Larval Lamprey Occurrence in a Tidally-Influenced Coastal Stream

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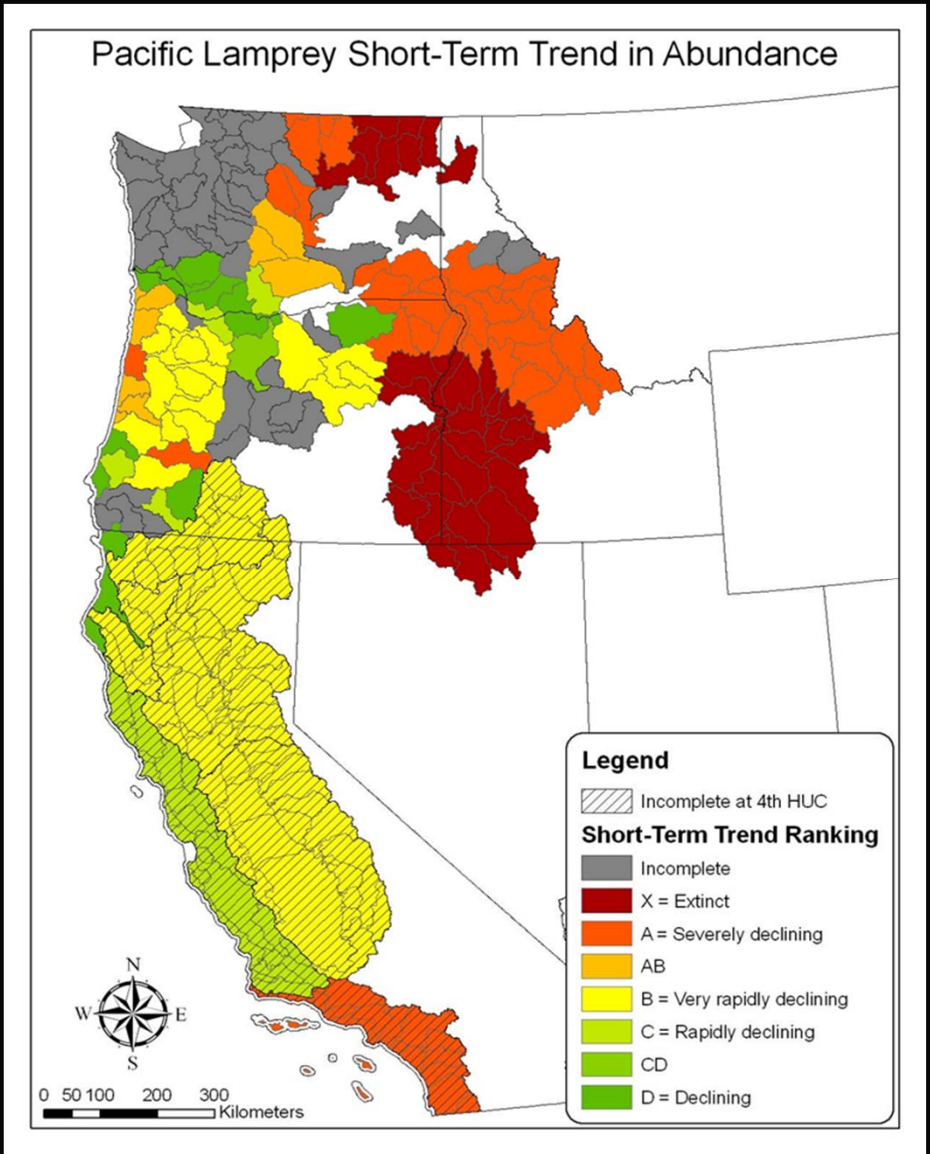
Pacific Lamprey: Status and Trend

- Declines in Pacific lamprey abundance and constriction in range, threaten persistence in the Western US
- Conservation a priority, efforts hampered by lack of biological and ecological information
- Addressing uncertainties relative to **larval distribution** is among many research needs identified



Luzier et al. 2011

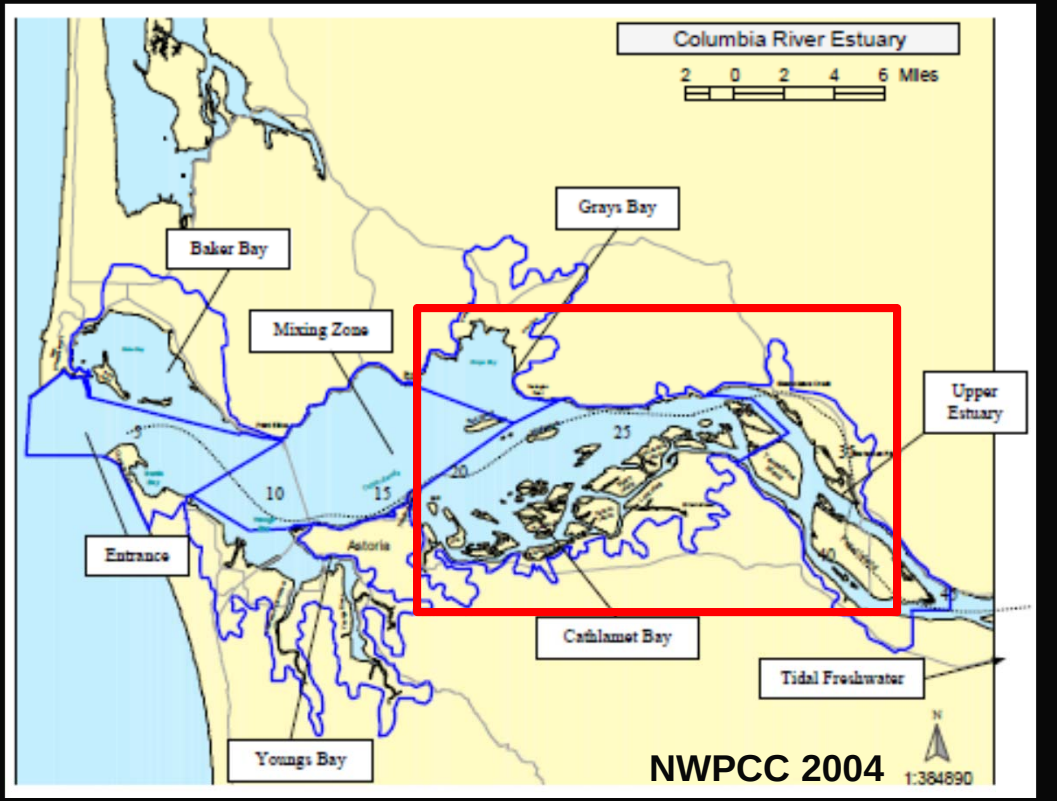
Proposed Research

To better understand distribution of larval Pacific lamprey in the PNW, we proposed to explore occurrence of larval lamprey in tidally-influenced estuary habitats

- Occurrence of larvae in estuary habitats largely unknown, not extensively investigated
- Likely due to both
    i. Difficulty sampling for larval lampreys in such habitats
    ii. Uncertainty whether freshwater-adapted larval lampreys can survive in saline estuarine waters

Proposed Research

- Upstream regions of estuaries (e.g., oligohaline habitats) have low or episodic salinity
- Low levels of salinity may be within range tolerable by larvae
- Habitats may potentially be suitable for larval occurrence



- These habitats may comprise extensive areas in some estuaries (such as the Columbia estuary) and potentially be valuable for larval rearing

Research Implications

Understanding larval estuary habitat usage may prove important for lamprey conservation & management

- Informing design and implementation of estuary habitat restoration projects
- Gauging potential impacts of channel dredging, development, climate change, and other disturbances on larval lampreys

Thesis Project Summary

The Question

- **Do larval Pacific lamprey occur in a tidally-influenced estuarine area?**

Phase I

- **Evaluate larval lamprey osmoregulatory ability and tolerance to a range of salinities in laboratory experiments. Use results to guide Phase II.**

