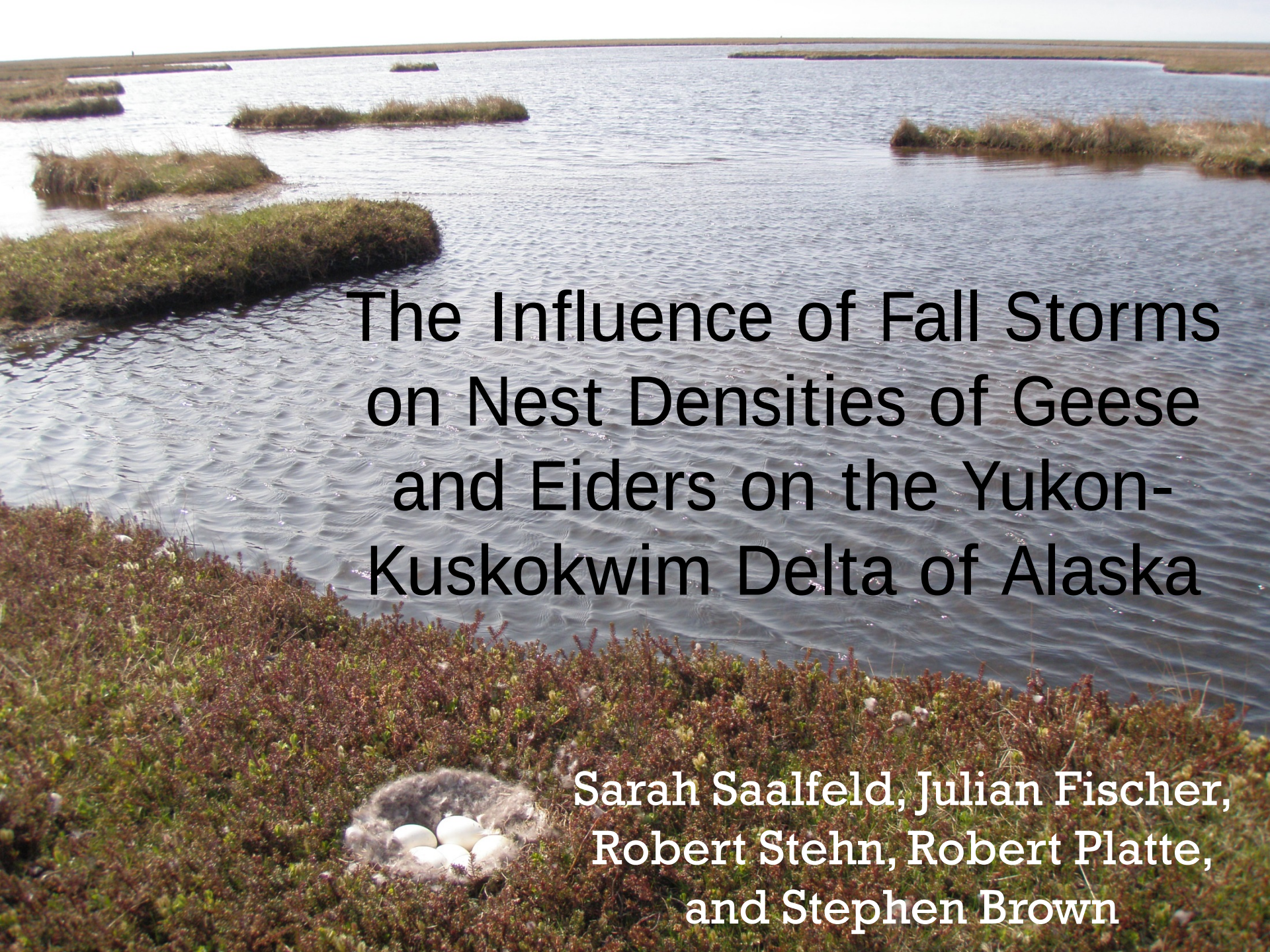


The Influence of Fall Storms on Nest Densities of Geese and Eiders on the Yukon-Kuskokwim Delta of Alaska

Sarah Saalfeld, Julian Fischer, Robert Stehn, Robert Platte, and Stephen Brown

Yukon-Kuskokwim Delta (YKD)

- Largest intertidal wetland in North America – globally important for millions of waterbirds
  - Entire breeding population of Emperor and Cackling Geese
  - Most of the Pacific Flyway population of Black Brant and Greater White-fronted Geese
  - Several species of conservation and management concern
    - Threatened Spectacled Eider

