

Quantifying Effects of Predation on Plover Productivity and Evaluating Effectiveness of Predator Management



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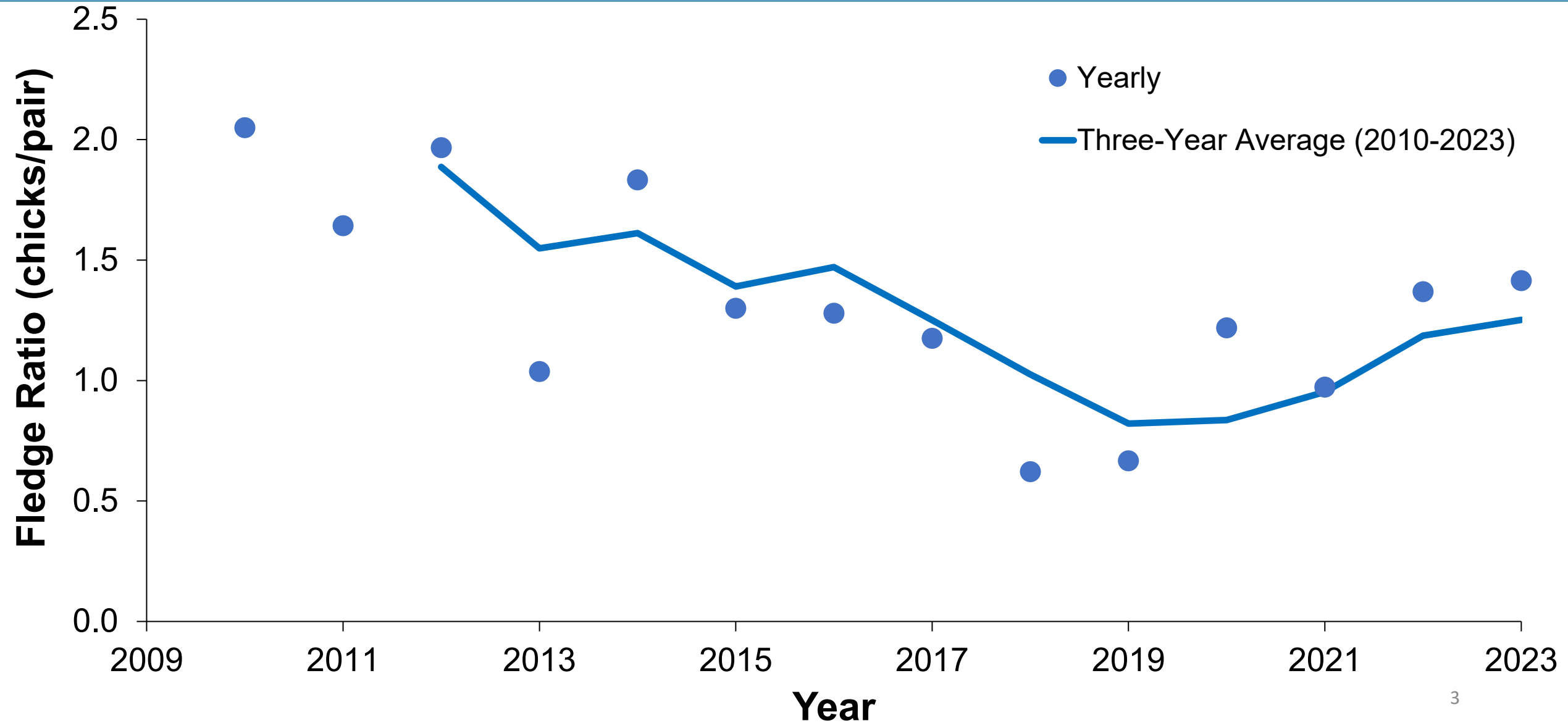
Jason Bruggeman, EDO—Science Plan Reporting Session, February 21, 2024

