Potential Paths out of Isolation for Yellowstone Grizzly Bears

Christopher Peck, Frank T. van Manen, Cecily Costello, Mark Haroldson, Lisa Landenburger, Lori Roberts, Daniel Bjornlie, and Richard Mace
Yellowstone genetics

Proctor et al. 2012
Genetic diversity

Genetic diversity in different regions:
- Lower 48
- BC, AB
- AK, YT, NT

Regions:
- Southern Divide Ecosystem (NCDE)
- Yellowstone
- Southern Selkirk Mountains

Proctor et al. 2012
Effective population size

$N_e$: estimator by parentage assignment (EPA)

$N_c$: derived from Chao2 (3-yr moving average)

Kamath et al. (2015)
Occupied Range

Northern Continental Divide
55,200 km² (2004-2014 data)

Greater Yellowstone
58,314 km² (2000-2014 data)

Costello et al. 2016, Bjornlie et al. 2014
Genetic connectivity

• Long-term management goal for Montana Fish, Wildlife and Parks

• Facilitating natural movement favored over translocation of bears between ecosystems
Information need

- Habitat linkages/corridors have not been identified based on grizzly bear location data
- Identify paths between NCDE and GYE with habitat conditions conducive to male dispersal
- Explore trade-off between optimal and exploratory paths
Study approach
Data

• males ≥2 years old
  • 124 individuals
  • 199 bear-years
  • 126,000 steps

• Spatial data layers
  • Land cover, road features, hydrological features, human presence, topography (300-m resolution)
Step-selection functions

- Turning angles and step-lengths
- Model selection with $\text{AIC}_c$
- 5-fold cross-validation, repeated 100 times
  (Median Spearman rank correlations: NCDE = 0.94, GYE = 0.86)
Randomized shortest paths (RSP)

- Trade-off between exploration and optimal exploitation of landscape
- 100 random start and end nodes
- Average number of net passages

[Map showing 25-km buffers and Elevation]
Randomized Shortest Paths

Northern Continental Divide
to
Yellowstone
Randomized Shortest Paths

Yellowstone
to
Northern Continental Divide
Randomized Shortest Paths

Intersect of paths between
Northern Continental Divide
and
Yellowstone
Ad-hoc validation

- 21 verified records
- Mortalities, remote camera, tracks, or DNA
- 1998-2017
- 87% in last 4 years
- High correspondence with path predictions: quantiles = 0.75 to 0.87
• no successful “immigration event” for 20,000 simulations of correlated random walks
Informing management

- Path layers available online (USGS Science Base)
- Identify and prioritize conservation measures supporting potential dispersal
  - Conservation easements and land purchases
  - Mitigation of potential barriers (e.g., highways)
  - Proactive attractant management
  - Education and information programs

- Target groups: land managers, NGOs, public
Paper:

GIS layers:
https://www.sciencebase.gov/catalog/search "grizzly bear paths"
Acknowledgments

Funding: U.S. Fish and Wildlife Service – Grizzly Bear Recovery Office

Blackfeet Nation
Confederates Salish and Kootenai Tribes
Idaho Fish and Game
Montana Department of Fish, Wildlife and Parks
National Park Service
U.S. Geological Survey
U.S. Fish and Wildlife Service
Wind River Fish and Game-Eastern Shoshone & Northern Arapaho Tribes
Wyoming Game and Fish Department

Chris Servheen, Justin Gude, Robert Inman, Dave Gustine

Photo: Craig Whitman