Nesting Habitats on the YKD

- Waterbird nest densities are highest within coastal fringe habitats, with some species only occurring within these areas

- These habitats are dependent on coastal estuarine processes
  - Tidal erosion
  - Deposition of sediments
  - Storm-tide flooding
  - Salt intrusion

Climate Change and the YKD

- Predicted changes include
  - Sea-level rise
  - Increased frequency and intensity of coastal storms
  - Reduction in permafrost
- These changes have the potential to dramatically alter waterbird nesting habitat
  - As sea levels rise, suitable habitat may become inundated
  - Increased frequency and intensity of storms may alter habitat conditions as well as result in reproductive failure if storms occur during the nesting season

Overall objectives

1. Determine how historic storms have impacted nesting waterbirds on the YKD

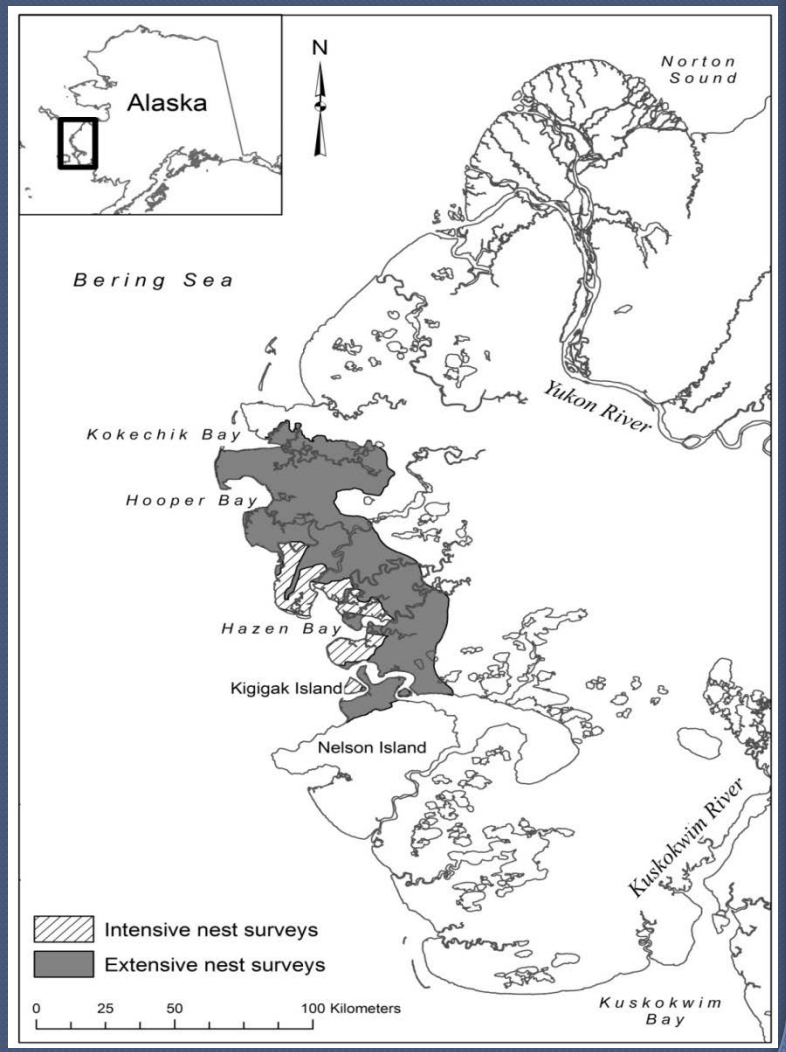
2. Determine potential impacts of future storms under climate change

Data inputs

- To complete these objectives, we used:
  1. 29 years of ground-based surveys conducted as part of USFWS's long-term waterbird monitoring program
  2. Flood indices modeled for 10 storms since the 1990s (Ravens and Allen)
  3. Time-static environmental variables

Nest Surveys

- 2,318 plots (0.32 km^2) were surveyed using single-visit area searches during incubation
- Plots were randomly selected
  - Restricted not to overlap plots surveyed in the past 5 years