PRRIP Plover Monitoring

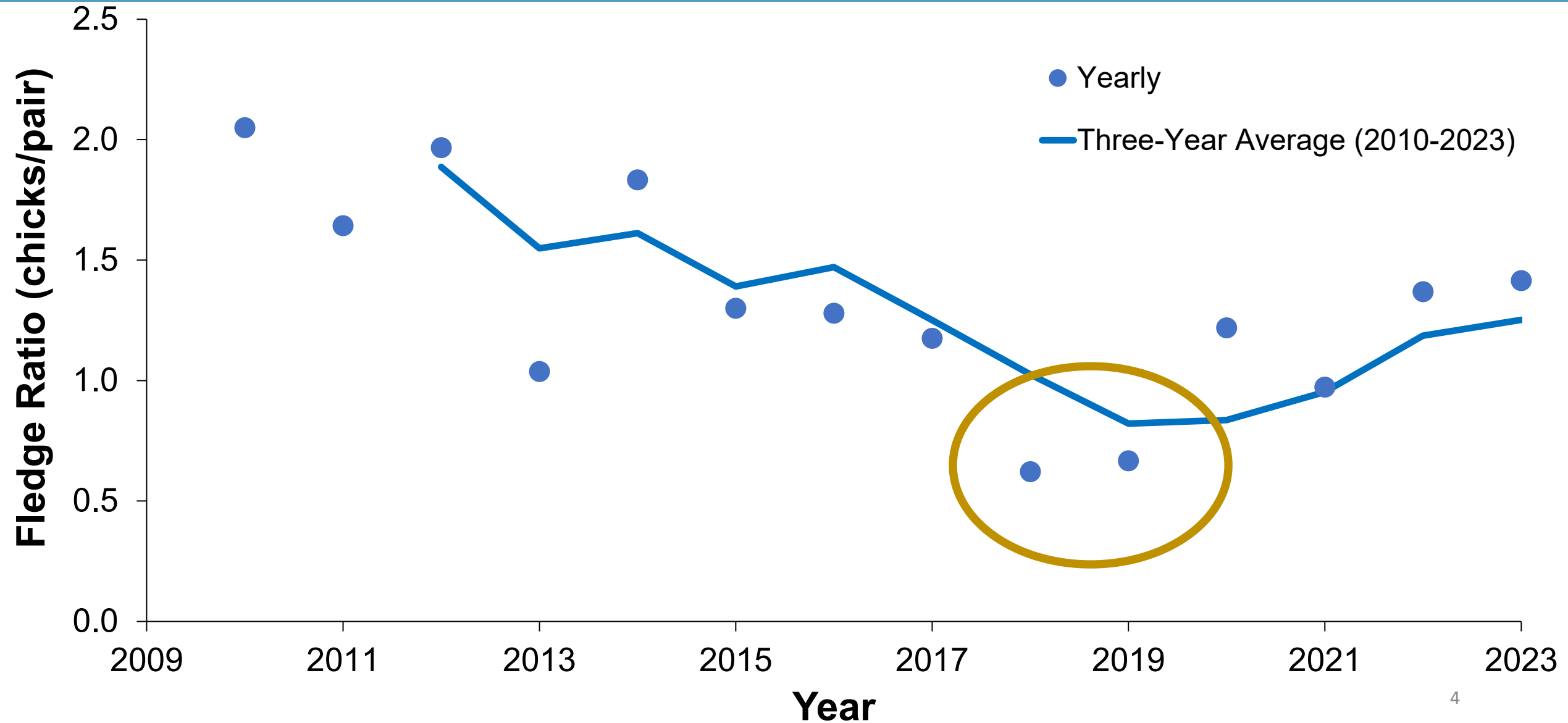
- Management objective:
 - Improve productivity
 - Increase number of fledged chicks
 - Reduce adult mortality
- Status indicators:
 - Number of breeding pairs
 - Fledge ratios



Plover Fledge Ratios



Plover Fledge Ratios



Science Plan Extension Big Questions

- **EBQ #8:** How much of an effect does predation have on plover productivity?
- **EBQ #9:** How effective is Program management at mitigating losses of plover productivity due to predation?

