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# Evaluation of an Innovative Fish Passage Device to Provide Upstream Fish Passage at Cle Elum Dam, Washington, 2017

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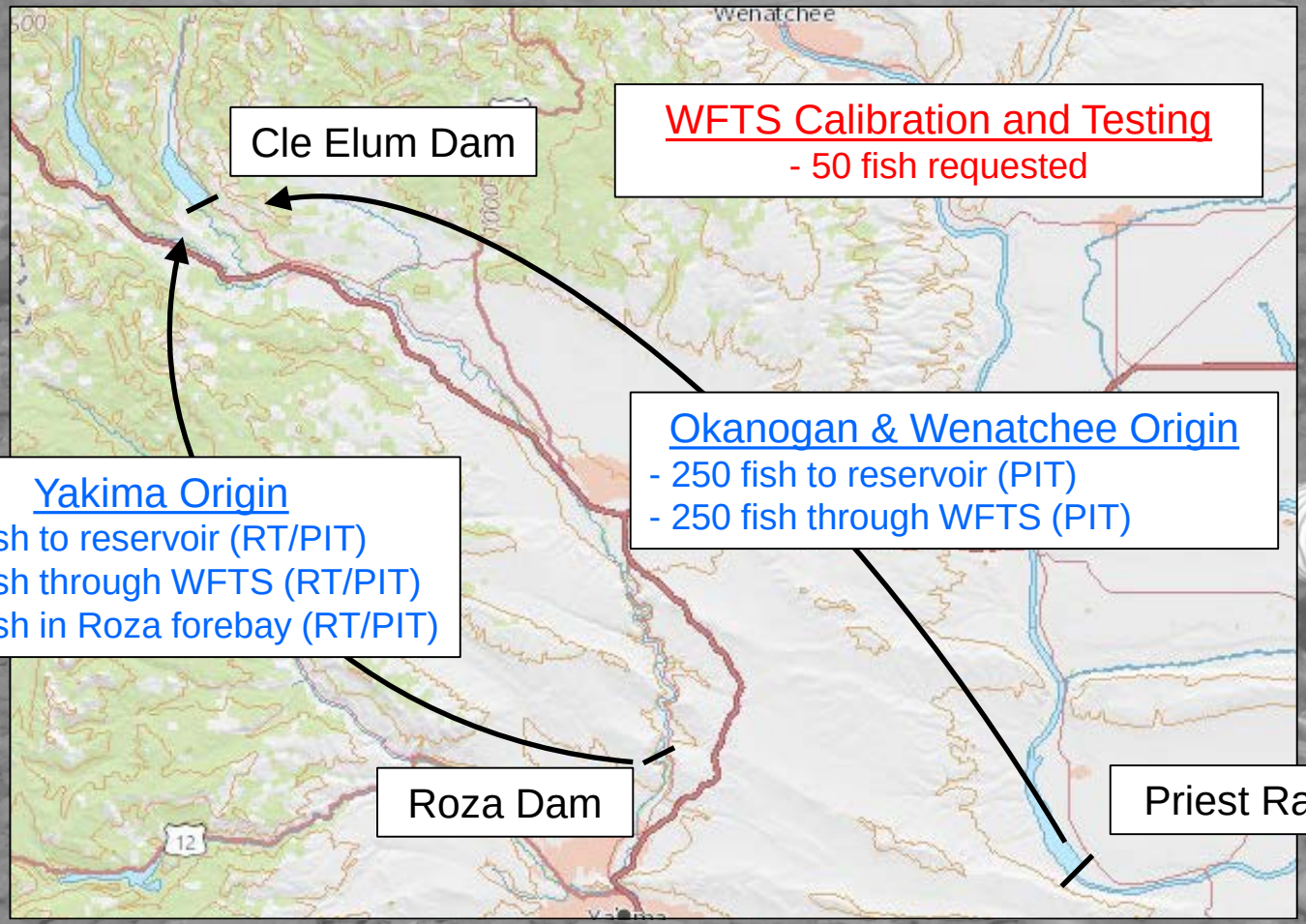
**U.S. Department of the Interior**
**U.S. Geological Survey**

# Original Study Design

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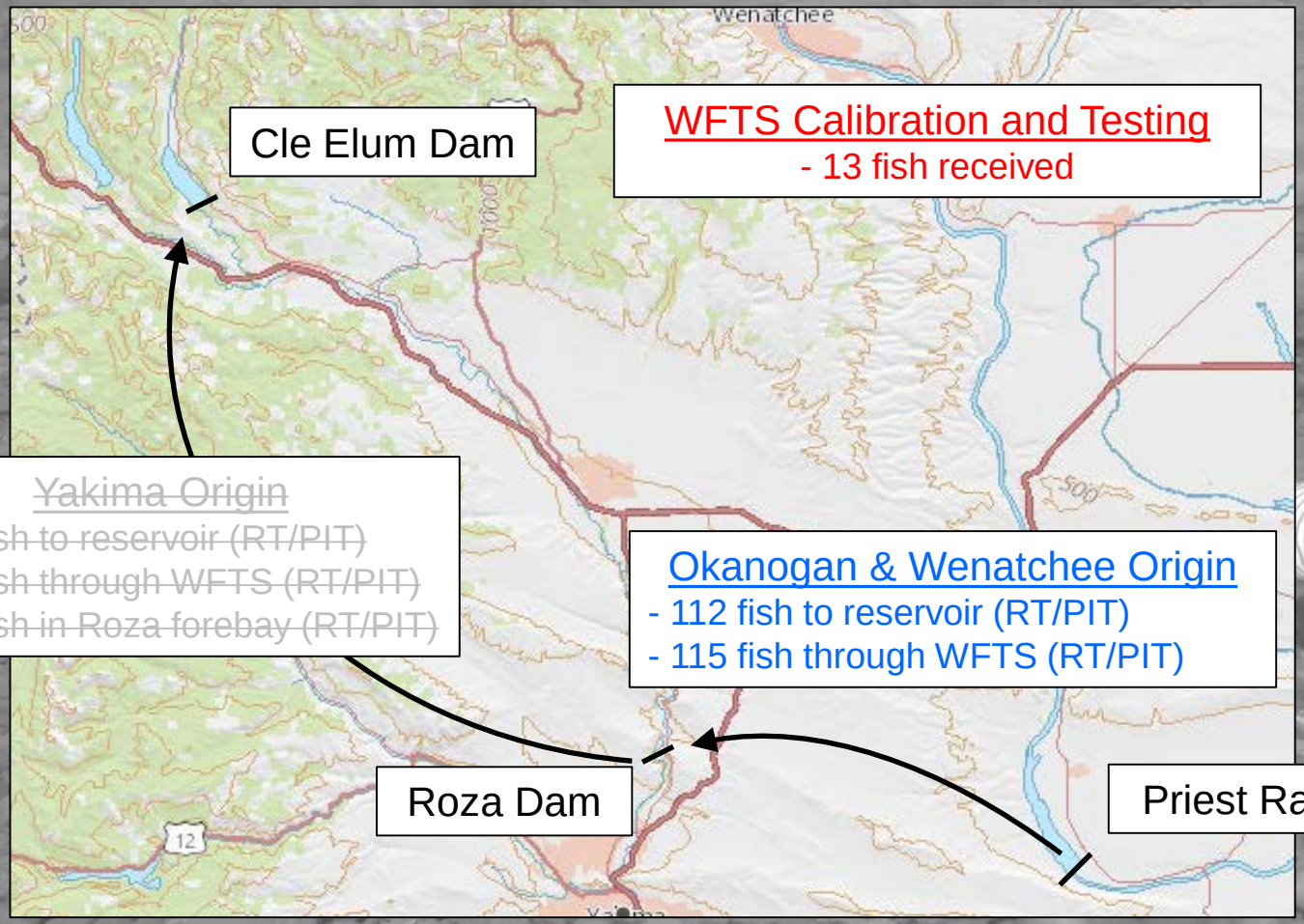
# Revised Study Design

