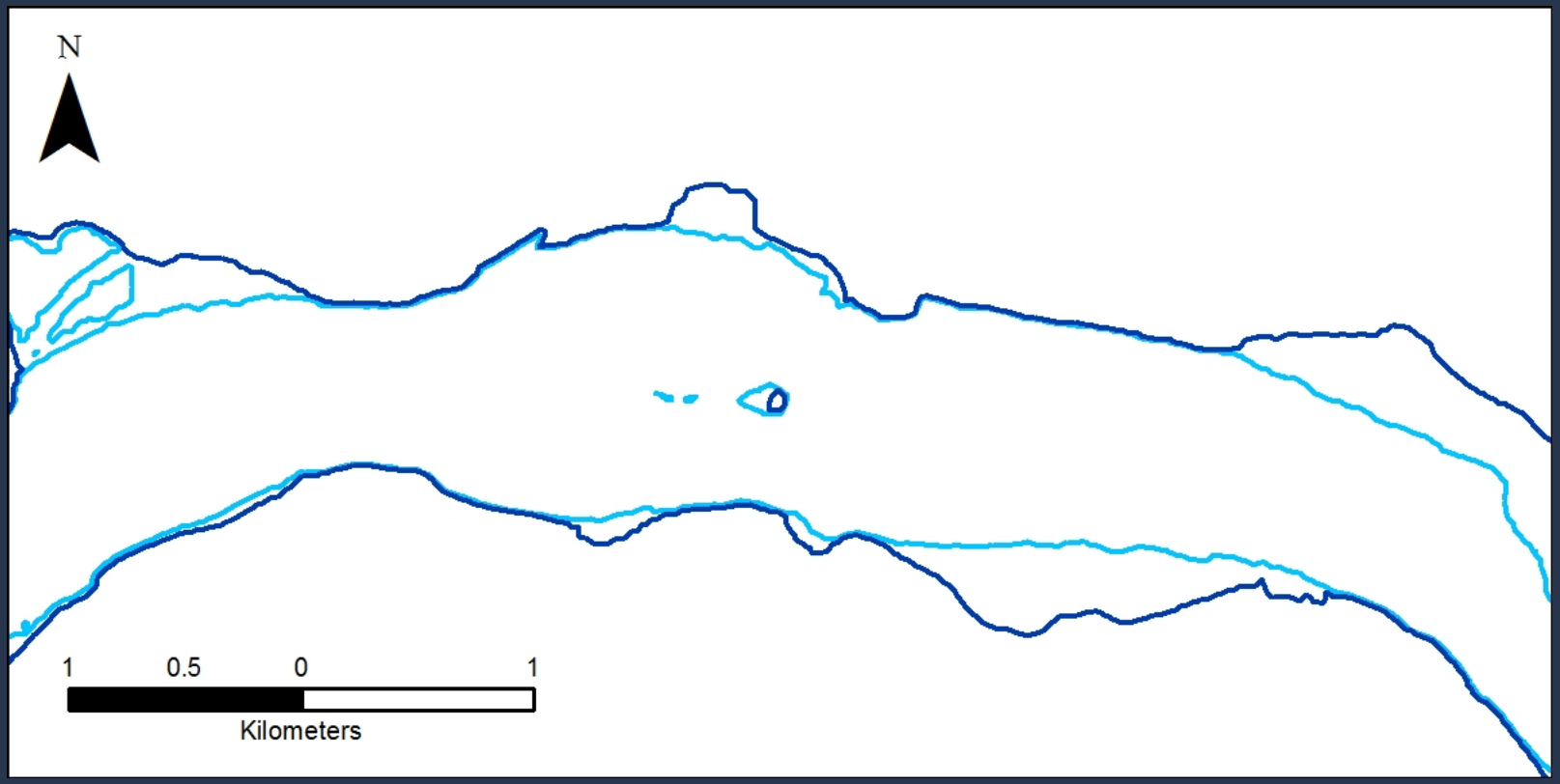
Shallow Water Strata



2D Hydrodynamic Model

- BON forebay elevation and TDA tailwater
- Bounding conditions modeled

Shallow Water Strata



Shoreline Model

- Low and high water conditions
- Area between potentially dewatered

Tools and techniques

Deepwater electrofisher methodology

- Boat-mounted bottom sampler ('bell')
- Samples 0.61m^2
- Suction pump coupled to ABP-2 efisher

