

Sensitivity analysis in wildlife linkage design

Shawn Newell, Paul Beier, Dan Majka, Northern Arizona
University

Clint Cabañero, South Coast Wildlands

Sensitivity analysis in wildlife linkage design

- Overview of sensitivity analysis as it relates to linkage design
- Illustration of sensitivity analysis for a particular linkage.

Why Sensitivity Analysis?

As conservation scientists & practitioners, we should worry about 2 things:

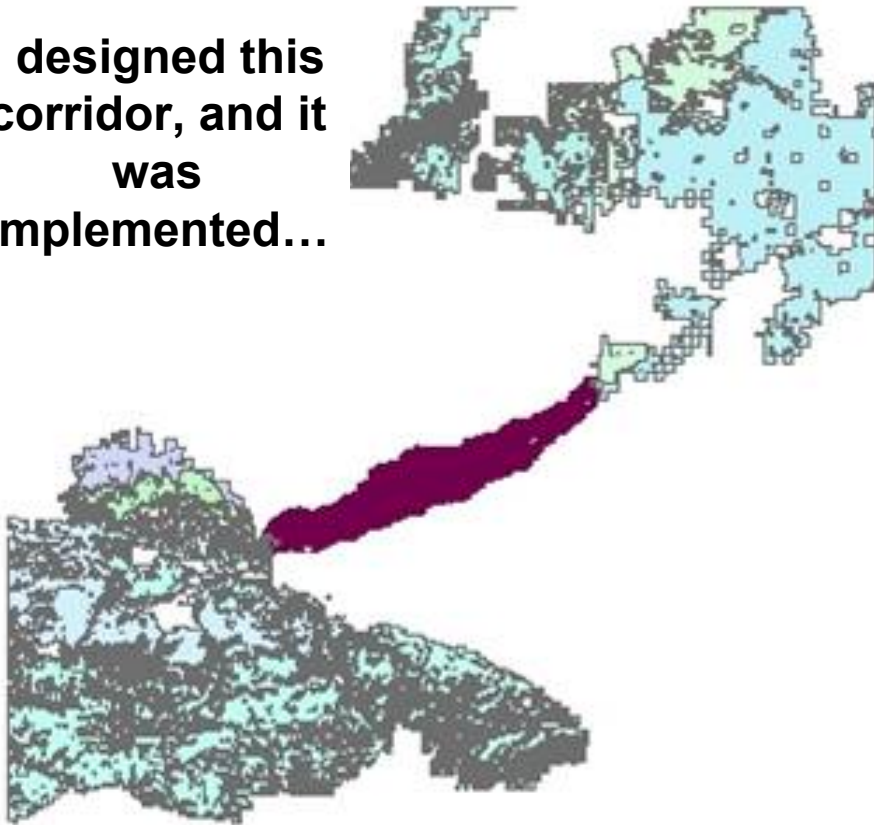
- (1) Our advice will be ignored.
- (2) Our advice will be followed.

Why Sensitivity Analysis?

1. Most important: As scientists, we worry about being wrong.
2. Provides transparency for stakeholders, skeptics, and critics.

How badly did I do?

I designed this
corridor, and it
was
implemented...



But the green
corridor is the
real
optimum...



Sensitivity Analysis: seeing how **sensitive**
the model output (linkage design) is to
uncertainty in the **inputs**.

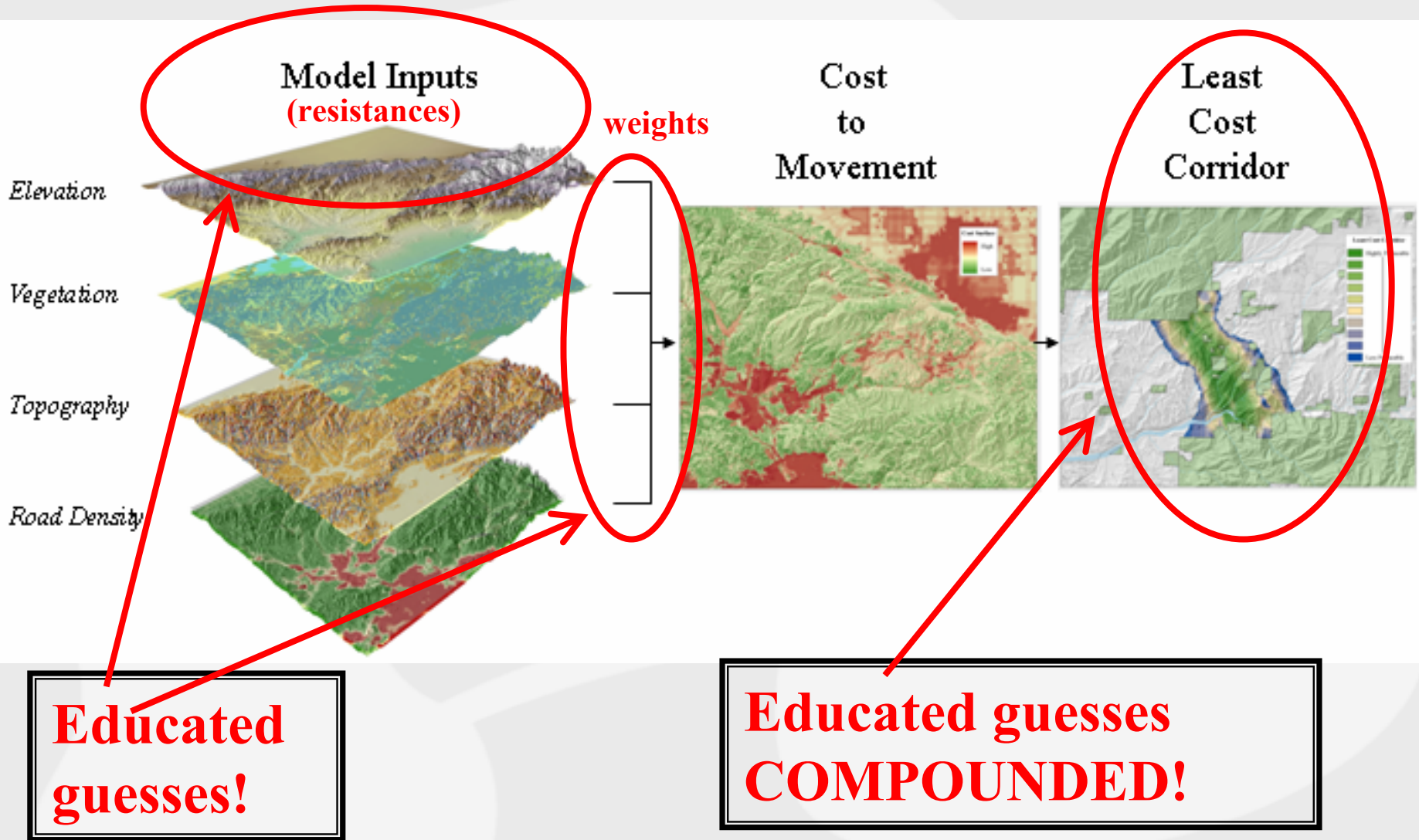
...uncertainty in *what* “inputs”?

- Delineation of analysis area
- **Choice of focal species**
- Choice of factors to include in the model
- Choice of metric for each factor
- **Uncertainty in estimates of resistance for each class of pixels**
- **Uncertainty in weighting for each factor**
- Choice of weighting algorithm
- How corridor terminus is delineated
- How habitat patches are delineated
- Whether and how corridor dwellers were modeled
- Procedure to identify continuous swaths of low-resistance pixels
- How corridors of multiple focal species are combined

How robust is my model to number of focal species, and uncertainty in resistance estimates & factor weights?