Results

- **High survival of larvae in 12 ppt & 15 ppt tidal simulation experiments. Suggest larvae may occur in similar habitats in the wild.**

Phase II

- **Investigate larval lamprey occurrence in a tidally-influenced estuarine habitat**

Phase II

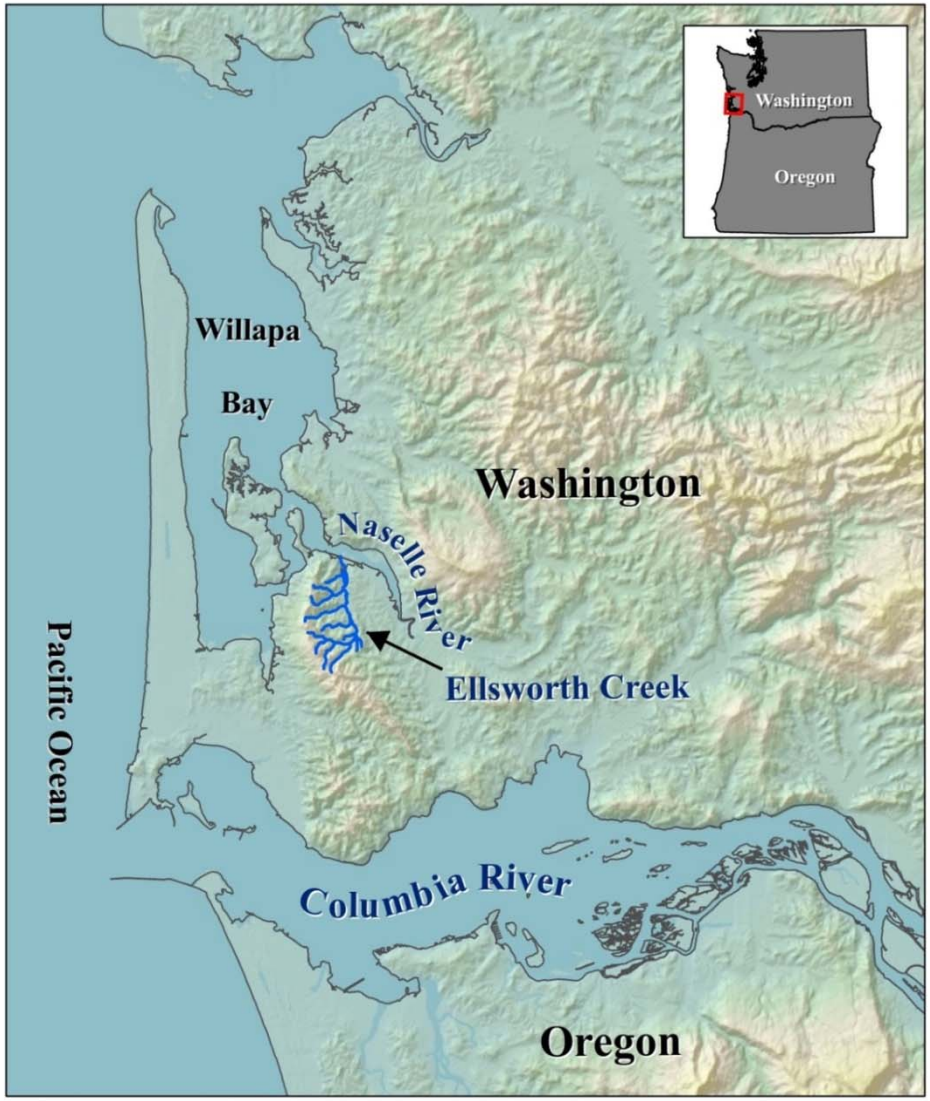
Objective. Investigate larval lamprey occurrence in a tidally-influenced estuarine environment

Task 1. Determine larval lamprey presence or absence across a gradient of salinity in a tidally-influenced estuarine habitat by electrofishing

Task 2. Characterize salinity conditions in tidally-influenced habitats where larvae are detected through installation of salinity loggers

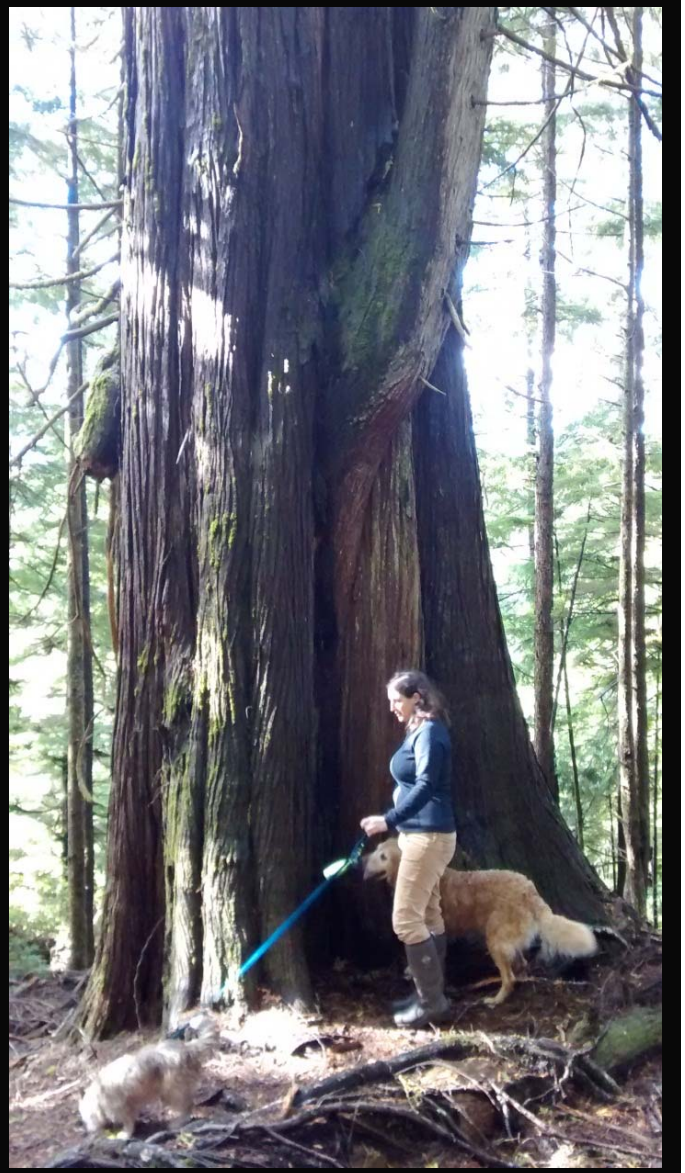
Study Area
Ellsworth Creek

- In southwestern WA, near Long Beach
- Wade-able 3rd order stream
- Flows into Naselle River estuary, then Willapa Bay
- Mouth is ~30km from Pacific Ocean



Study Area
Ellsworth Creek Preserve

- Experimental forest, entire watershed owned by The Nature Conservancy
- Impressive examples of old-growth Sitka spruce, western redcedar, western hemlock, Douglas fir



