The effects of climate change and advancing growing seasons on the nesting phenology of American kestrels in Southwestern Idaho

Shawn H. Smith, Alexandra M. Anderson, Karen Steenhof, Chris J.W. McClure, Julie A. Heath

- Shifts in breeding phenology are a common biological response to climate change Walther et al. (2002)
  - All over the world and across multiple taxa

Smooth Newt
Beebee (1995)

Three-lined Skink
Telemeco et al. (2009)

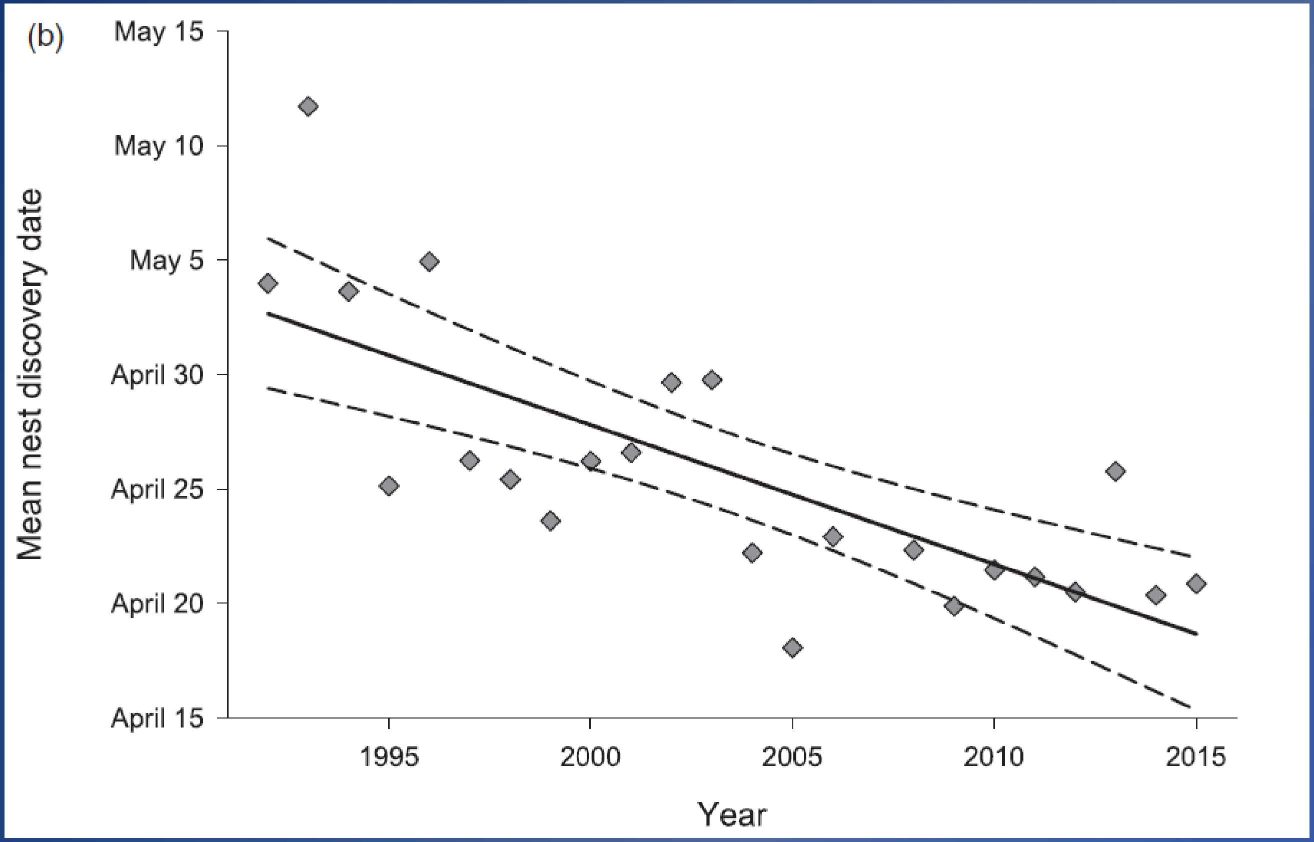
Mexican Jay
Brown et al. (1999)

Deer Mouse
Millar & Herdman (2004)

- Heavily studied in Passerine systems Crick et al. (1997), Forchammer et al. (1998), Both et al. (2004), Both et al. (2009), etc.
  - Warm springs affect plant phenology and insect emergence
  - Birds nest earlier to time reproduction to coincide with peak prey abundance (Lack 1954)