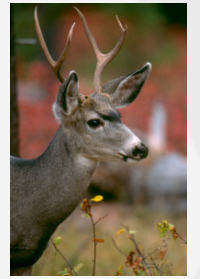
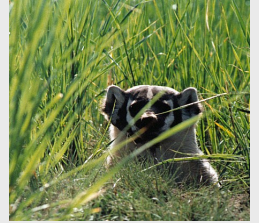
There is NO GENERAL answer to this question.

You can answer it only for a particular linkage area and set of focal species.



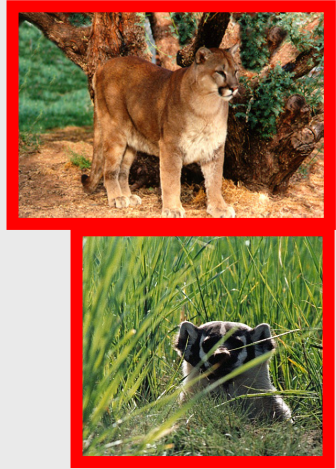
Conclusions *about the Tehachapi Linkage Design*

I. For most species, predicted least-cost corridors were robust to uncertainty in input parameters.



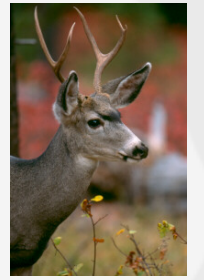
Conclusions *about the Tehachapi Linkage Design*

2. Some species models were not robust, capturing as little as 0% of some biologically plausible alternatives, accompanied by potentially large increases in resistance.



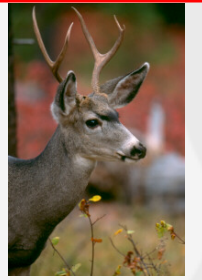
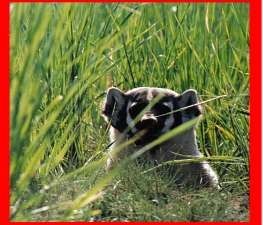
Conclusions *about the Tehachapi Linkage Design*

3. The linkage design for 8 focal species will likely serve all 8 species, even though some individual species models were not robust to uncertainty.



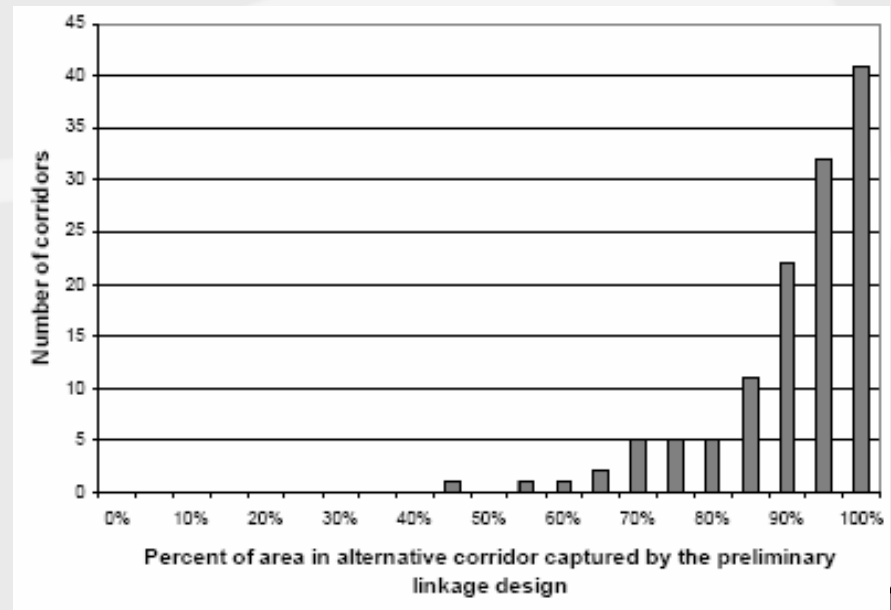
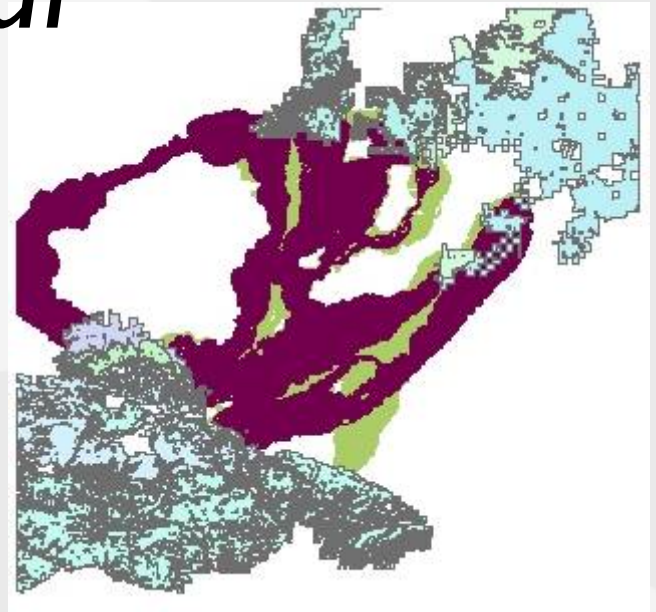
Conclusions *about the Tehachapi Linkage Design*