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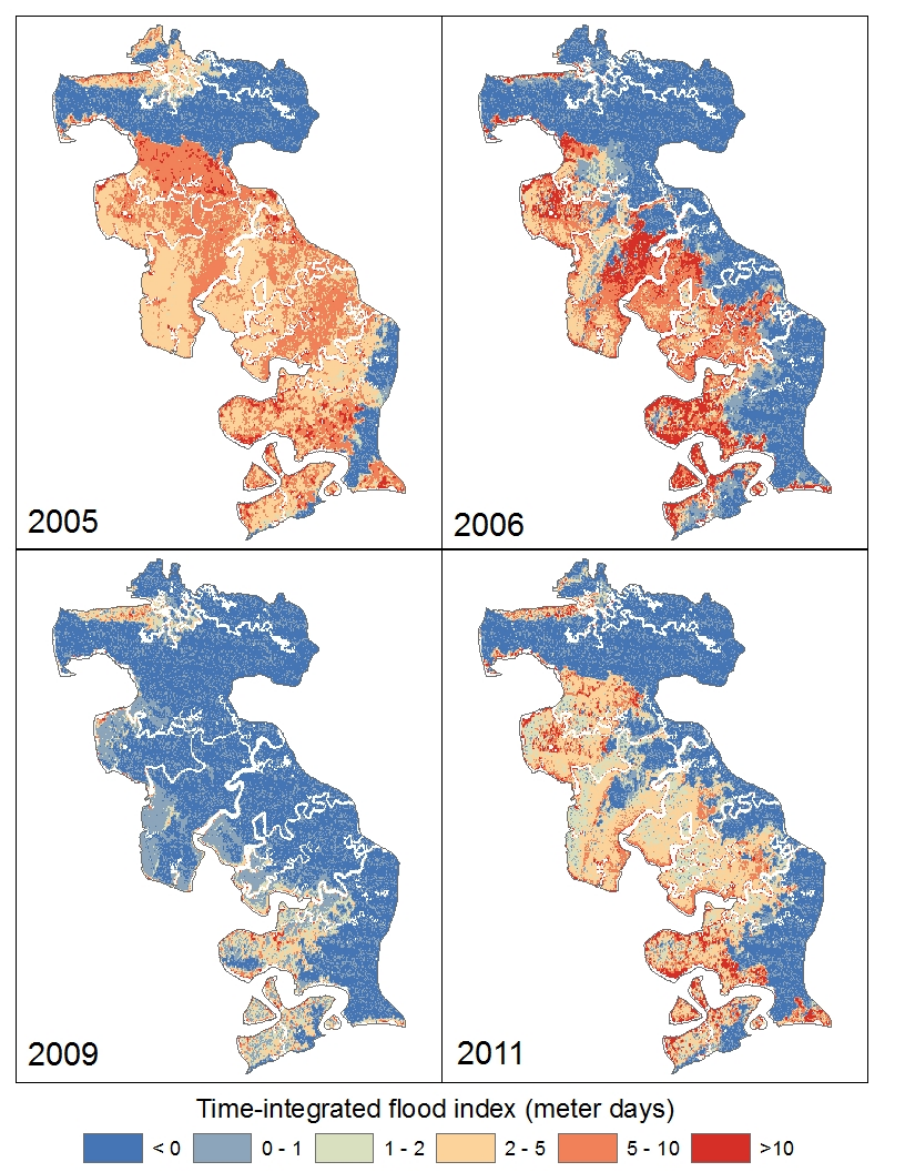