Study Area
Ellsworth Creek

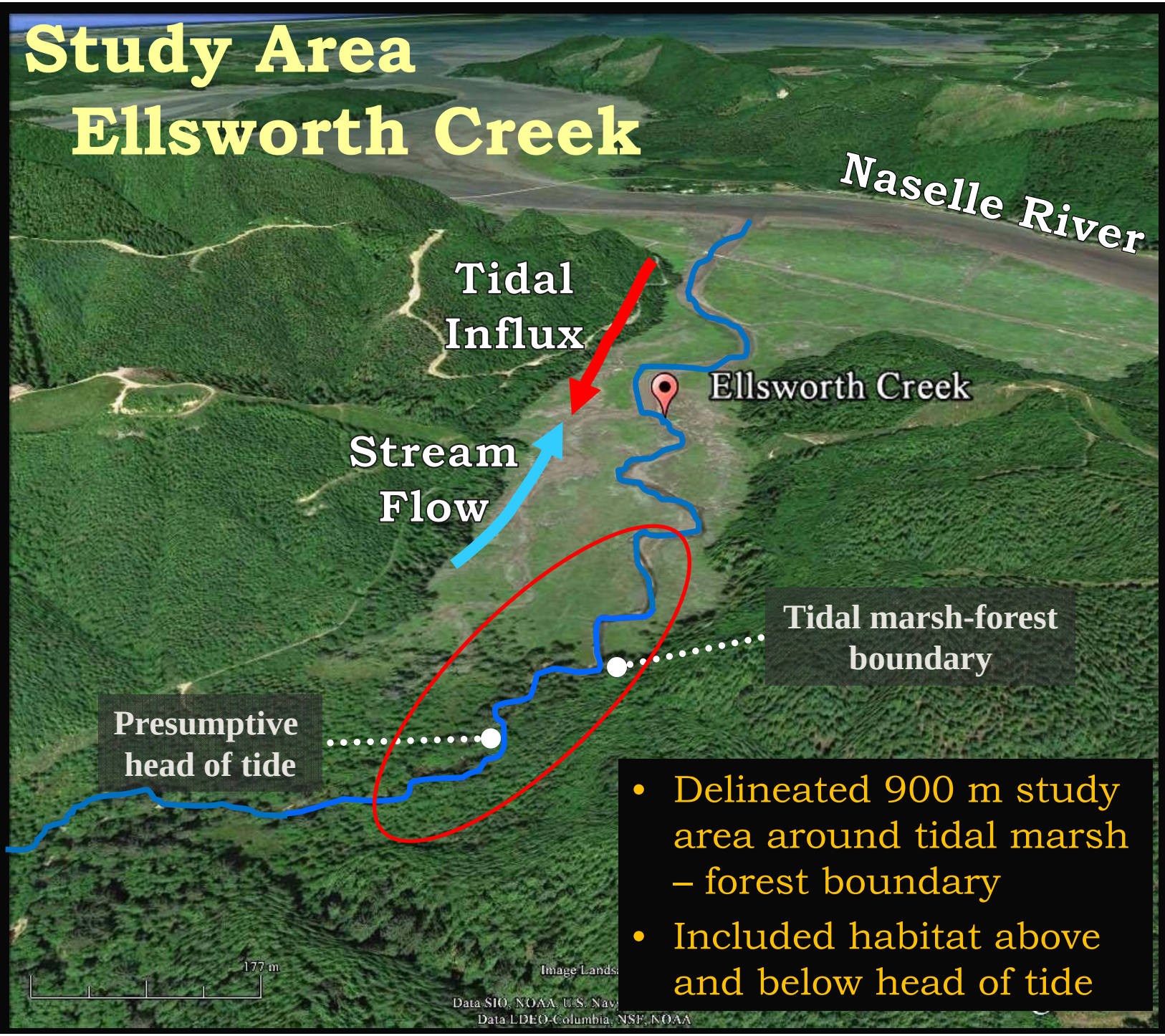
- Originates in coastal mountains
- Drains through ~2500m long tidal marsh at downstream end

- Non-tidal habitats occupied by Pacific, Western Brook (*Lampetra richardsoni*), and/or Western River (*L. ayresi*) lampreys
  - Henceforth *Lampetra* spp.

Study Area
Ellsworth Creek

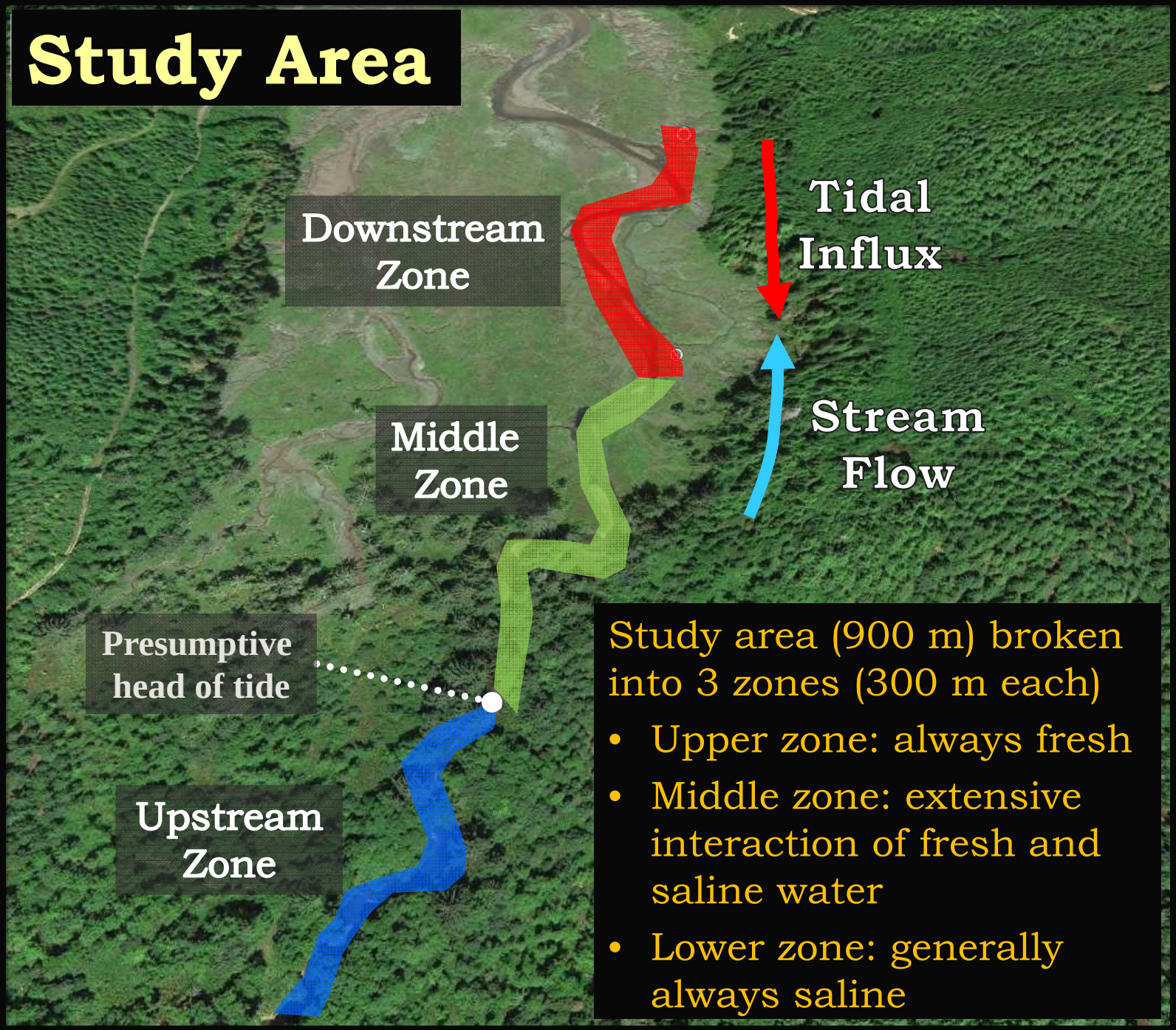
- Tidal influence extends upstream beyond tidal marsh – forest boundary ~200 m
- Water surface elevation varies generally between 1 m to 2 m from high to low tide in this region

Study Area
Ellsworth Creek



- Delineated 900 m study area around tidal marsh – forest boundary
- Included habitat above and below head of tide

Study Area



Study area (900 m) broken into 3 zones (300 m each)

- Upper zone: always fresh
- Middle zone: extensive interaction of fresh and saline water
- Lower zone: generally always saline