4. The carnivores, singly or together, were not good umbrellas for the other species.

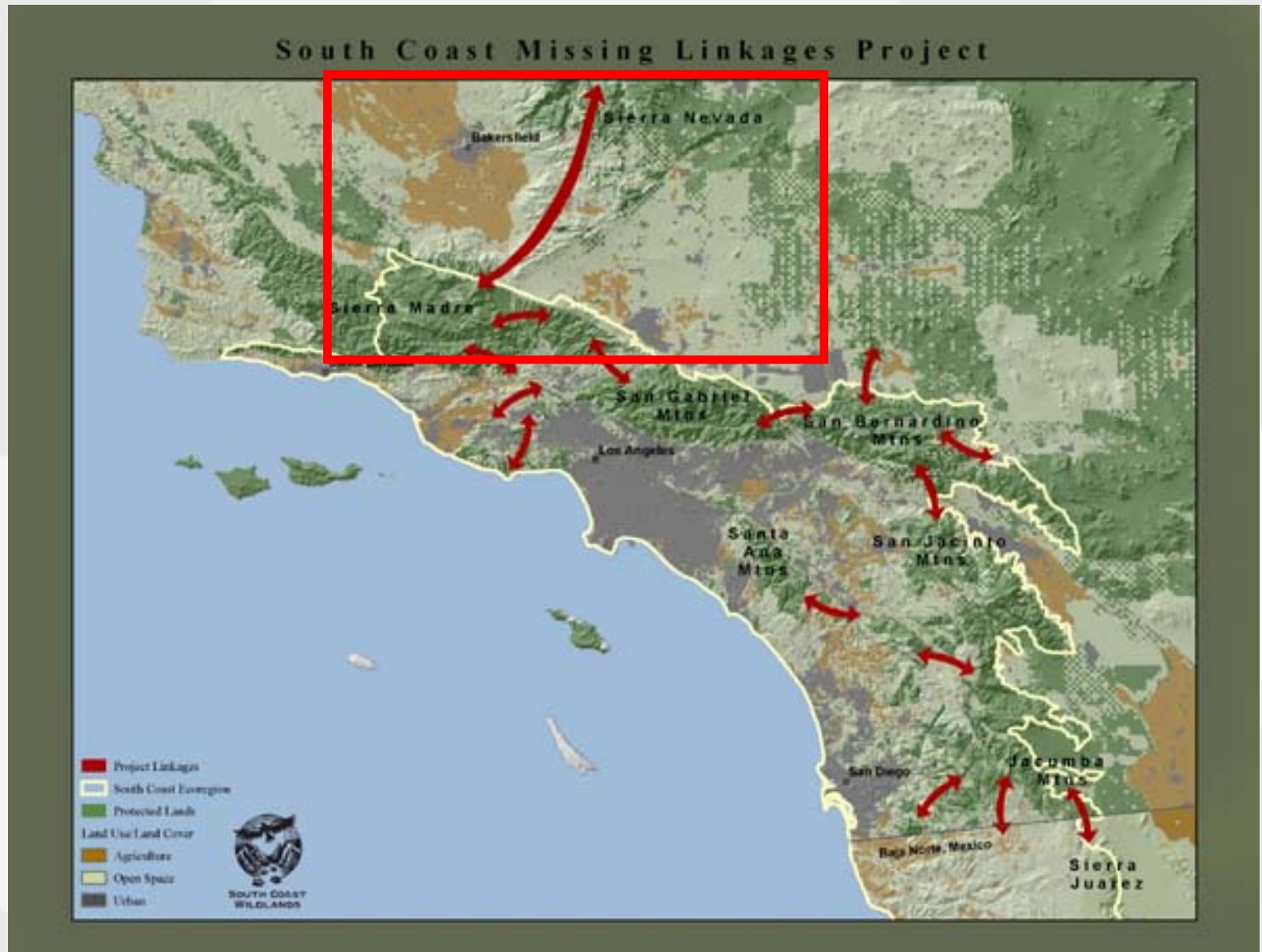


Conclusion about *your* Linkage Design

You should conduct sensitivity analysis and provide investors with maps and graphs illustrating the impact of uncertainty.

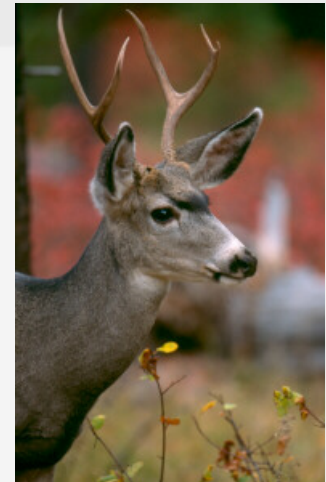


Case study: an 80-km linkage



8 focal species

- Puma
- American badger
- San Joaquin kit fox
- Mule deer
- Western gray squirrel
- Tipton kangaroo rat
- Tehachapi pocket mouse
- California spotted owl



We compressed & spread out class resistance estimates:

Factor: topography

Classes:

-  Ridgetop
-  Slopes
-  Flats
-  Canyon bottom



We compressed & spread out class resistance estimates:

Factor: topography

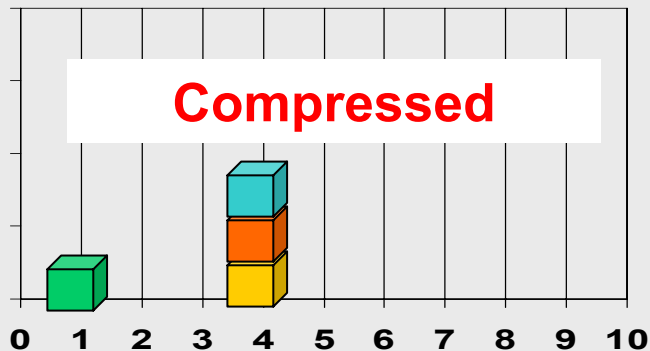
Classes:



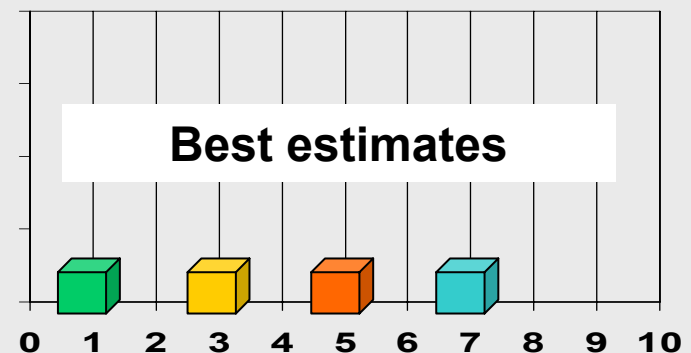
Best estimates



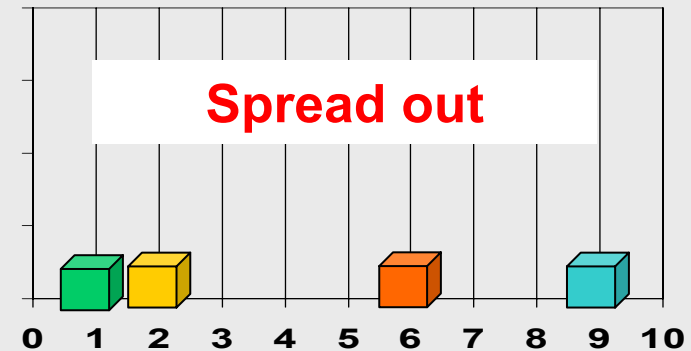
Compressed



Best estimates

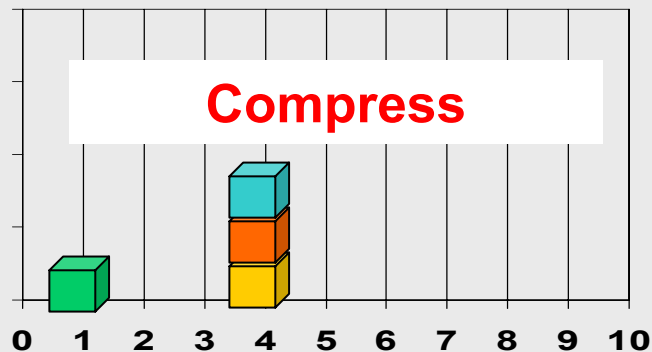


Spread out

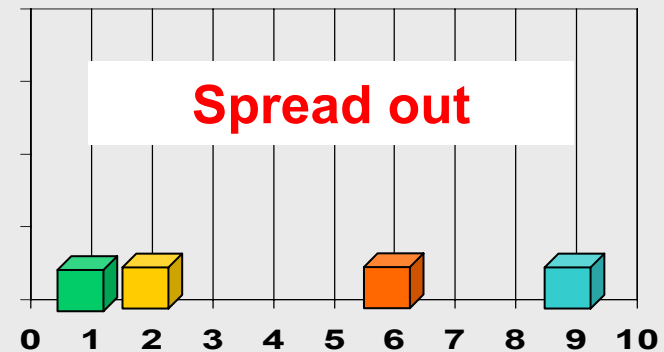


We tested 17 alternatives for each species.