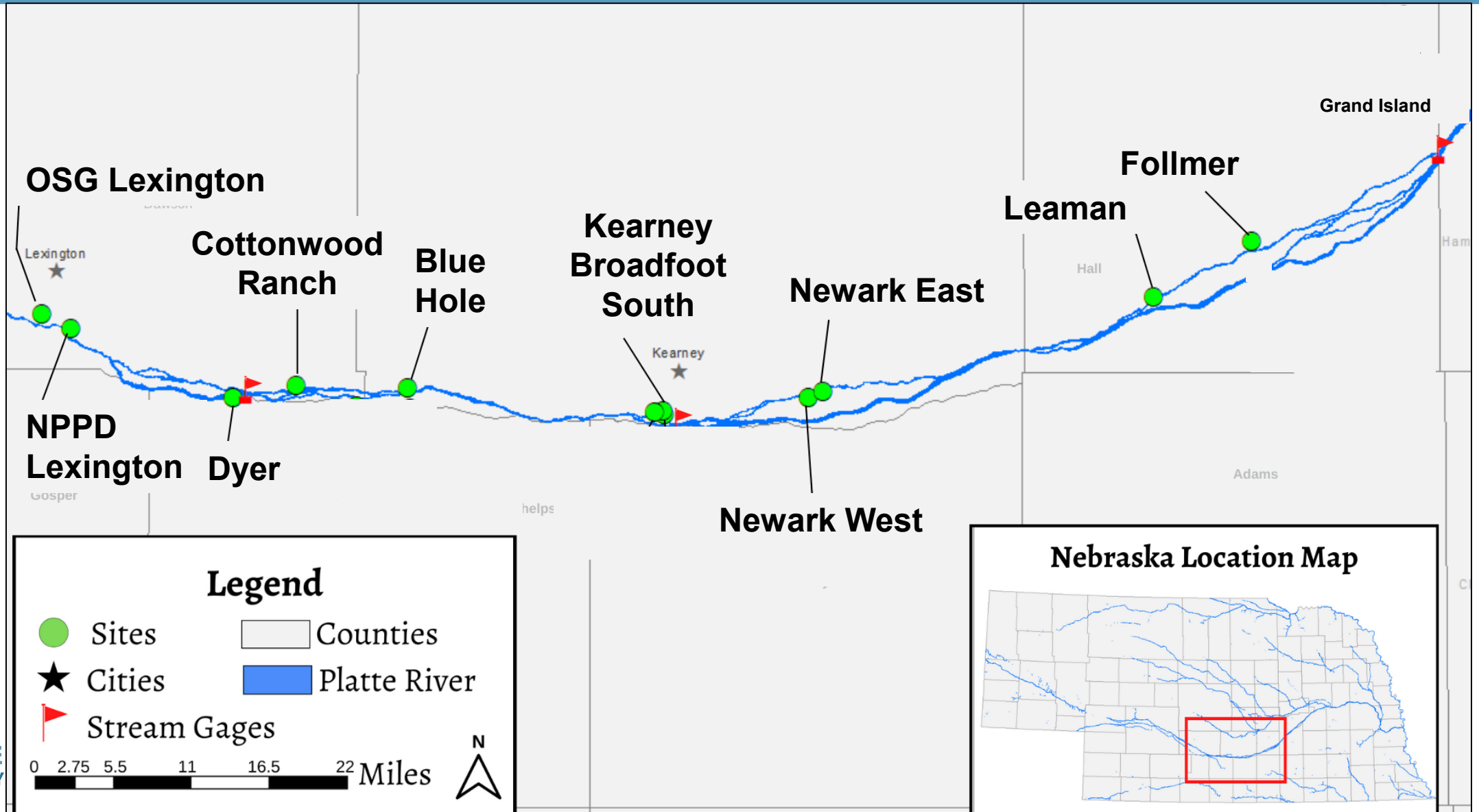


PRRIP Monitoring and Management

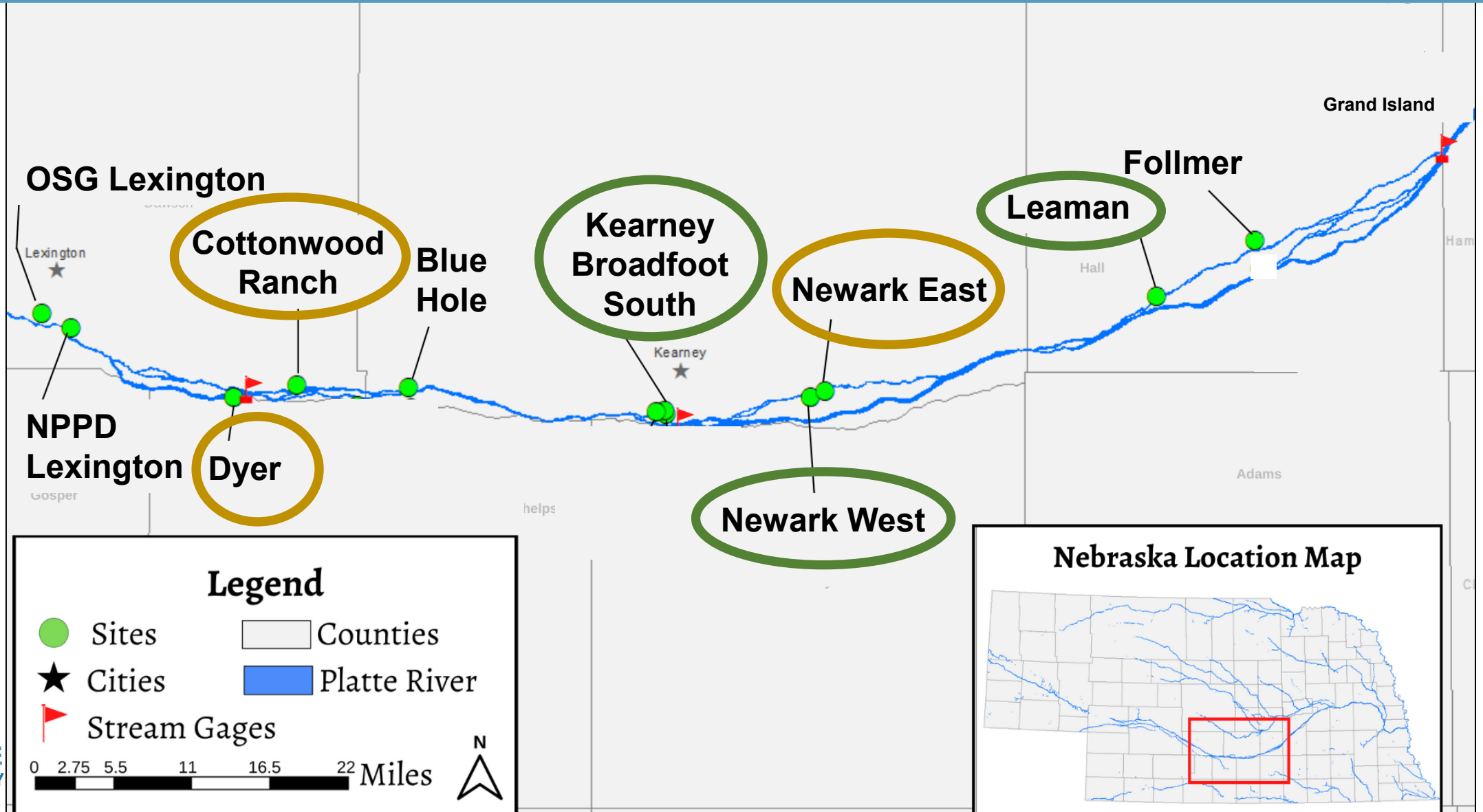
- Off-channel sand and water (OCSW) site surveys
 - May 1 – August 1
 - Twice monthly
 - Twice weekly if nesting
- 10 OCSW sites—
basic predator management
 - Electrified fence—entrance
 - Fence panel wings
 - Tree removal
 - Avian spikes
 - Trapping



OCSW Study Areas



OCSW Study Areas



Predator Research and Management

- Predator monitoring at six OCSW sites
 - Remote camera monitoring
 - Predator track surveys
- Three sites—additional predator management
 - Predator exclusion fencing
 - Deterrent lighting