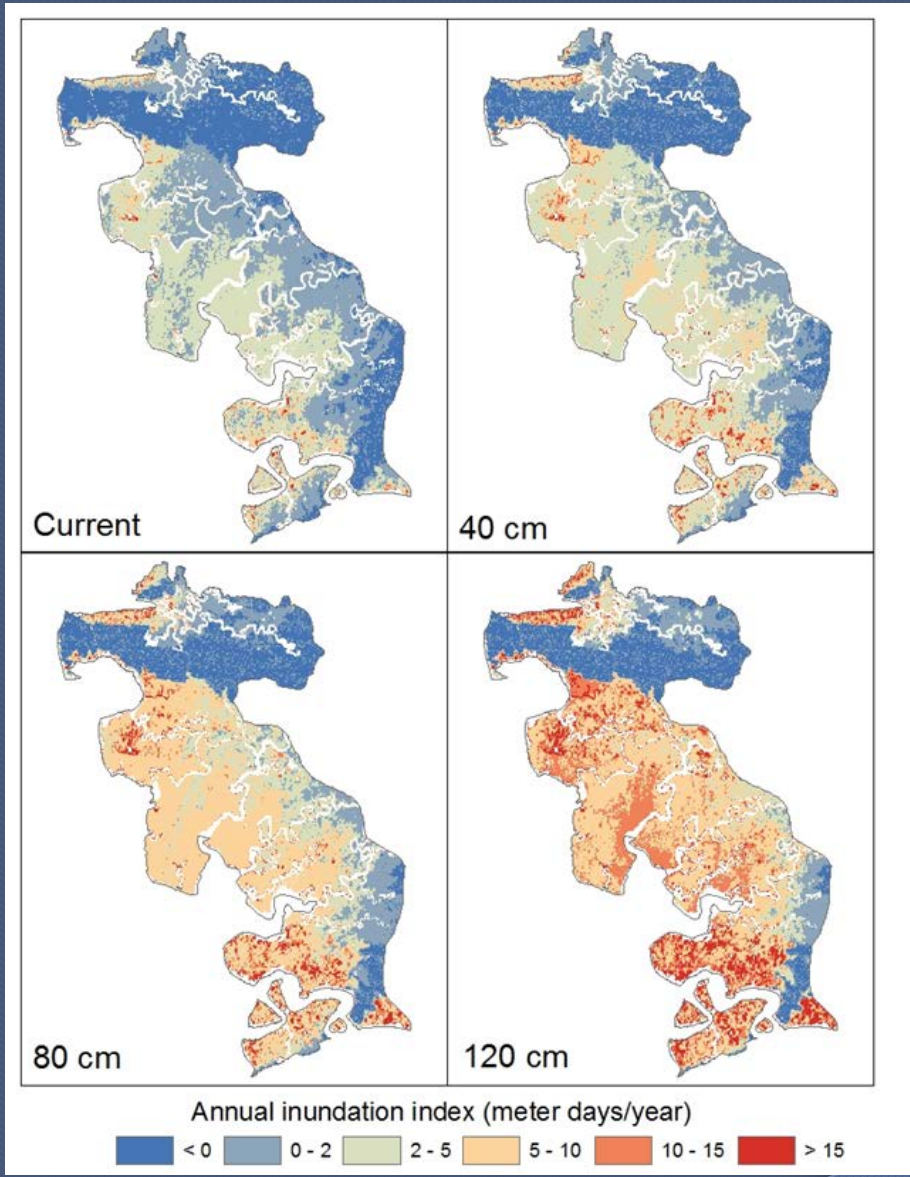
Time-integrated flood index

