

A Mechanistic View of Piping Plover Meta-Population Dynamics

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What is a Meta-Population?

- A group of sub-populations of the same species that are spatially separated, but still interact
 - Periodic immigration/emigration among sub-populations

What Motivates Movements of Plovers?

- Habitat (ultimately)
 - Availability:
 - Lack of habitat in previously used area
 - Opportunistic find of new habitat (during migration)
 - Quality:
 - Marginal habitat characteristics in relation to selection cues
 - High densities of birds (density dependent processes)
 - Past failure experience (predation, inundation)
- Others?

Why Study Meta-Population Dynamics?

- Interesting ecologically
 - Complex aspect of population ecology

Why Study Meta-Population Dynamics?

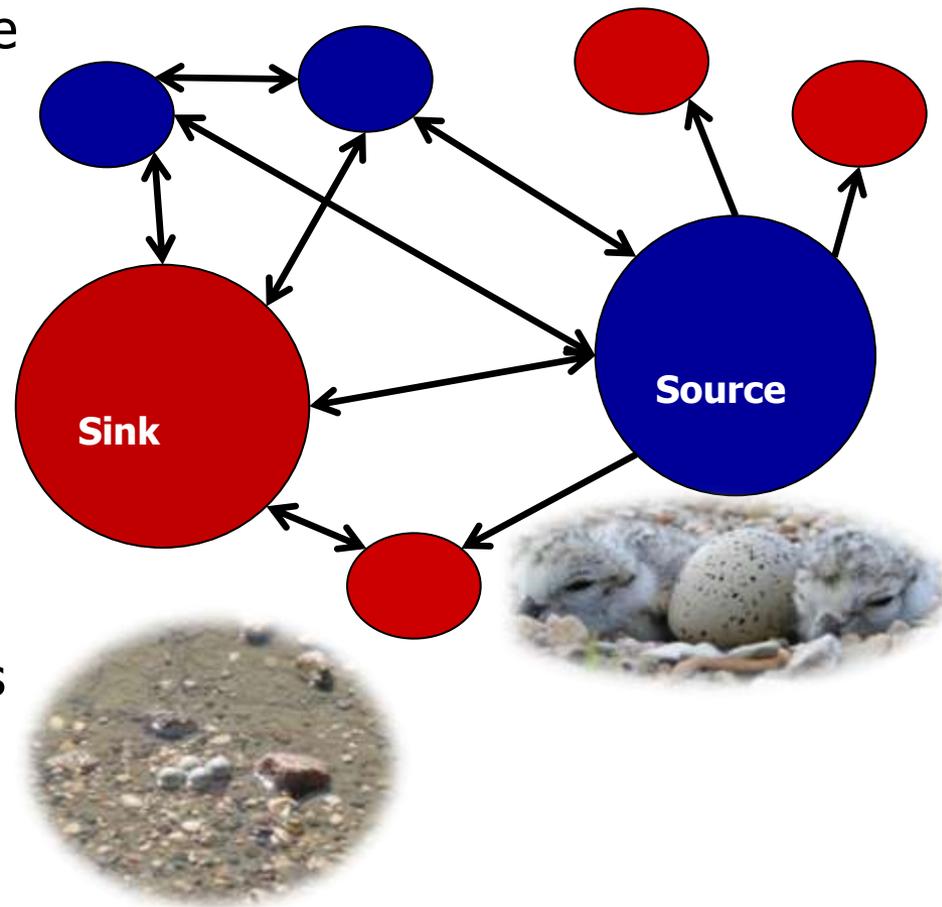
- Conservation concerns
 - Resilience to population decline or extinction if mechanisms influencing sub-populations are separate
 - Management questions about how to apportion conservation efforts among sub-populations (e.g., is it ok to let some sub-populations decline for short periods?)
 - Others?

Why Study Meta-Population Dynamics?

- Evaluating population resilience and prioritizing conservation
 - Understand movement rates among sub-populations
 - Understand costs of movement among sub-populations
 - Understand costs of **not** moving when habitat quality **or** availability is poor

Habitat and Meta-Populations

- Some breeding areas have more available habitat than others
- Not all breeding areas provide quality habitat
- Meta-populations often have source-populations and sink-populations
- We may not expect that plovers may make optimal decisions about where to breed when faced with a changed array of habitat