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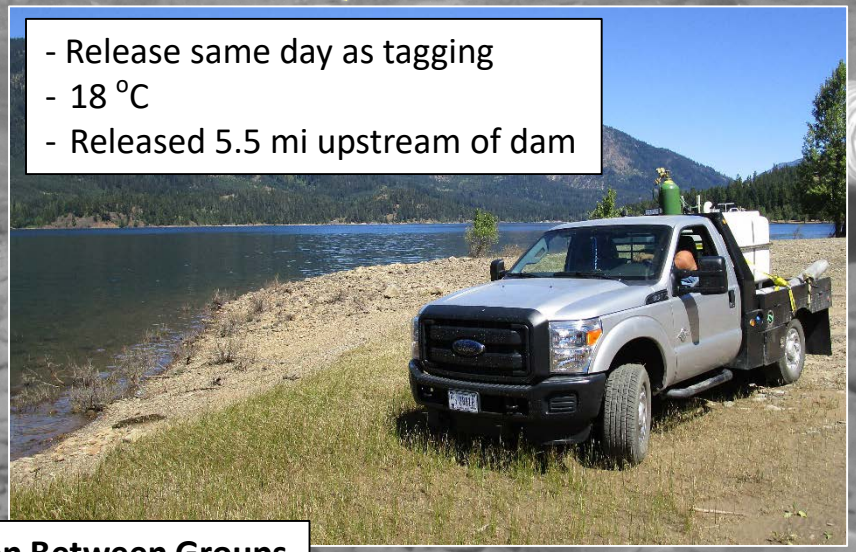
# Fish Tagging and Release

| Tag date | WFTS | Reservoir |
|---|---|---|
| July 14 | 25 | 25 |
| July 17 | 27 | 27 |
| July 18 | 32 | 30 |
| July 19 | 31 | 30 |
| Total = | 115 | 112 |

- WFTS passage day after tagging
- 9 °C
- Passed into Cle Elum forebay



- Release same day as tagging
- 18 °C
- Released 5.5 mi upstream of dam

**Overall Comparison Between Groups**

- Fork length not different (p = 0.609)
- Origin not different (p = 0.319)