Study Area

Sample Design

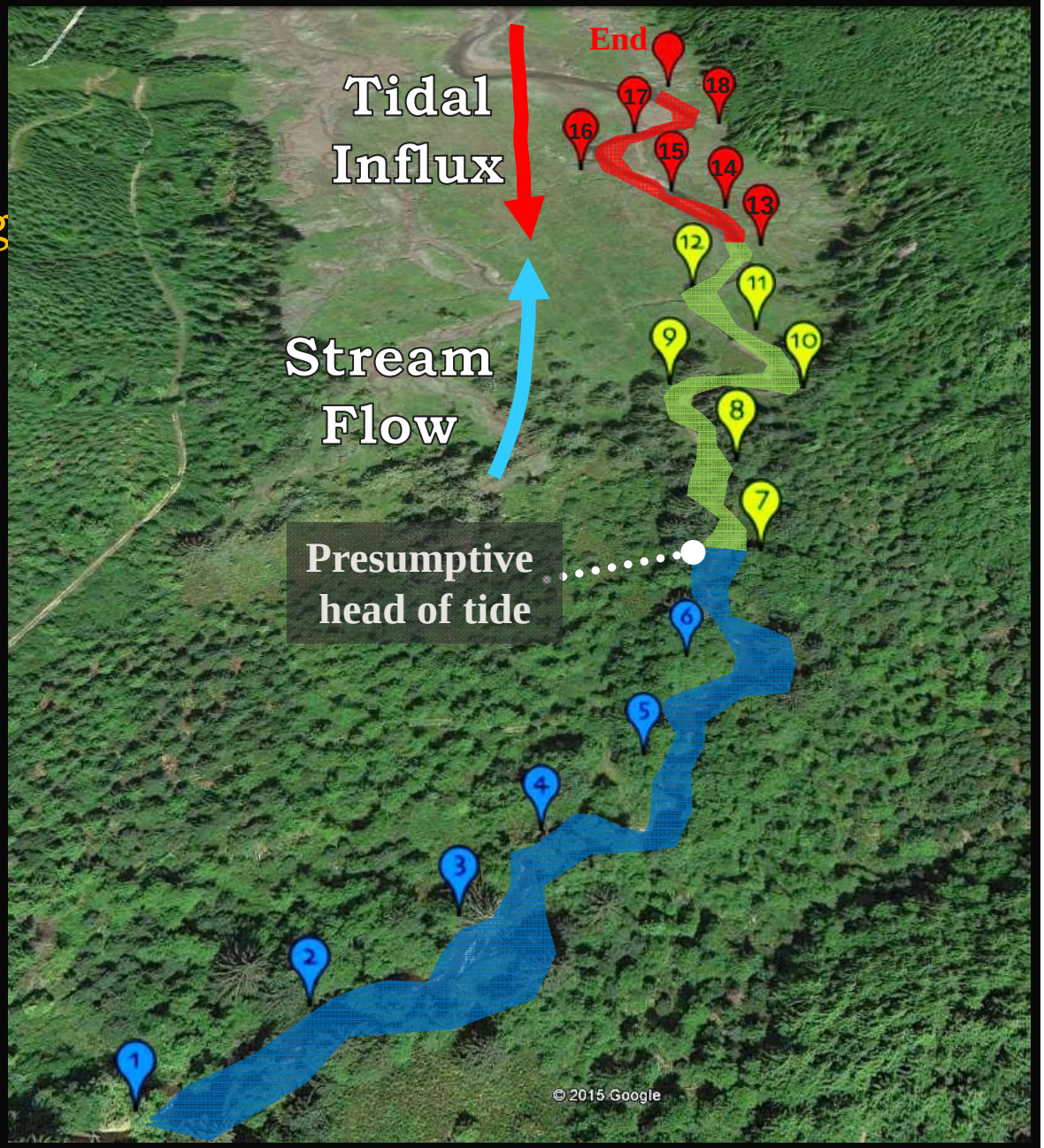
- Each zone divided into 6 contiguous 50 m long sample reaches

Flags denote reach numbers, increase moving downstream

  - 1 most upstream
  - 18 most down

Task 1

- Sample each reach for presence/absence of larval Pacific and *Lampetra* spp.



Methods: Larval Sampling

Reach Sampling

- Low tide
- Single electrofishing pass with ABP-2 backpack electrofisher
- Sample from downstream to upstream, begin at reach 18 (lower-most reach)
- Work up catch after each reach

Methods: Habitat Data Collection

In each reach, at time of sampling measure

- Salinity
- Conductivity
- Water temp
- Dissolved O_2

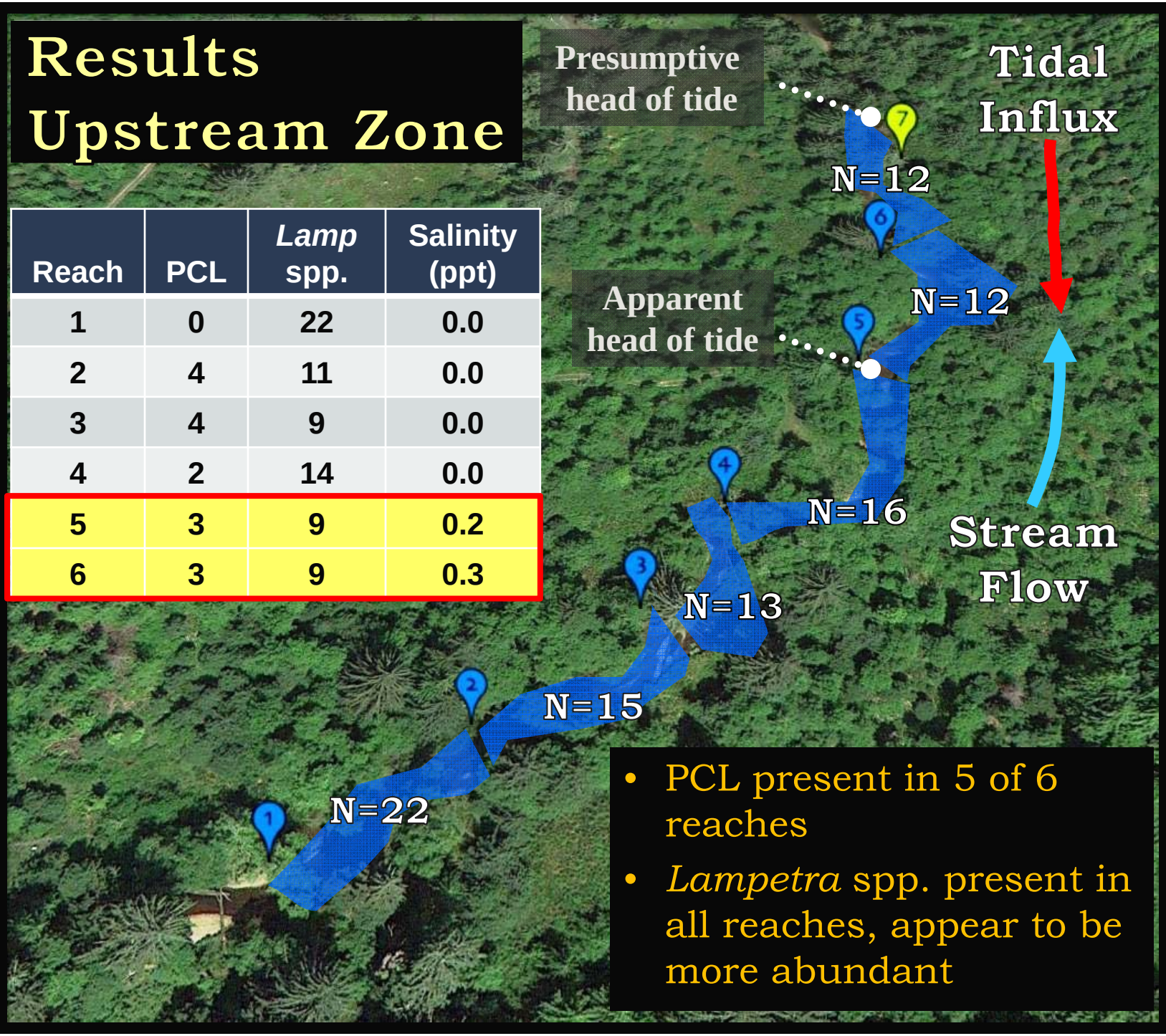
Methods: Larval Sampling

Larval Data Collection

- Anesthetize (Buffered MS-222)
- Identify to Genus
- Measure TL, weight
- Snip caudal tissue (genetic identification)
- Release back into reach where collected