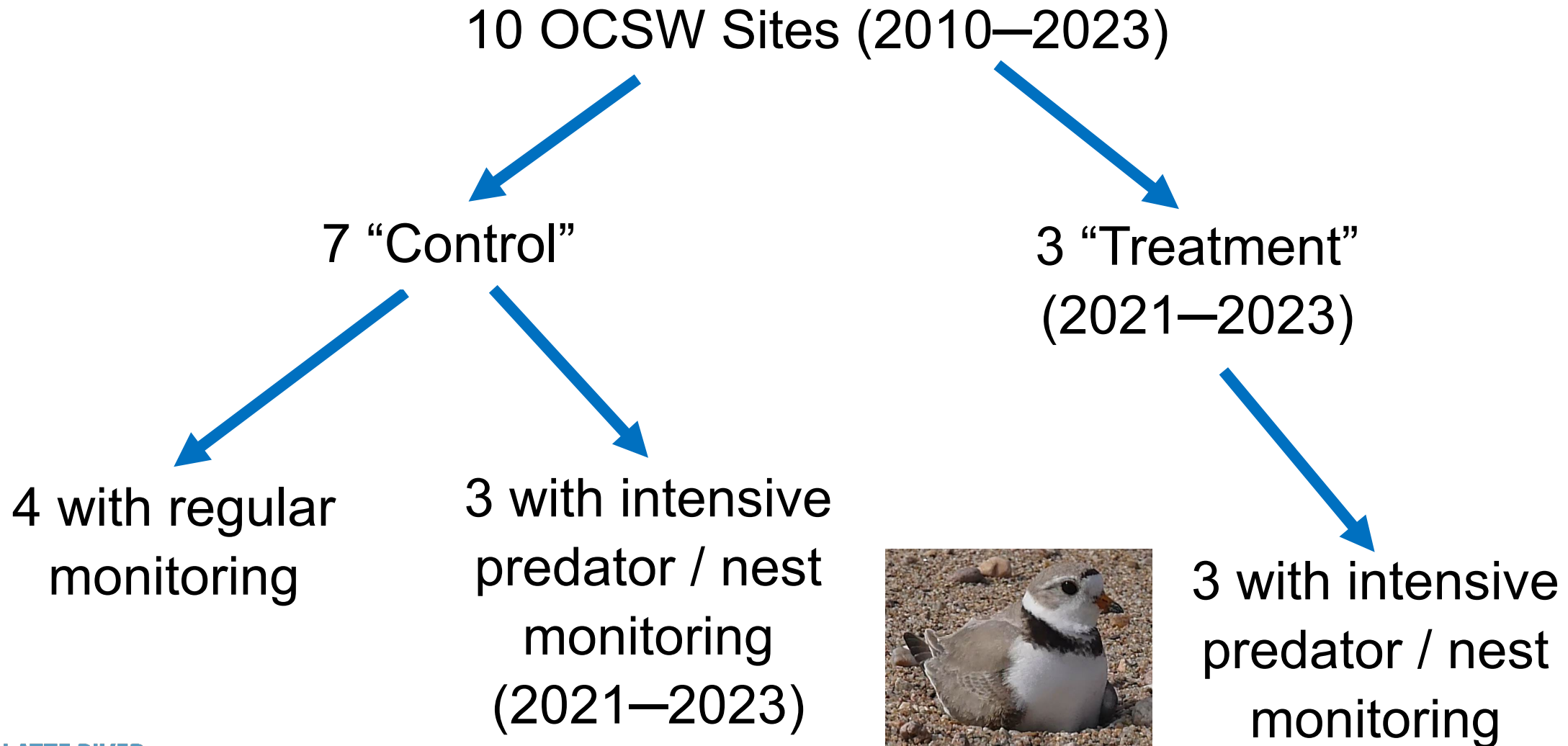
Predator Management Methods



Experimental Design



Experimental Design



Summary of Data Analyses

1. **Evaluating management effectiveness for improving fledge ratios with a BACI paired series design**
- 2.
- 3.
- 4.
- 5.

Analysis 1—Fledge Ratios BACIPS

- Before-After-Control-Impact Paired Series (BACIPS) design
 - Paired data before and after treatment
 - Distinguish treatment effects from background differences and variability

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- Before-After-Control-Impact Paired Series (BACIPS) design
 - Paired data before and after treatment
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- Approach 1:
 - Generalized linear mixed-effects modeling
 - Response variable:
 - $fledgeratio_{site, year}$
 - Covariates:
 - $treatment$ (control; treatment)
 - $time$ (before; after)
 - Model:
 - $fledgeratio_{site, year} = treatment + time + treatment*time$