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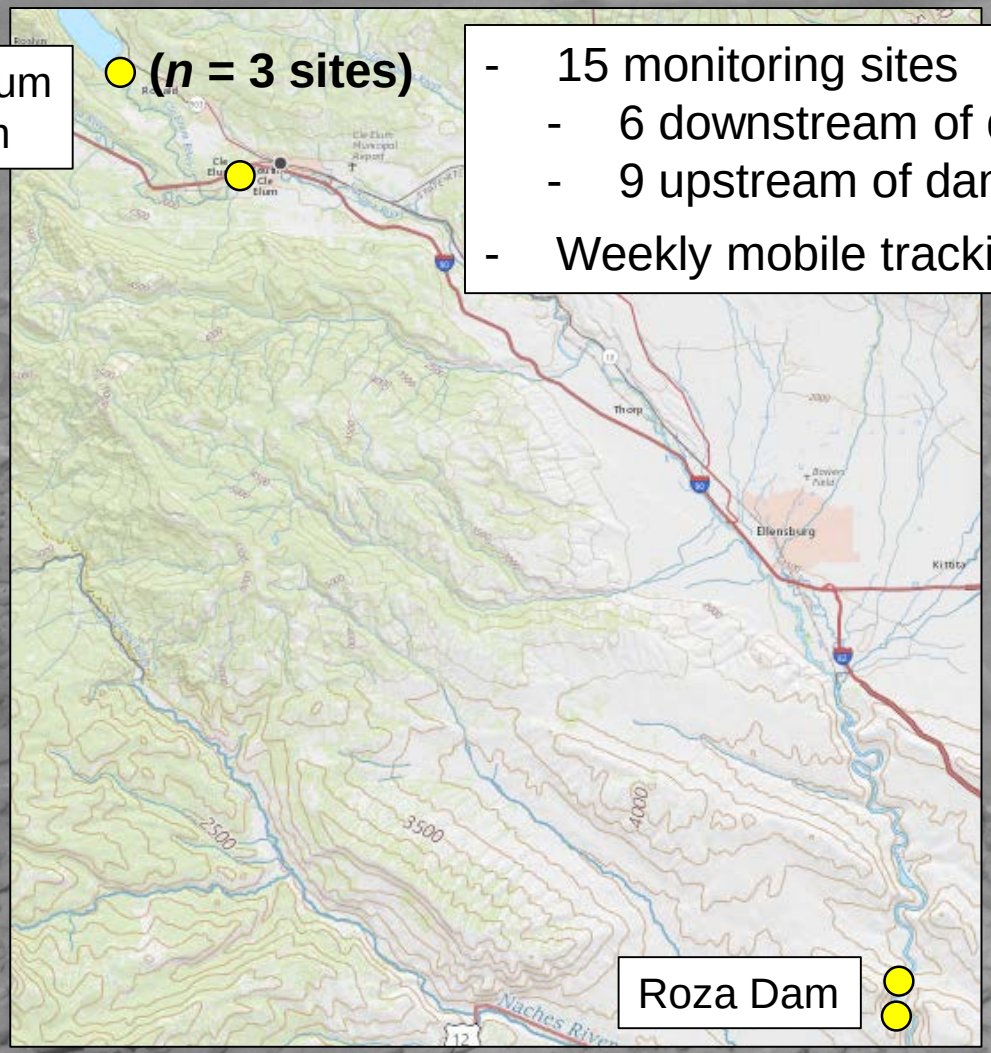
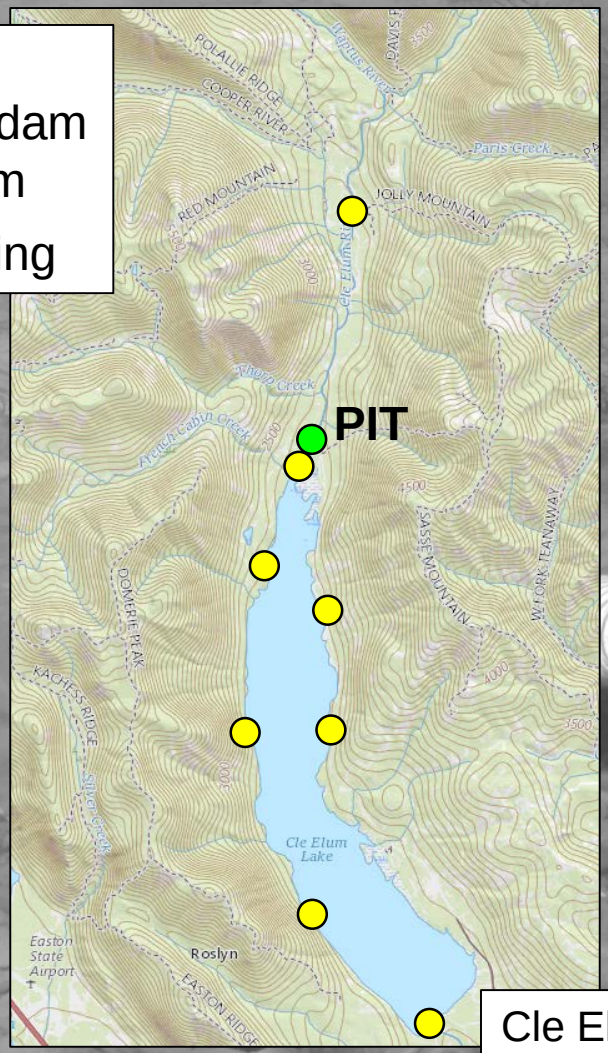
# Detection of Tagged Fish

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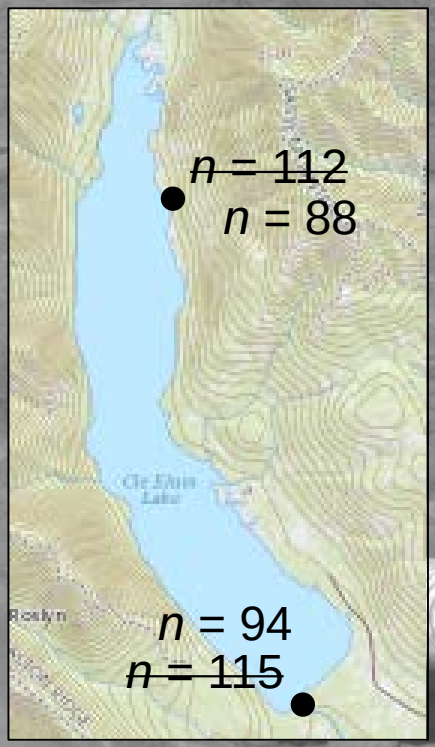
# Survival Analysis

- Fallback fish removed from dataset

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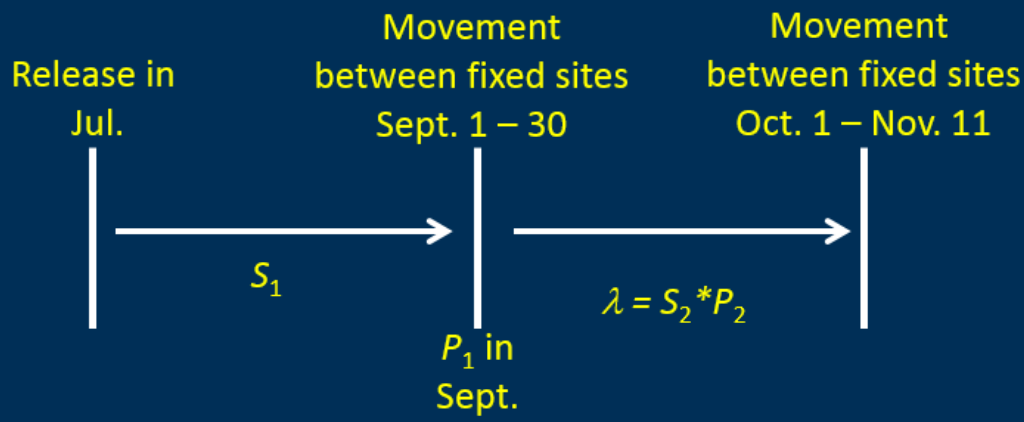
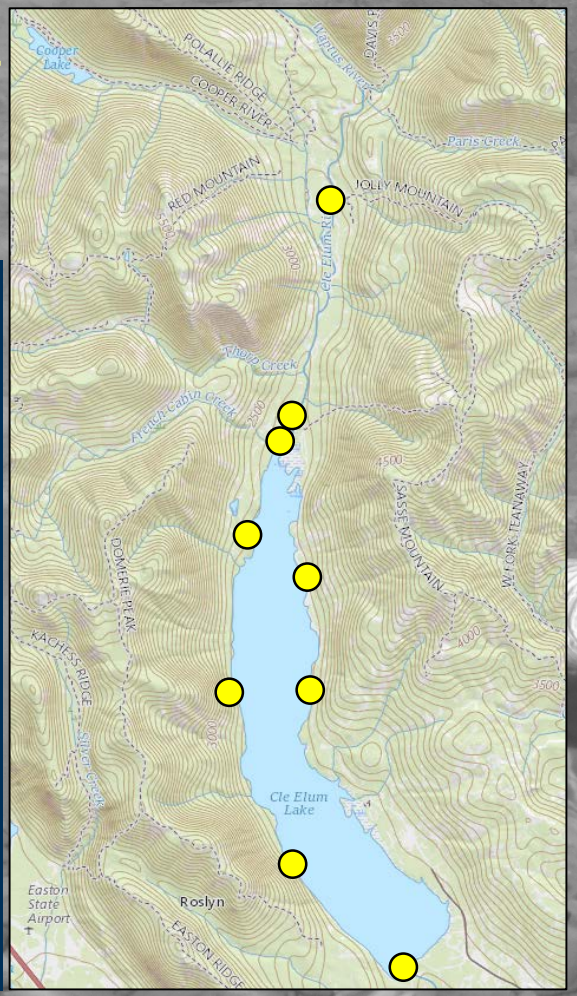
# Survival Analysis