- Storm-specific measure that accounts for both water depth and the amount of time flooding occurred on the landscape



Annual inundation index

- Time-static storm footprint calculated based on the time-integrated flood index from 7 modeled storms and their annual return rate



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Environmental Variables

- Vegetation type – Ducks Unlimited land cover map
  - % coastal dwarf shrub
  - % coastal dwarf shrub/pond mosaic
  - % lower coastal salt marsh
  - % upper coastal brackish meadow
  - % coastal graminoid
  - % sandbar/mudflat
  - % upland
  - Distance to inland mudflat
- Water/shoreline – National Hydrography Dataset
  - Mean density of water bodies
  - % area of waterbodies
  - % area of riverine
  - Length of pond shoreline
  - Length of riverine/tidal sloughs
  - Distance to coast

First part of this project

- Identified important environmental variables related to waterbird nest densities
- Mapped predictive surfaces of waterbird nest densities

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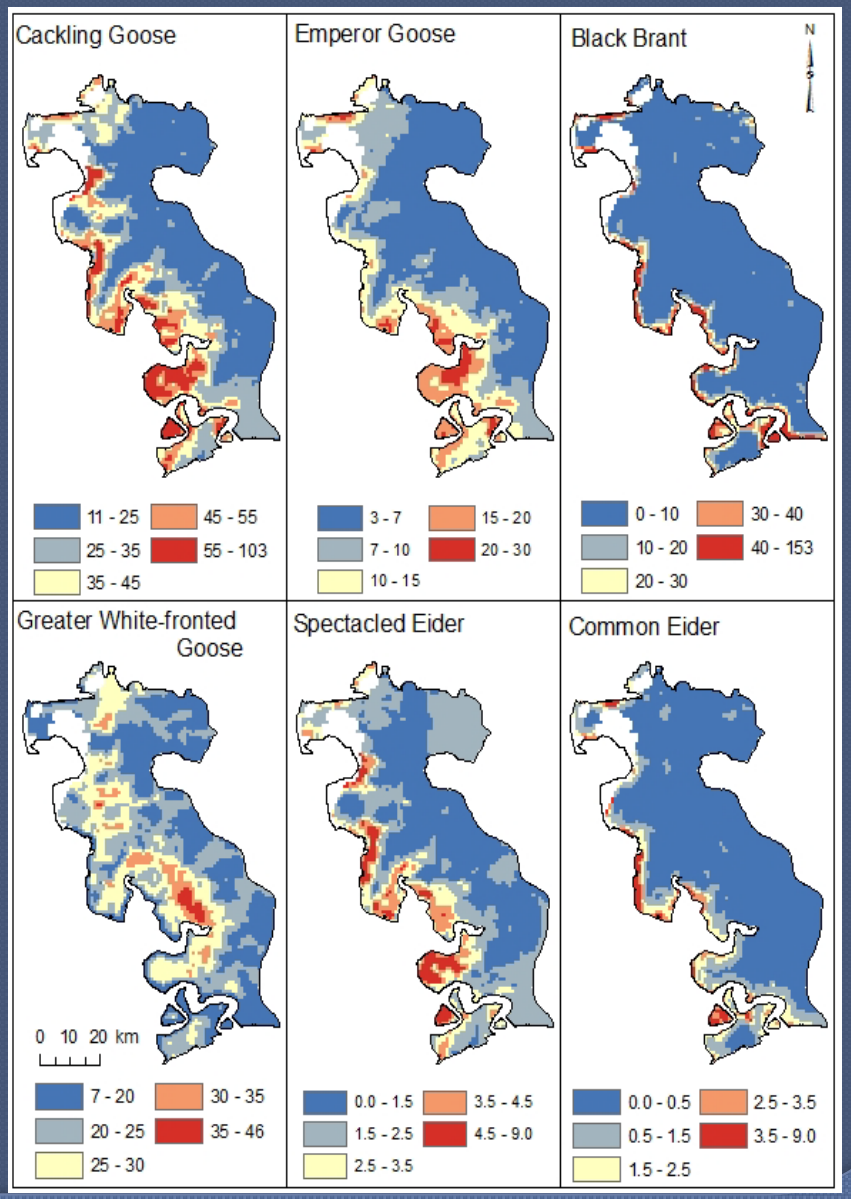
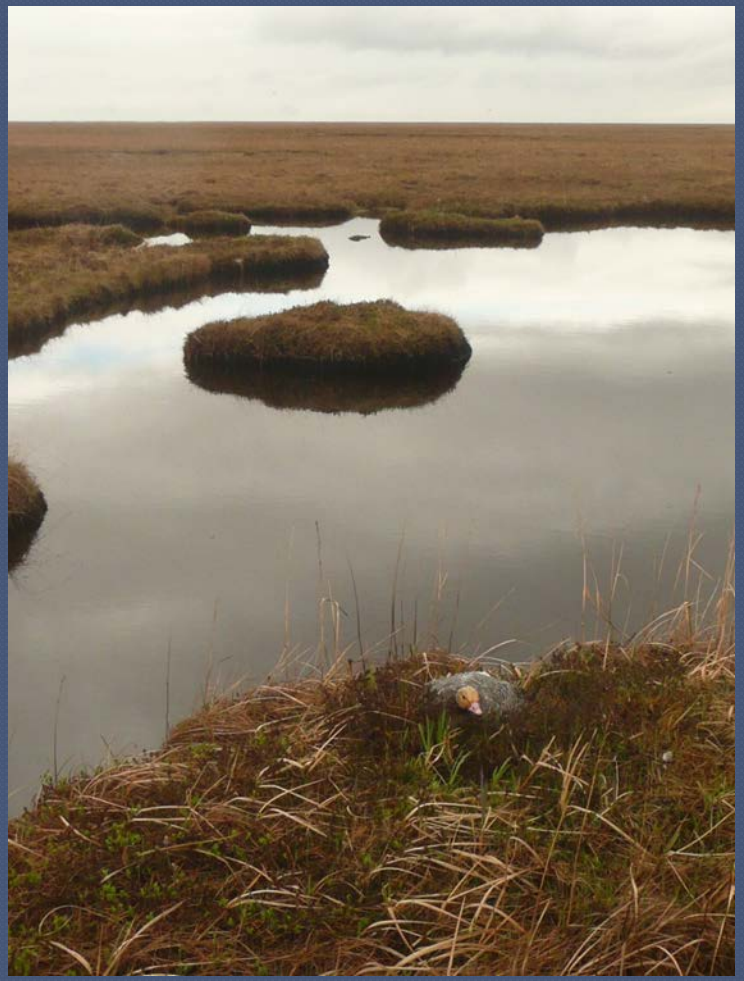