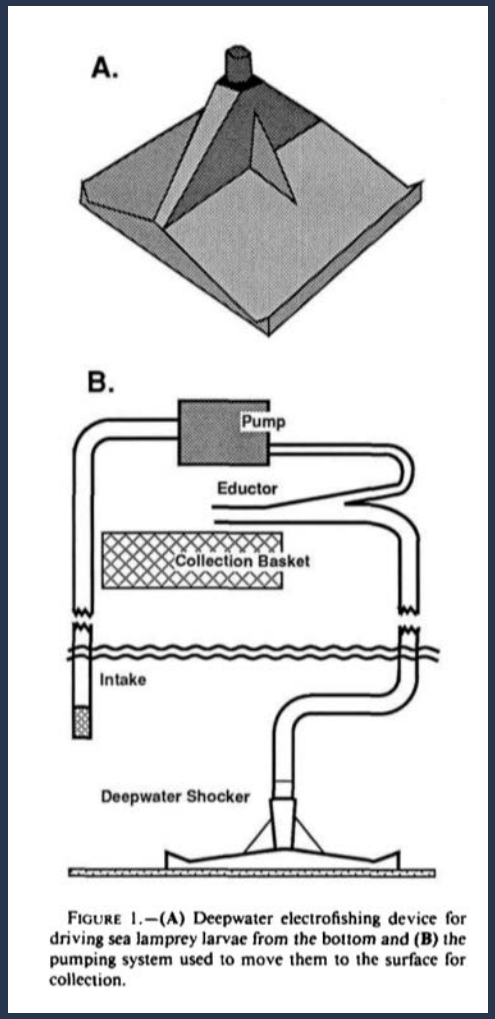


FIGURE 1.—(A) Deepwater electrofishing device for driving sea lamprey larvae from the bottom and (B) the pumping system used to move them to the surface for collection.

Bergstedt and Genovese 1994

Tools and techniques

- 3 pulses/sec, 10% duty, 2:2 pulse train
- Voltage 0.6 - 0.8 V/cm at substrate
- 1 min pulse w/concurrent suction (+1 min additional suction)
- Larvae strained into collection basket
- Deployed in depths up to 68’

Tools and techniques

Captured larvae are

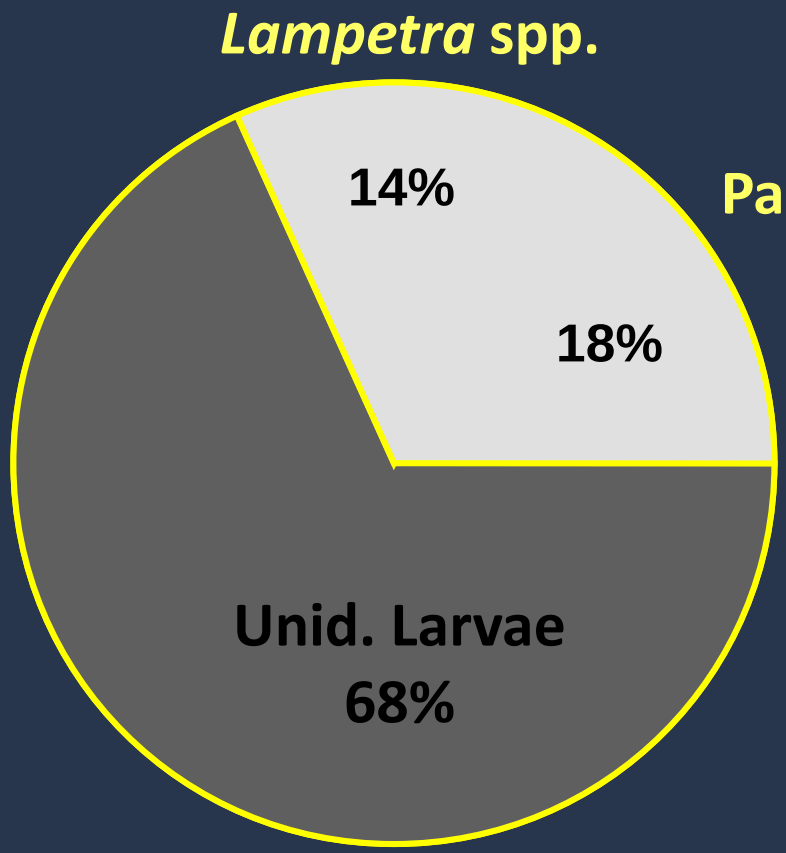
- Anesthetized
- Measured for TL
- Identified to genus using caudal pigmentation
- Caudal fin clip
- Released

2013 Preliminary Results

- All strata occupied by larval lamprey (PCL at all but LWS)
- The Dalles Pool occupied only within Deschutes River mouth
- Detection (*d*) of larvae was 0.03 in BON, and 0.11 in tributary mouth strata
- Sampled depths 0.2-20.7 m, lampreys occupied 0.3 – 13.1 m
- Number larvae in any quadrat 0 - 14