- Fallback fish removed from dataset
- Mark-recapture model
  - Based on fish movement




$S$ = survival probability
P = detection probability given survived past Sept.

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# Mobile Tracking

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# Detecting Fish in the River

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# Detecting Fish in the Reservoir

| CHCOD | RDATETIME | RSITE | RCVR | DATETIME |
|---|---|---|---|---|
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C10 | 21JUL2017:10:02:29 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C13 | 28JUL2017:13:31:00 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C15 | 30JUL2017:07:28:45 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C14 | 31JUL2017:04:26:47 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C15 | 06AUG2017:18:54:57 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C10 | 12AUG2017:06:57:00 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C13 | 30AUG2017:23:59:20 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C11 | 21SEP2017:03:44:41 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C12 | 21SEP2017:05:22:45 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C11 | 21SEP2017:08:30:09 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C10 | 21SEP2017:14:13:04 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C13 | 21SEP2017:18:27:36 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C10 | 22SEP2017:06:18:43 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C13 | 27SEP2017:23:51:36 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C10 | 28SEP2017:22:29:40 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C13 | 30SEP2017:18:13:22 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C10 | 01OCT2017:00:48:04 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C11 | 01OCT2017:01:49:48 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C13 | 01OCT2017:04:12:05 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C11 | 01OCT2017:15:25:04 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C13 | 01OCT2017:17:18:03 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C10 | 06OCT2017:23:27:32 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C11 | 07OCT2017:00:31:55 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C13 | 07OCT2017:03:17:10 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C10 | 07OCT2017:05:43:05 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C11 | 07OCT2017:09:29:20 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C10 | 07OCT2017:11:50:11 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C13 | 07OCT2017:17:33:43 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C11 | 08OCT2017:03:37:58 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C10 | 08OCT2017:21:12:27 |

| | | | | |
|---|---|---|---|---|
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C11 | 09OCT2017:22:44:04 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C10 | 10OCT2017:21:44:35 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C11 | 11OCT2017:00:17:07 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C10 | 13OCT2017:05:55:53 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C13 | 13OCT2017:21:01:36 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C11 | 14OCT2017:01:57:54 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C10 | 14OCT2017:03:20:55 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C11 | 14OCT2017:04:53:06 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C12 | 14OCT2017:22:10:32 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C11 | 15OCT2017:03:46:36 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C10 | 15OCT2017:05:36:04 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C11 | 15OCT2017:14:43:34 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C10 | 15OCT2017:18:44:29 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C11 | 15OCT2017:20:00:42 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C13 | 15OCT2017:23:17:23 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C11 | 16OCT2017:06:54:52 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C13 | 17OCT2017:21:48:32 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C11 | 18OCT2017:07:37:05 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C13 | 20OCT2017:00:45:24 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C11 | 20OCT2017:04:48:44 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C13 | 20OCT2017:13:38:03 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C11 | 20OCT2017:21:57:39 |
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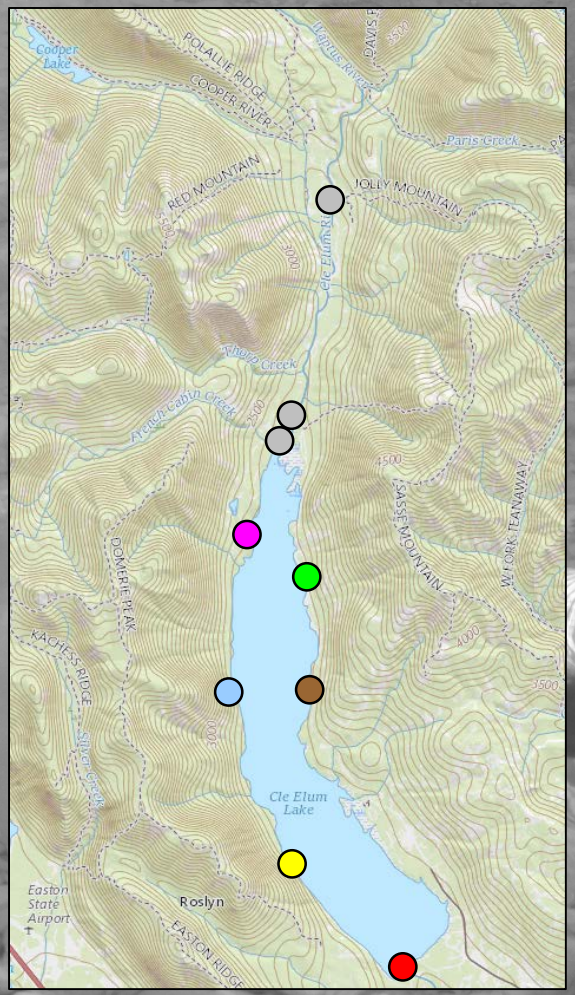
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C11 | 21OCT2017:22:10:28 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C13 | 22OCT2017:10:34:25 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C11 | 22OCT2017:16:47:31 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C13 | 22OCT2017:19:19:37 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C11 | 23OCT2017:01:15:22 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C13 | 25OCT2017:01:43:41 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C11 | 25OCT2017:08:42:58 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C13 | 01NOV2017:10:48:15 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C11 | 01NOV2017:16:53:54 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | C13 | 03NOV2017:13:35:26 |
| 03198A | 18JUL2017:11:55:00 | RESERVOIR | MOB | 09NOV2017:23:00:00 |

