Measuring the cumulative and additive effects of colonial waterbird predation on steelhead survival in the Columbia River Basin

Acknowledgments

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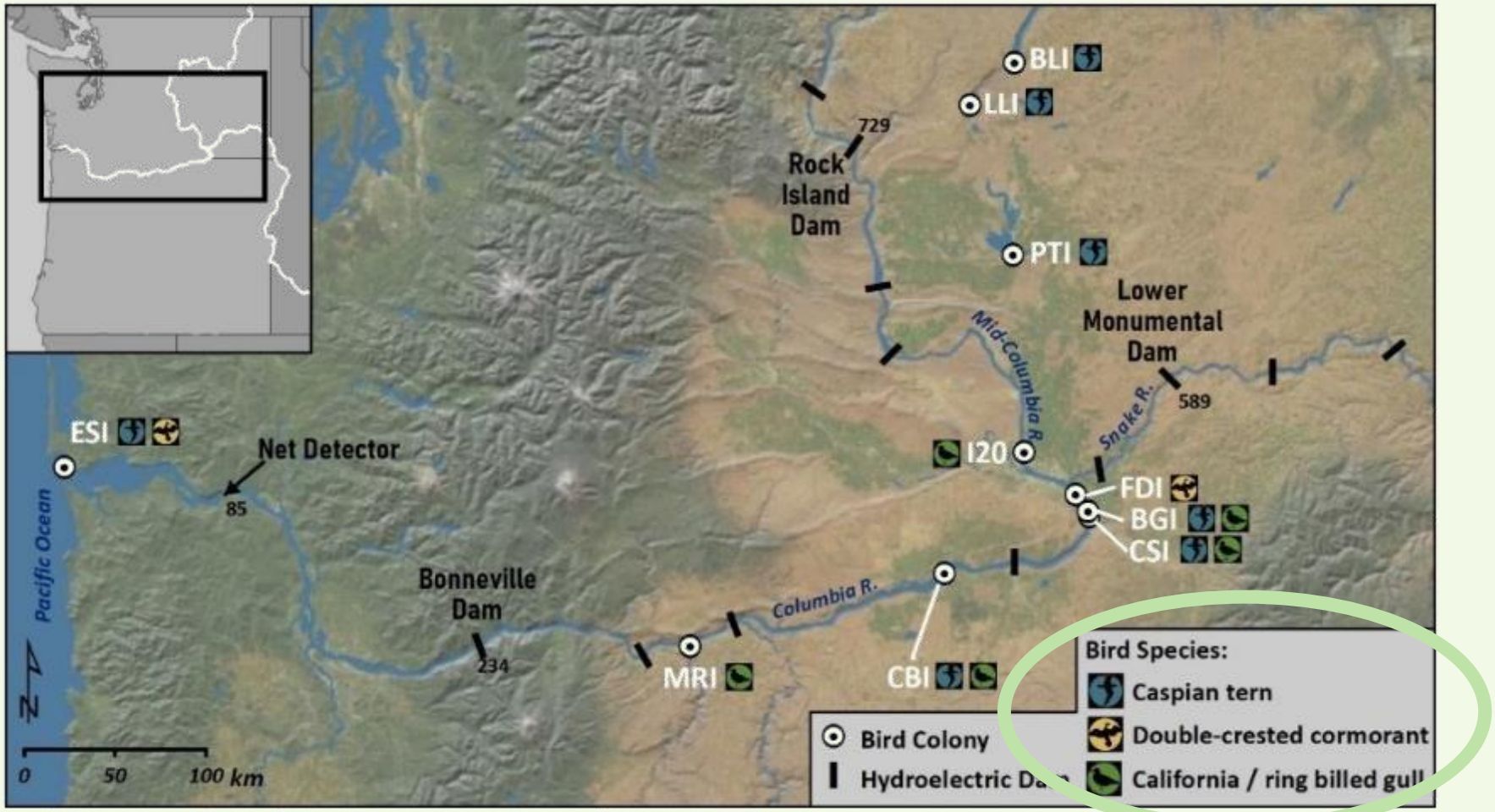
Background -- the region

- Avian predation research in the Columbia Basin began over 20 years ago
- Colonies of piscivorous waterbirds are widespread throughout
- Nesting season largely overlaps with the smolt out-migration period
- 3 primary genera of avian predator of concern

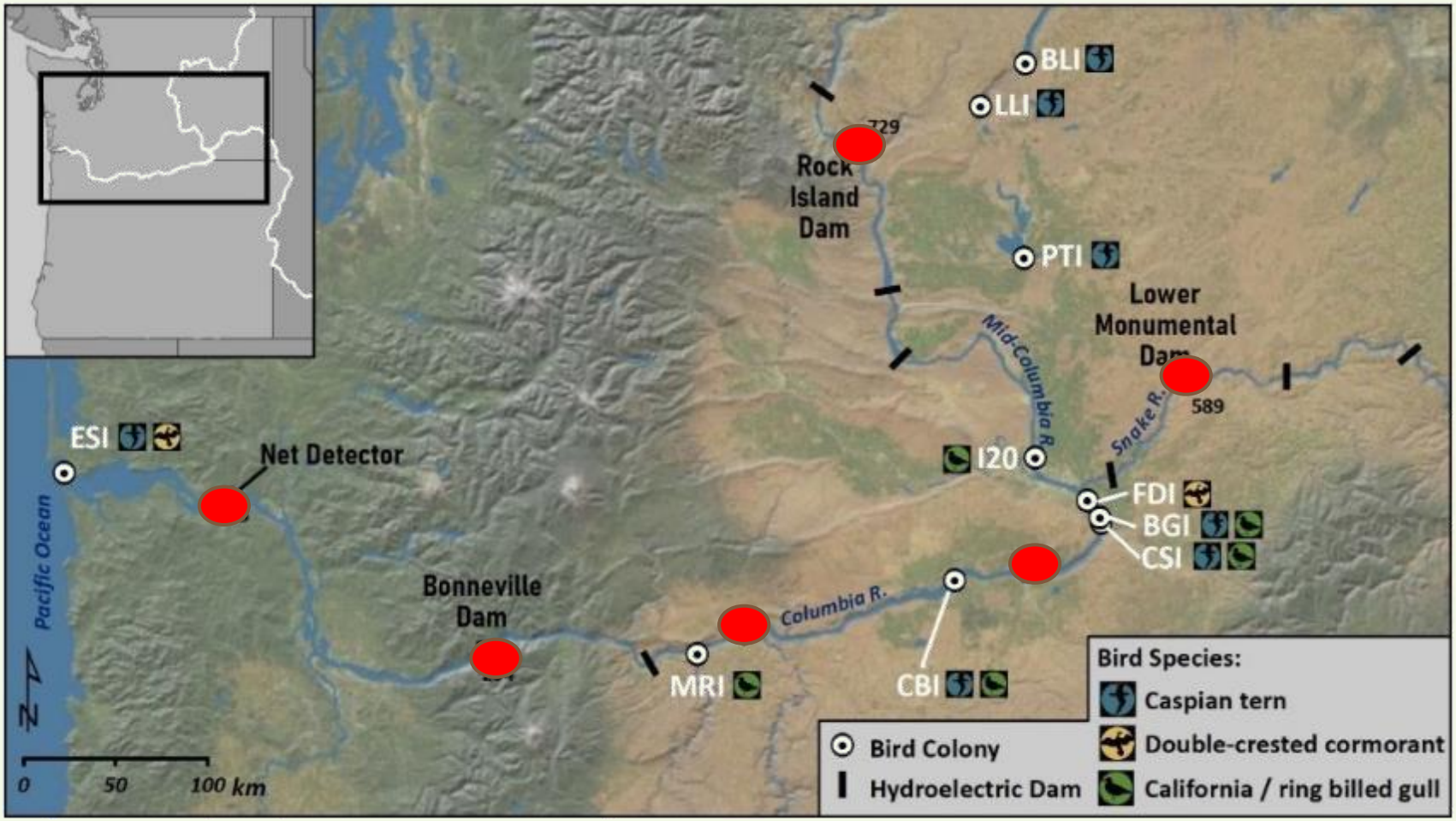


Background -- the models

- Predation probability model
  - Estimation of uses recovered tags from bird colonies
  - Not all consumed tags are “deposited” on the colony
  - Not all deposited tags are recovered by researchers