Both et al. 2004 and 2009, Both and Visser 2005, Visser et al. 2006, Reed et al. 2013

- American kestrel research in southwestern Idaho
  - Long-term nest box program began in 1986
    - Started with 34 nest boxes and have since averaged 103 each year (Steenhof and Peterson 2009)
  - Kestrels have advanced nesting period by 15 days (Smith et al. 2017)



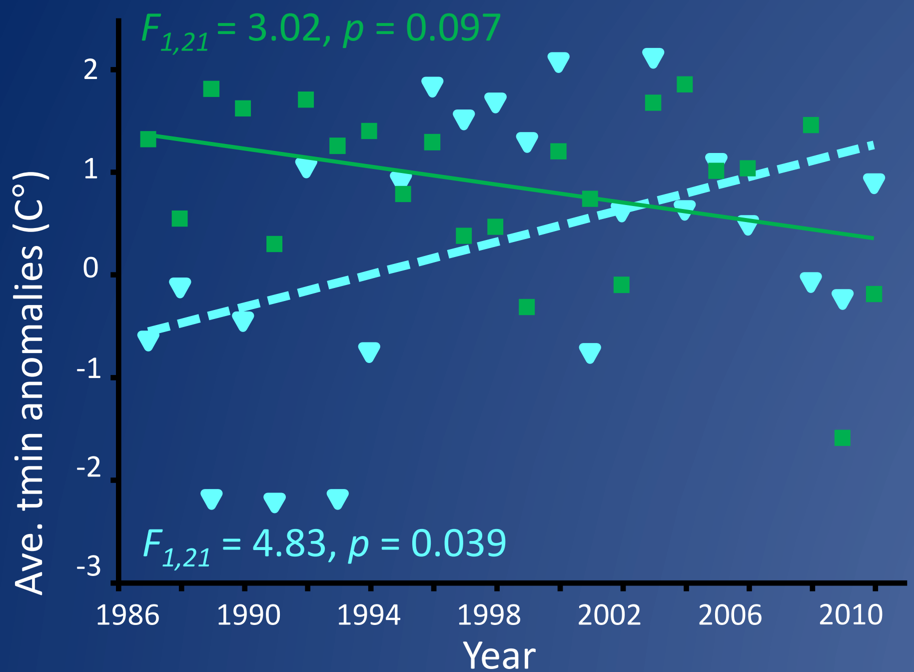
Two hypotheses to explain earlier nesting:

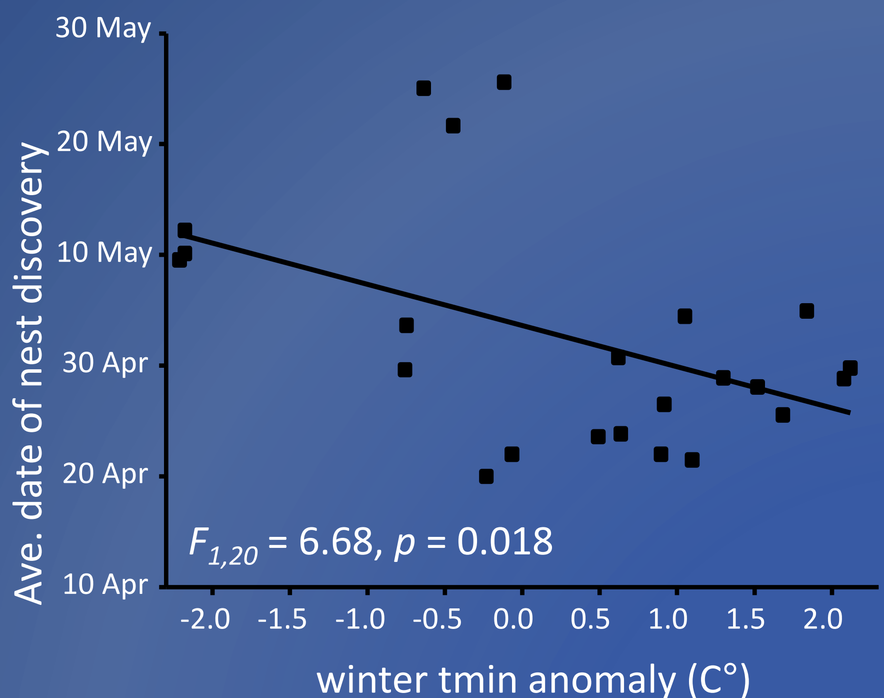
1. Warmer winters have released former constraints (such as migration) on early nesting that, when combined with seasonal declines in fecundity, drive advancement in nest date
2. Shifts in the growing season have led to earlier peaks in prey abundance and kestrels are tracking these earlier peaks