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# Survival Analysis

- Fallback fish removed from dataset
- Mark-recapture model
  - Based on fish movement
- Estimate survival to start of spawning period
  - Reservoir-released fish (single release estimate)
  - Whooshh-passed fish (single release estimate)
  - Whooshh passage survival (paired release estimate)

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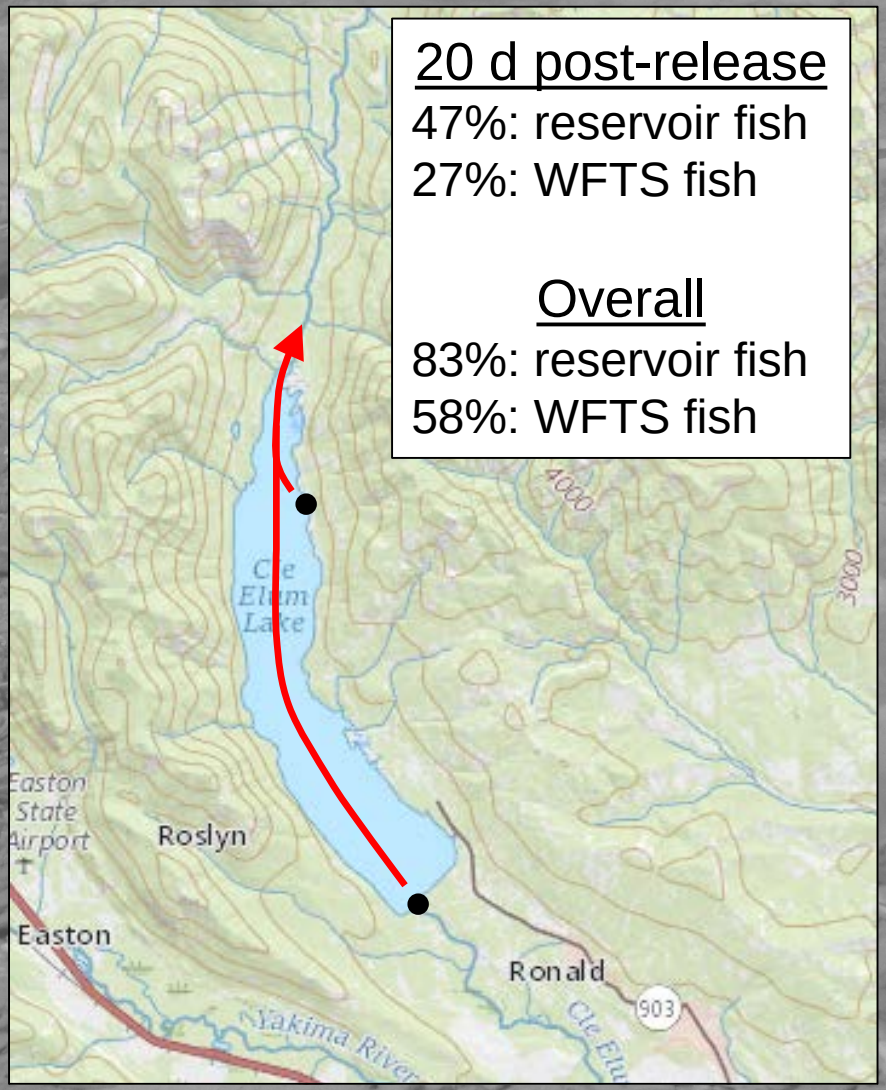
# Upstream Movement

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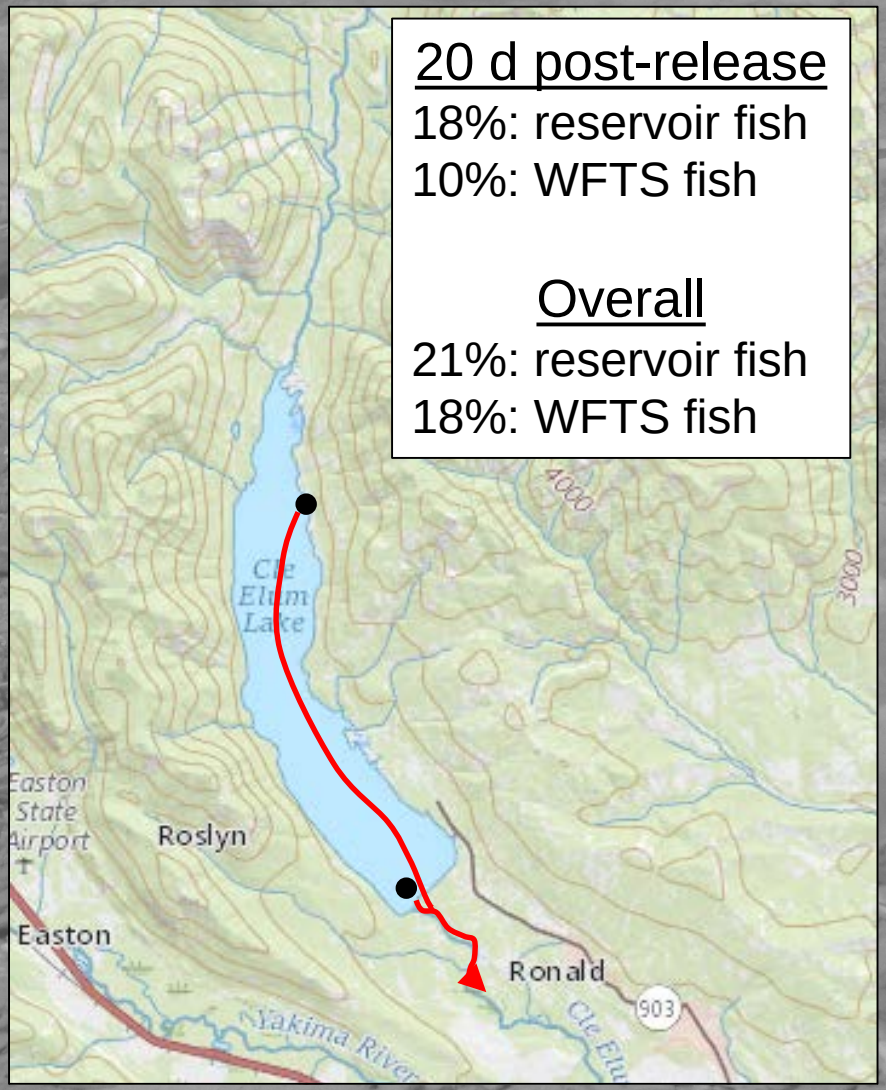
# Fallback