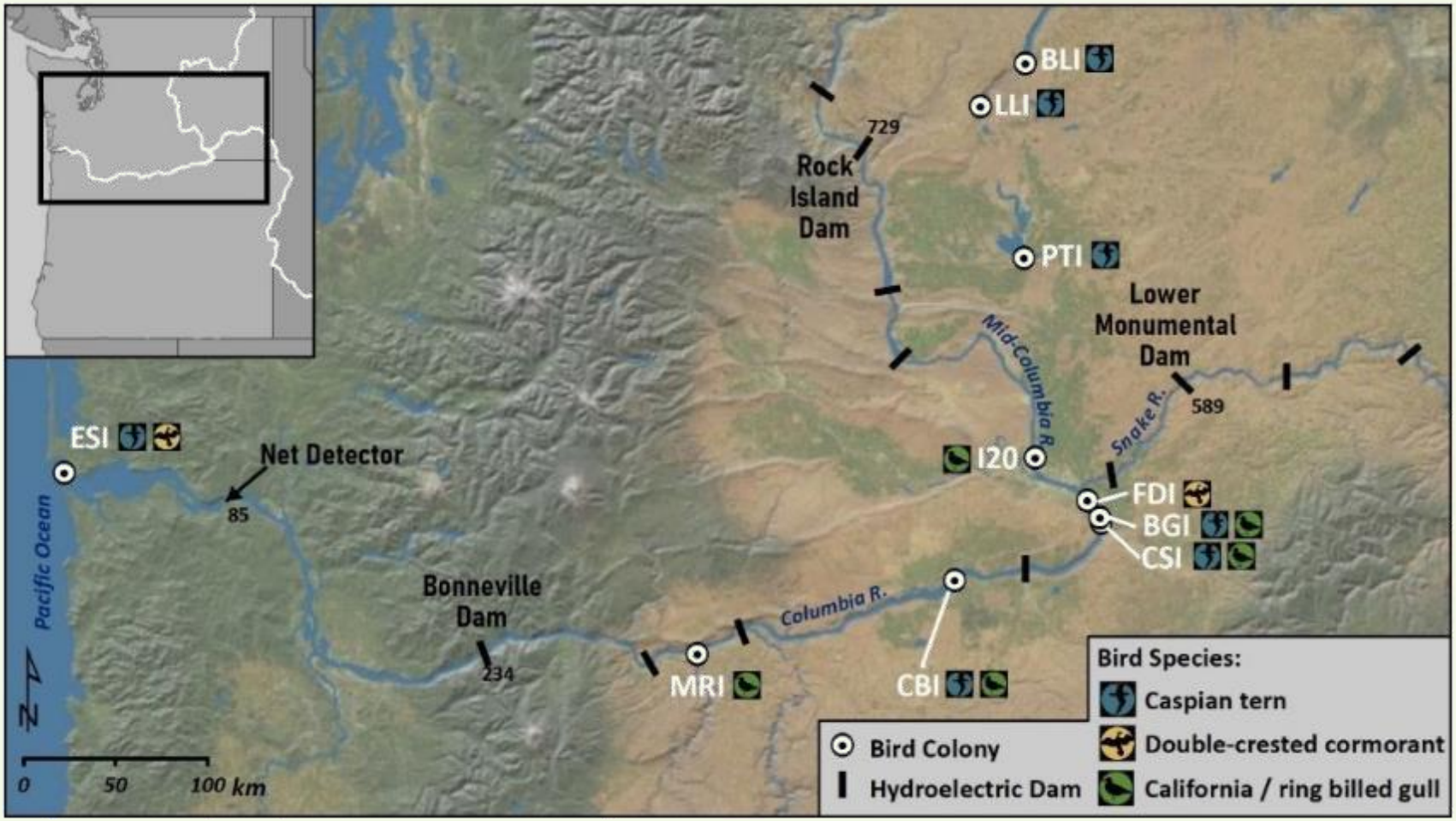
Background -- the models

- Joint Mortality and Survival model
  - Aggregate and accumulate predation across colonies
  - Use tag interrogations at dams to jointly inform survival



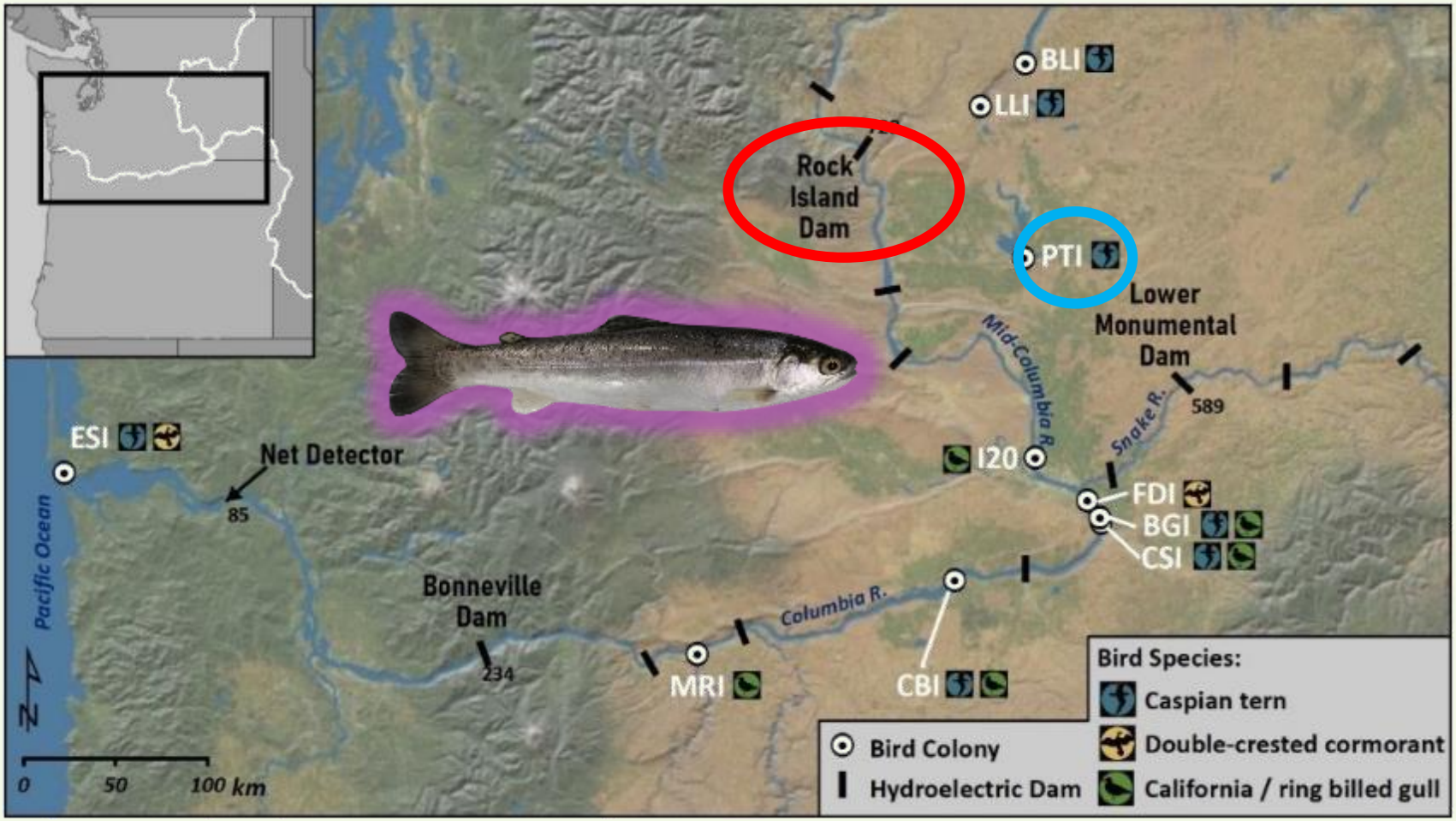
Background -- the models

- Compensatory/Additive mortality model (Payton et al. 2020)
  - Do birds eat fish "fit" enough to survive to outmigration or even to adulthood?
  - What proportion of consumed fish would have survived in the absence of avian predation?