Results
Upstream Zone

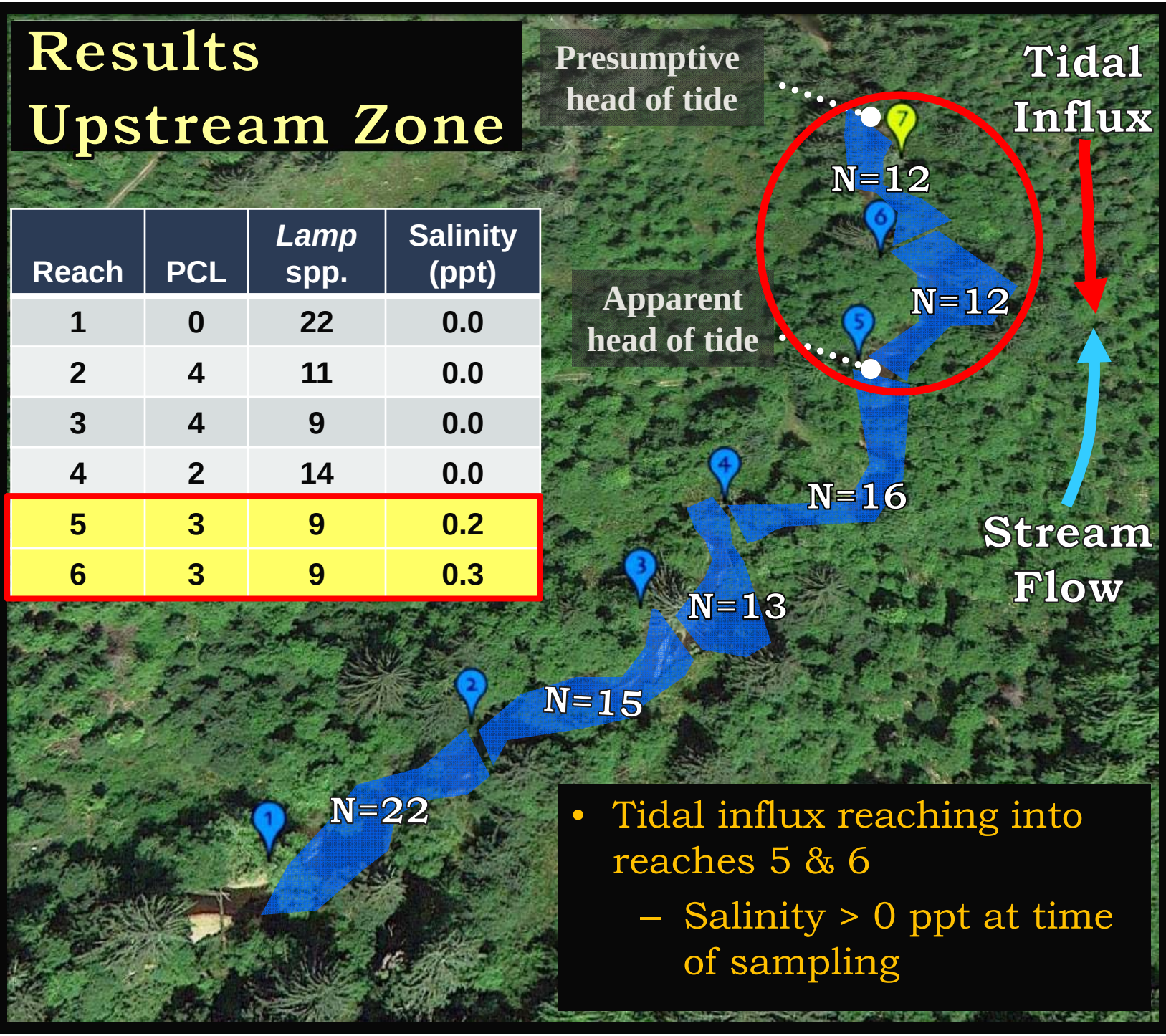
Reach	PCL	*Lamp* spp.	Salinity (ppt)
1	0	22	0.0
2	4	11	0.0
3	4	9	0.0
4	2	14	0.0
5	3	9	0.2
6	3	9	0.3



- PCL present in 5 of 6 reaches
- *Lampetra* spp. present in all reaches, appear to be more abundant