Analysis 1—Fledge Ratios BACIPS

- Before-After-Control-Impact Paired Series (BACIPS) design
 - Paired data before and after treatment
 - Distinguish treatment effects from background differences and variability
- Approach 2:
 - Fledge ratios:
 - Mean difference treatment - control after (2021—2023)
 - Mean difference treatment - control before (2010—2020)
 - Evaluate treatment effect:
 - after - before

Summary of Data Analyses

1. Evaluating management effectiveness for improving fledge ratios with a BACI paired series design
2. **Quantifying role of predation on daily nest and brood survival with a BACI paired series design**
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Analysis 2—Nest & Brood Survival BACIPS

- Bayesian multinomial logistic exposure nest survival model (Darrah et al. 2018)
 - Incorporate multiple nest fates
 - Add random effects to account for clustering of fates
 - Account for unknown fates
 - Include covariates



Analysis 2—Nest & Brood Survival BACIPS

- Response variables:
 - Daily plover nest survival
 - Daily plover brood survival
- Covariates:
 - Predator management and monitoring
 - Site and nest attributes
 - Random effects



Analysis 2—Nest & Brood Survival BACIPS

- Response variables:
 - Daily plover nest survival
 - Daily plover brood survival
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 - interior fence; exterior fence; deterrent lighting; camera
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 - Random effects
 - site; year

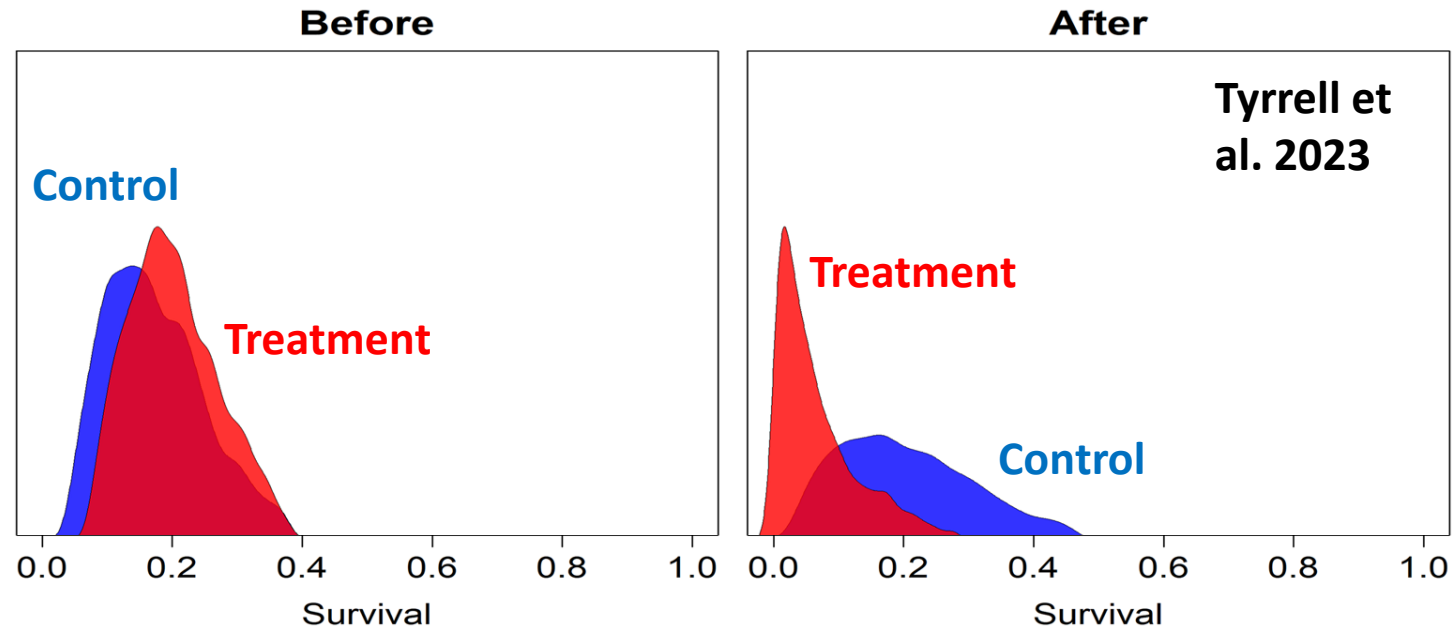


Analysis 2—Nest & Brood Survival BACIPS

- BACI ratio (Conner et al. 2016)
- θ_{year} : posterior distribution cumulative probability nest survival
- Each year:
 - $R_{\theta_{year}, t|c} = \theta_{year, treatment} / \theta_{year, control}$
- Average ratio across years for period
 - $\overline{R}_{\theta_{t|c}, before}$
 - $\overline{R}_{\theta_{t|c}, after}$