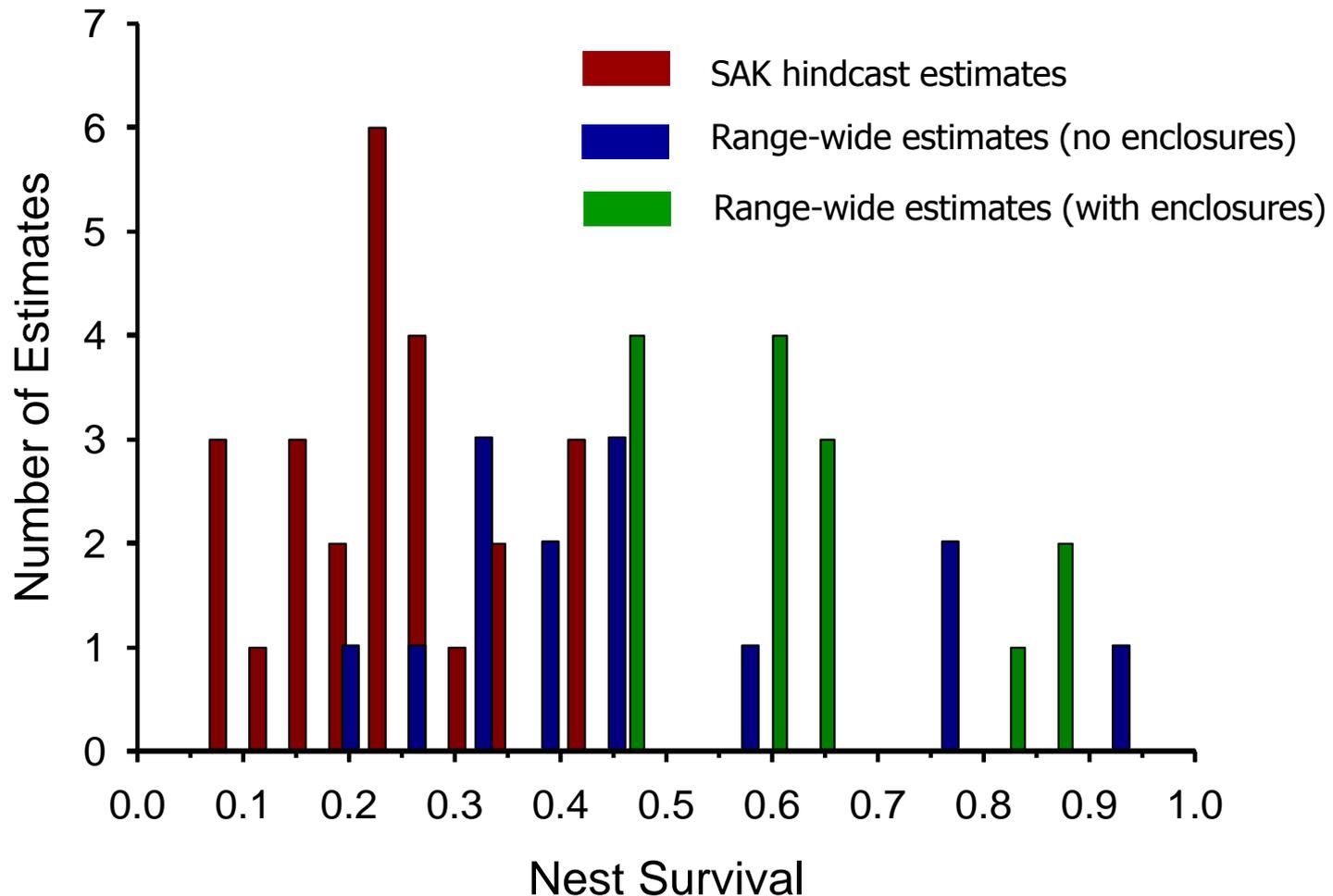


Sakakawea: Example of an Ecological Trap

- Plovers are attracted to large expanses of available, seemingly high-quality habitat in early summer
- Plover's nest-selection cues lead them to nest at low elevations
- Water levels generally increase in midsummer

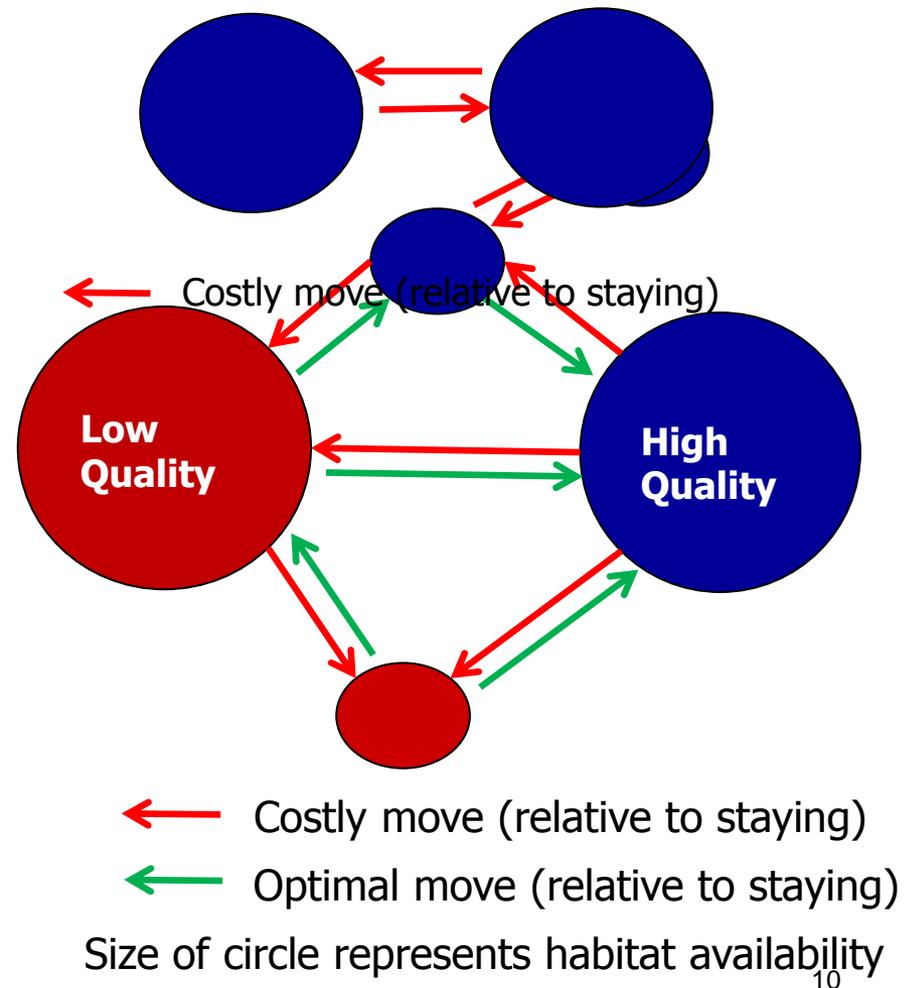


Sakakawea: Example of an Ecological Trap



Meta-Populations Movement Costs?