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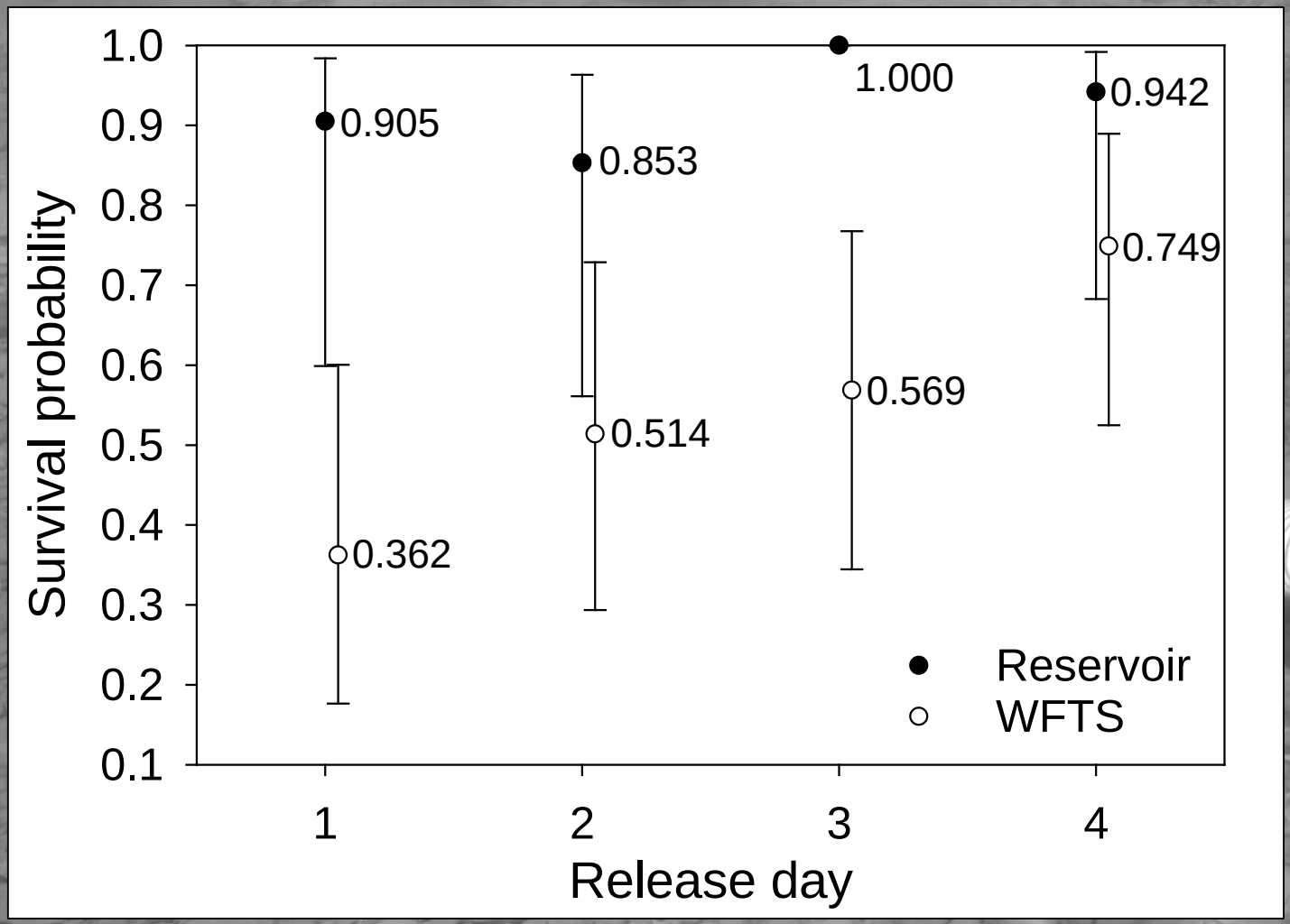
# Single Release Survival Estimates