- Benefits of early breeding:
  - Earliest pairs produced the most young (Newton and Marquiss 1984)
  - Higher apparent survival in young hatched early (Newton and Marquiss 1984)
  - Young produced early are more likely to recruit into breeding population (Verboven and Visser 1998)

- In our population:
  - Earlier hatched young had higher apparent survival and more likely to recruit into population (Steenhof and Heath 2013)
  - Early nesters have potential for second successful clutch (Steenhof and Peterson2009, Heath unpub. Data)

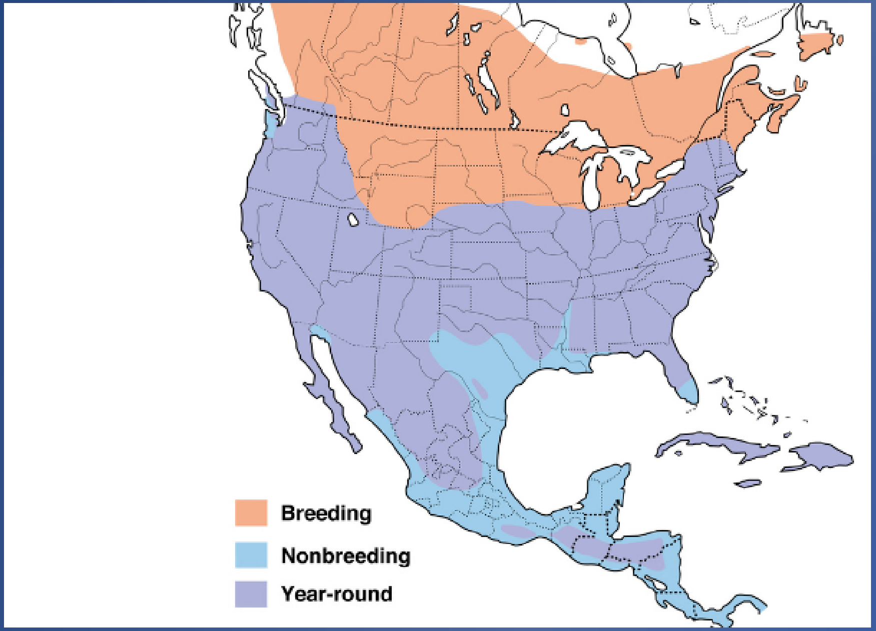
- Climate change in Idaho
  - Warmer winter temperatures
  - No change in spring temperatures
  - Kestrels nest earlier following warmer winters





Heath et al. 2013

- Examined
  - Bird banding records from Bird Banding Lab
    - Western kestrels banded in spring and encountered in winter or vice versa for years 1960-2009
      - Resulted in 104 records
  - Christmas Bird Count Data for 1960-2009
    - Looked for shifts in distribution of wintering kestrels



- In years with warmer winters, kestrels:
  - Migrated shorter distances
  - Increased overwintering residency in northern states and reduced in southern states
- As a result:
  - Development of two populations:
    - Early breeding residents
    - Late breeding migrants (Heath et al. 2013)