First part of this project

- Management implications
  - Identified important regions for nesting geese and eiders that provide a basis for future management and conservation priorities
  - Can be used in conjunction with layers predicting changes to environmental variables due to climate change
    - Identify areas most at risk and habitat refugia
    - Develop species-specific vulnerability assessments and adaptation strategies
  - Inform future monitoring efforts
- Models do not include storm surge effects

Second part of this project

- Determine historic responses of waterbirds to storm surges while controlling for large-scale habitat selection patterns

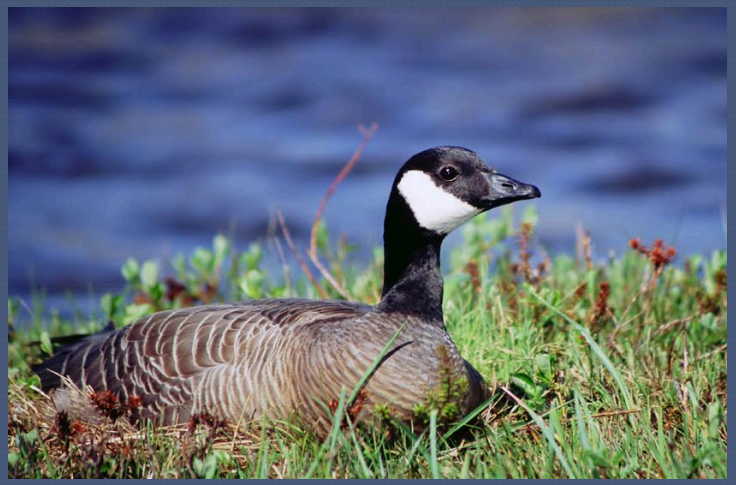


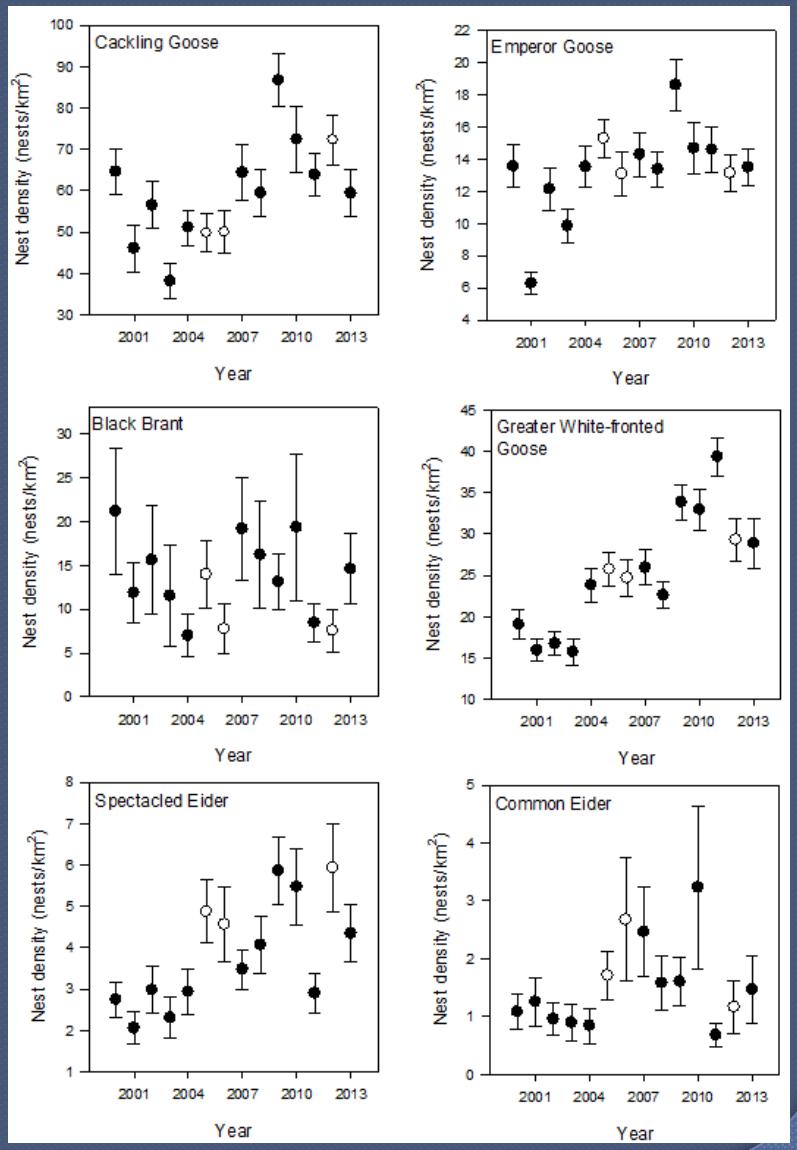
Methods

- Short-term impacts
  - Compared nest densities in relation to magnitude of storms that occurred in the prior fall
  - Modeled nest densities in relation to environmental covariates and time-integrated flood index using Random Forests
- Long-term impacts
  - Modeled nest densities in relation to environmental covariates and annual inundation index using Random Forests

Results

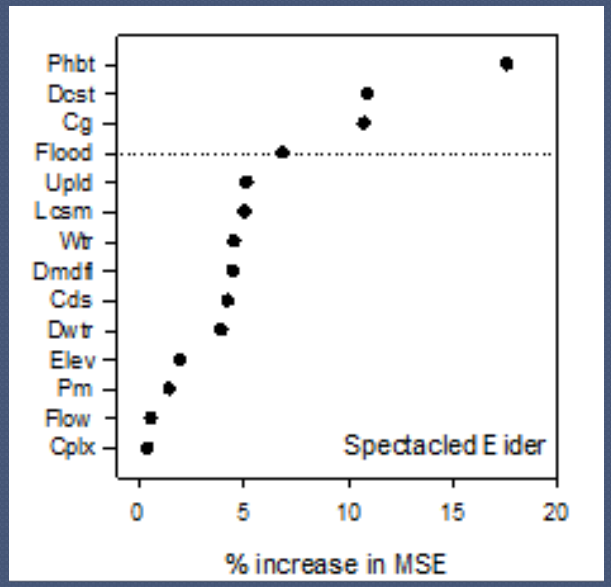