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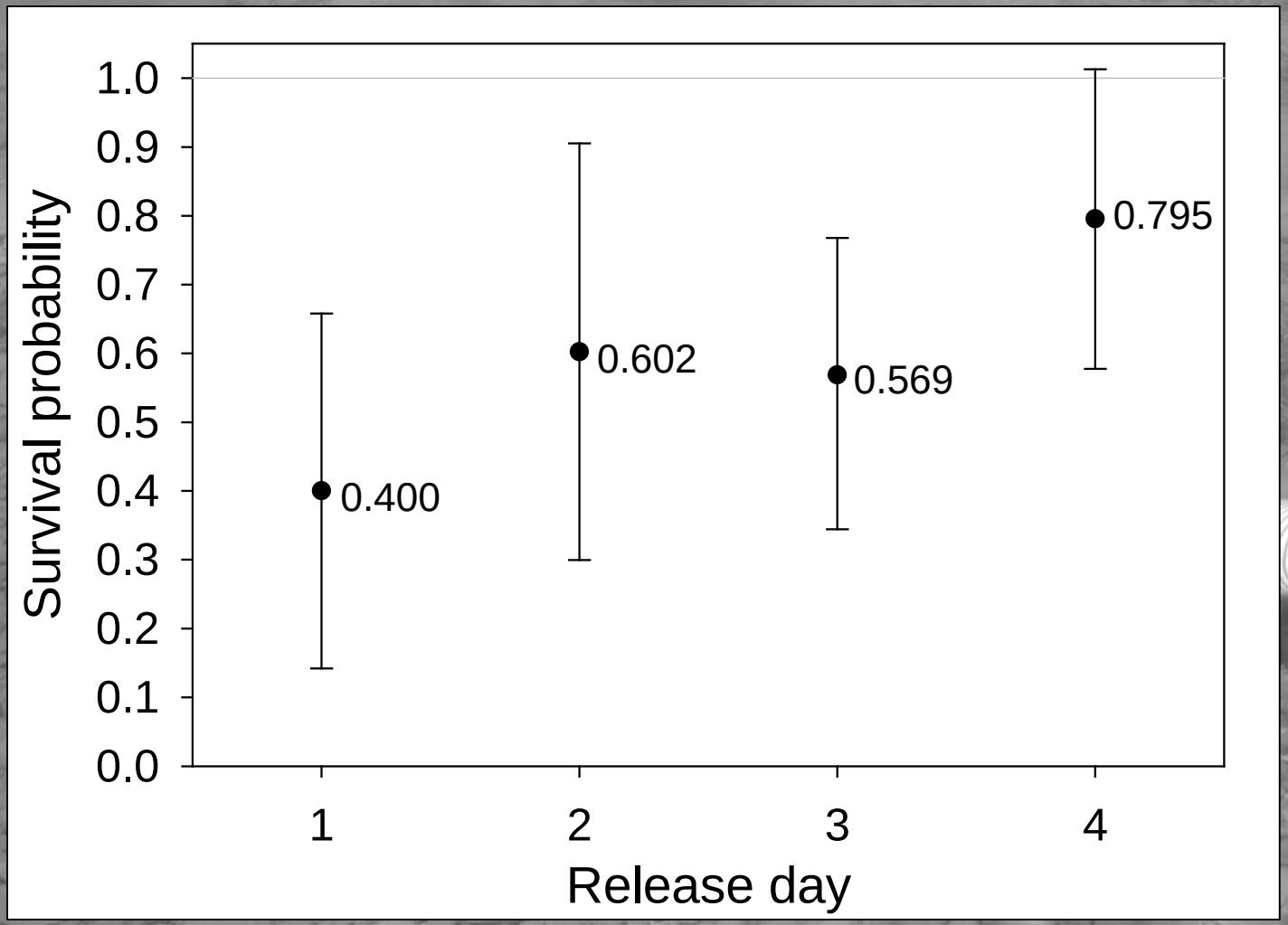
# Paired Release Survival Estimates

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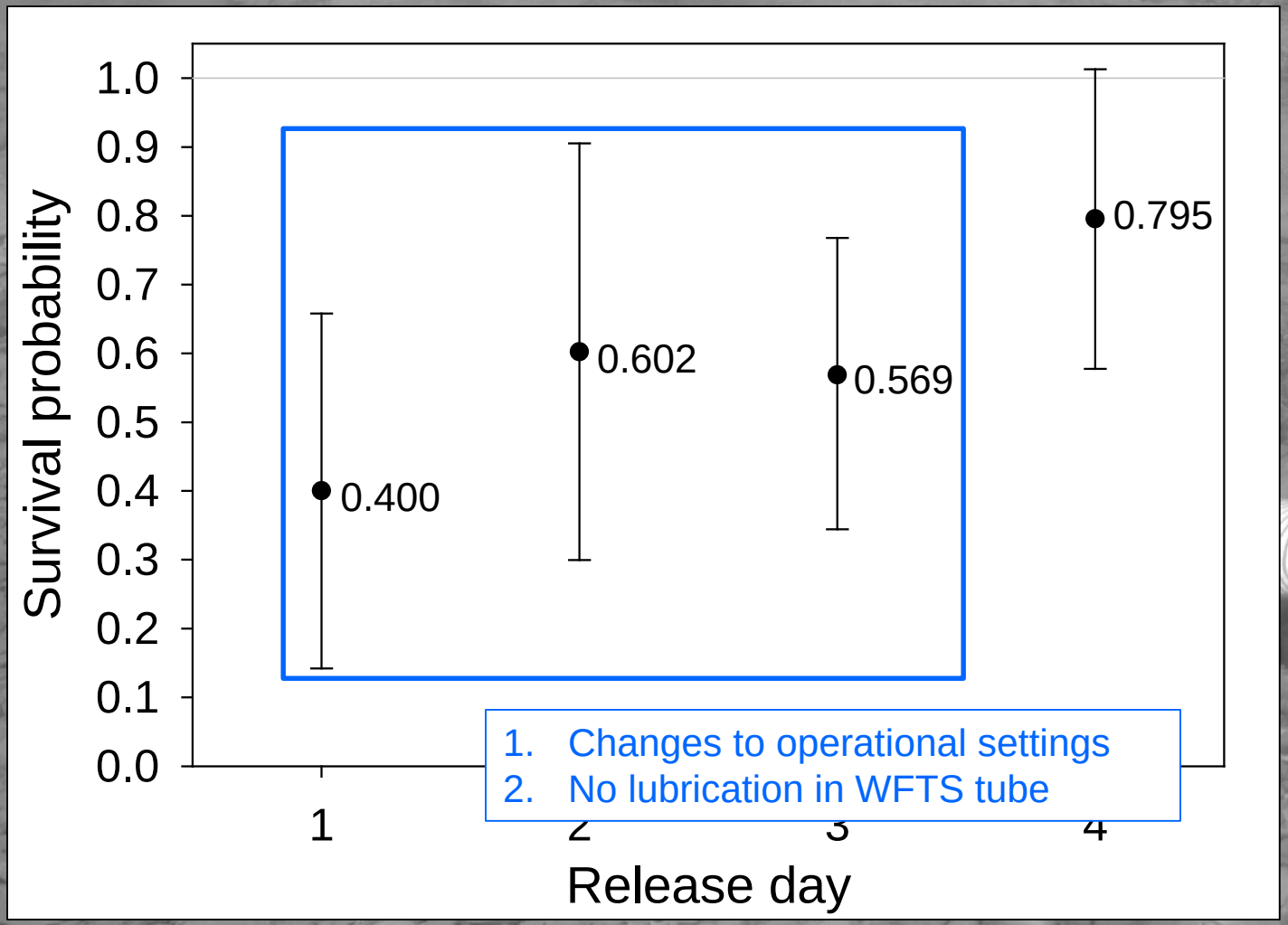
# Paired Release Survival Estimates