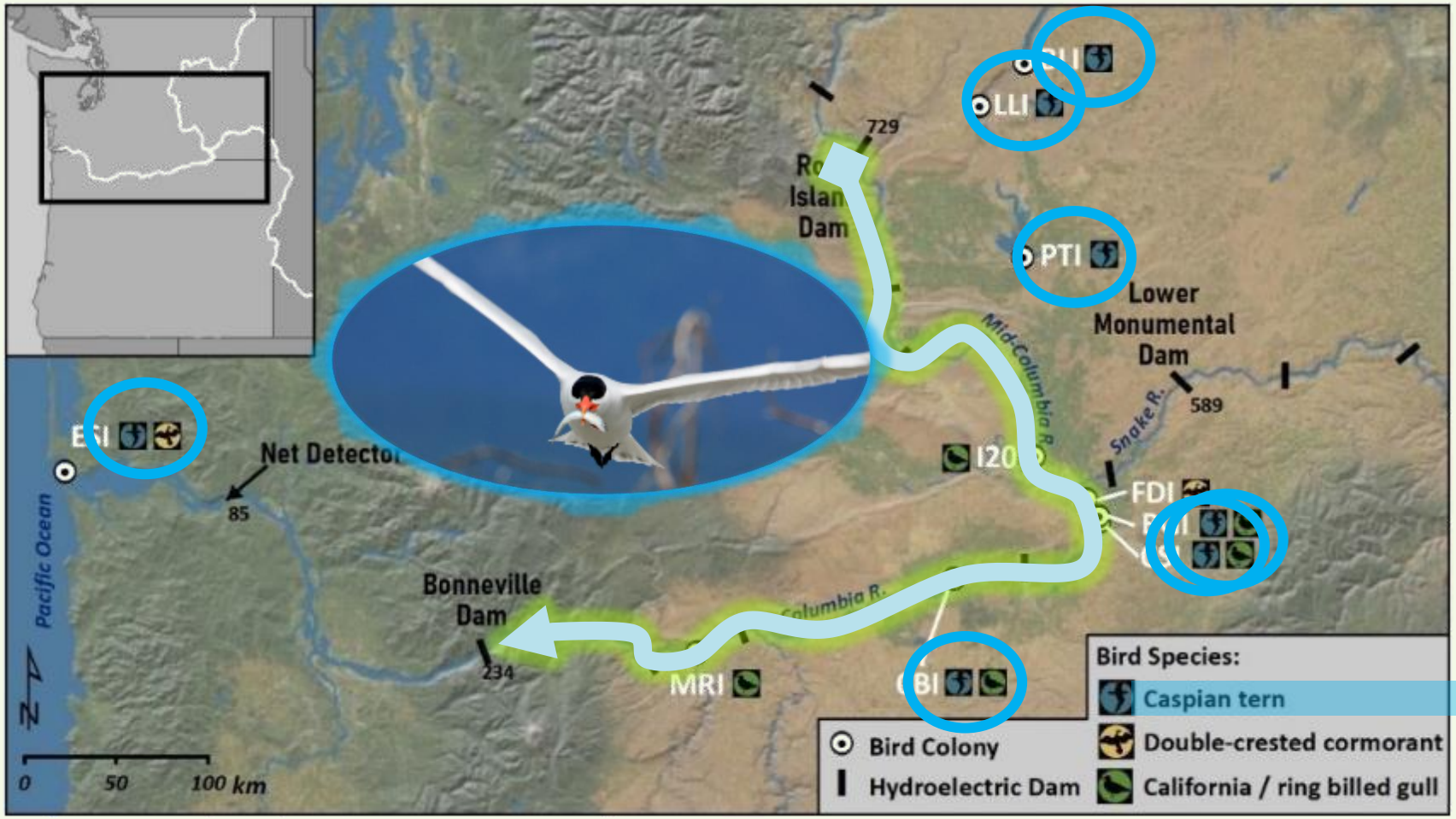
Payton et al. (2020) -- the fish

- In 2008, we began tagging and releasing steelhead from Rock Island Dam
  - ~7,000 steelhead selected at random regardless of size, rear-type, or condition and tagged in proportion with the run at-large (9-to-12-weeks/yr)
- Rock Island Dam was chosen due to its location relative to avian predators

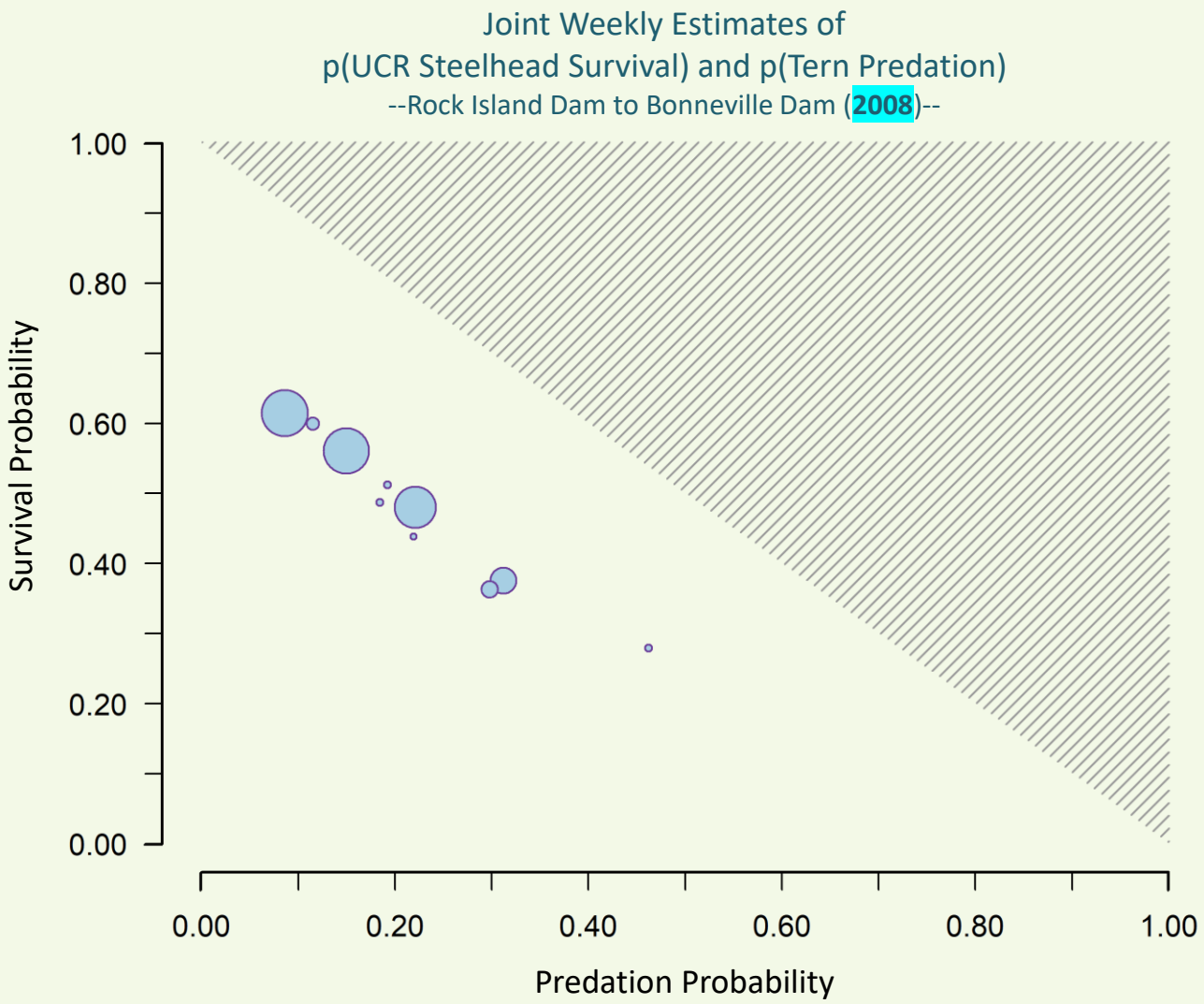


Payton et al. (2020) -- the birds

- Steelhead encounter terns from up to six colonies on their outmigration
- Also, the world's largest Caspian tern colony on East Sand Island in the Columbia River estuary



Survival $\stackrel{?}{=} f(\text{predation})$



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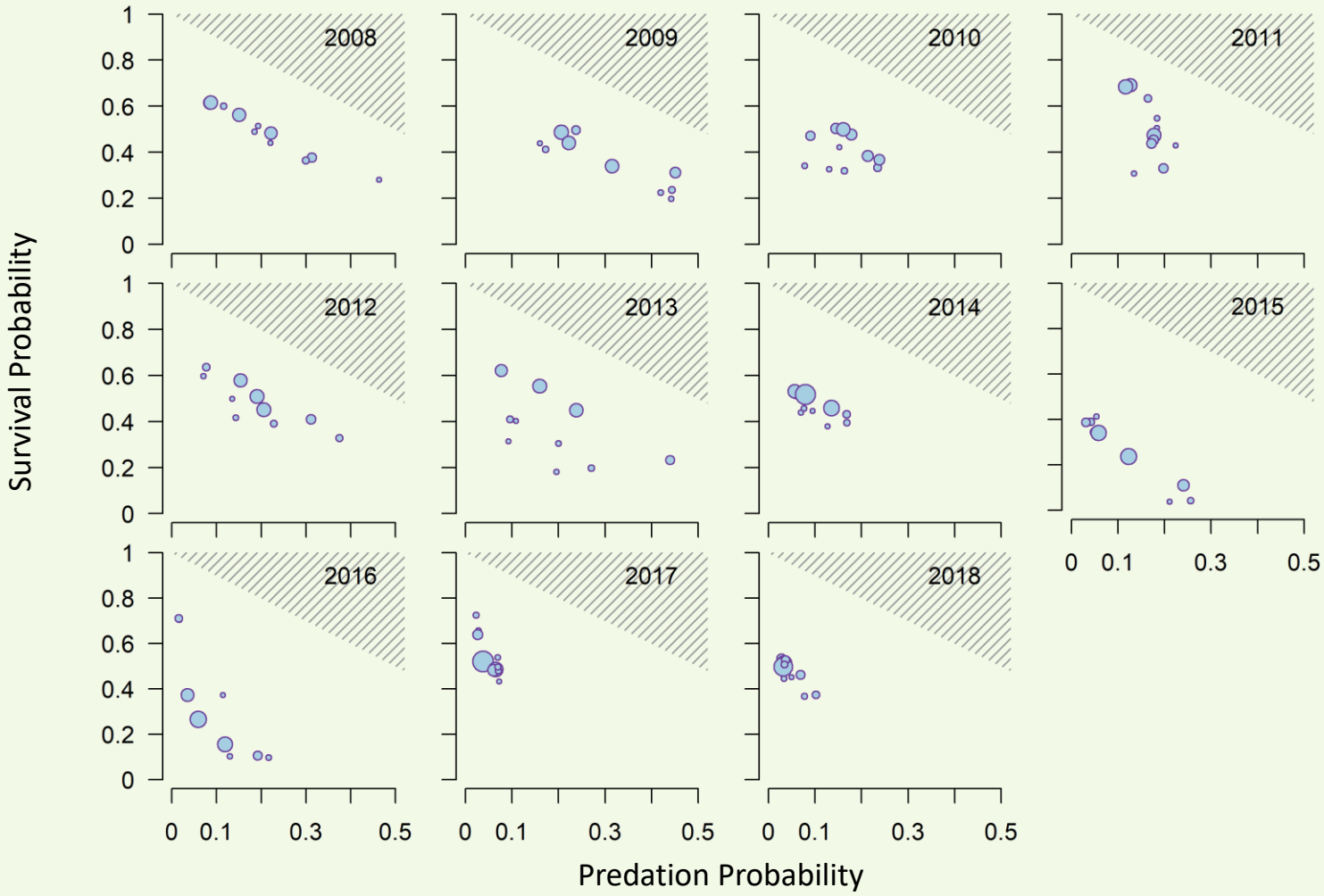
Joint Weekly Estimates of p(UCR Steelhead Survival) and p(Tern Predation)