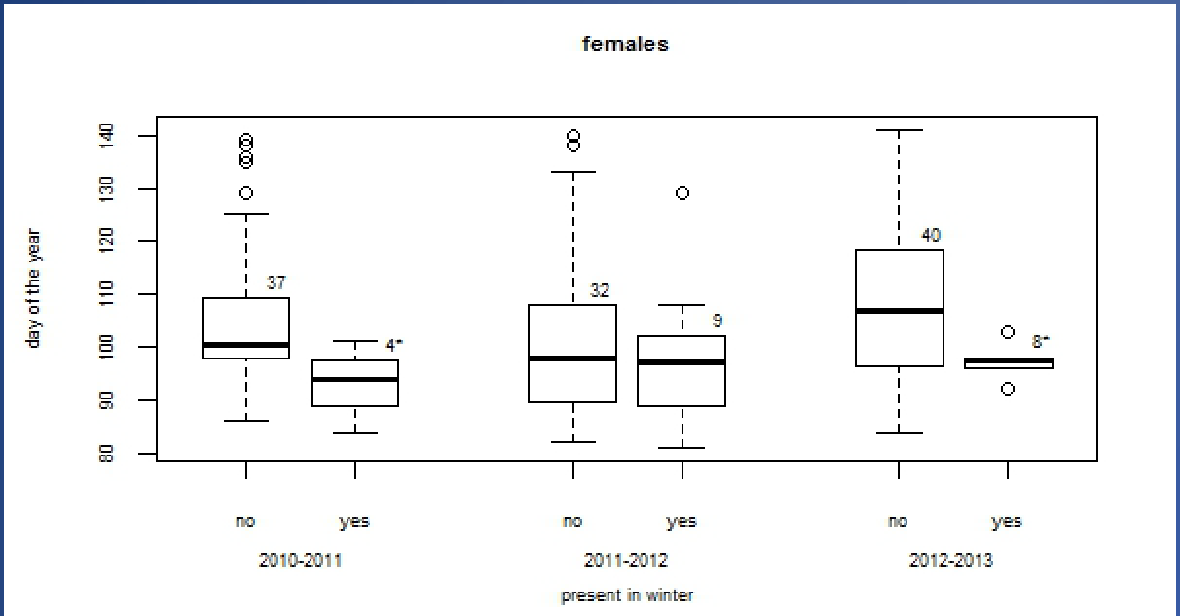
Photo by Ben Dudek

Photo by Dan Cook

Resident and Migrant populations

- Assortative (or nonrandom) mating could result in a quick population change (Anderson et al. 2016)
  - Tested hypothesis that mating of residents with residents (earlier breeders) and migrants with migrants (later breeders) would result in genetic divergence
  - If true, this should accelerate shift towards early breeding because of higher fitness of early breeders

- Assortative mating results:
  - Residents were more likely to mate with residents
  - Non-residents were more likely to mate with non-residents
  - Residents did nest earlier than non-residents
  - No evidence of genetic differences between earliest and latest breeding birds



Anderson et al. 2016

- Hypothesis 1:
  - Warmer winters have released former constraints (such as migration) on early nesting that, when combined with seasonal declines in fecundity, drive advancement in nest date
- Conclusions:
  - Warmer winters resulted in
    - Migrated shorter distances
    - Increased overwintering residency
      - Development of two populations
    - Earlier nesting the following spring