resistance of topographic classes

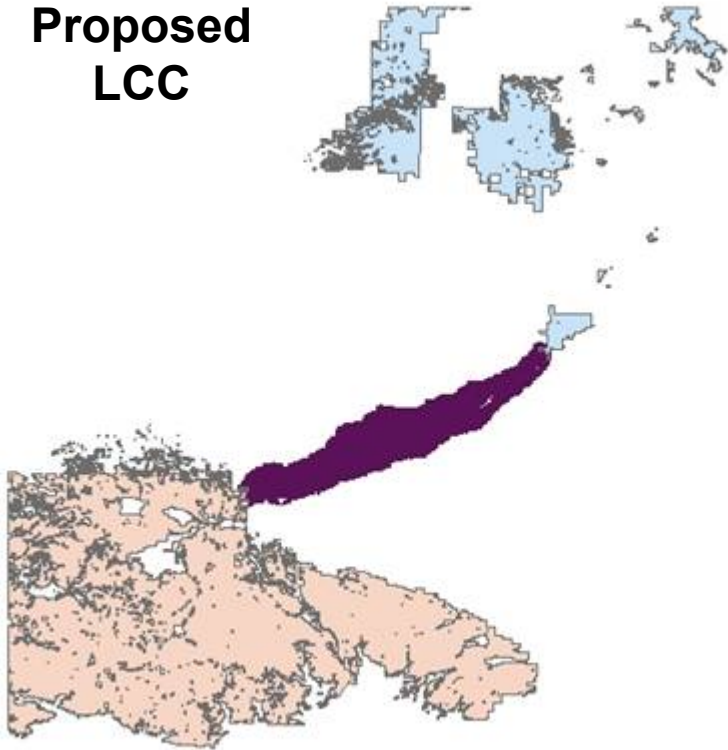


resistance of road density classes

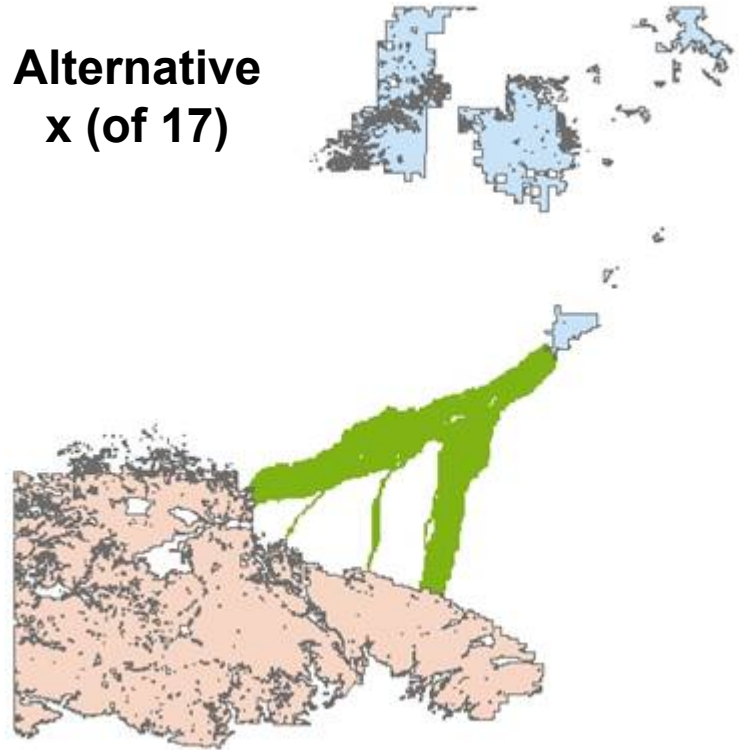


How to compare the proposed corridor to each alternative?

**Proposed
LCC**



**Alternative
x (of 17)**

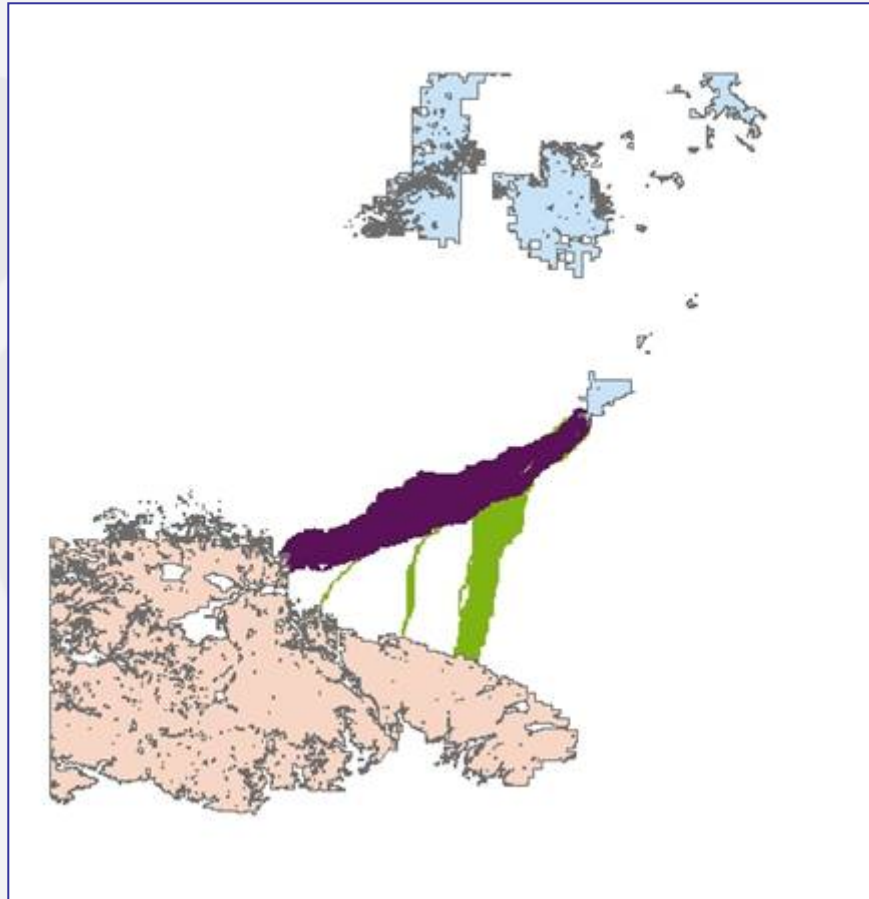


Our main response variable: % of alternative overlapped by the proposed corridor.

If we
implement the
proposed
corridor,

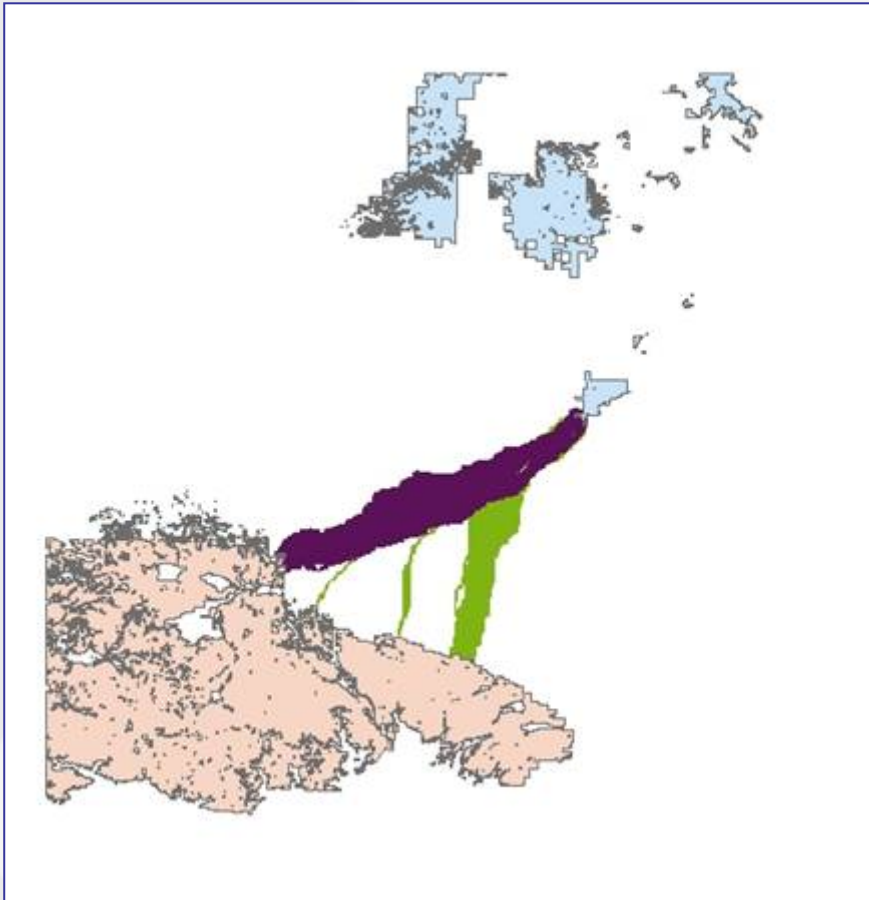
but the
alternative is
right,

how badly did
we do?