Date	Reach	Quads sampled	Quads where detected	*d*	Number larvae	PCL	WBL	UNID
8/7	Deschutes mouth	34	3	0.09	7	1	0	6
8/14-8/15	Klickitat mouth	34	4	0.12	6	5	0	1
8/29 - 9/4	Klickitat mouth	34	9	0.26	53	4	0	49
9/11	Klickitat mouth	34	12	0.35	42	3	0	39
8/19	Wind mouth	34	6	0.18	17	3	8	6
9/10	Wind mouth	34	7	0.21	23	7	8	8
9/24	Wind mouth	34	8	0.24	25	2	7	16
9/12 - 10/22	Hood mouth	34	3	0.09	6	3	0	3
9/12 - 11/4	White Salmon mouth	34	4	0.12	7	4	0	3
11/19	Little White Salmon mouth	34	3	0.09	4	0	4	0
11/4 - 11/18	Bonneville Reservoir	34	1	0.03	2	2	0	0
11/20 - 11/21	The Dalles Reservoir	32	0	0.00	0	0	0	0
				Totals	192	34	27	131

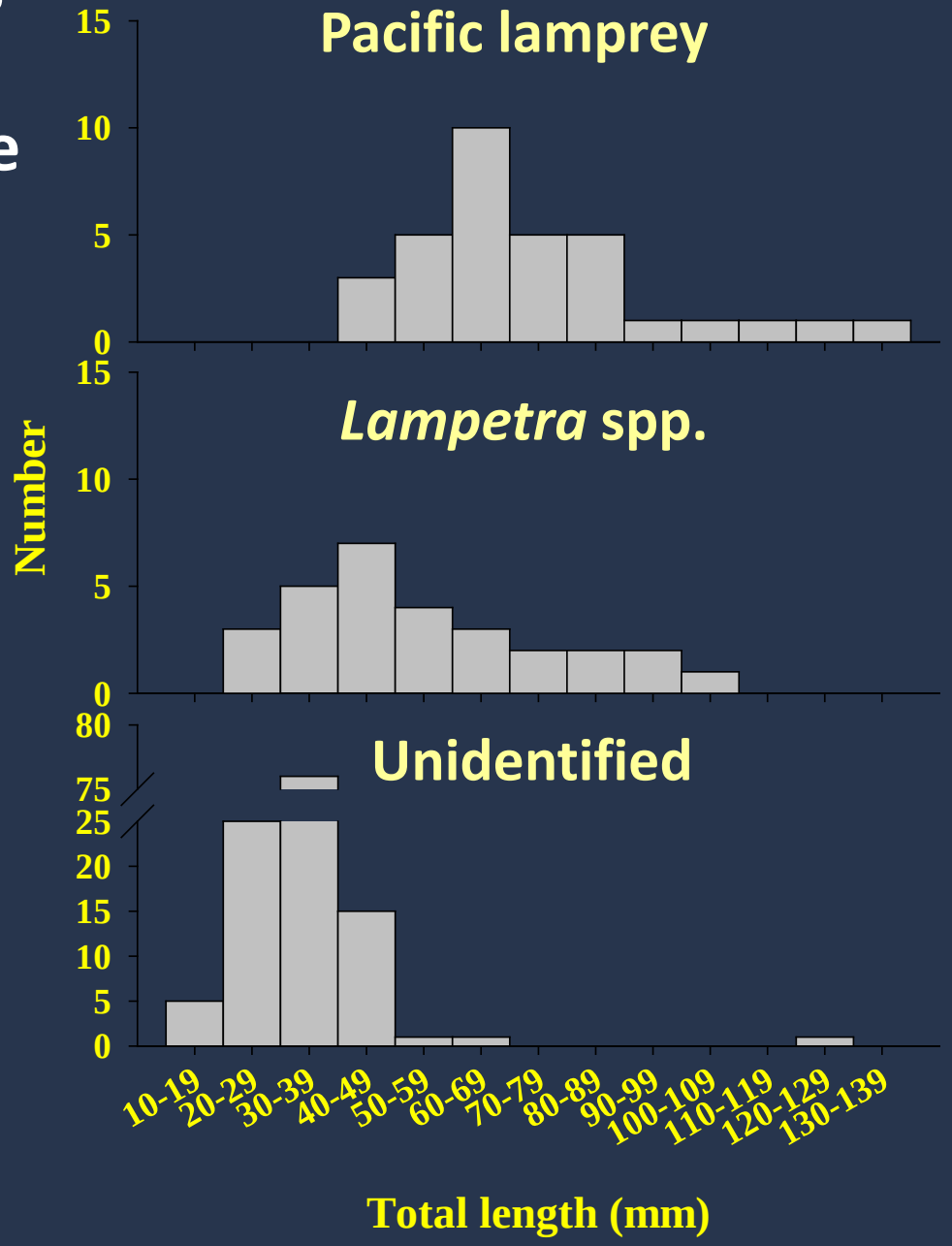
Species



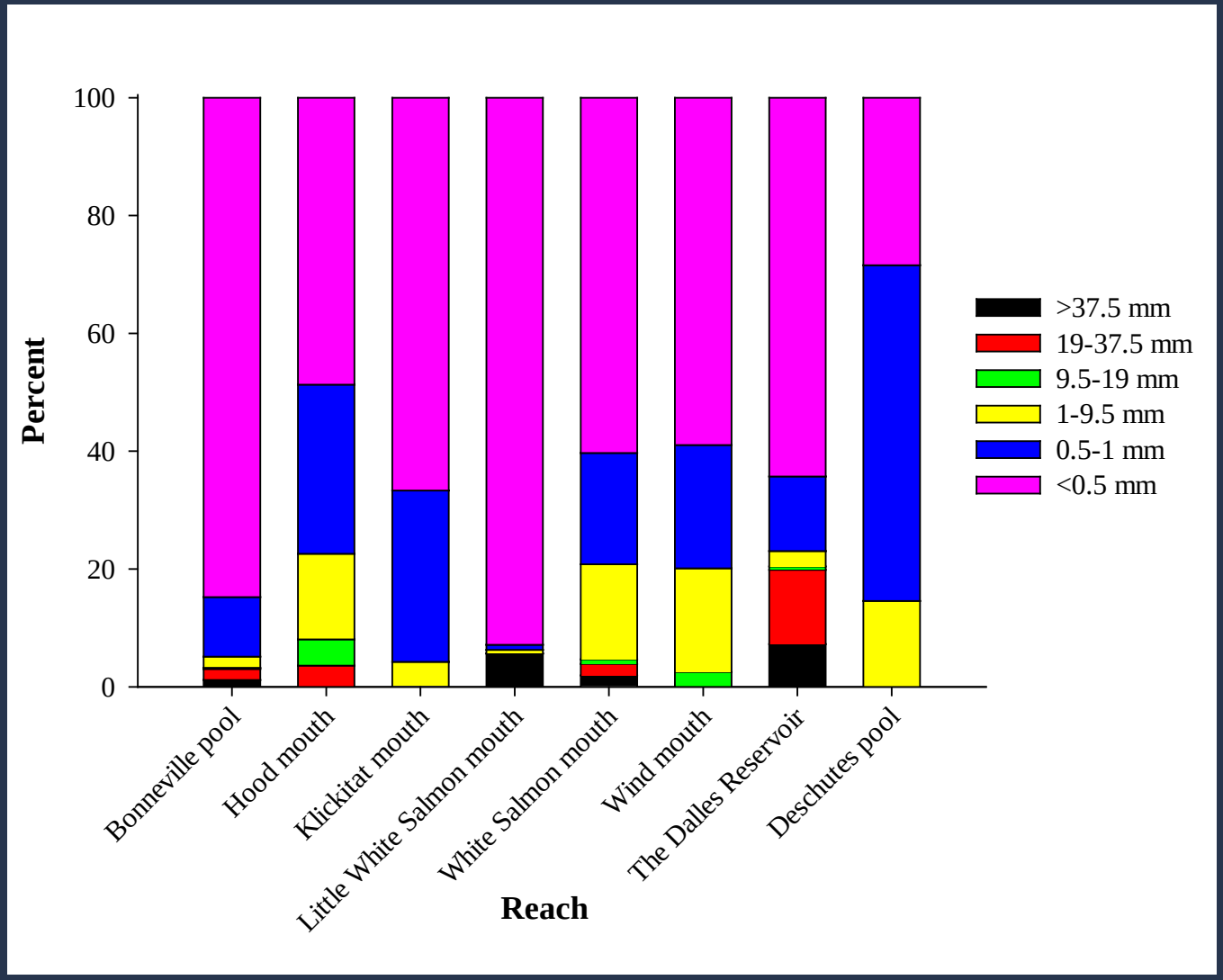
- 192 larvae total
  - 34 Pacific lamprey
  - 27 *Lampetra* spp.
  - 131 unid. larvae

Preliminary Results

- Abundant age 0 larvae
- TL range 15 – 140 mm



Substrate


Percent
100
80
60
40
20
0
Bonneville pool
Hood mouth
Klickitat mouth
Little White Salmon mouth
White Salmon mouth
Wind mouth
The Dalles Reservoir
Deschutes pool
Reach
>37.5 mm
19-37.5 mm
9.5-19 mm
1-9.5 mm
0.5-1 mm
<0.5 mm