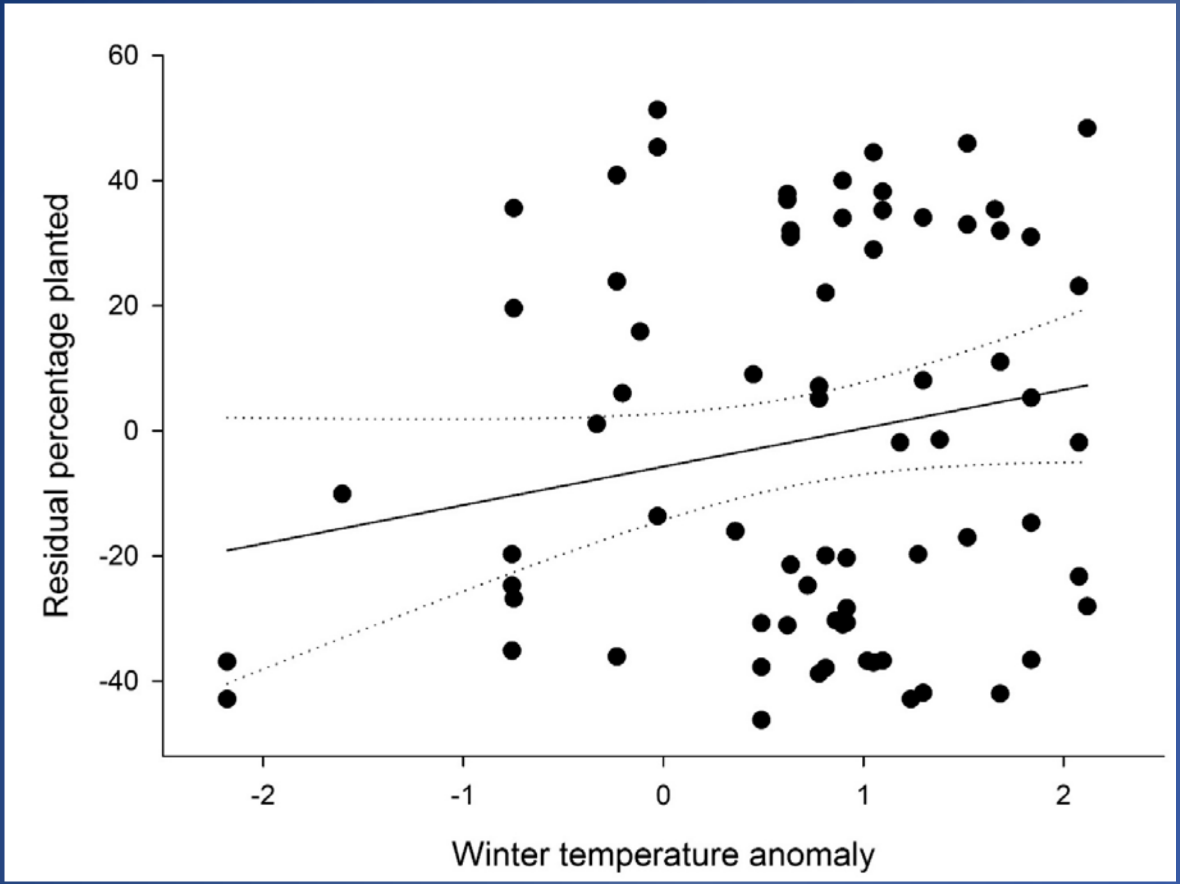
Heath et al. 2013

- Hypothesis 2: Shifts in the growing season have led to earlier peaks in prey abundance and kestrels are tracking these earlier peaks
  - Growing seasons are changing around the world
    - Longer growing seasons (Schwartz et al. 2006)
    - Cold tolerant crop strains that can be planted earlier in year (Kucharik 2006)
  - Organisms are responding to human decisions
    - European starlings advanced nesting in agricultural areas following warmer winters (Williams et al. 2015)
    - Eurasian blackcaps changed migration patterns with supplemental bird feeding and warmer winters (Plummer et al. 2015)

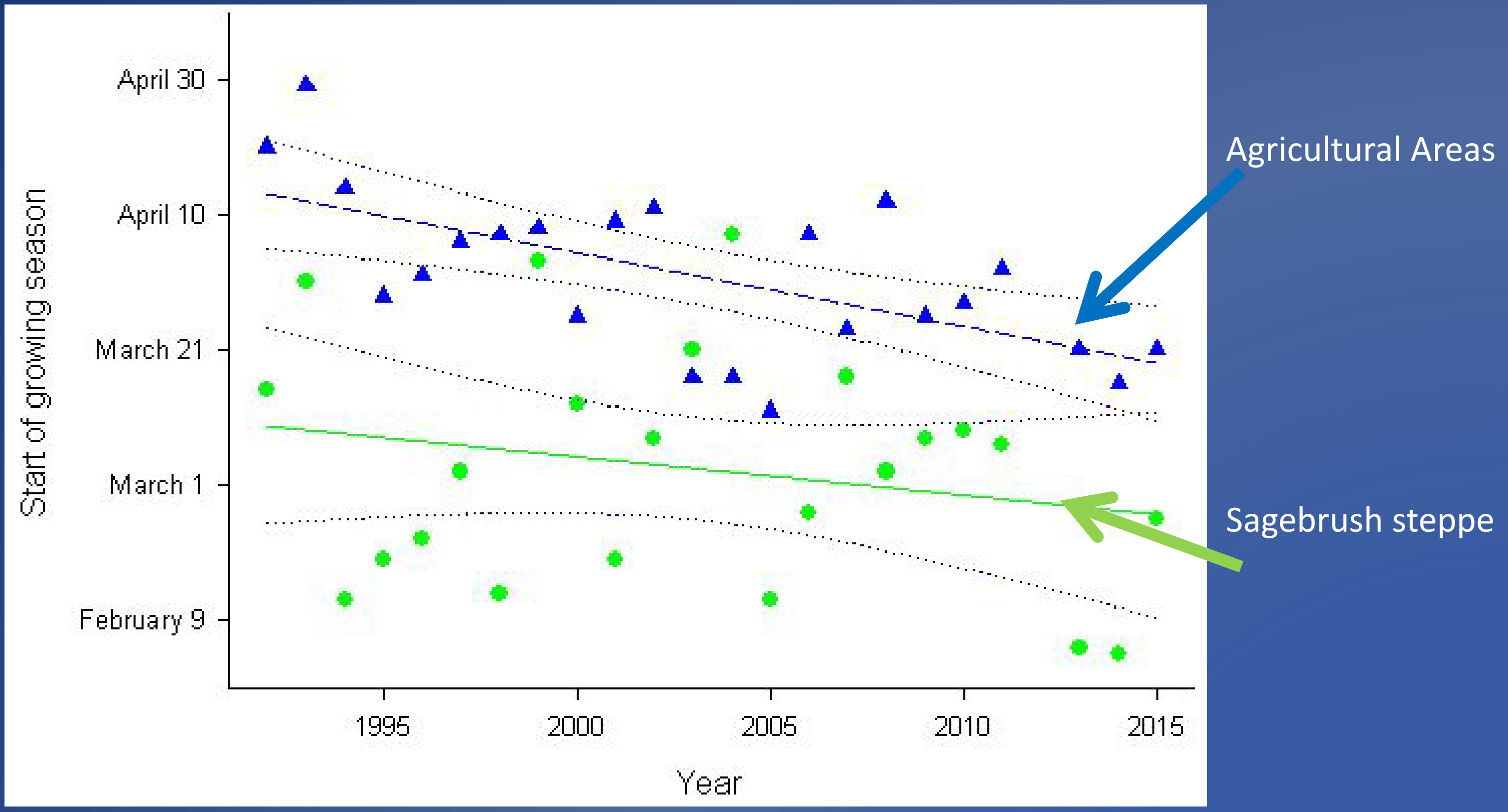
- Methods:
  - Determined small mammals were dominant prey item during breeding season
    - Used nest cameras
  - Linked peaks in small mammal abundance to growth patterns of vegetation
    - Established measurable proxy
  - Vegetation was monitored via satellite by measuring NDVI, or greenness values
    - Used to estimate the start of the growing season (SoGS)
  - Analyzed Idaho Crop Progress and Condition Reports
    - To determine when farmers were planting their crops each year
  - Determined kestrels had access to both agricultural and sagebrush steppe areas within 1km of nest boxes

