## Potential Paths out of Isolation for **Yellowstone Grizzly Bears**

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Photo: Jake Davis

**Grizzly/Brown Bear Range** 

North America

Greater Yellowstone Ecosystem

IUCN, IGBST, MTFWP

## Yellowstone genetics



Proctor et al. 2012

## **Genetic diversity**



Proctor et al. 2012

## Effective population size



Kamath et al. (2015)

### **Occupied Range**

Northern Continental Divide 55,200 km<sup>2</sup> (2004-2014 data)

**Greater Yellowstone** 58,314 km<sup>2</sup> (2000-2014 data)



Kalispell

CADINI

MERCAN

Shelby

**Great Falls** 

CANADA MONTANA

Billings

MONTANA WYOMING

150

1224

MONTAN

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

Photo: IGBST/van Manen

## Data

- males <a>2</a> 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 AIC<sub>c</sub>
- 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







### 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



### Rare events

 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: Peck et al. 2017. Ecosphere 8(10):e01969

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

REVEALED IN SUCCESSION

Photo: Jake Davis

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Photo: Craig Whitman