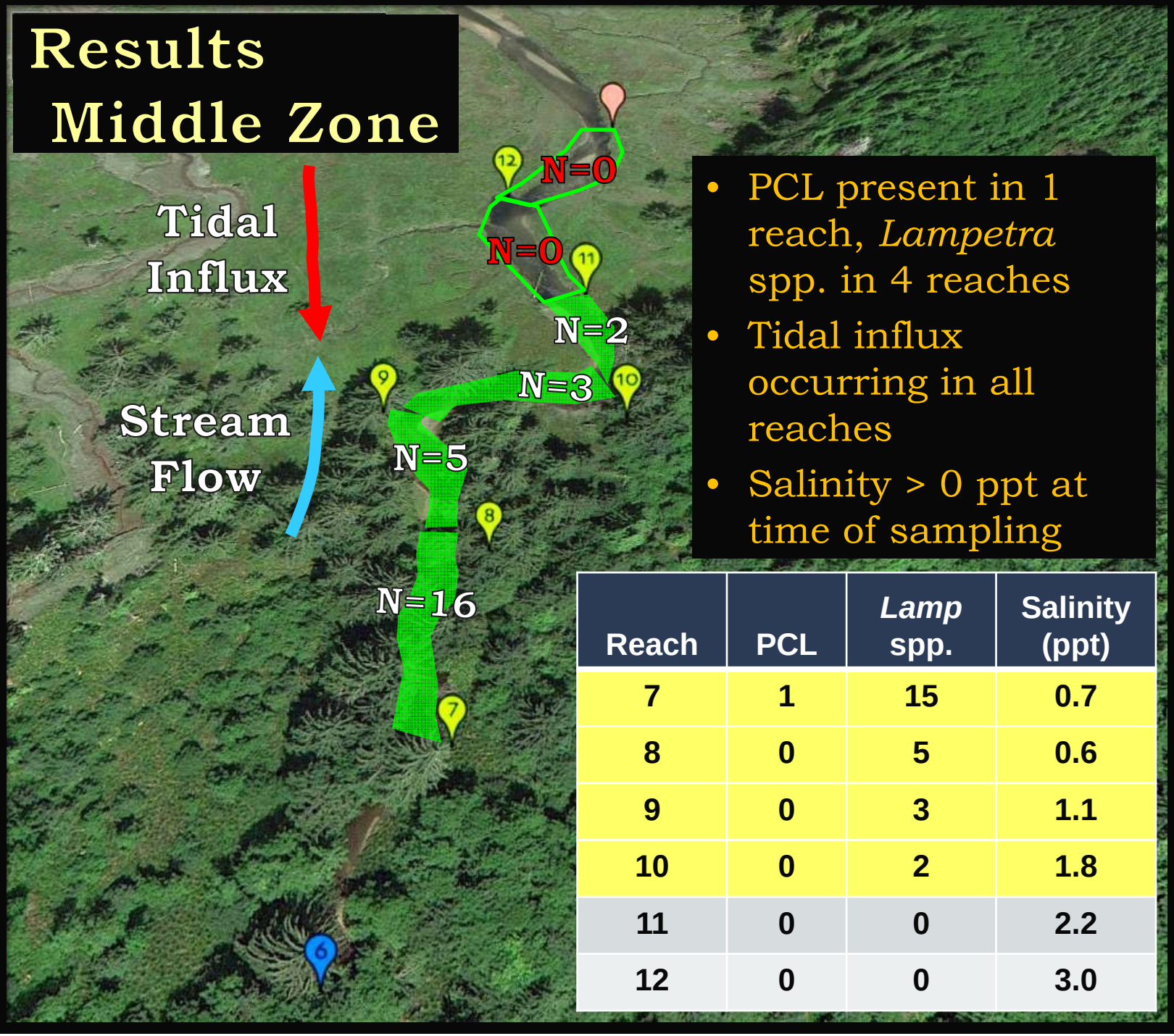
Results
Upstream Zone

Reach	PCL	*Lamp* spp.	Salinity (ppt)
1	0	22	0.0
2	4	11	0.0
3	4	9	0.0
4	2	14	0.0
5	3	9	0.2
6	3	9	0.3



- Tidal influx reaching into reaches 5 & 6
  - Salinity > 0 ppt at time of sampling

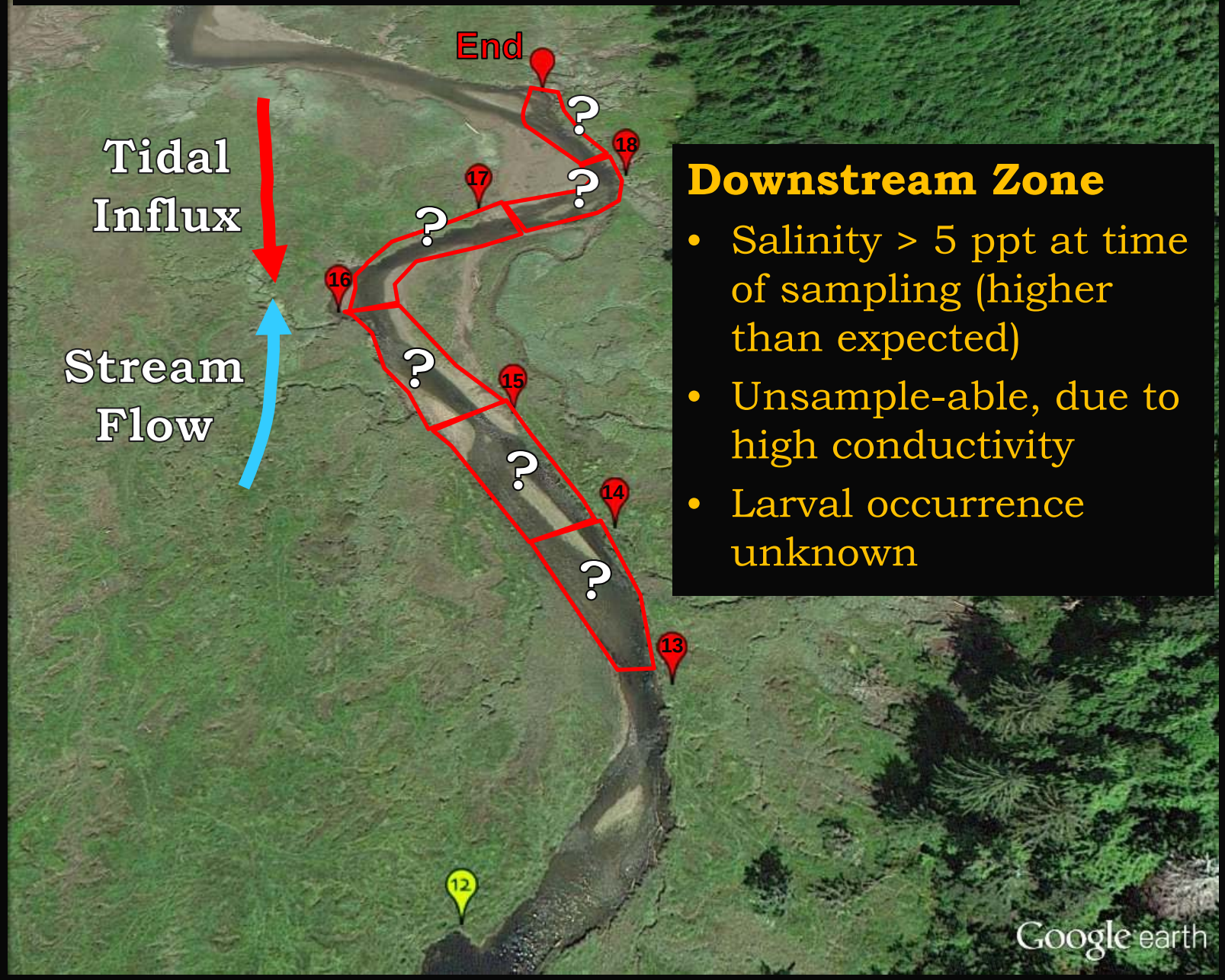
Results
Middle Zone



- PCL present in 1 reach, *Lampetra* spp. in 4 reaches
- Tidal influx occurring in all reaches
- Salinity > 0 ppt at time of sampling

Reach	PCL	*Lamp* spp.	Salinity (ppt)
7	1	15	0.7
8	0	5	0.6
9	0	3	1.1
10	0	2	1.8
11	0	0	2.2
12	0	0	3.0

Results: Downstream Zone



Downstream Zone

- Salinity > 5 ppt at time of sampling (higher than expected)
- Unsample-able, due to high conductivity
- Larval occurrence unknown