Year	Reach	*d*	Pacific lamprey	Western brook lamprey	Unid	Total	Source
2009	Lower Willamette River	0.07	5	6	1	12	Jolley et al. 2012c
2010	Bonneville Reservoir	0.02	1	0	0	1	Jolley et al. 2011a
	Bonneville Tailwater	0.00	0	0	0	0	
2011	Bonneville Tailwater	0.03	0	1	0	1	Jolley et al. 2012a
	Hood River mouth	0.06	1	1	0	2	
	Klickitat River mouth	0.00	0	0	0	0	
	White Salmon River mouth	0.00	0	0	0	0	
	Wind River mouth	0.29	22	9	6	37	
	Lower Klickitat River	0.26	13	0	2	15	Jolley et al. 2012b
	Lower White Salmon River	0.29	5	11	3	19	
	Lower Wind River	0.32	13	9	4	26	
2012	Klickitat River mouth	0.12	3	0	2	5	Jolley et al. 2013b
	White Salmon River mouth	0.03	1	0	0	1	
	Wind River mouth	0.29	6	15	16	37	
	Lower Klickitat River	0.03	1	0	0	1	
	Lower White Salmon River	0.09	0	4	0	4	
	Lower Wind River	0.24	4	10	1	15	
	The Dalles Pool	0.00	0	0	0	0	Jolley et al. 2013a
	Deschutes River mouth	0.00	0	0	0	0	
2013	Deschutes mouth	0.09	1	0	6	7	Jolley et al. *in prep*
	Klickitat mouth	0.12	5	0	1	6	
	Klickitat mouth	0.26	4	0	49	53	
	Klickitat mouth	0.35	3	0	39	42	
	Wind mouth	0.18	3	8	6	17	
	Wind mouth	0.21	7	8	8	23	
	Wind mouth	0.24	2	7	16	25	
	Hood mouth	0.09	3	0	3	6	
	White Salmon mouth	0.12	4	0	3	7	
	Little White Salmon mouth	0.09	0	4	0	4	
	Bonneville Reservoir	0.03	2	0	0	2	
	The Dalles Reservoir	0.00	0	0	0	0	

Summary

- BON and TDA pools are occupied with larval lamprey
- Detection rates were higher proximate to tributary inputs
- Multiple species over wide size range were present – large number of age-0 larvae
- Larval lamprey may be widely distributed throughout the Columbia River mainstem
- It is possible that mainstem areas of large rivers are important rearing areas for larval lamprey and that larvae may rear in these habitats for numerous years

2014 Work

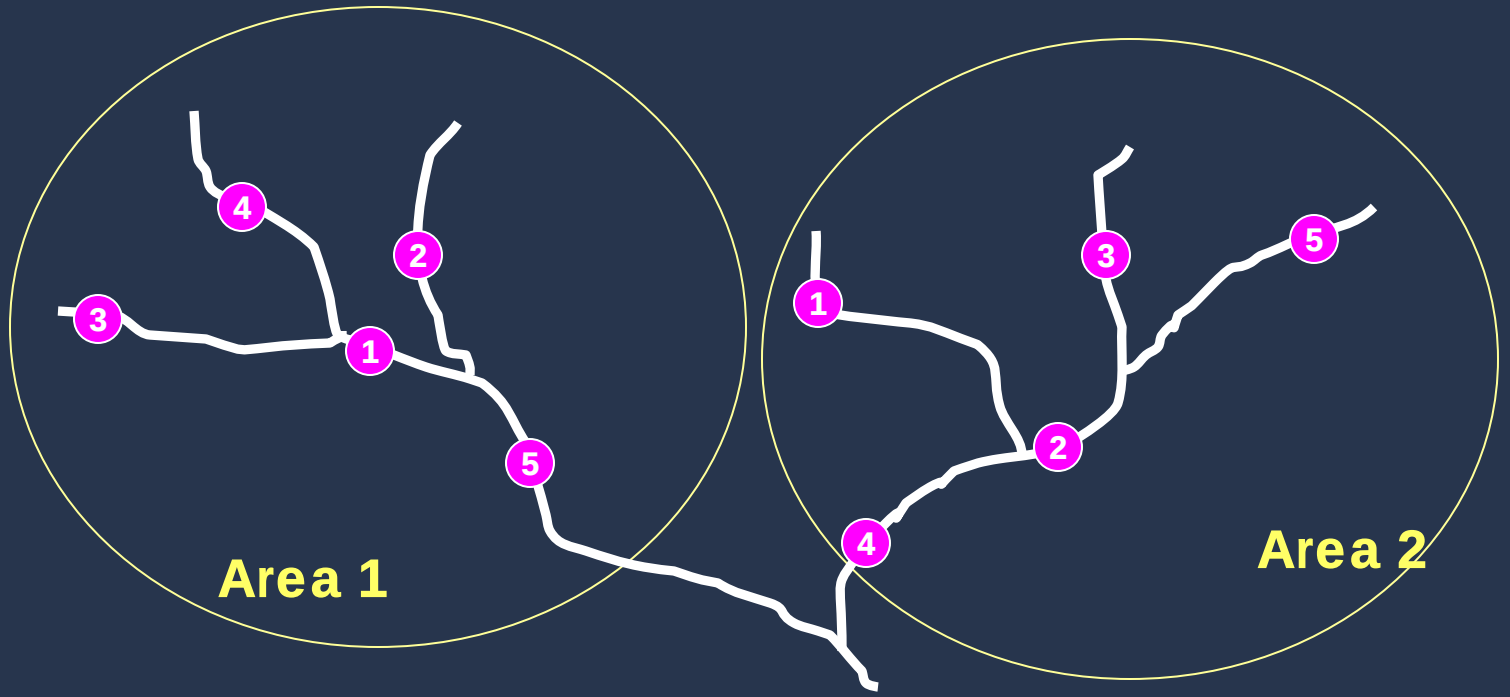
- Sample shallow strata in BON
- Analysis of tissue samples for genetic ID
- JDA and MCN pools