- Generally, there is a **gross** cost of movement (relative to not moving)
 - Risky travel/dispersal and unknown habitat
- However, differences in habitat availability or quality may balance or counteract movement costs
- Understanding mechanism for movement is critical to evaluate **net** movement costs

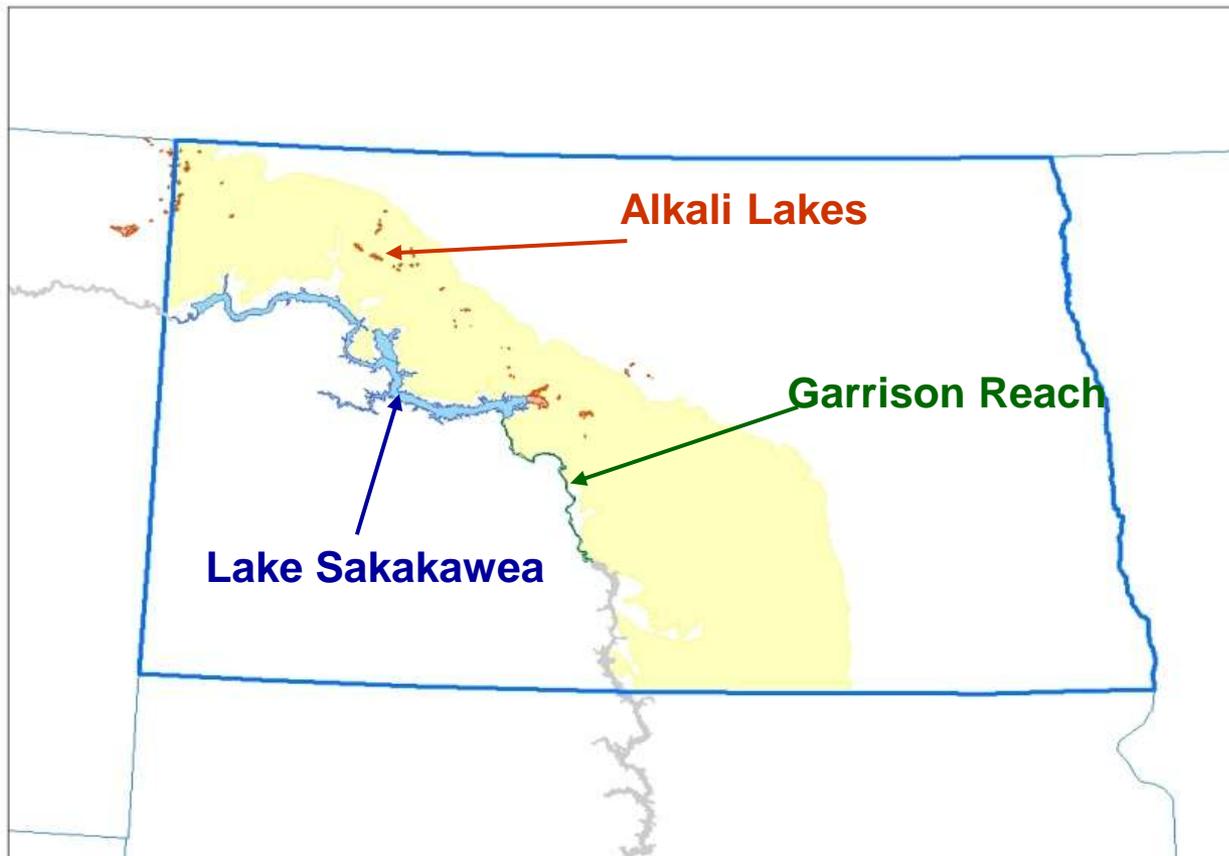


Resilience to Population Decline or Extinction

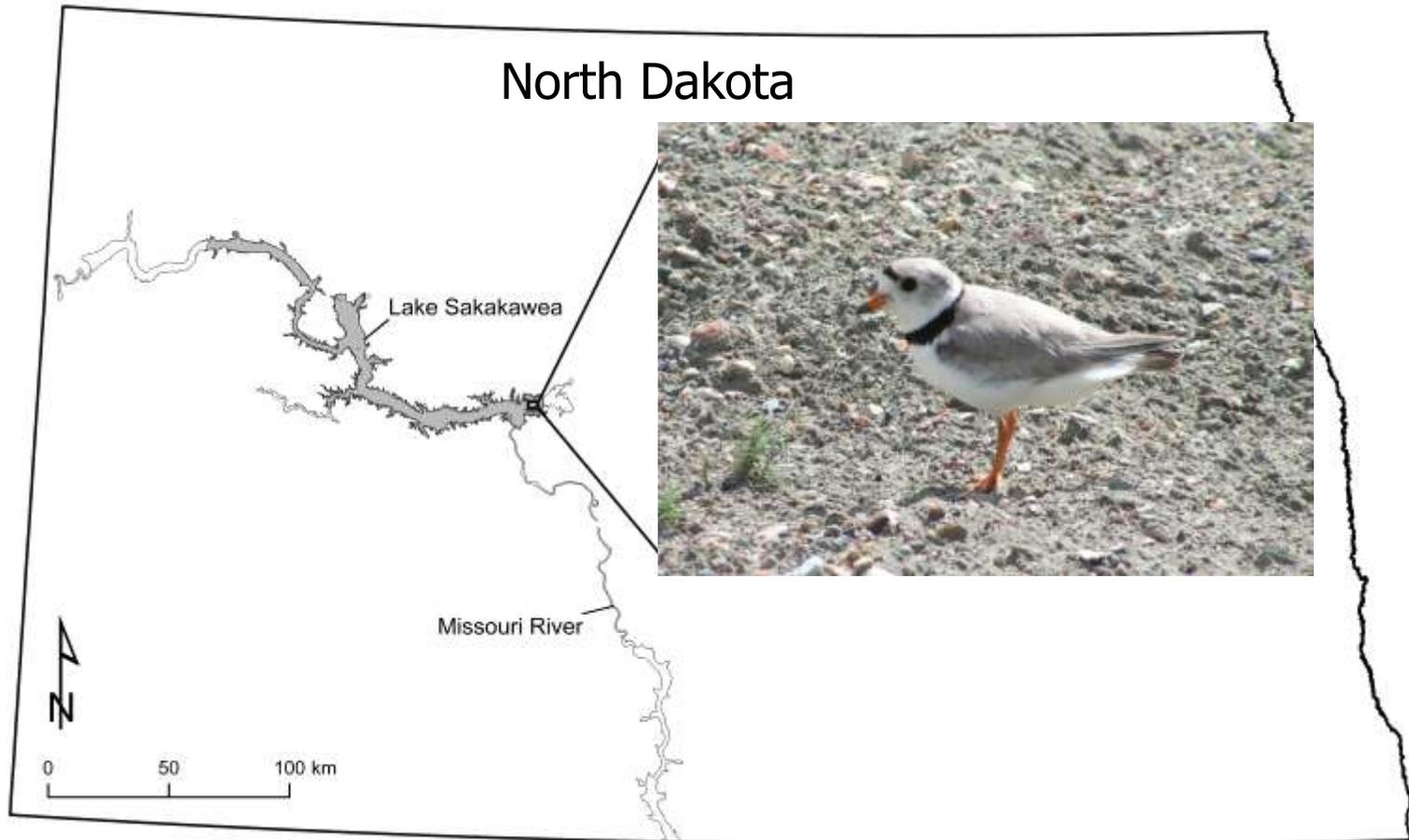
- Water-level dynamics
 - Inter-annual dynamics create and maintain habitat in most plover breeding habitats
 - Within a year can limit the availability of habitat or breeding productivity (nest inundation)
 - The degree of synchronicity in inter-annual dynamics among sub-populations is an important factor influencing the potential “*lifeboat*” affect of meta-populations