The proposed
corridor
captured 66%
of this
plausible
alternative.

But a proposed corridor that fails to overlap a plausible alternative might still be as permeable as the alternative!



Second response variable: increase in resistance in the proposed corridor compared to the alternative (using parameter values associated with the alternative)

RESULTS: Most predicted corridors were robust to uncertainty *on average*

Species	Mean % of 17 alternative scenarios captured within proposed corridor
Puma	31%
American badger	54%
San Joaquin kit fox	89%
Mule deer	67%
Western gray squirrel	79%
Tipton kangaroo rat	94%
California spotted owl	69%
Tehachapi pocket mouse	77%

But some individual species models captured 0% of some alternatives.

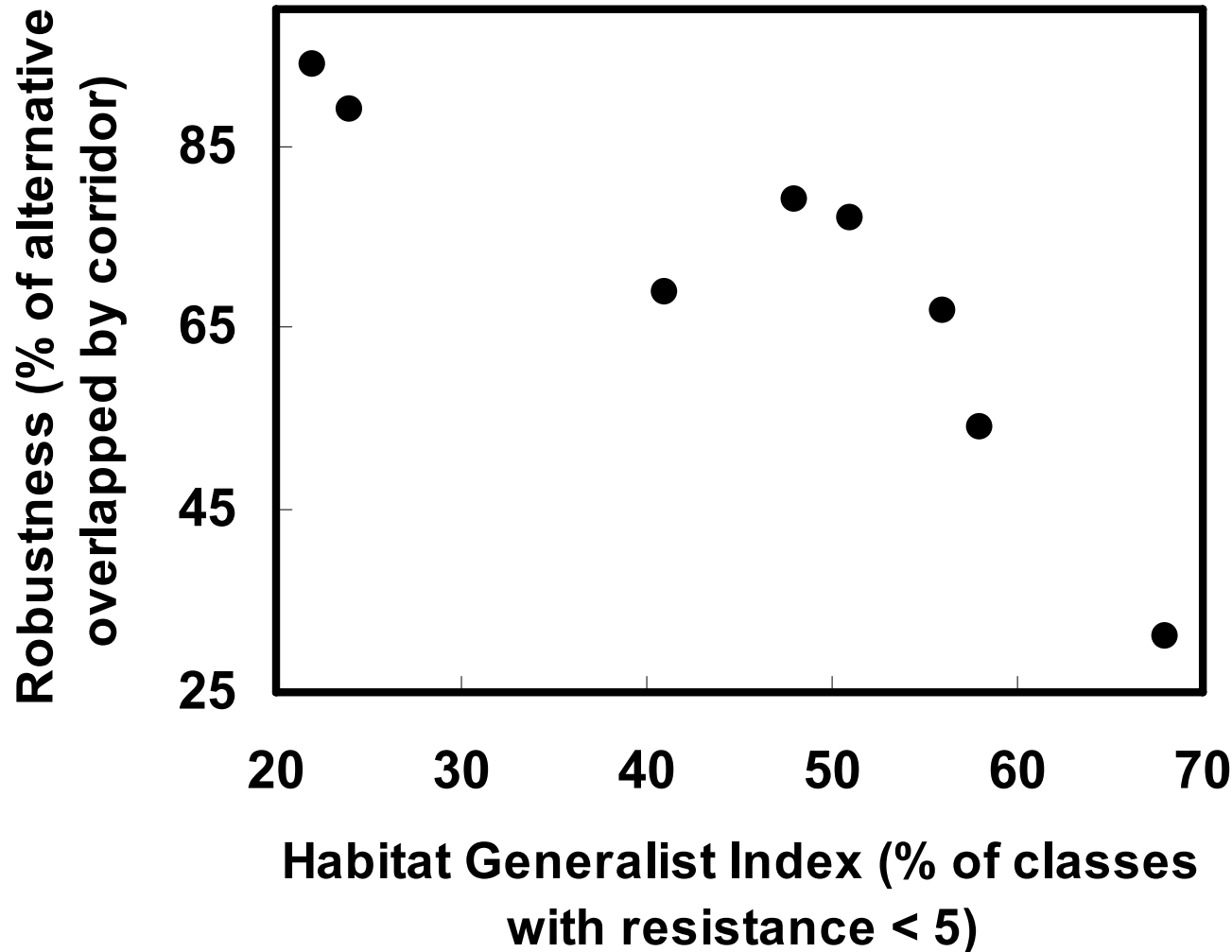
Species	Mean % of alternative captured in proposed corridor	Range
Puma	31%	0-97% (0% of 5 alts)
American badger	54%	0-100% (0% of 4 alts)
San Joaquin kit fox	89%	71-100%
Mule deer	67%	93-98%
Western gray squirrel	79%	63-94%
Tipton kangaroo rat	94%	84-100%
California spotted owl	69%	87-100%
Tehachapi pocket mouse	77%	0-100% (0% of 2 alts)

But some individual species models captured 0% of some alternatives.