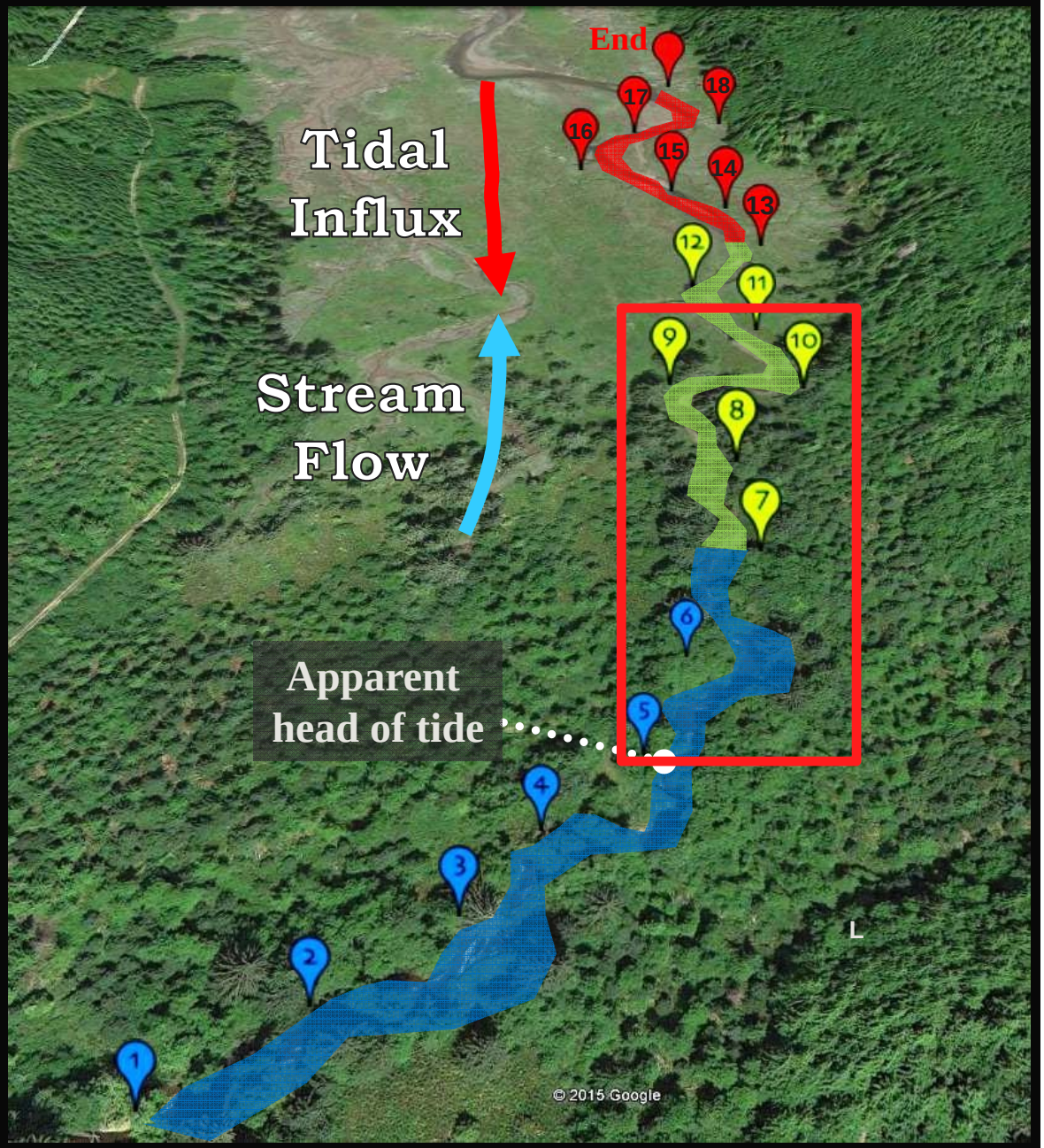
Salinity Monitoring

Task 2

Monitor salinity in reaches that:

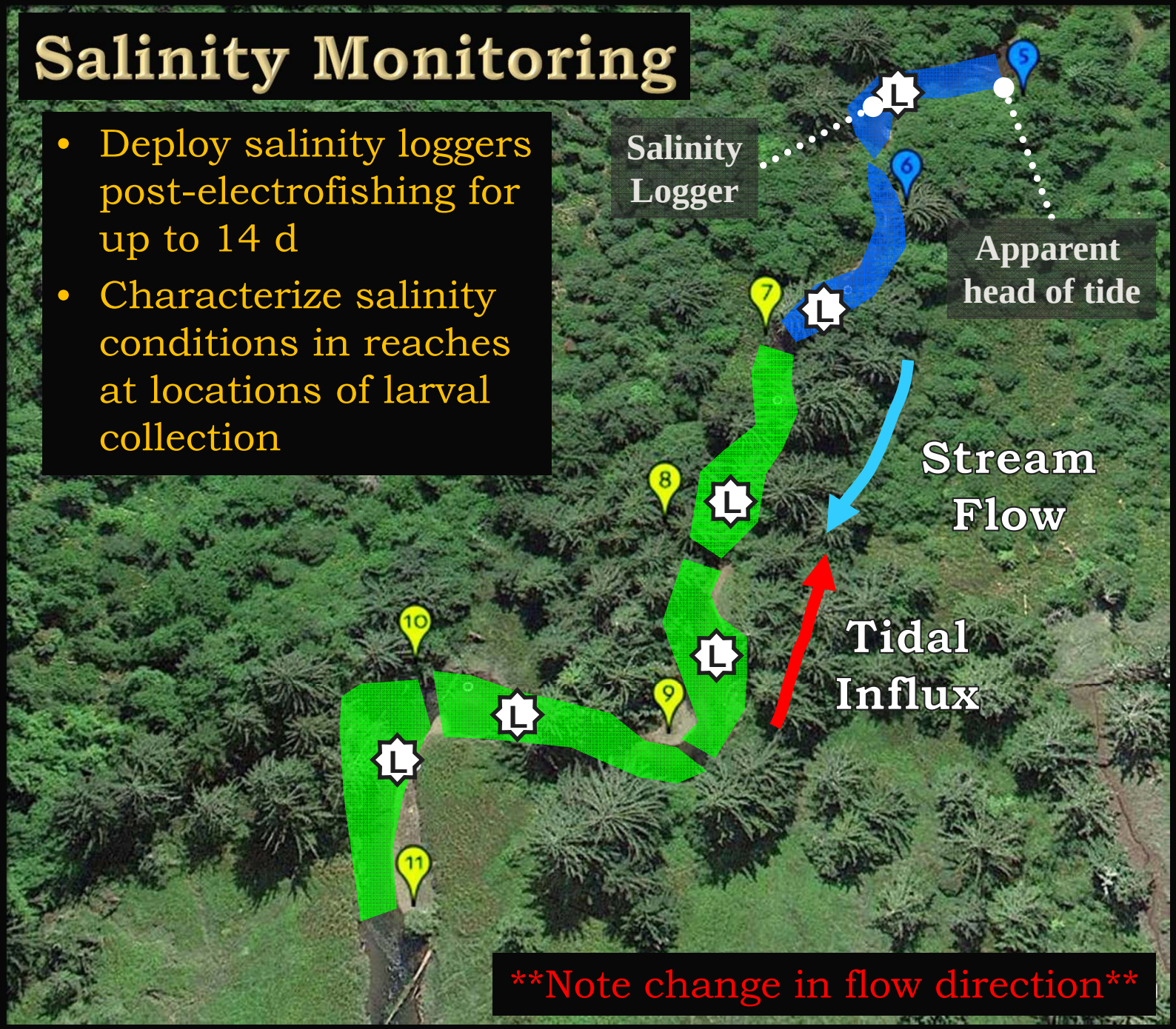
1. Were occupied by larval lampreys
2. Were tidally-influenced