Inter-Annual Habitat Dynamics

- North Dakota
 - Three discrete and adjacent habitat types

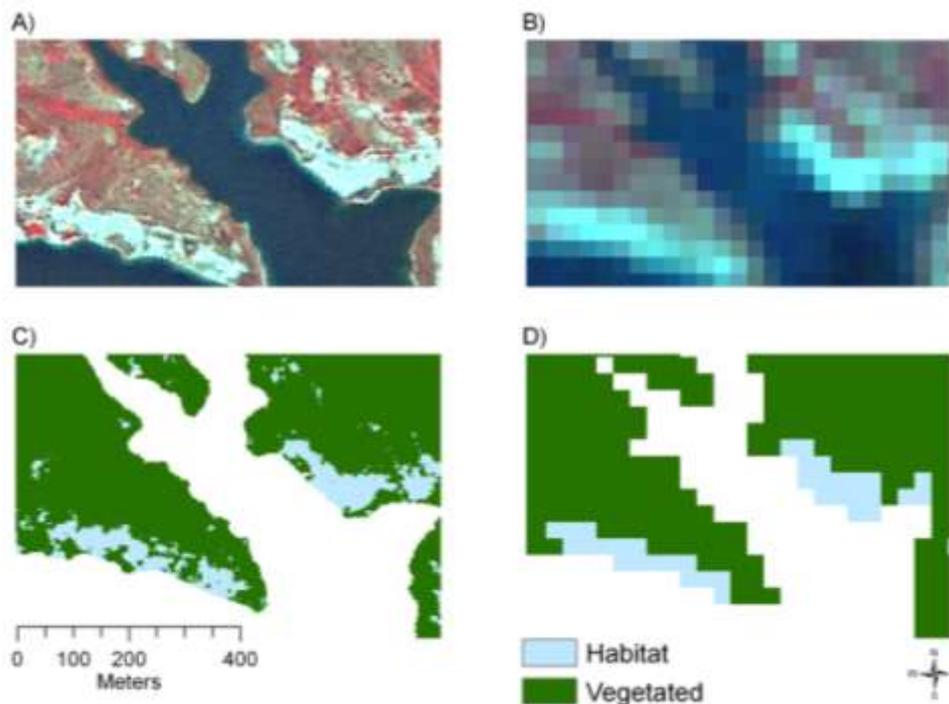


Lake Sakakawea and Piping Plovers



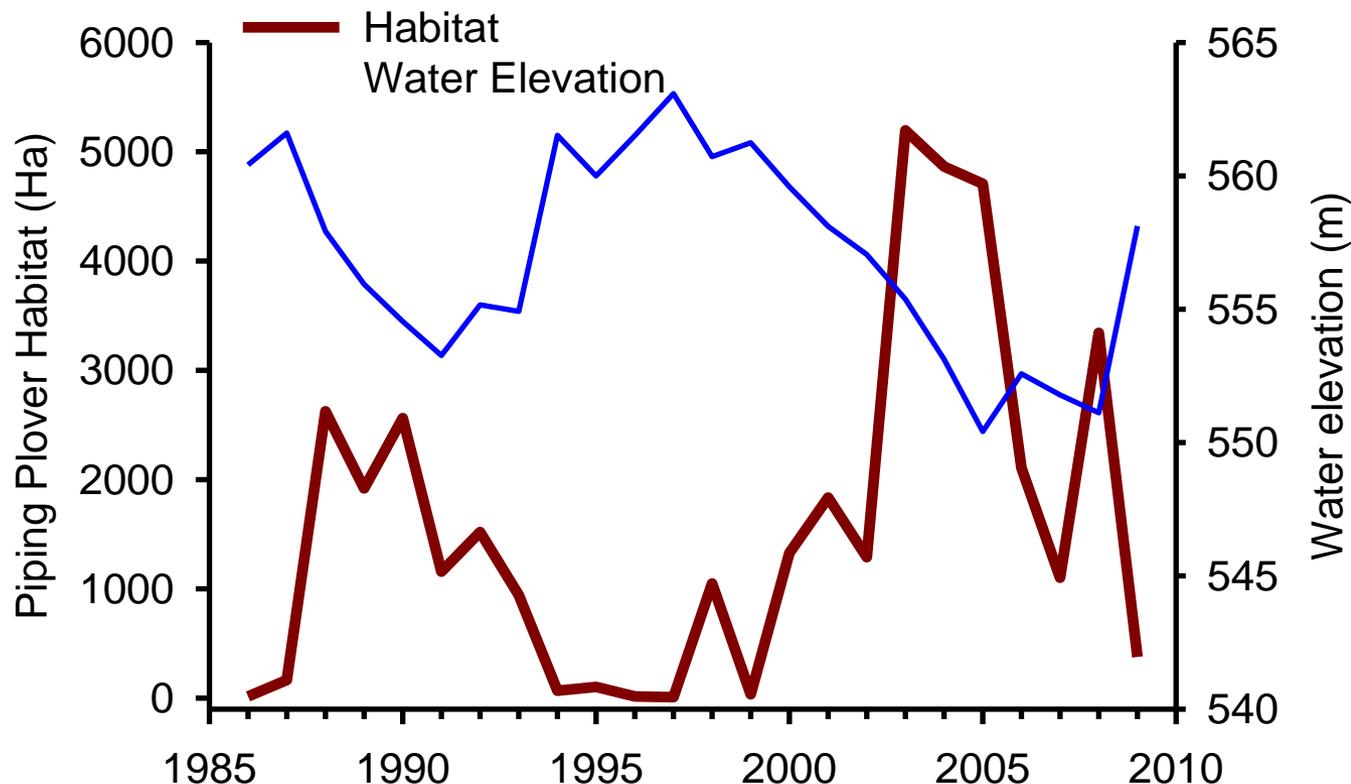
Inter-Annual Habitat Dynamics: Sakakawea

- Landsat TM data available annually dating back to 1986
 - Despite coarse resolution it provides good estimates of nesting habitat



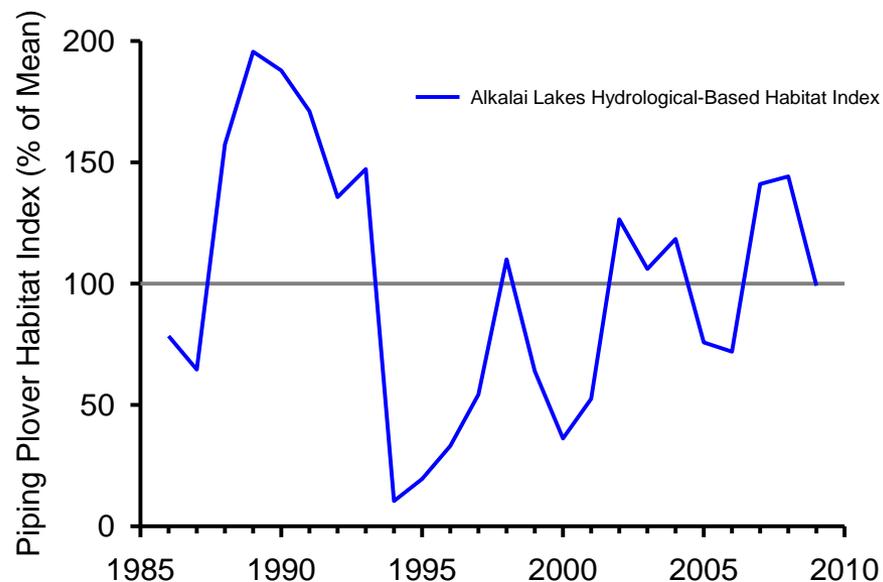
Inter-Annual Habitat Dynamics: Sakakawea

- Annual habitat estimates vary greatly (1,500 to 270,000 ha), largely in response to water levels