Models for
habitat
generalists
were least
robust

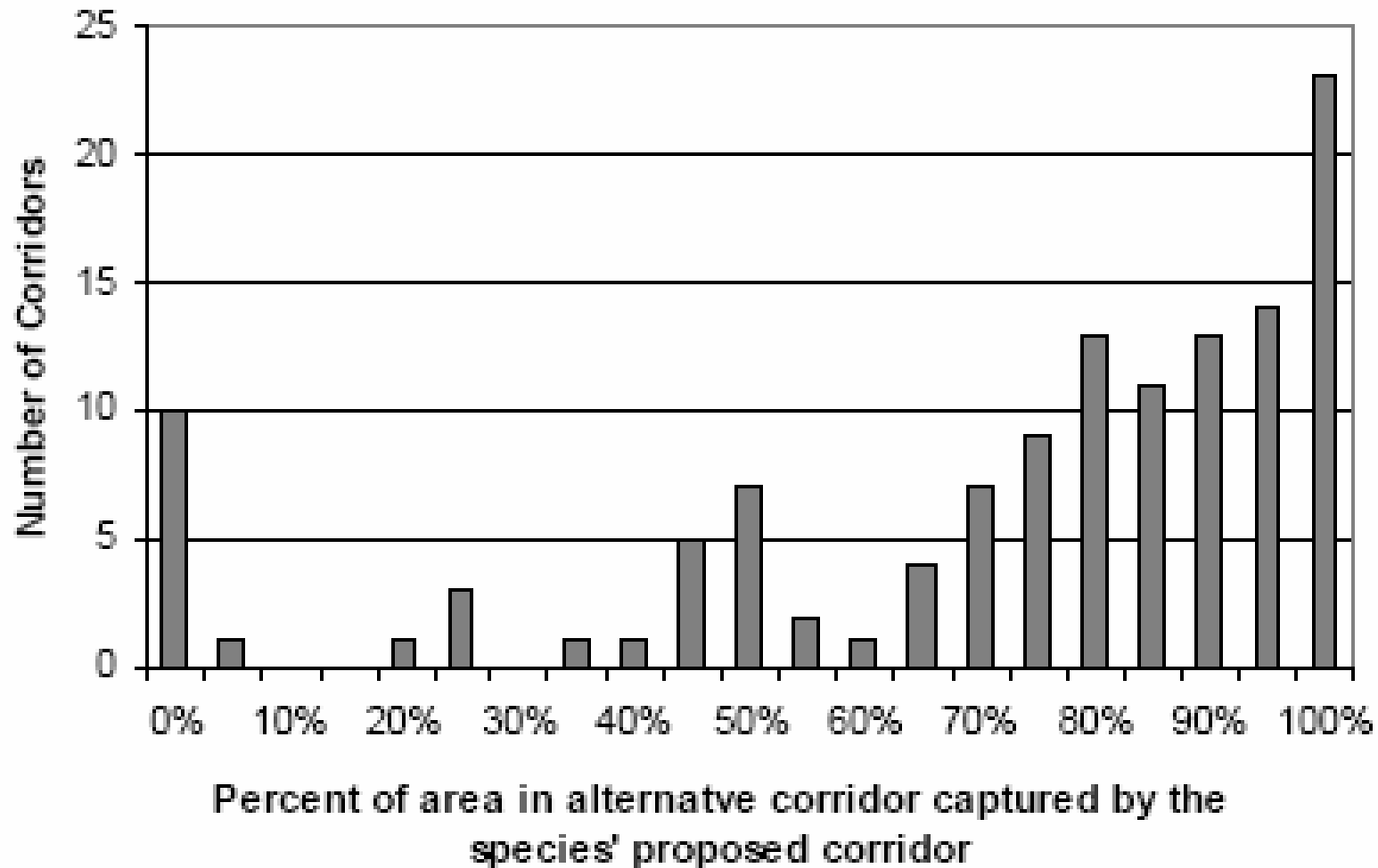


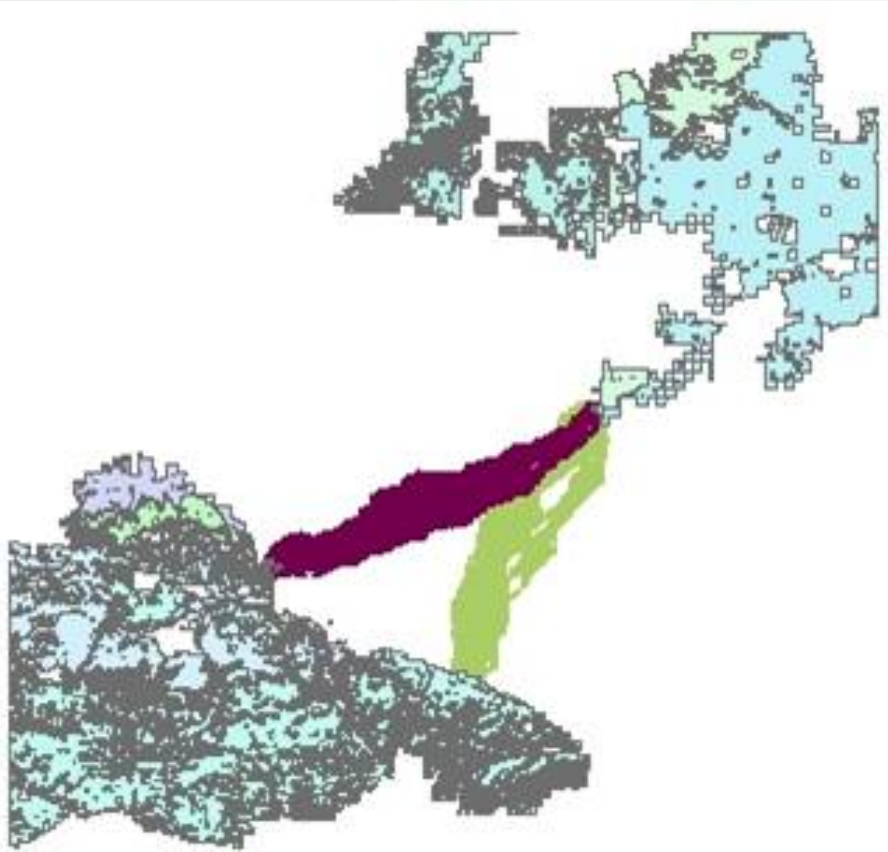
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Models for habitat generalists were least robust

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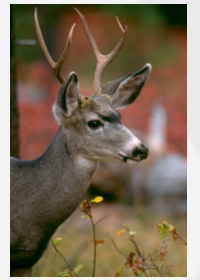
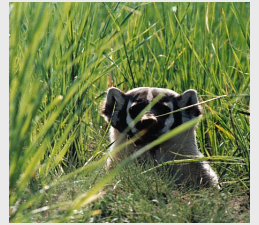


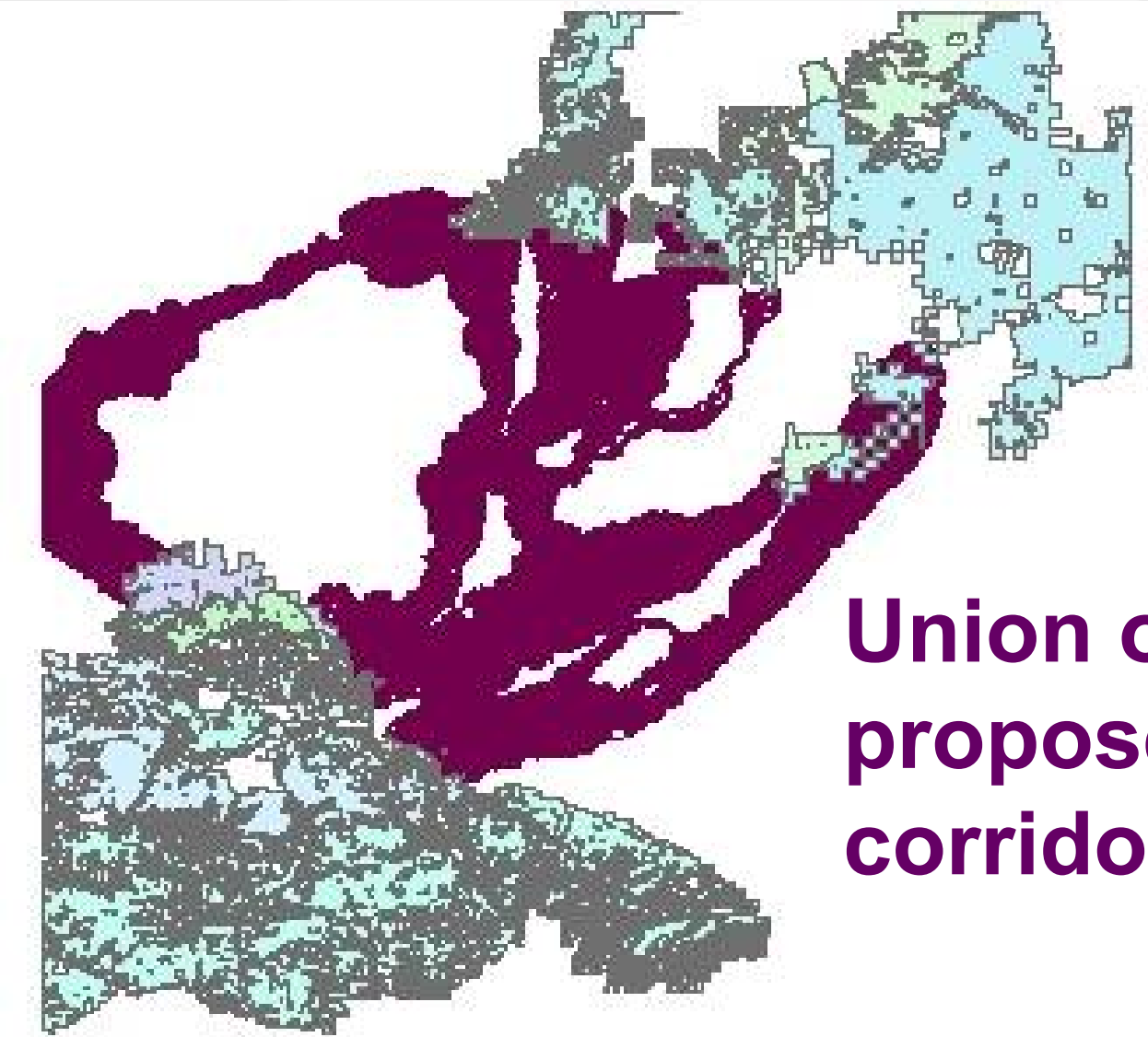
When predicted corridors did not overlap alternatives, resistance in the predicted corridor was typically $< 15\%$ worse.