– Reaches 5 – 10

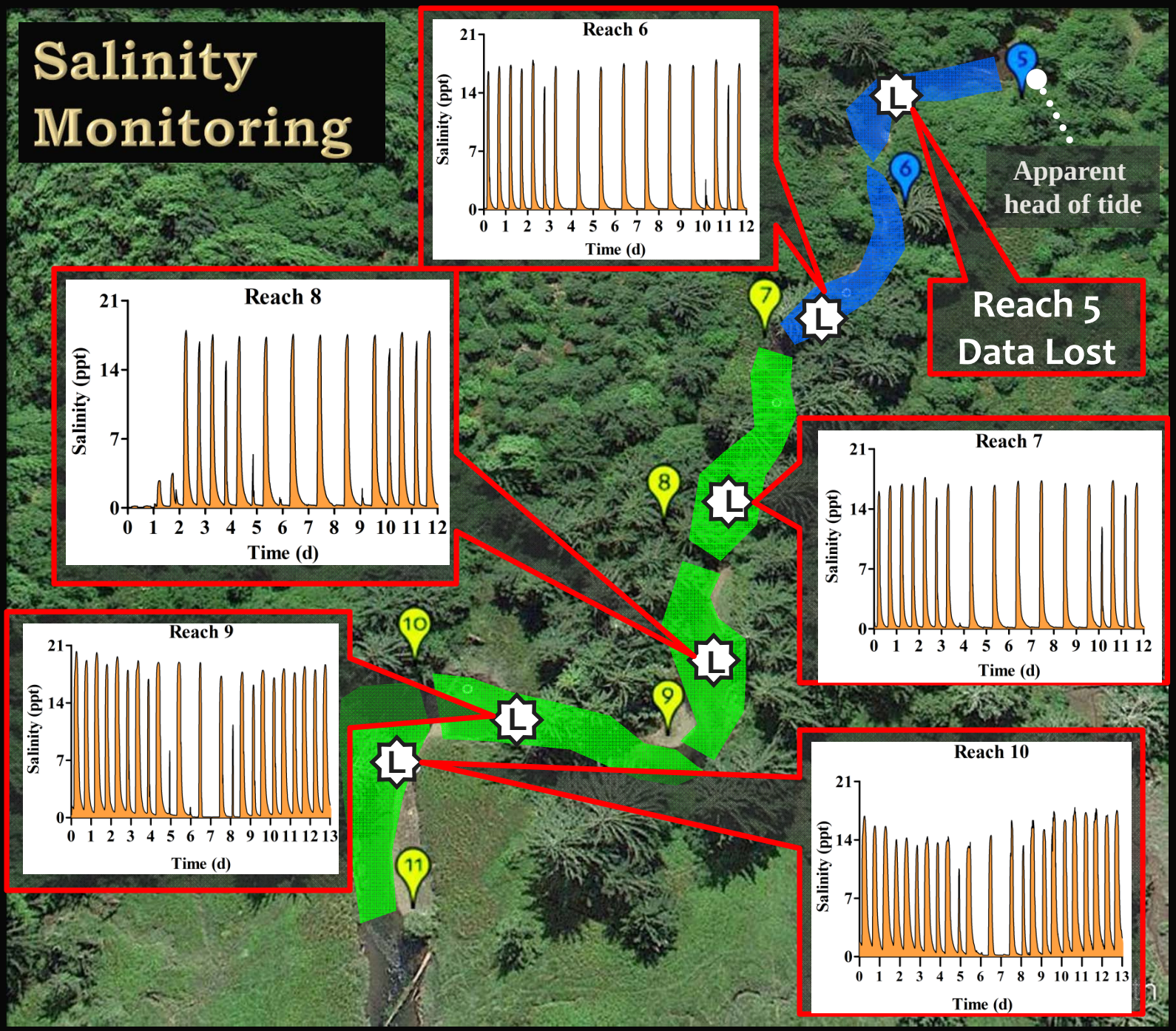


Salinity Monitoring

- Deploy salinity loggers post-electrofishing for up to 14 d
- Characterize salinity conditions in reaches at locations of larval collection

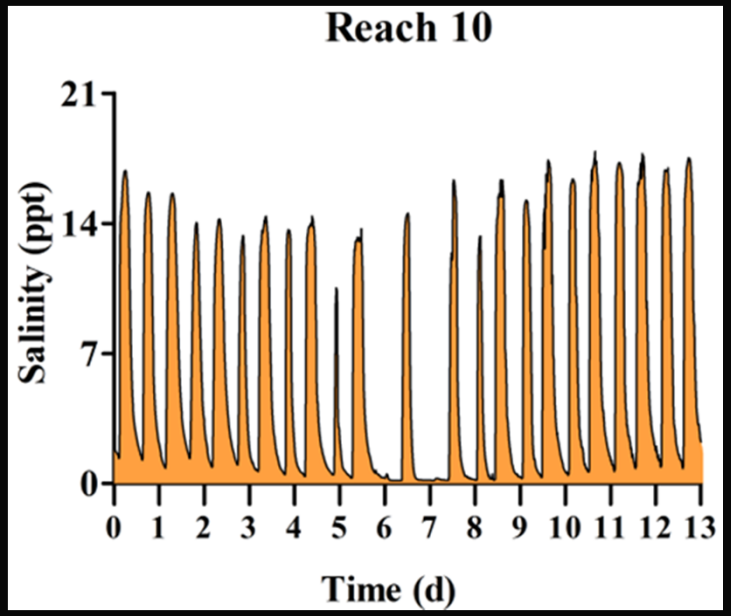


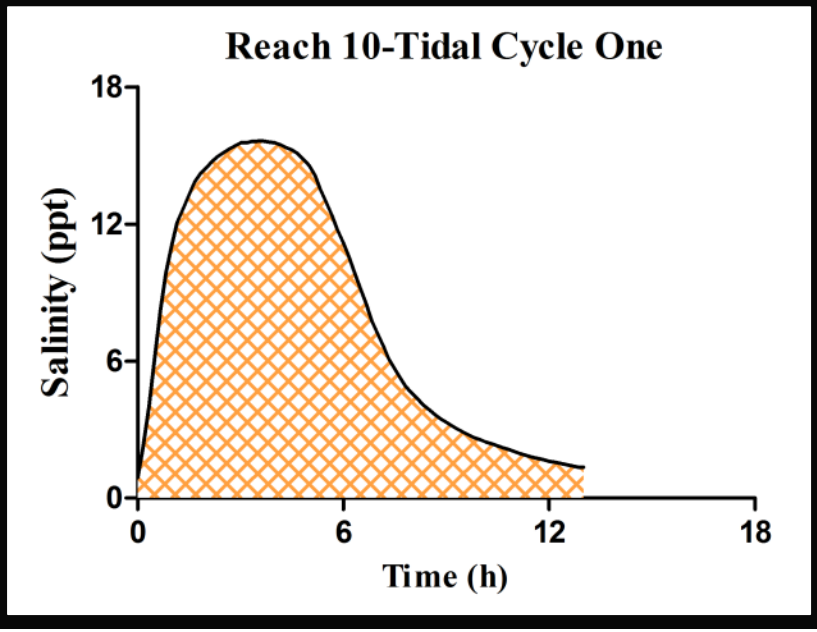
Salinity Monitoring



Salinity Data Analysis

- Transform continuous salinity data (below left) into individual tidal cycles to facilitate comparisons among monitoring sites
- To that end: partition continuous data into tidal cycles, from low tide to low tide (N=24-26 at each reach)
- Calculate:
  i. Average maximum & minimum tidal cycle salinity
  ii. Accumulated salinity units (ASU)





Salinity Data Analysis

Upstream

Reach #	Maximum Tidal Salinity (ppt)	Avgerage Maximum Tidal Salinity (ppt)	Minimum Tidal Salinity (ppt)	Avgerage Minimum Tidal Salinity (ppt)
6	17.98	12.02 ± 7.76	0.06	0.101 ± 0.019
7	17.68	12.25 ± 7.34	0.09	0.165 ± 0.047
8	17.98	10.77 ± 7.87	0.01	0.195 ± 0.063
9	20.26	16.27 ± 5.37	0.07	0.390 ± 0.261
10	17.88	14.17 ± 4.51	0.17	0.543 ± 0.314

Downstream

Average **max.** tidal cycle salinity

- 11 ppt in reach 8
- 16 ppt in reach 9

Average **min.** tidal cycle salinity

- 0.1 ppt in reach 6
- 0.5 ppt in reach 10

Both generally increased with distance downstream

Summary

- Larvae were detected in 6 tidally-influenced reaches
- In these 6 reaches, salinities at high tide averaged from 11 ppt to 16 ppt during 14 d monitoring periods
- Exploratory electrofishing conducted following salinity monitoring, resulted in recapture of 2 larvae (clipped caudal fins) 26 d days after initial capture and fin-clipping
  - Anecdotal observation suggests ability to tolerate tidal salinity exposure for extended periods
- Study represents first step in understanding potential importance of estuary habitats for larval lamprey: presence/absence sampling indicates they can occur in some estuary habitats
- Further research on long-term survival, abundance, growth, and occurrence in other systems (e.g., Columbia River estuary) needed to better understand potential importance estuary habitats for larval rearing

Potential Management Implications

- Knowledge on occurrence of larval Pacific lampreys in tidally-influenced estuarine habitats may
  - Inform future lamprey management and conservation actions
  - Be useful during design and implementation of estuarine habitat restoration projects
  - Aid in understanding potential impacts of activities including channel dredging, gravel-mining, tidal marsh development, climate change, etc., on larvae that may occur in estuary habitats

Many Thanks to…

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