--Rock Island Dam to Bonneville Dam (2008-2018)--



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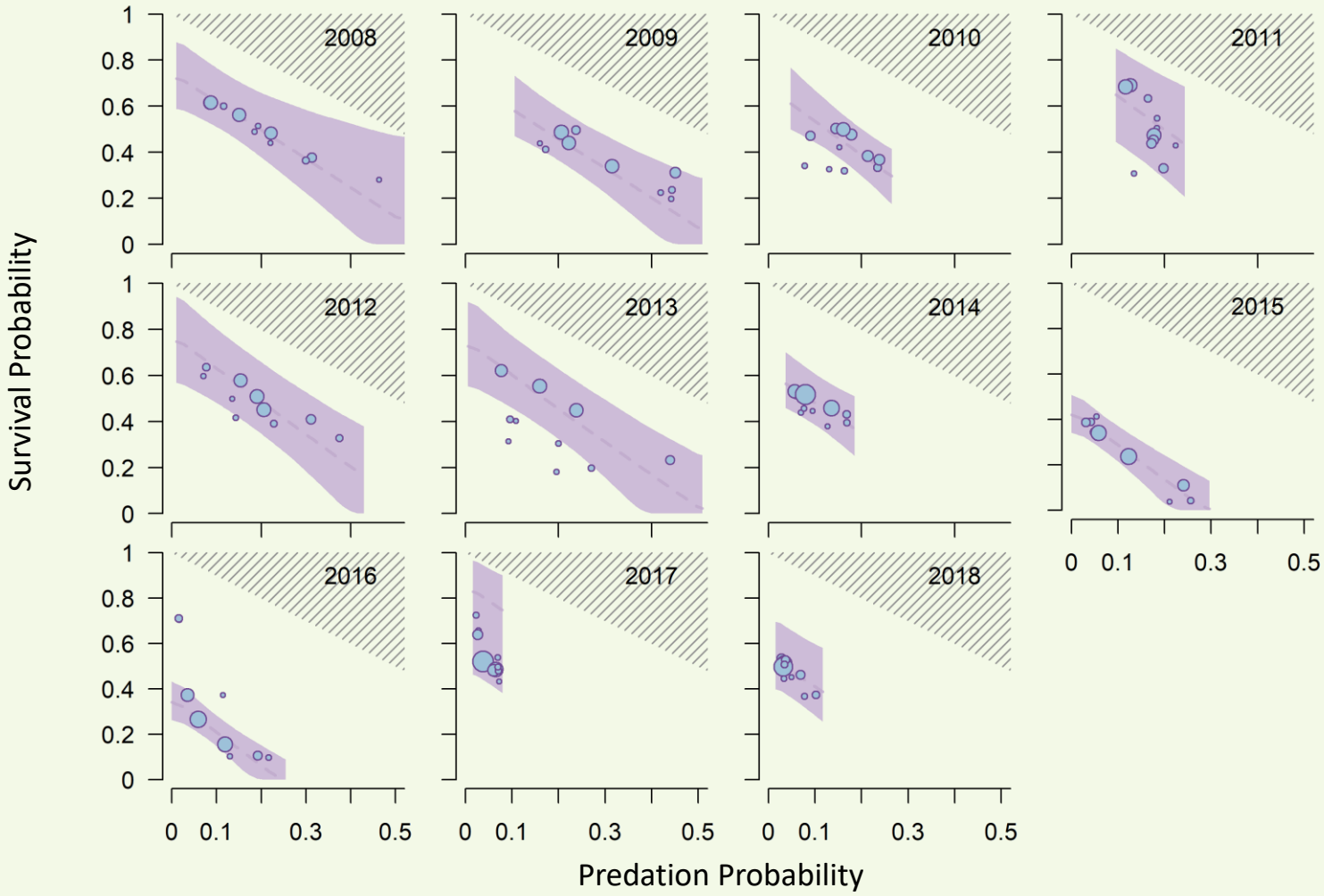

Super Additive Impacts?

- Across all years, $\hat{a} = 1.40\ (1.01, 1.81)$
  - Super-additivity
  - Implies that for every 10 steelhead that terns **consume**,

    14 don't make it to Bonneville that would have otherwise

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  - **Kleptoparasitism** (Adkins et al., 2011)
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  - **Predation by transient birds**

- How can we make a more meaningful statement about the impact of tern predation?

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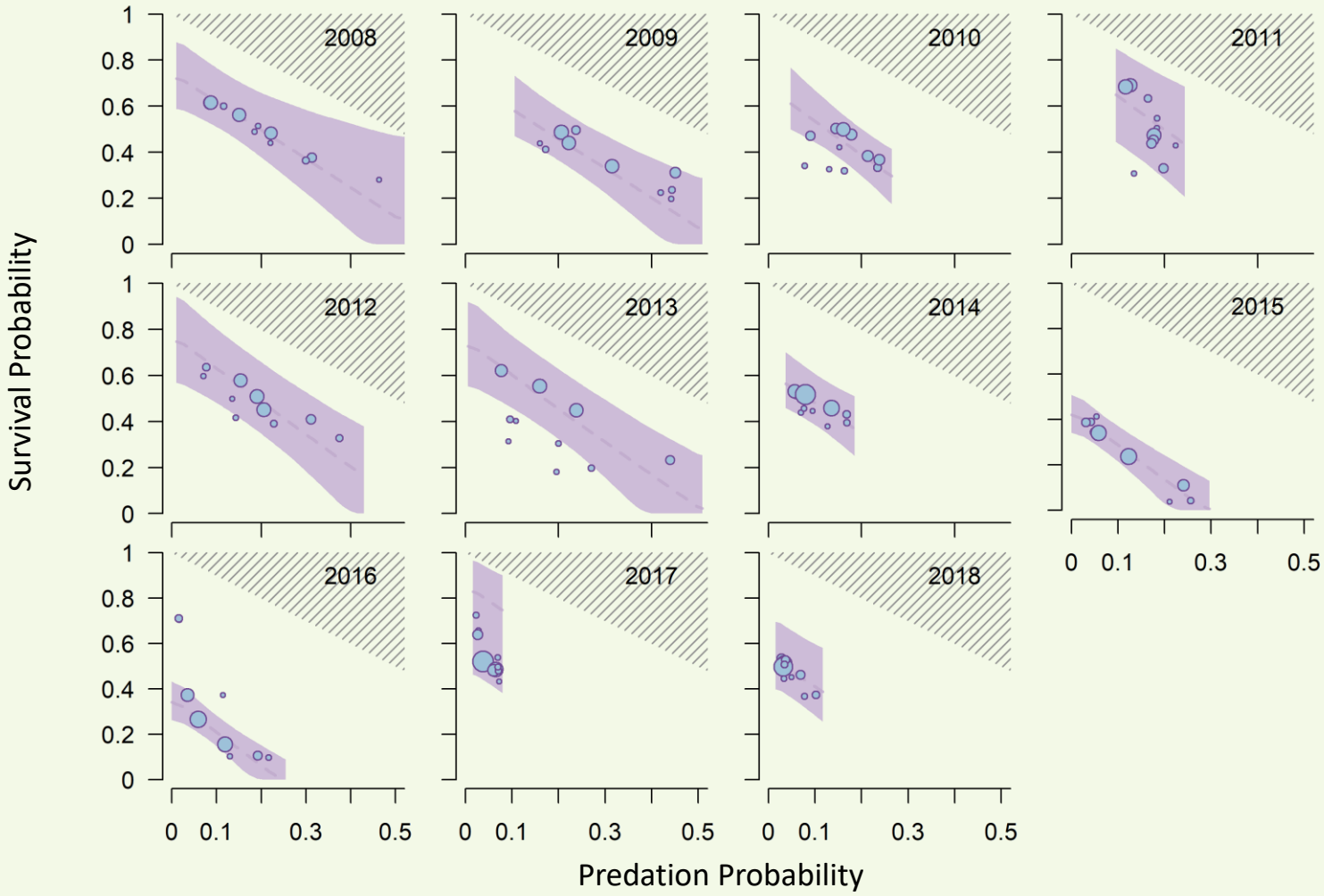