Guidance for Pacific lamprey distribution and occupancy

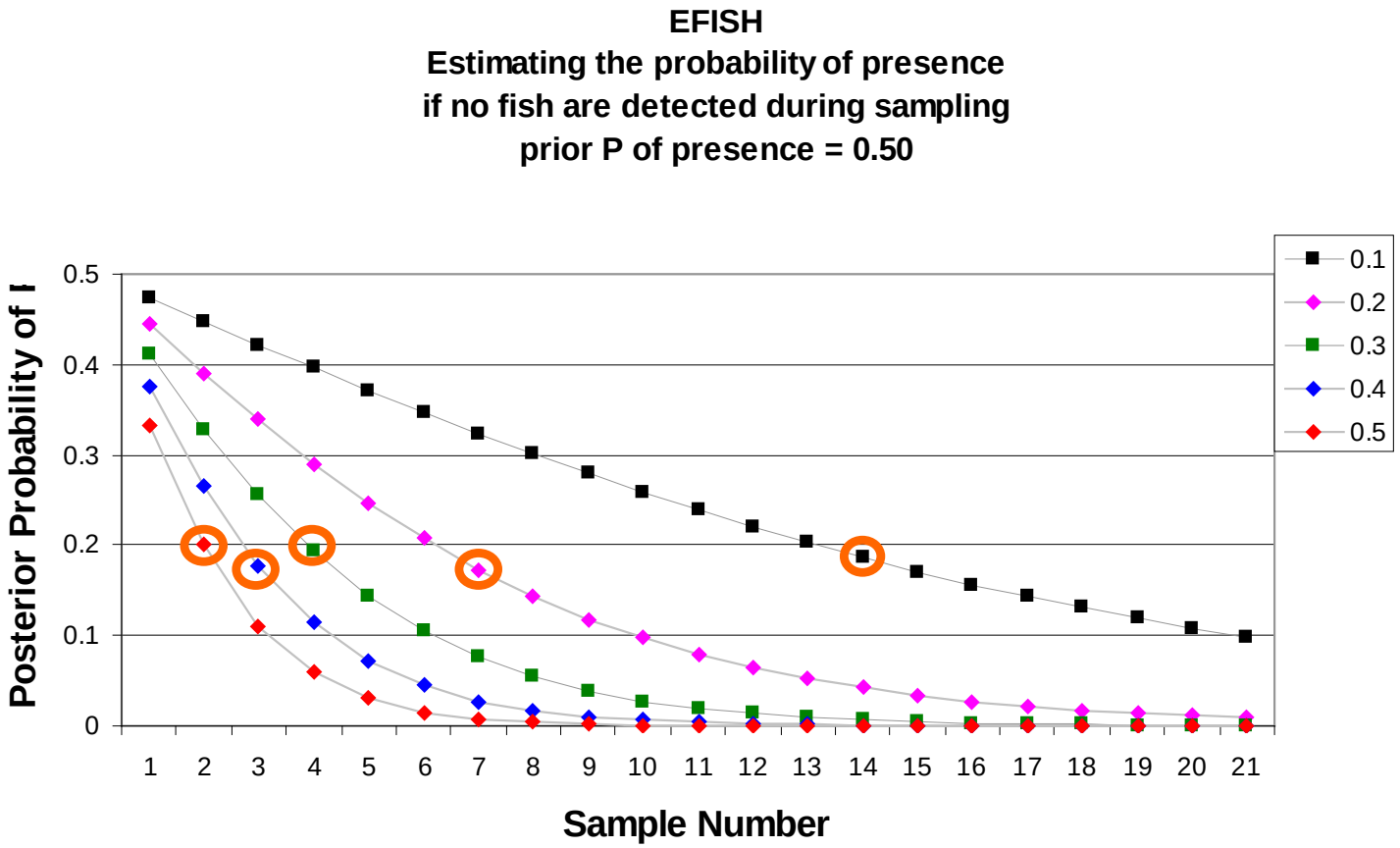
- Goal – provide one technique and useful applications (mostly for wadeable areas)
- Goal – collaborate, increase efficiency among partners
- Not – dictate how to sample