Some single-species models
were poor....

But we are implementing
multiple-species plans...

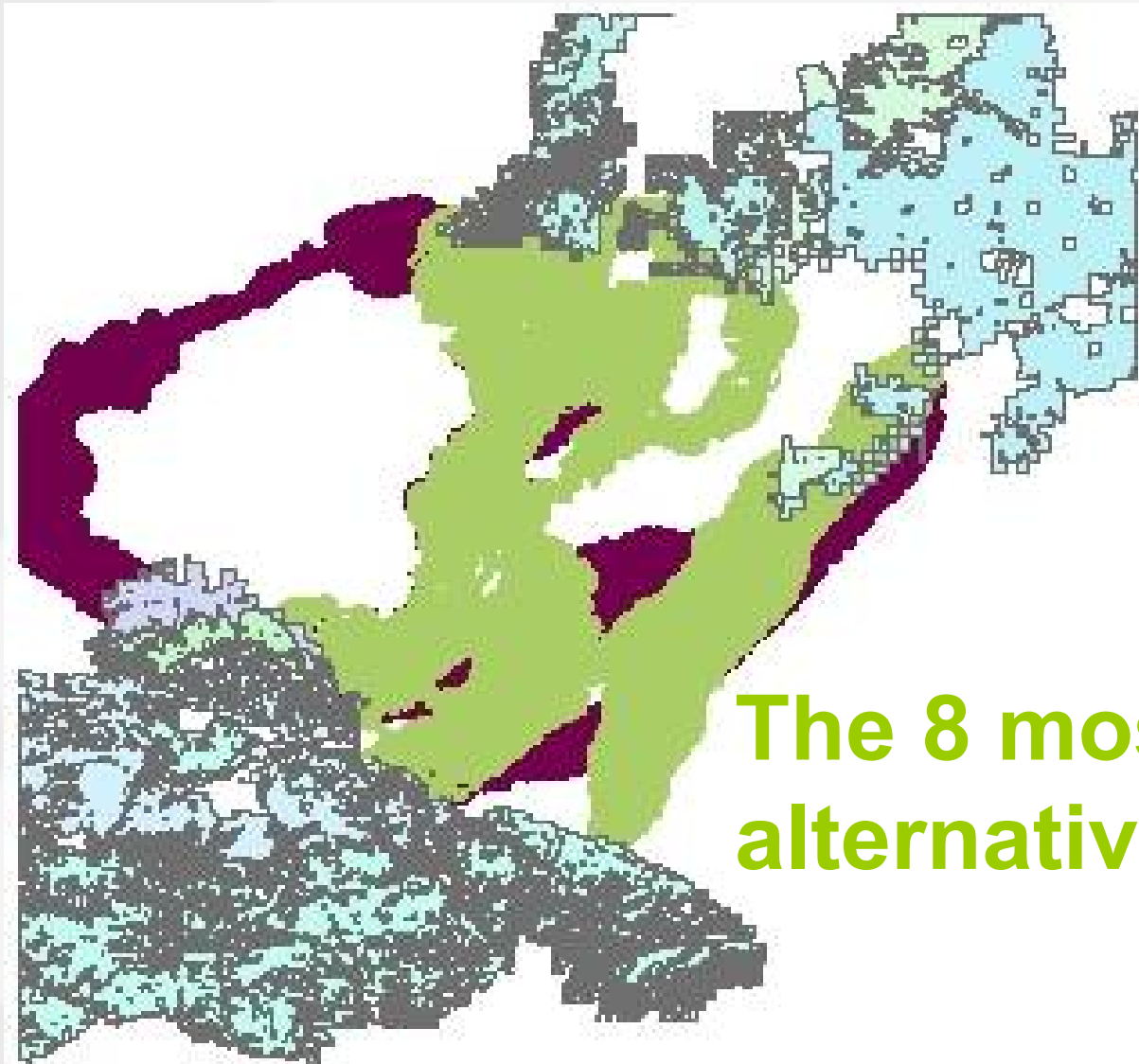
How stable is the linkage
design (union of proposed
corridors) to uncertainty in
the individual models?





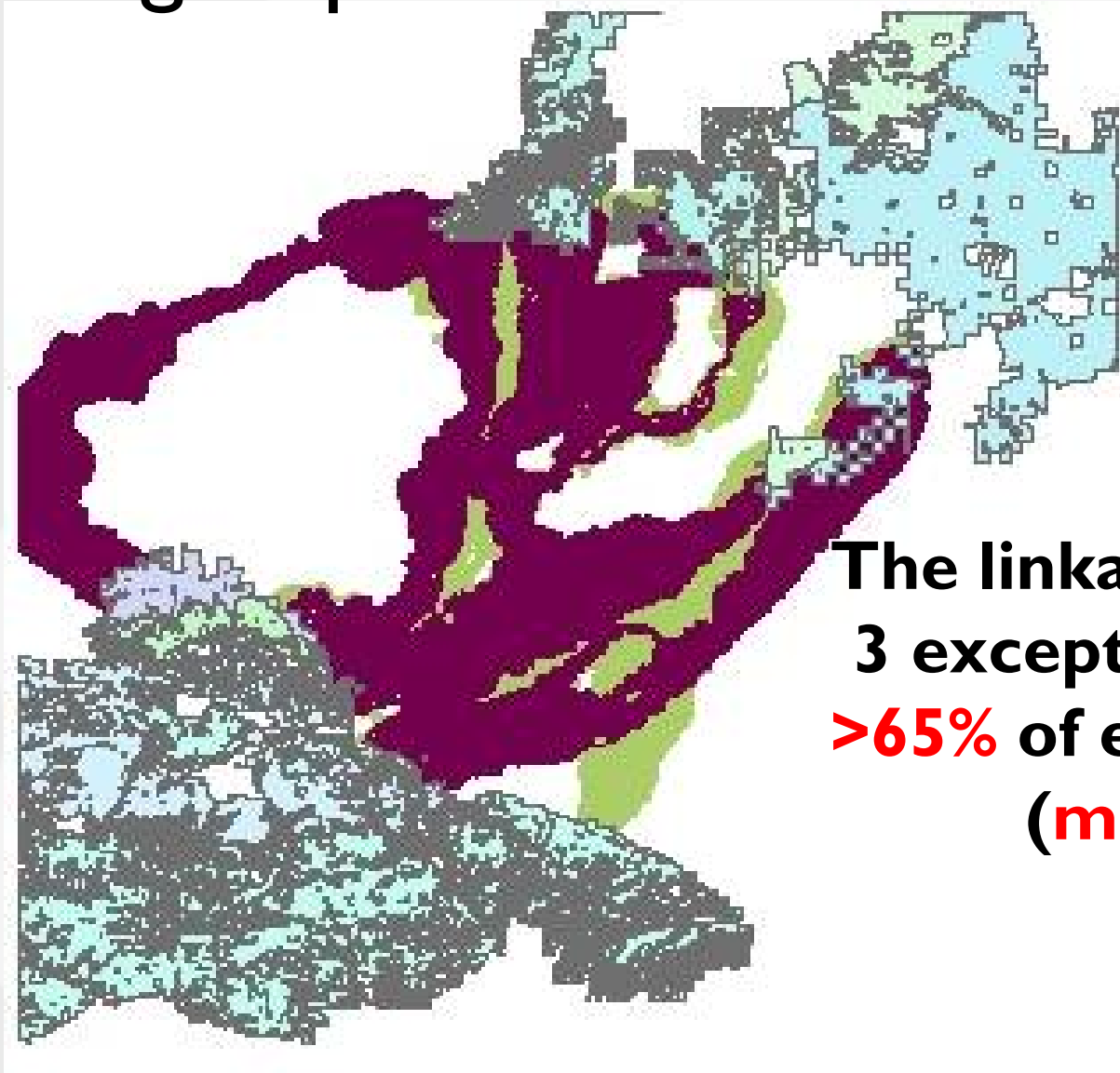
The image is a map of a coastal or estuarine area. It features several large blue areas representing water bodies, including a large one in the upper right and a smaller one in the lower left. The land is divided into numerous small, irregular polygons, likely representing property parcels. A thick, dark red line is drawn across the map, representing the 'Union of 8 proposed corridors'. This line starts in the lower left, winds through the land parcels, and extends towards the upper right, connecting different parts of the land area.