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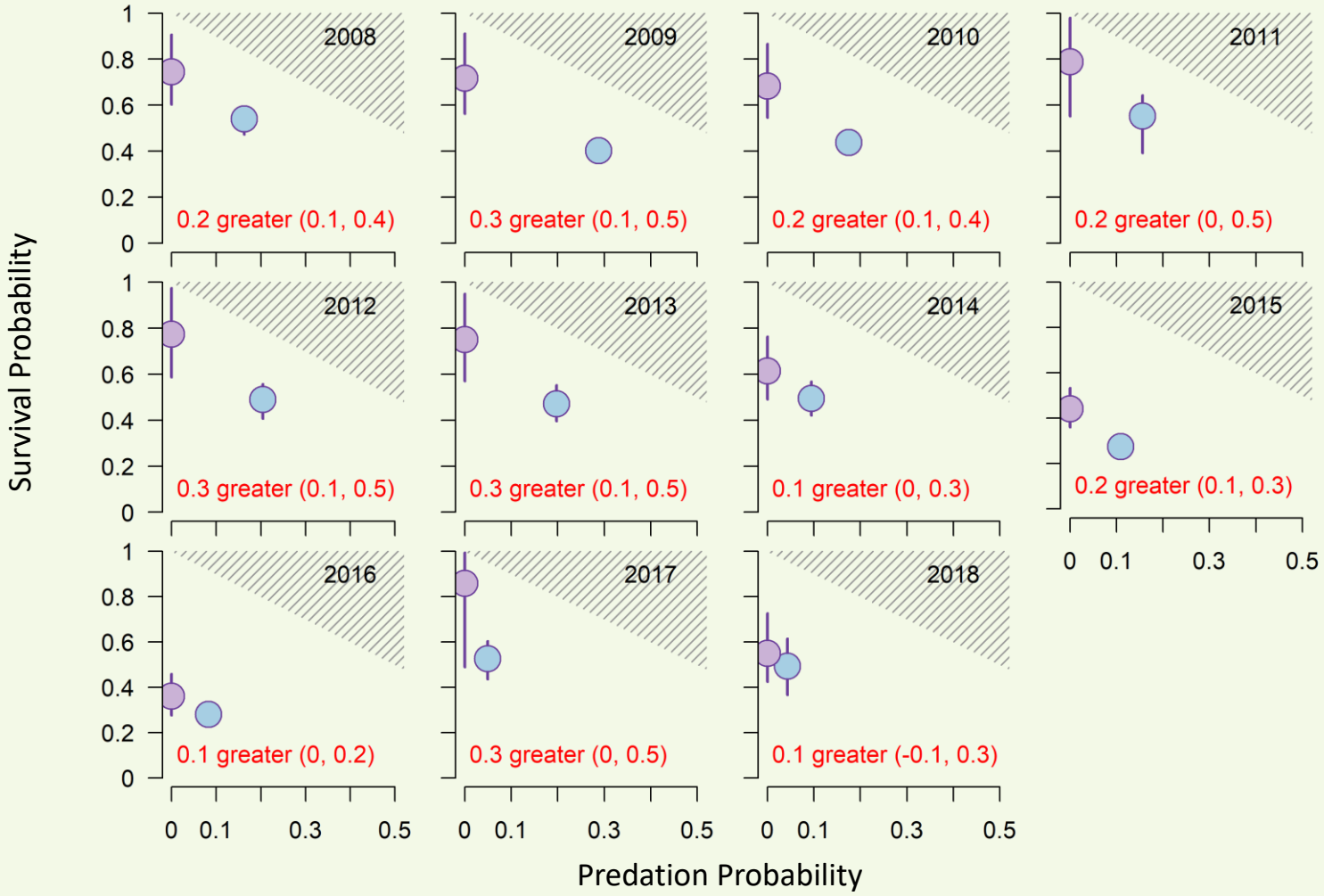

Repeatable results?

- What if we apply the same methods to Snake River Steelhead?
- Same study period (2008-2018)
  - Use passive detection an the JBS at Lower Monumental Dam
  - ~30,000 steelhead each year; ranging from 3,632 to 56,787/year

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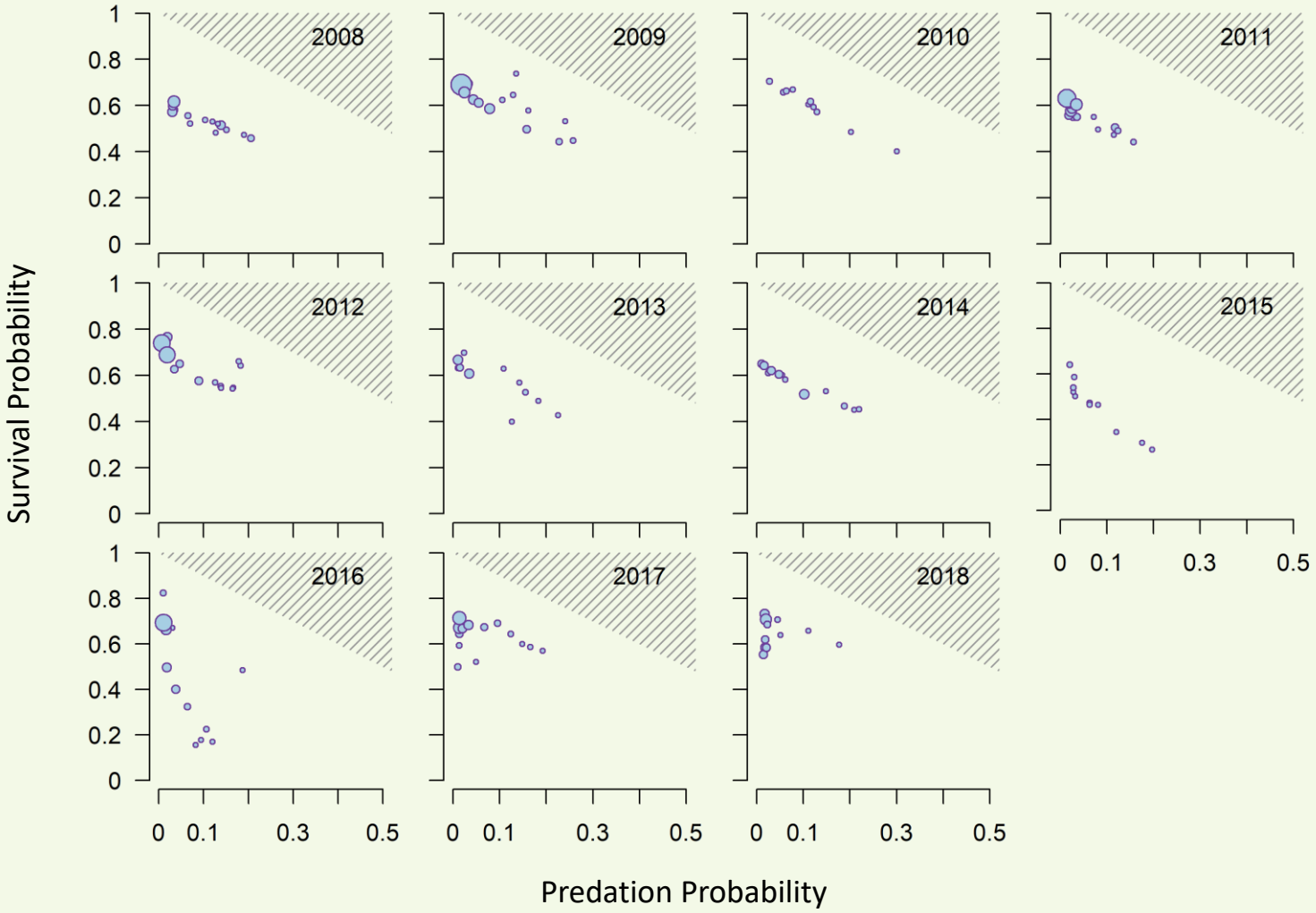

