Concurrent Sessions A: Passage Effectiveness Monitoring in Small Streams I - Motivation and Movement at Stream-Road Crossings: Observation and Experiments With Fish in the Pacific Northwest

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Movement and motivation at stream-road crossings: observations and relocation of fish on the Siuslaw National Forest.

John Speece, Aquatic and Riparian Effectiveness Monitoring Program, USDA Forest Service; Dalton Hance, Oregon State University, Department of Statistics; Jason Dunham, Nate Chelgren, Mike Heck, Dave Hockman-Wert, USGS Forest and Rangeland Ecosystem Science Center; Bruce Hansen, USFS Pacific Northwest Research Station.
General Question:

Does monitoring individual movement work for evaluating the effectiveness of single crossings?

- How do you set up the sampling design?
- Why would you motivate fish to move?
- Do culvert stream crossings affect fish movement behavior?
How do you set up the sampling design?

- Siuslaw National Forest
  - > 2000 culverts
  - 303 Red, Green, Gray culverts
- Study constraints used to filter possible sites
- Field reconnaissance
- Few sites suitable for study
Big Creek

Upper Stillwell Creek

Lower Stillwell Creek

Bays Creek
How do you set up the sampling design?

- 600 meter study reach
- 3 – pass through stationary antennae array
- Continuous monitoring June – Sept 2012
  - Maintenance and mobile tracking 2 – week intervals
How do you set up the sampling design?

• Tagging occurred spring of 2012

• Single pass electrofishing
  - Cutthroat Trout, Steelhead

• 12 mm HDX PIT tags
• Minimum size 70 mm

• Most fish ranged from 80 – 120 mm

• 28 % - 34% of captured fish PIT tagged
• Shrinking numbers problem
• Few fish moved through the culvert
• Fish move less during summer low flows
• Motivation to move is important factor
Bays Creek: Fish Relocation Sept - Oct

- Single pass electrofishing
- 120 new Cutthroat and Steelhead
  - Upstream fish to downstream of antenna
  - Downstream fish to upstream of antenna
Bays Creek: Fish Relocation

Cutthroat Trout: Summer
- 79 PIT - tagged
- 14% (n=11) passed through the culvert
- 3 - months

Cutthroat Trout: Relocation
- 83 PIT - tagged
- 29% (n=24) passed through the culvert
- 18 in first 7 days
Bays Creek: Fish Relocation

Steelhead: Summer
- 68 PIT - tagged
- 7 % (n=5) passed through the culvert
- 3 - months

Steelhead: Relocation
- 35 PIT - tagged
- 17 % (n=6) passed through the culvert
- 4 in first 7 days
Steps to individual movement

1. Can I model movement?
2. Can I tag enough fish?
3. Right time? When can I do this?
4. Right place? Up-downstream reaches
Statistical Analysis: Rationale
Do culvert stream crossings affect fish movement behavior?

Strategy: Develop probabilistic comparison of the patterns of movement at culvert stream crossing and at nearby reference points during monitoring period prior to relocation.

Some Simplifying Assumptions:
1. Individual fish move independently.
2. We only care whether a fish arrives at the antenna once during the interval.
3. No mortality
4. Detection efficiency at each antenna is approx. constant and approx. equal among antennas.
Statistical Analysis:

1. Account for effect of distance of tagging location on probability of detection at
   a) nearest antenna (fish enters culvert/reference crossing)
   b) furthest antenna (fish traverses culvert/reference crossing)

2. Investigate effects of:
   Culvert [Yes: 2->C (D) and 3->D (C) vs No: 1->B (A) and 4->E (F)]
   Direction [Up: 2->C and 4->E vs Down: 1-> B and 3-> D]
Statistical Analysis:

1. Account for effect of distance of tagging location on probability of detection at
   a) nearest antenna (fish enters culvert/reference crossing)
   b) furthest antenna (fish traverses culvert/reference crossing)

2. Investigate effects of:
   - **Culvert** [Yes: 2->C (D) and 3->D (C) vs No: 1->B (A) and 4->E (F)]
   - **Direction** [Up: 2->C(D) and 4->E(F) vs Down: 1-> B (A) and 3->D (C)]
   - **Species** [CTTR vs STTR]
Statistical Analysis: Logistic Regression

\[
\log\left(\frac{p}{1-p}\right) = \beta_0 + \beta_1 \times \text{Distance} + \beta_2 \times \text{Culvert} + \beta_3 \times \text{Distance} \times \text{Culvert} + \ldots
\]

\( p \) is the probability of detection, the product of the probability of movement and unknown detection efficiency.

Assume that detection efficiency is constant and identical (but not necessarily = 1) at all antennas.

Test for significance of effects with Likelihood Ratio Tests.

![Culvert effect graph](image)

![No Culvert effect graph](image)
Preliminary Results for Bays Creek Before Relocation Near Antenna:

Logistic Regression Stepwise Likelihood Ratio Tests

<table>
<thead>
<tr>
<th>Model</th>
<th>Df</th>
<th>Deviance</th>
<th>Resid.Df</th>
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Preliminary Results for Bays Creek Before Relocation Far Antenna:

Logistic Regression Stepwise Likelihood Ratio Tests

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Statistical Analysis: Next Steps

Construct Bayesian Hierarchical Logistic Regression Model to account for:

1. Imperfect detection
2. Mortality
3. Updated location information
Conclusion...

- Monitoring individual movement addresses whether culverts affect fish movement behavior
- Significant investment of time and resources
- Relocating fish may reduce time investment but it may alter the question
- Statistical analysis needs to address detection efficiency
Thank You! Questions.....

Jared Blake, Nathan Breece, Loretta Ellenburg, Dave Leer, Jeff Metzger, Mark Raggon, Ben Ramirez, Allen Gillette, Stephanie Olind, Sheila VonHofwegen, Ben Bramburg
### Table 1. Average length of Cutthroat Trout and Steelhead that passed through a stationary antennae array.

<table>
<thead>
<tr>
<th>Location and Antennae Array</th>
<th>Downstream Direction</th>
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<td></td>
<td>Cutthroat Length (mm)</td>
<td>(n)</td>
<td>Steelhead Length (mm)</td>
<td>(n)</td>
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* No data for this field