Detection Probability Approach

- EPA/EMAP work
- Generalized Random Tesselation Stratified (GRTS)
- Random selection
- Spatially balanced
- Statistically robust



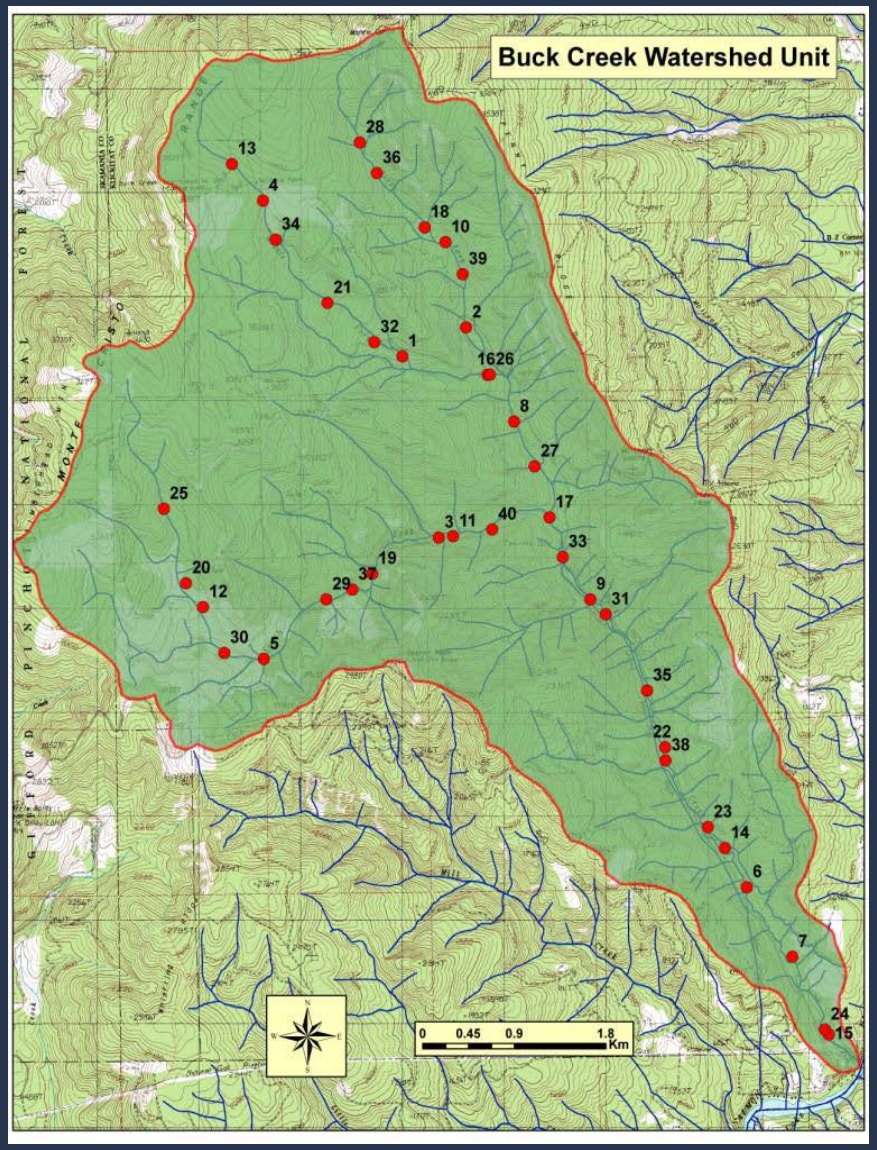
Probability of Detection - Model

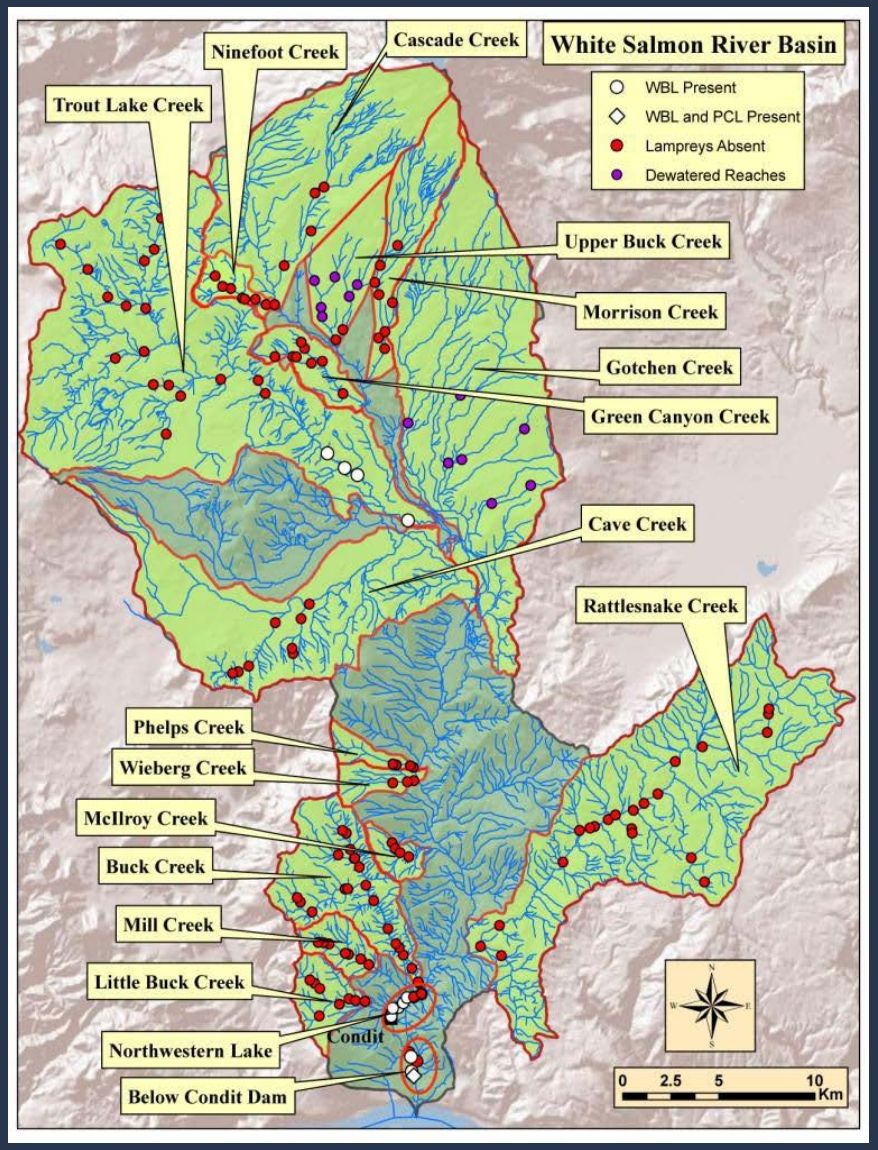


Occupancy - Lamprey

- **White Salmon River Application**
  - pre/post Condit dam removal assesment
  - are lamprey there (above)?
  - assume P(d) ~ 0.20 = 7 reaches (80% certainty)
  - assess occupancy (3rd order patches)
  - gain additional P(d)

White Salmon - Lamprey





White Salmon - Lamprey

Unit	Year	#RSam	#ROcc	Est. Prob. of Occ.
Buck Creek	2007	21	0	< 0.02
Trout Lake Creek	2007	21	4	1.00
Rattlesnake Creek (b)		2007	3	0 < 0.35
Little Buck Creek	2008	8	0	< 0.20
Mill Creek	2008	7	0	< 0.20
Morrison Creek	2008	5	0	< 0.30
Phelps Creek	2009	4	0	0.30
Wieberg Creek	2009	3	0	< 0.35
Gotchen Creek	2009	0	0	-
Upper Buck Creek	2009	2	0	< 0.40
Rattlesnake Creek	2007, 2009	21	0	< 0.02
Green Canyon Creek		2010	8	0 <0.20
Cave Creek	2010	8	0	<0.20
Ninefoot Creek	2010	8	0	<0.20
Cascade Creek	2010	4	0	0.30
McIlroy Creek	2010	4	0	0.30

Lessons

1)Can we use reaches/GRTS?
    1) YES
2)What is P(d)?
    1) Approximately 0.95 (Cedar Creek experience)
    2) HIGHLY detectable
3)Required Effort?
    1) 3.5 min/reach to detect
        1) Evaluate occupancy (8 reaches)
        2) Determine P(d) (21 reaches)

Limitations/Opportunities

1) Unknown relationship between (i.e.) abundance & D.P.
    1) Reintroductions could help

2) Standardized approach throughout region?

Workshops

- Stay tuned on workshop announcements
- Contact me if you are interested

- Questions….

Preliminary Results

The problem: detecting rare/patchily distributed animals

	Present	Absent
Present	Correct	Non-sensical
Absent	Incorrect (false absence)	Correct

Probability of Detection - Reach