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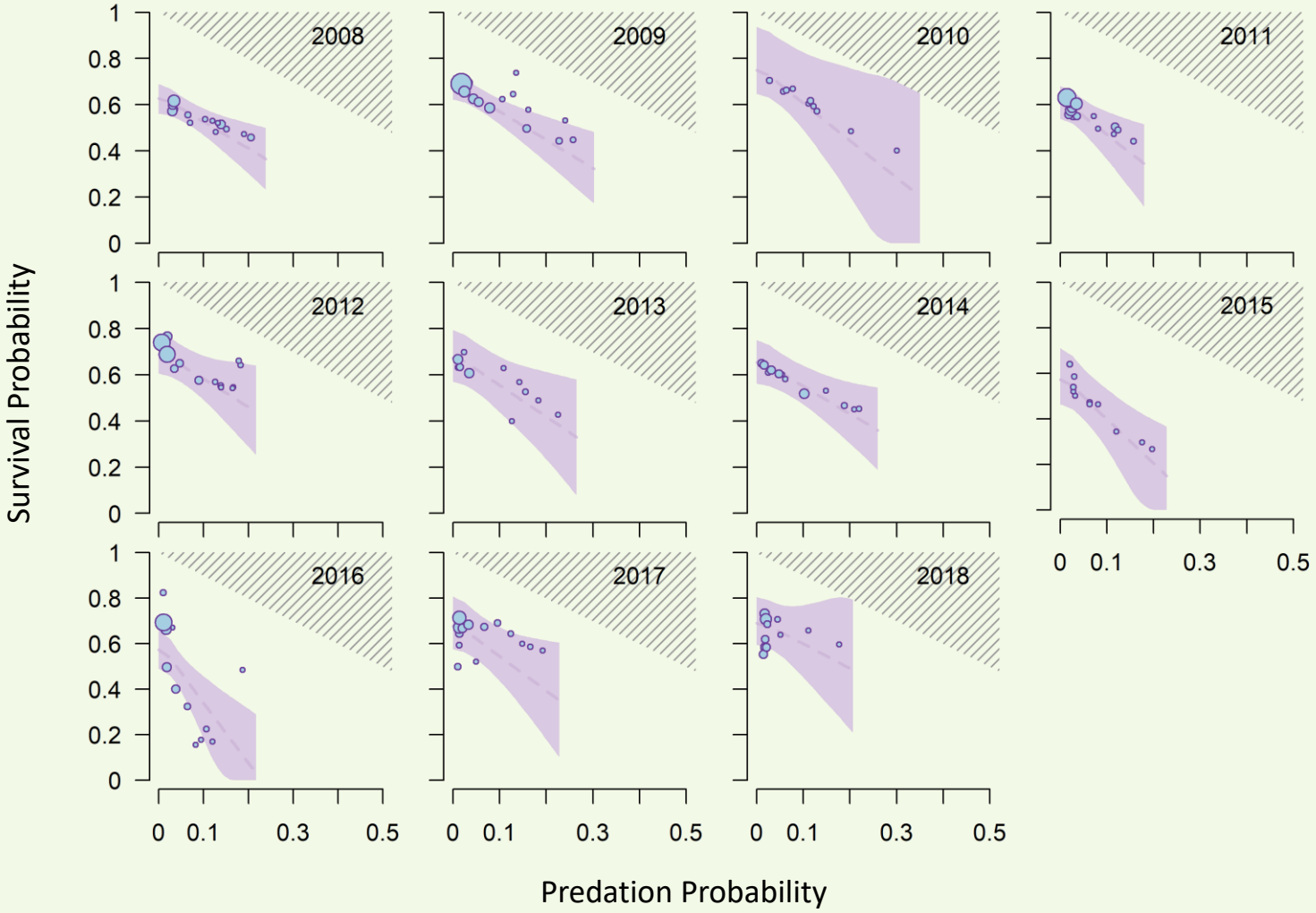

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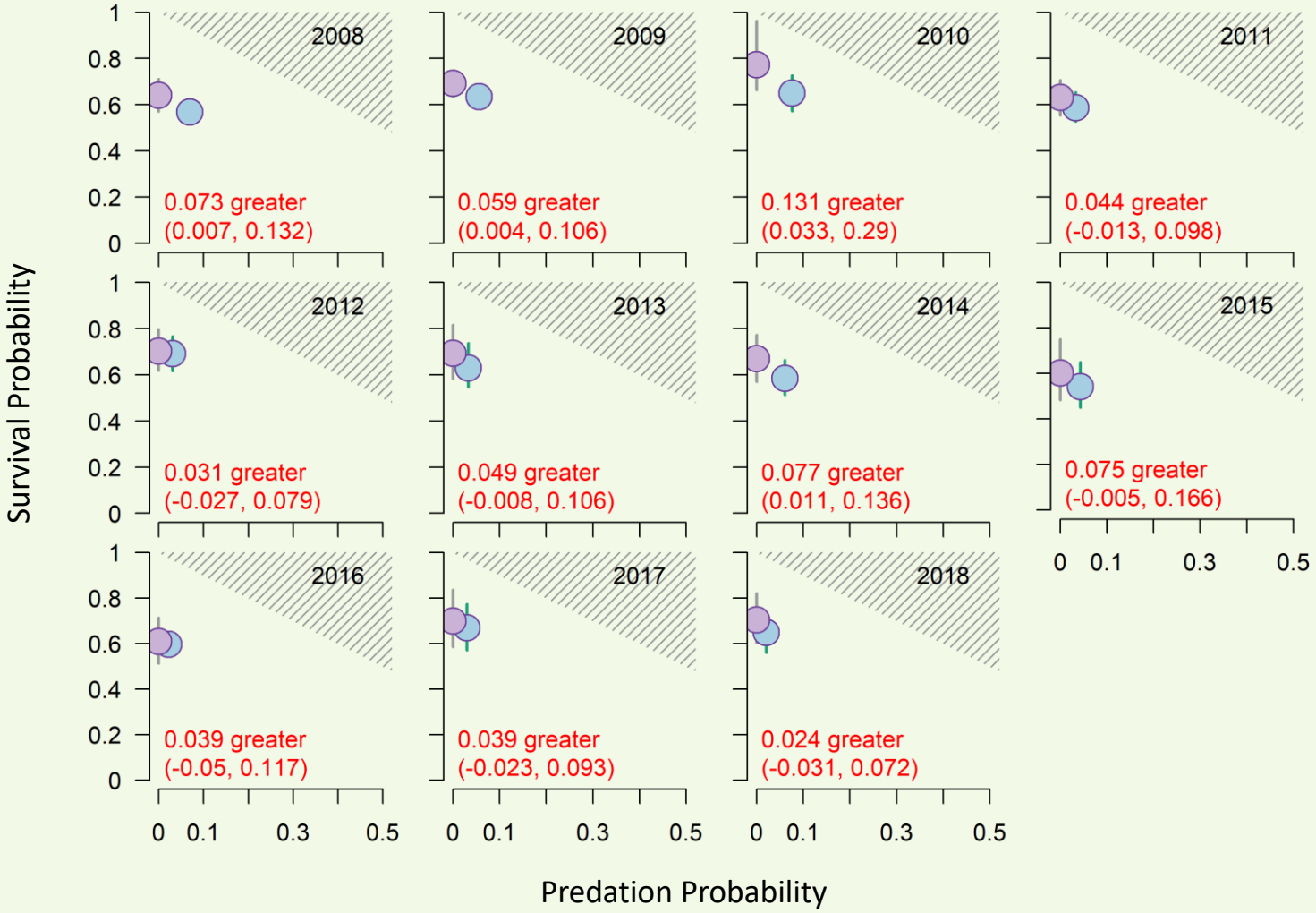
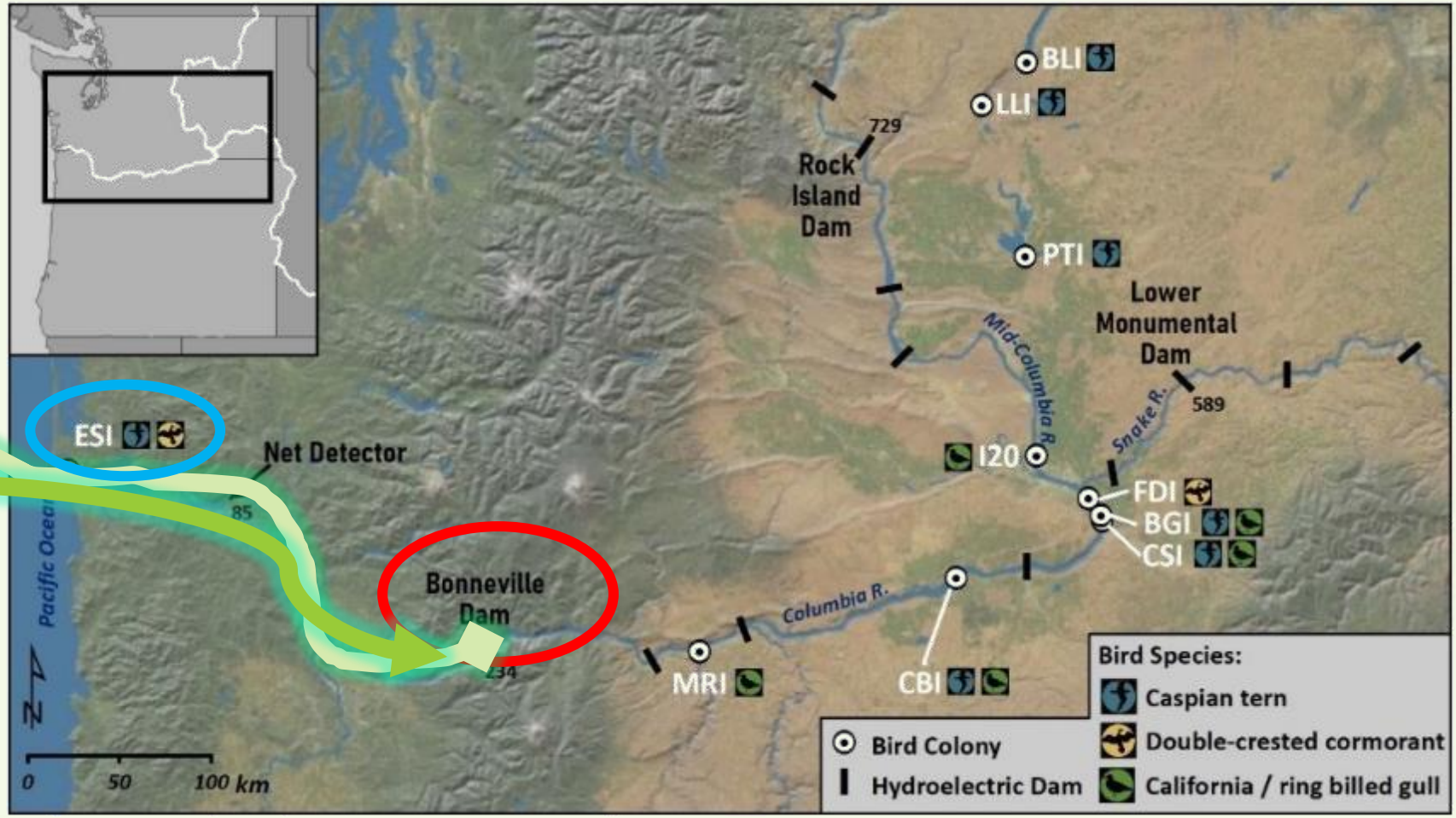