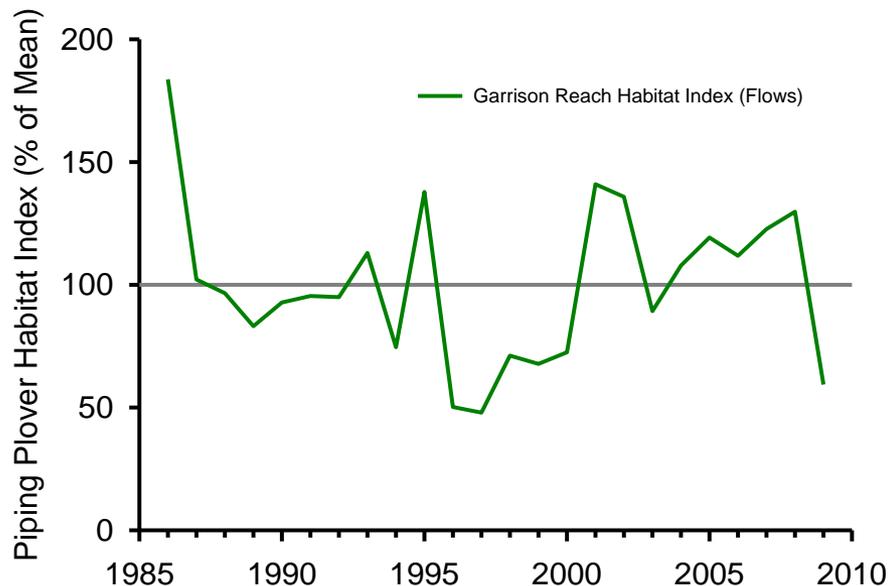
Inter-Annual Habitat Dynamics: Alkali Lakes

- No long-term habitat data available
- Indexed with hydrological data
 - Has not been evaluated with observed water levels and could vary with land use
- Suggests considerable inter-annual variability in habitat



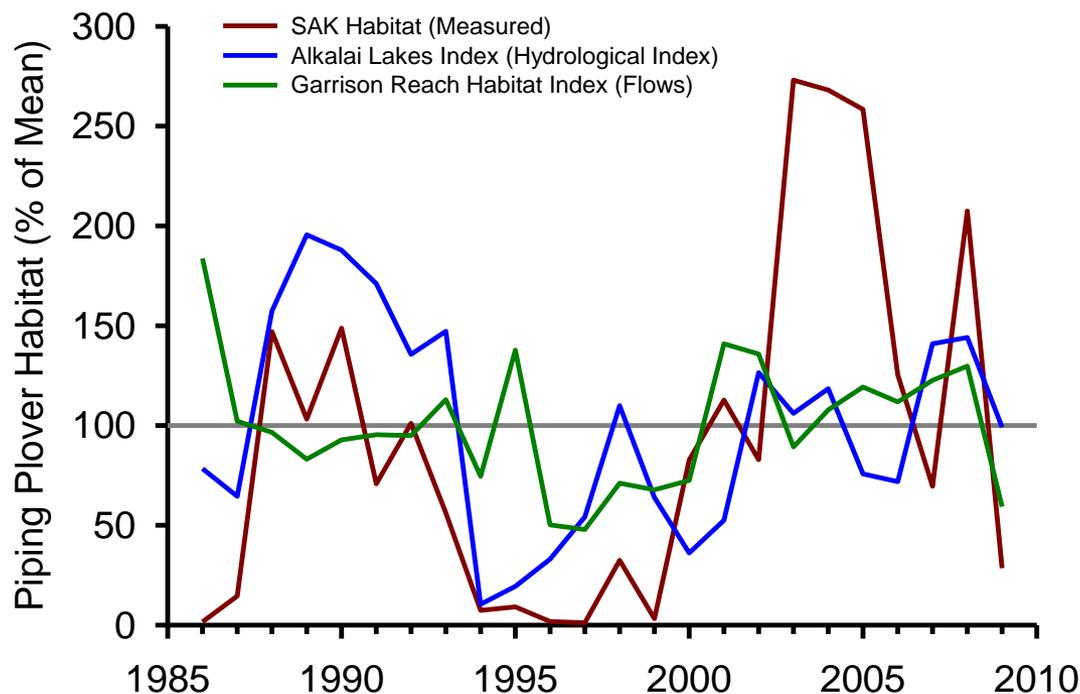
Inter-Annual Habitat Dynamics: Garrison

- No long-term habitat data available
- Indexed by the reciprocal of river flows (15-31 May)
 - Does not account for flood created habitat or that lost through erosion or vegetation succession
 - Has not been evaluated with observed habitat estimates
- Perhaps suggests less inter-annual variability in habitat