- Nest densities varied both spatially and annually, but appeared to be unrelated to storm magnitude the prior fall

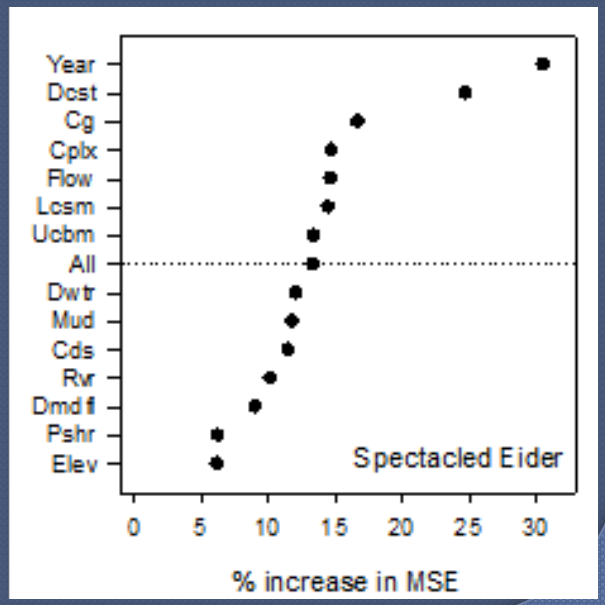




Results

- Neither the time-integrated flood index nor the annual inundation index improved estimates of spatial variation in nest densities above that already explained by habitat
  - Other environmental variables (e.g., distance to coast and % lower coastal salt marsh) appeared to be more influential





Conclusions

- Failure to find any short-term impacts of storms
  - High site fidelity results in small scale adjustments not able to be seen at the scale of this study
  - Storms were not large enough or occurred in such frequency to result in structural changes
  - Species adapted to annual or periodic flooding
  - Affects other demographic parameters (e.g., clutch size, nest success, fledgling success)

Conclusions

- Failure to find any long-term impacts of storms
  - Annual inundation index may not be a good measure of long-term habitat patterns
    - Not correlated with habitat features on the plot level
  - Changes in flooding may impact waterbirds in the future
    - Future work should focus on predicting long-term changes to waterbird habitats as a result of climate change