Impacts on SARs?

- What if we look at smolt-to-adult return (from BON as smolts to adult return at BON
- Shorter study period (allow for up to 3- year ocean residency)
- Much smaller signal (only one tern colony)
- Much greater noise (mortality in ocean overwhelming)



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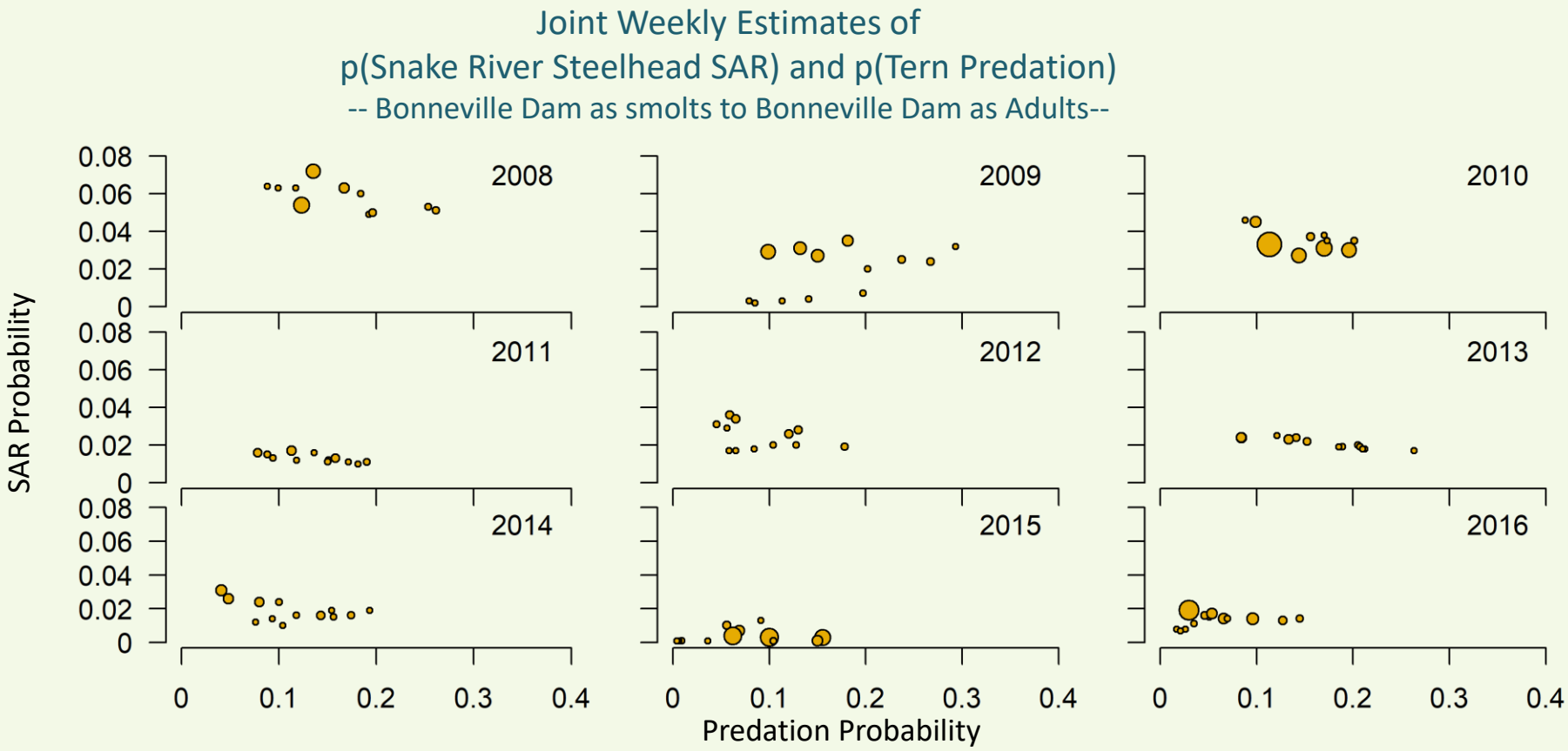