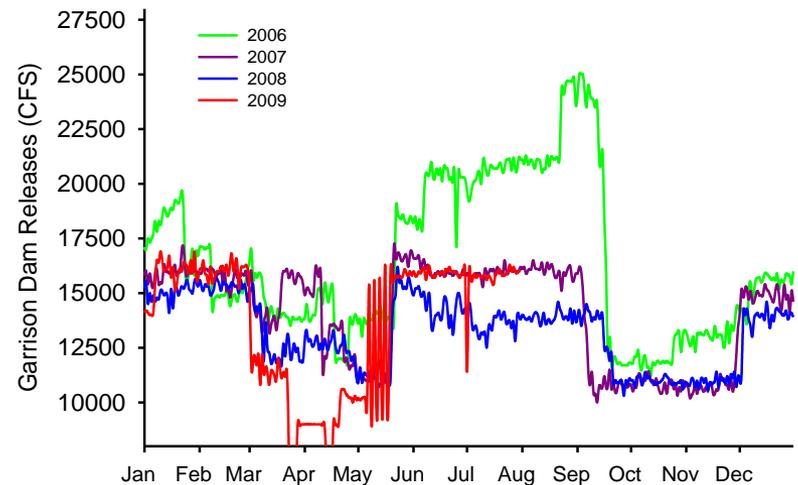
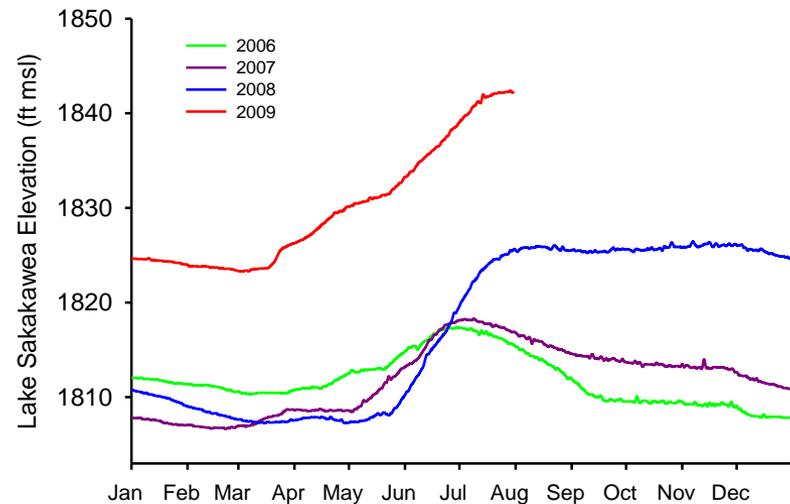
Inter-Annual Habitat Dynamics: North Dakota

- Generally habitat is more dynamic on Sakakawea
- May negatively affect plovers through increasing sub-population movements
- The habitat indices have limited value
- Could evaluate synchronously among habitats
- Long-term habitat estimates at all areas are needed



Inter-Annual Water Level Variation

- Each area is influenced by its local weather but Missouri River sites are influenced by Rocky Mountain climate and flow management strategies
 - Flow management can shift where and when plover habitat is available
 - 2006 high flows at Garrison => low rise on SAK
 - 2009 "normal" flows at Garrison => high rise at SAK



Changing Climate

- Models predict geographic variation in climate change
- How will climate change influence the frequency and synchronicity of habitat dynamics of breeding areas?
 - Important implications to productivity and survival of plovers



How Do We Move Forward?

- What conservation questions will understanding meta-population dynamics inform?
 - Do we need estimates of movement rates from one sub-population to another?
 - Can estimates of habitat, sub-population size, and productivity tell us what we need to know?