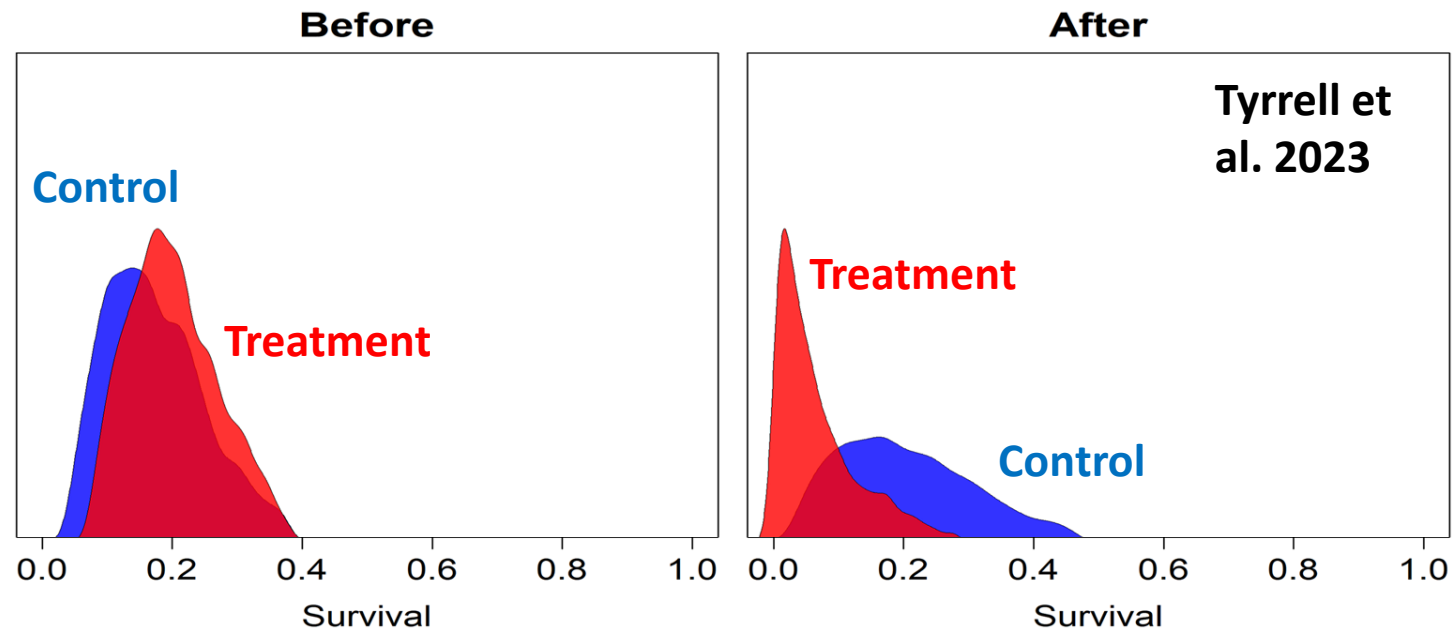
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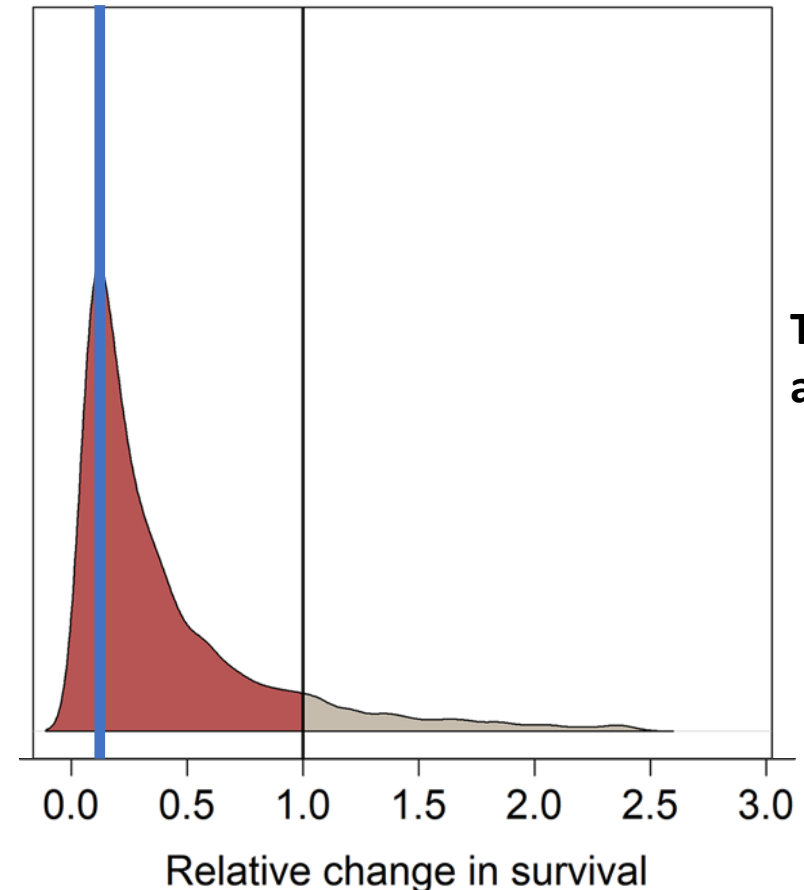
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Tyrrell et
al. 2023