**Union of 8
proposed
corridors**



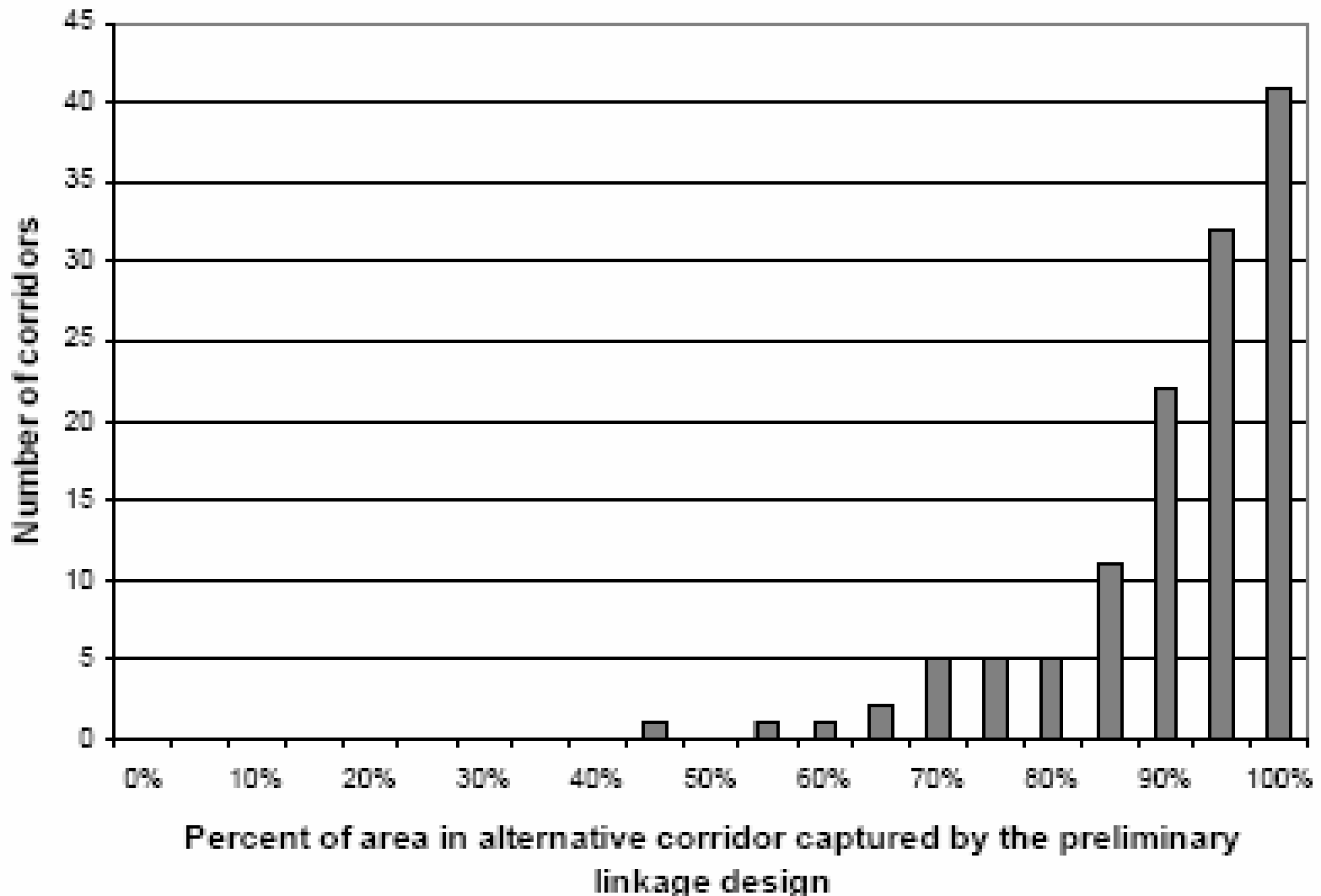
**The 8 most divergent
alternatives**

Using multiple species mitigates errors in single-species models



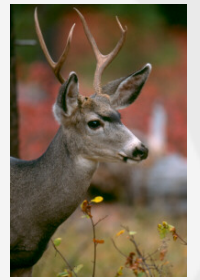
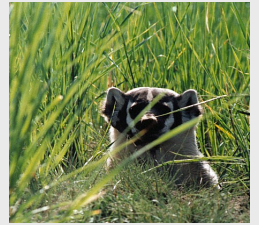
**The linkage design (with
3 exceptions) captured
>65% of each alternative
(mean: 89%)**

The multiple species design is robust to uncertainty in single-species models



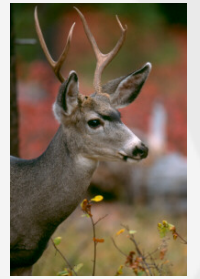
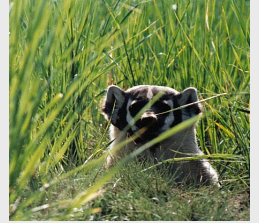
How robust is my model?

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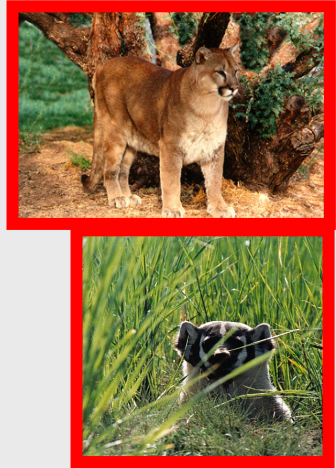
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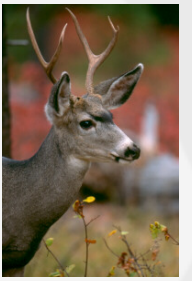
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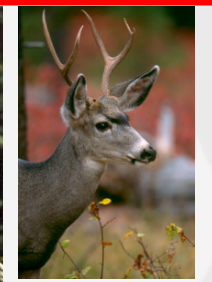
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Conclusion about *your* Linkage Design

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