Smith et al. 2017

- Results:
  - From 1992-2013
    - Farmers were increasing the amount of each crop type planted at the start of each planting season
    - Farmers planted earlier in springs following warmer winters



- Results:
  - From 1992-2013:
    - Spring significantly advanced by 26 days in agricultural areas but did not significantly change in sagebrush areas



- Conclusions:
  - Earlier kestrel nesting phenology can be explained by
    - Hypothesis 1:
      - Climate change (warmer winters)
        - » Shorter migration distances
        - » Overwintering further north or overwintering near breeding grounds
    - Hypothesis 2:
      - Human adaptations to climate change are affecting the growing seasons
        - » Planting crops earlier following warmer winters
          - Advancing growing season by 26 days
        - » Resulting in earlier peaks in prey abundance
        - » Kestrels nest earlier in response to these earlier peaks in prey

Thank you!





Elizabeth Urban
Catilin Davis
Robert Miller
Jeff Roelke
Erin Strasser
Neil Paprocki
Eric Nolte
Terra Gleeson
Trina Patel
Christine Hayes
Emily Tyrrell
Josie Braun

Beth Sassani
Mike Zinn
Kyle McCormick
Becca Wagner
Jim Edgemon
Brit Peterson
Joni Clapsdale
Christina Hartmann
Lisa Courchane
Alia Parrish
Lauren Kruger
Schelby Rosebrook

Rob Spaul
Jade Weeks
Mark Foster
Christeena Sevy
Erin Wonder
Beth Wommack
Jon Bart
Al Dufty
Jim Smith
Steve Novak
Leah Dunn
Stuart Hardegree

Chris McClure
Jessi Brown
Mike Henderson
Cassi Smith
Jim Belthoff
Evan Brooks
Nancy Glenn
Ben Pauli
All of the Idaho landowners!

Funding:

- •Boise State Raptor Research Center
- •Boise State Biological Sciences Department
- •NSF Idaho EPSCoR REU Program (EPS-814387 to MLC)
- •NSF Raptor Research REU award (DBI-1263167 to LNK)
- •NSF (DEB 1145552)
- •Boise State Provost's Office Work Study Award
- •Golden Eagle Audubon Society
- •The Peregrine Fund and American Kestrel Partnership
- •AFO Bergstrom Award
- •Osher Institute
- •Michael Butler Ecological Research Award
- •NSF Raptor Research Site Award
- •Boise Sate NSF GK-12 program
- •Adopt a Box Program

Questions?