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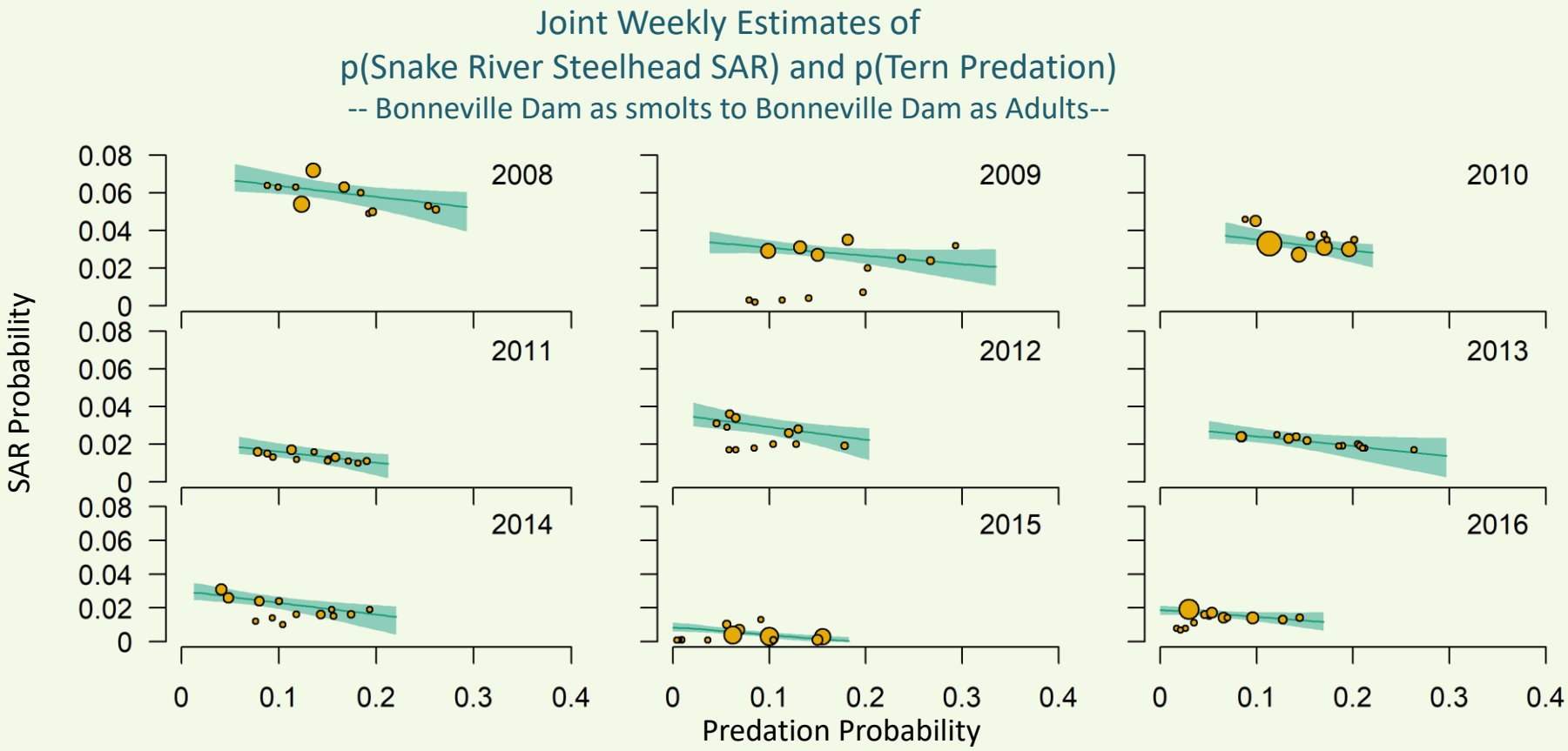
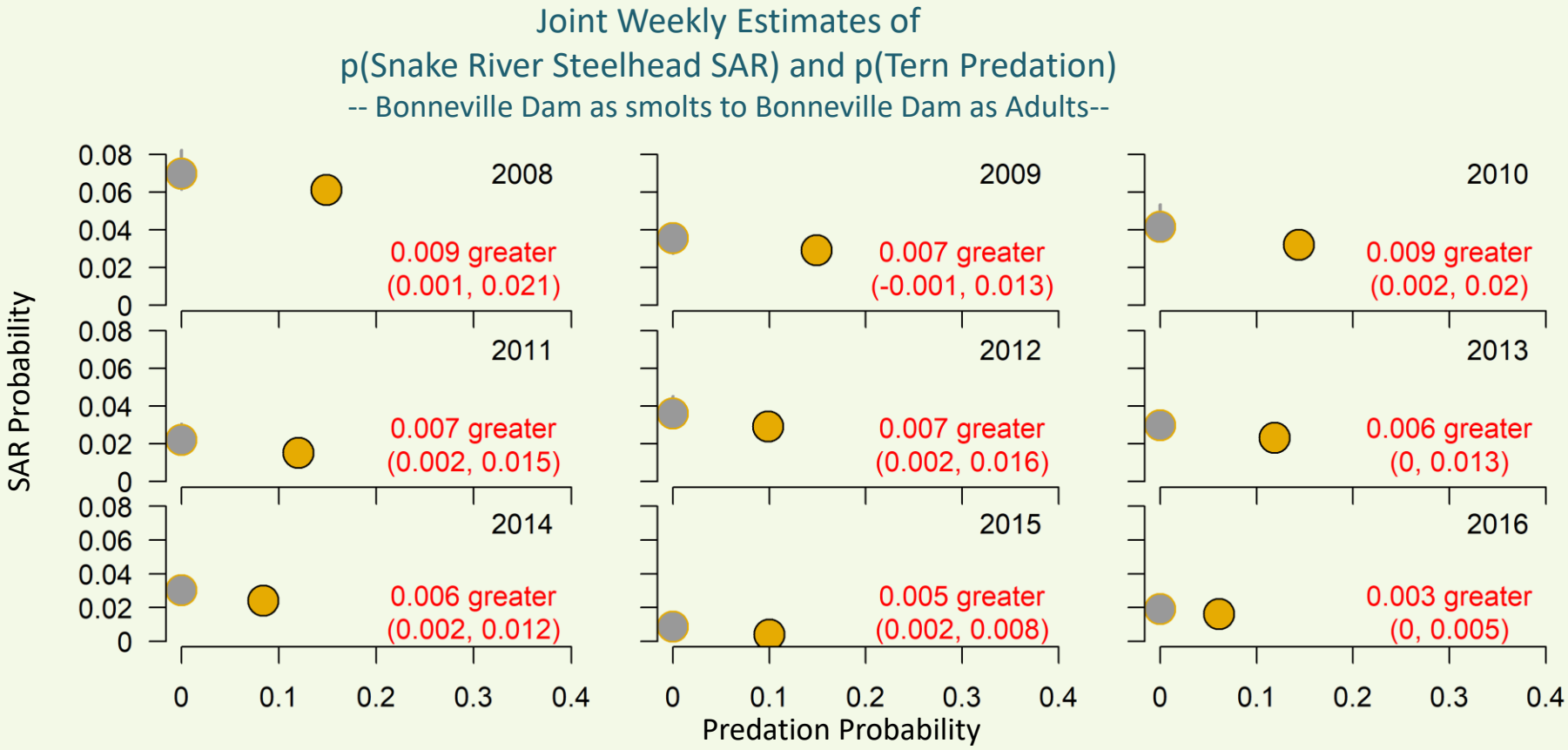


- Relationship again significant in many years
- Largely but not completely compensatory

Impacts of SARs?



- Relationship again significant in many years
- Largely but not completely compensatory
- Estimates of baseline survival consistently significantly greater than observed survival even in years with greatly diminished adult returns

Results Summary and Caveats

- We found evidence that Caspian tern predation was largely an additive source of mortality for UCR steelhead smolts upstream of Bonneville Dam
- We found evidence that Caspian tern predation was largely an additive source of mortality for SR steelhead smolts upstream of Bonneville Dam
- We found evidence that Caspian tern predation was a largely, nut not completely, compensatory source of mortality for SR steelhead smolts to adult returns

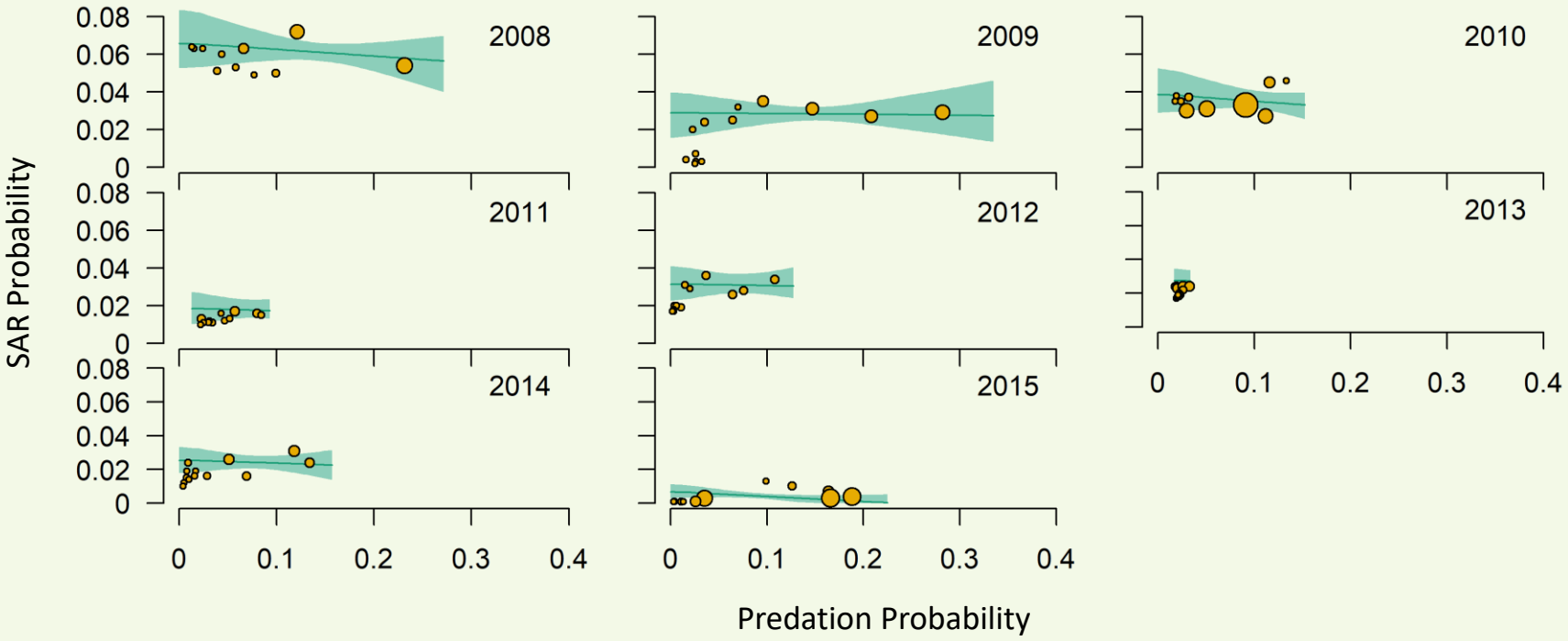
- Other predator impacts have proven more difficult to measure
  - We know gull impacts are compensatory to some extent
  - Cormorant impacts can be great
    - Diet is more variable
    - Only one colony upstream
    - The ocean creates a lot of noise to signal ratio

Questions?

Discussion

Largely but not Completely Compensatory
(SAR –Bonneville Dam to Return at Bonneville Dam--)

Joint Weekly Estimates of
p(Snake River Steelhead SAR) and p(Cormorant Predation)
-- Bonneville Dam to Bonneville Dam as Adults--



Discussion

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