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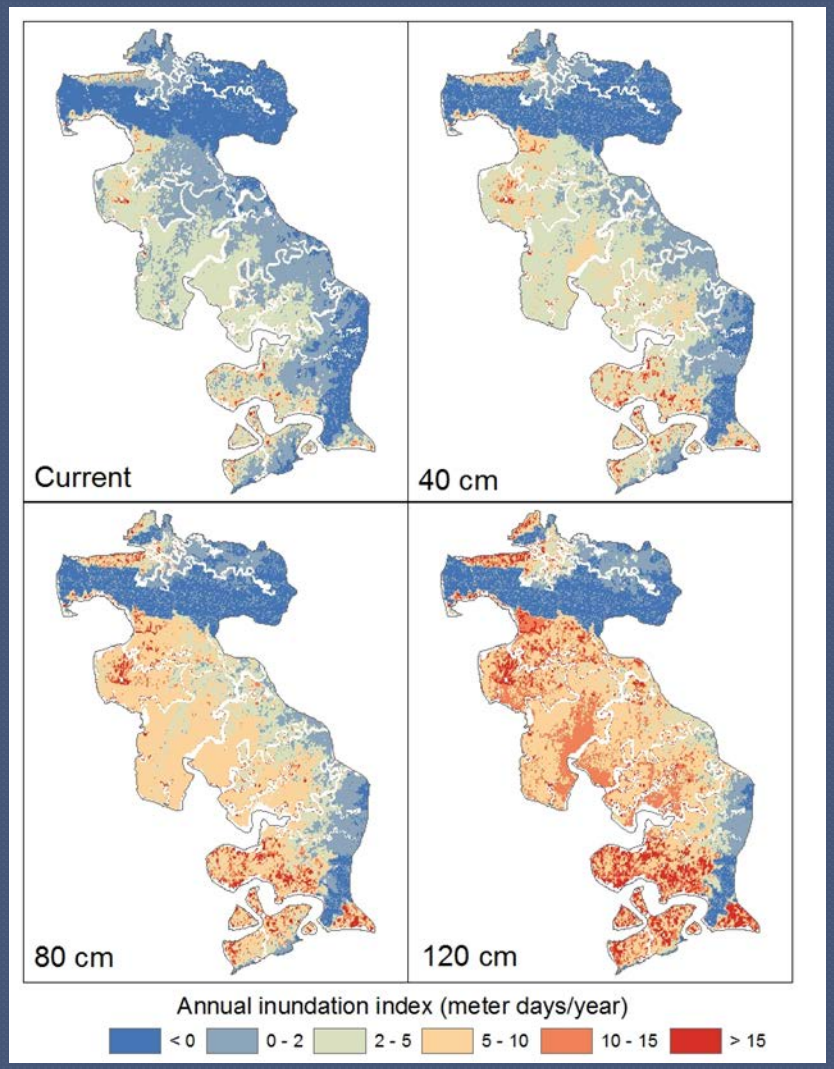
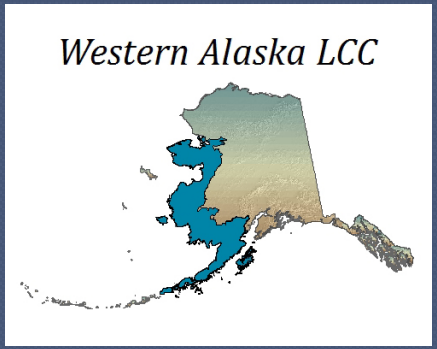


Conclusions

- Limitations of study
  - Sampling design
    - Nest surveys were designed for a much different purpose
    - Resampling same plots before and after storms
  - Availability and scale of avian data
    - Fine scale data at the nest level
    - Other metrics such as clutch size, nest success, or fledgling success
  - Availability and scale of inundation projections
    - Small scale impacts remain undetected
- Future efforts
  - Sampling design specifically for the purpose of evaluating storm effects
    - Determine if apparent lack of an effect is real or simply reflects limitations of the sampling design

Acknowledgments

- Financial, logistical, and technical support for summarizing these data was provided by:
  - Western Alaska Landscape Conservation Cooperative
  - U.S. Fish and Wildlife Service
  - Manomet Center for Conservation Sciences
- We thank all the surveyors for their long hours of field work



Questions