Summary of Data Analyses

1. Evaluating management effectiveness for improving fledge ratios with a BACI paired series design
2. Quantifying role of predation on daily nest and brood survival with a BACI paired series design
3. **Quantifying factors affecting abundance, survival, and recruitment, and using BACI effect to evaluate predator management effectiveness**
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Analysis 3—Abundance, Survival & Recruitment

- Dail and Madsen (2011) model
 - *N*-mixture model
 - Open population
 - Use repeated counts



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- Model parameters
 - Initial abundance ($N_{i,1}$)
 - Apparent survival ($S_{i,t+1}$)
 - Survival – Emigration
 - Gains ($G_{i,t+1}$)
 - Reproduction + Immigration
 - Detection probability



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$$N_{i,1} \longrightarrow N_{i,2} \longrightarrow N_{i,3}$$
$$= S_{i,2} + G_{i,2} \qquad = S_{i,3} + G_{i,3}$$



Analysis 3—Abundance, Survival & Recruitment

- Covariates
 - Site attributes and previous nesting
 - Weather variability
 - Temporal
 - Predator management
 - BACI: $\text{treatment} + \text{time} + \text{treatment} \times \text{time}$
- Model selection
 - AIC



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4. **Assessing predator communities and responses to management through evaluation of camera monitoring data**
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4. Assessing predator communities and responses to management through evaluation of camera monitoring data
5. **Using Monte Carlo projection model to predict impacts of predation on future abundance**



Analysis 5—Monte Carlo Projection Model

Empirical data

- Area of habitat
- Breeding pairs
- Fledge ratios



N_0

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$$N_0$$

Parameter estimates (θ_0) with distribution

- Survival
- Immigration
- Emigration
- Nesting density



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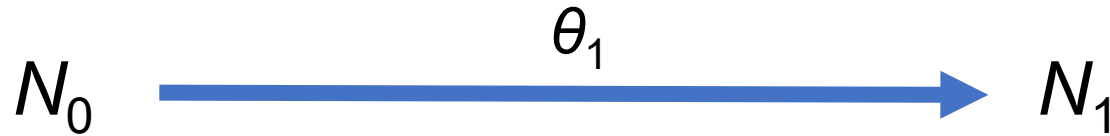
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Prediction



Parameter estimates (θ_0) with distribution

- Survival
- Immigration
- Emigration
- Nesting density



- Breeding pairs
- Fledge ratios



Tasks and Timeline

Quantify Impact of Predation and Other Factors

March — October 2024



Assess Predator Community Response

June — October 2024



Evaluate Management Effectiveness

July — October 2024



Results Synthesis and Decision Making

May — December 2024



Implementation Planning for 2025

Fall 2024 — April 2025

Questions?