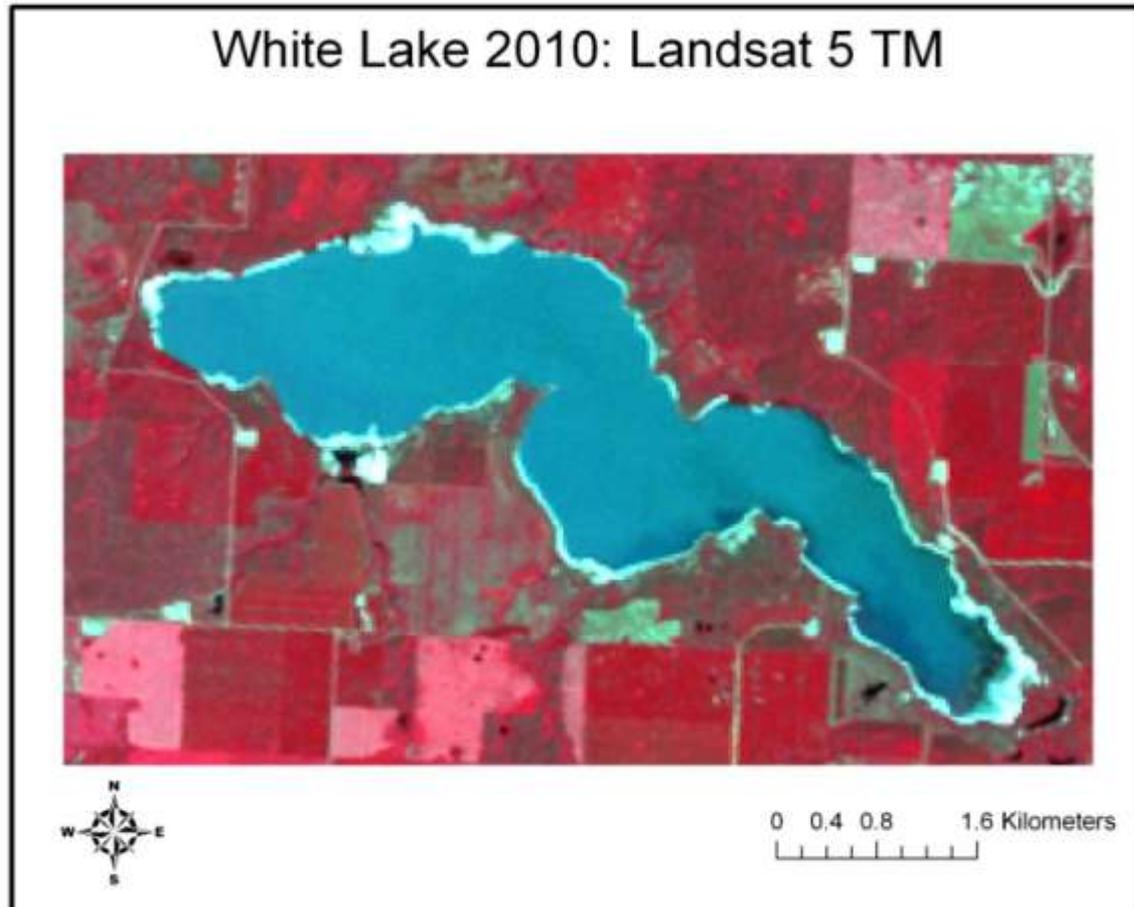
Linkages with Monitoring Plans

- The evaluation of the Corps's monitoring plan suggests that monitoring data have differing biases with location
- Perhaps, updating and linking plover monitoring programs to provide comparable estimates of adults, fledglings, and habitat would provide the information to understand sub- and meta-population dynamics
 - Depending upon the relevant to conservation questions
- We contend that to understand implications of sub- or meta-population dynamics requires estimates (or good indices) of habitat availability and quality
 - Is this possible?

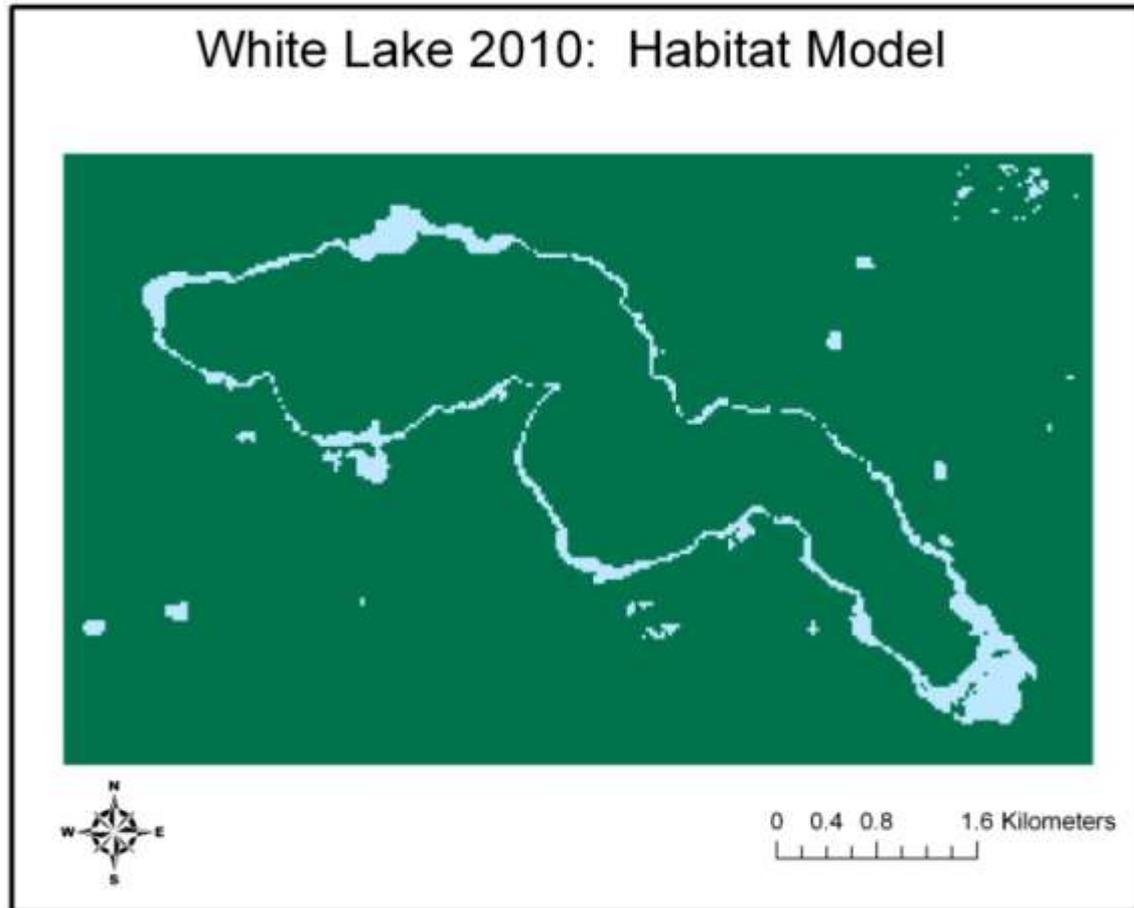
Remote Sensing Habitat

- ✓ Riverine-sandbar habitat
- ✓ Reservoir shoreline
- Large wetlands and Alkali Lakes?

Inter-Annual Habitat Dynamics: Alkali Lakes



Inter-Annual Habitat Dynamics: Alkali Lakes



Monitoring Habitat: Options

- Landsat satellites
 - Data acquisitions date back to 1982
 - Coarse resolution (30m) – adds some challenges
- Landsat 8: Launch scheduled Dec 2012
 - Will have a 15m resolution panchromatic band, which will allow for pan-sharpening multispectral bands to 15m resolution
- Several other options (e.g., RapidEye, SPOT, etc)

Monitoring Habitat: Northern Great Plains?

Decision Support Tool....



Thanks!