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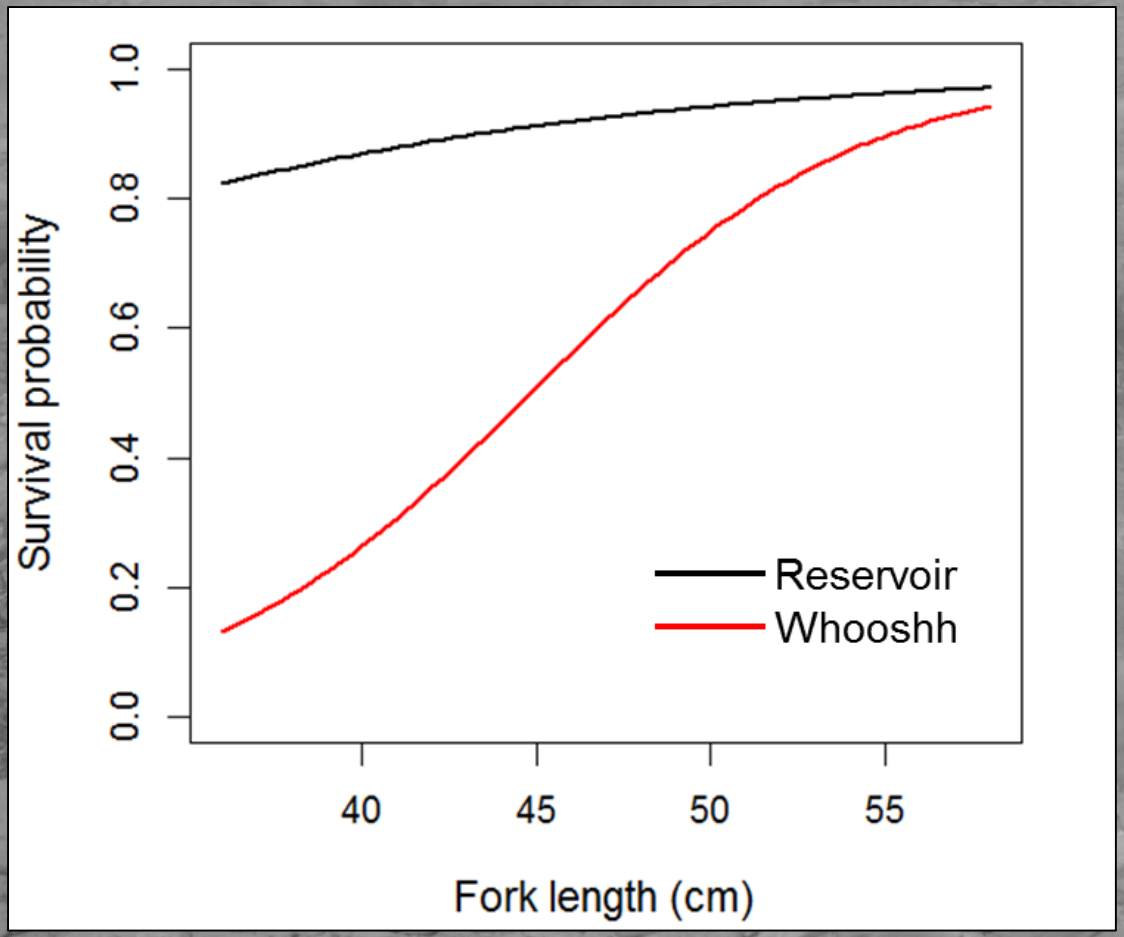
# Effect of Fish Size [ Single Tube]

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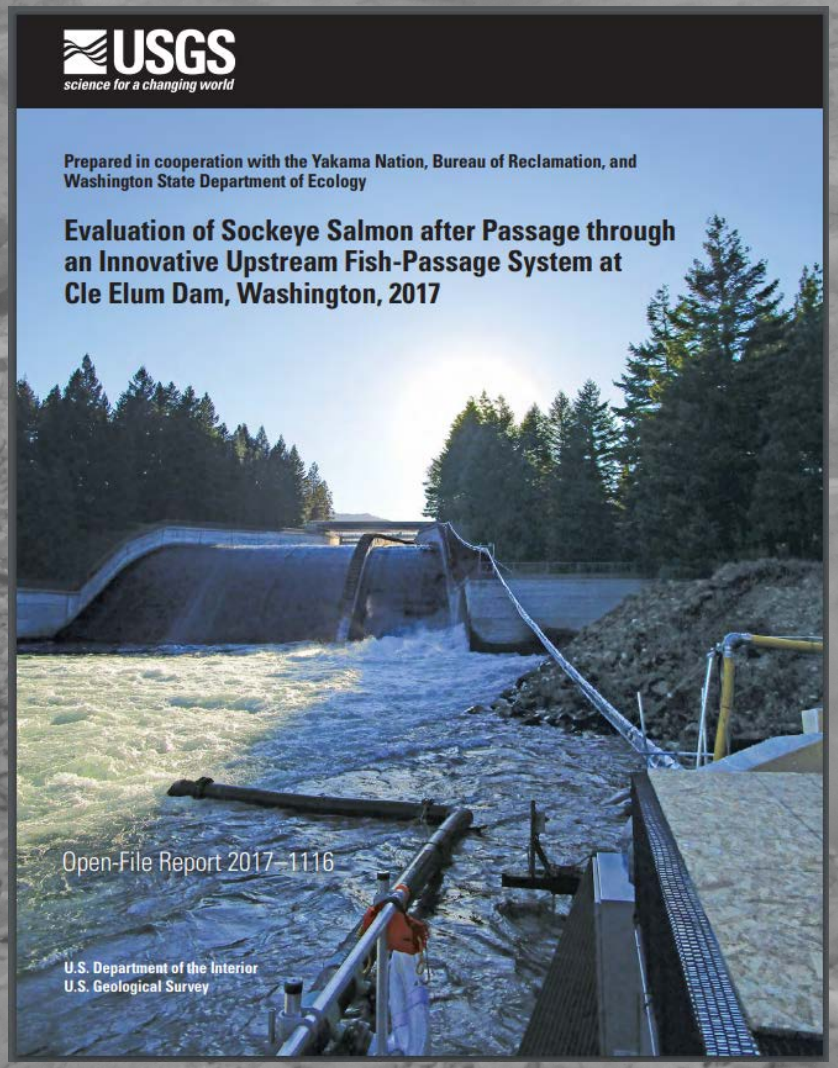
# Final Report

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https://pubs.usgs.gov/of/2018/1116/ofr20181116.pdf