Fish and Wildlife Population Ecology:

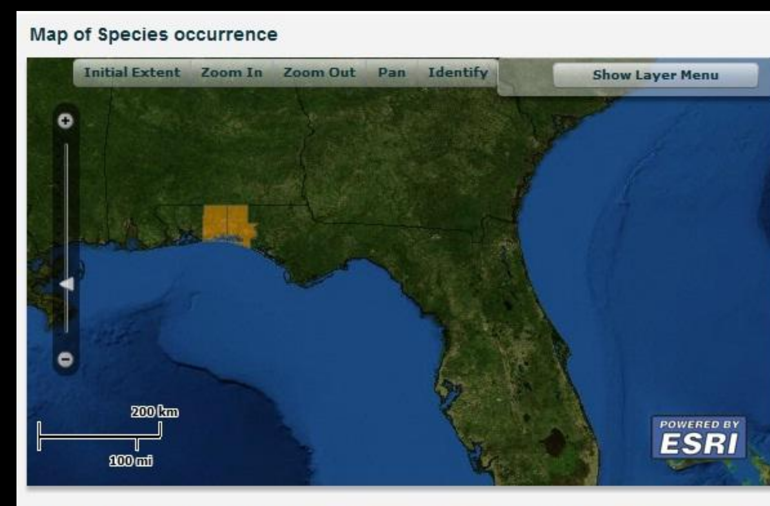
Population Ecology in practice…

Prepared by J. Horne (2010) & D. Oleyar (2011)

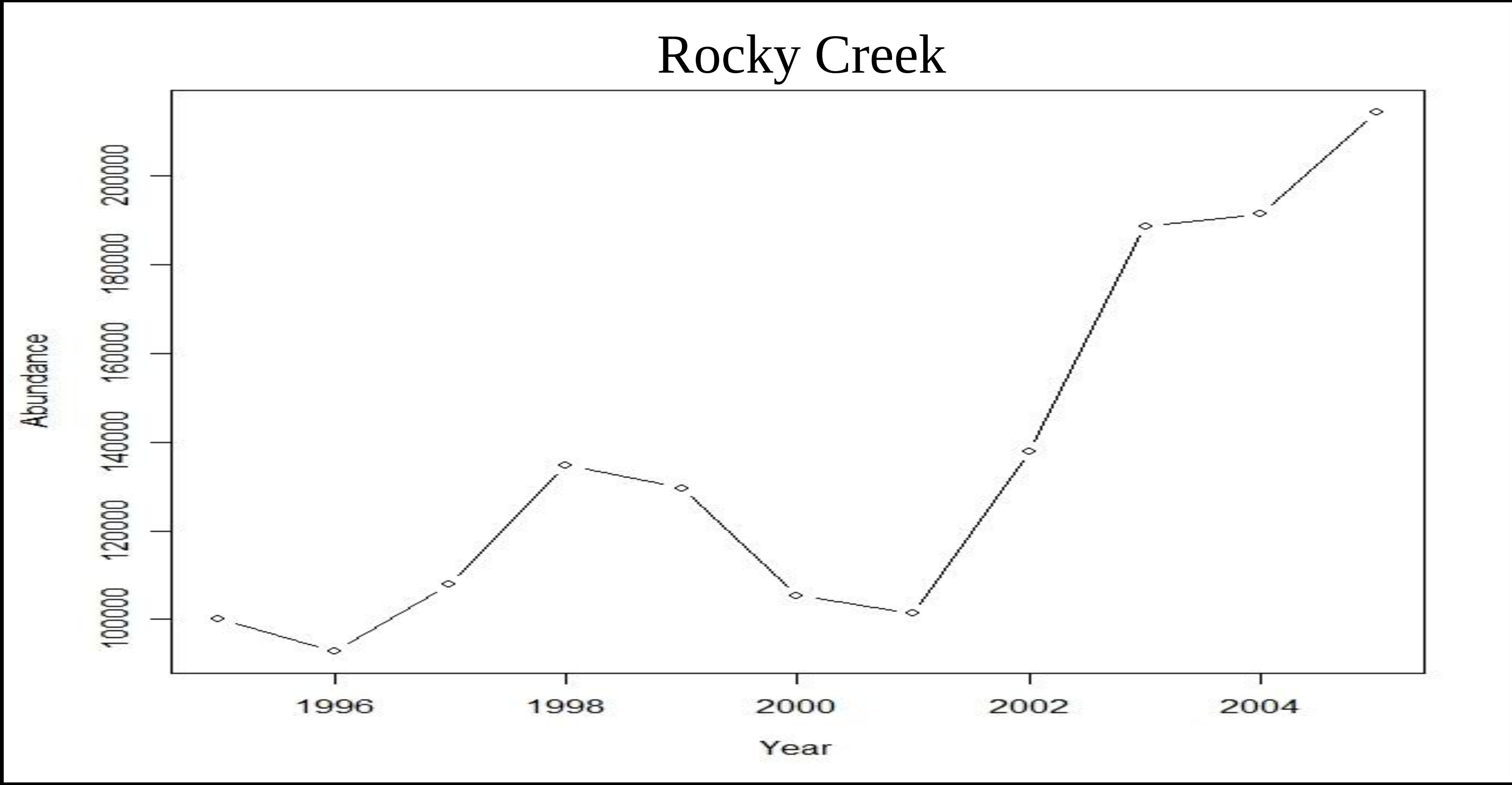
Okaloosa Darters…

How are they doing?

- Choctawhatchee Bay drainage in Florida
- Inhabit vegetated sand runs of clear creeks
- Listed as Endangered June 4, 1973
- Fish and Wildlife Service has recommended downlisting to Threatened
- How would you determine their status??



Time Series of Abundance Estimates



Fit Population Growth Models

Model	Input Data*	Density Dependence	Type(s) of Noise
☐ Exponential growth with observation error (EGOE)	continuous time	none	observation error
☑ Exponential growth with process noise (EGPE)	continuous time	none	process noise
☑ Exponential growth state space model (EGSS)	continuous time	none	process noise and observation error
☑ Gompertz density dependent (GOMP)	discrete time	R(t) = a - b*logN(t-1)	process noise
☑ Ricker density dependent (RICK)	discrete time	R(t) = a - b*N(t-1)	process noise
☐ Theta-logistic density dependent (THET)	discrete time	R(t) = a - b*N(t-1)^theta	process noise

Models with Environemental Covariates

☐ Open options form for modeling population growth with environmental covariates

Next >>

*

Analysis of Population Growth Using Time Series Data

File Analyses Output

Select Excel Worksheet

Turkey Creek
Rocky Creek
Sheet3

Select Columns for Analysis

Apply current selection for time

Time column: **Year**

Apply current selection for abund.

Abund. column: **Abundance**

Rocky Creek

Year	Abundance
1995	100256
1996	92836
1997	107961
1998	134787
1999	129650
2000	105393

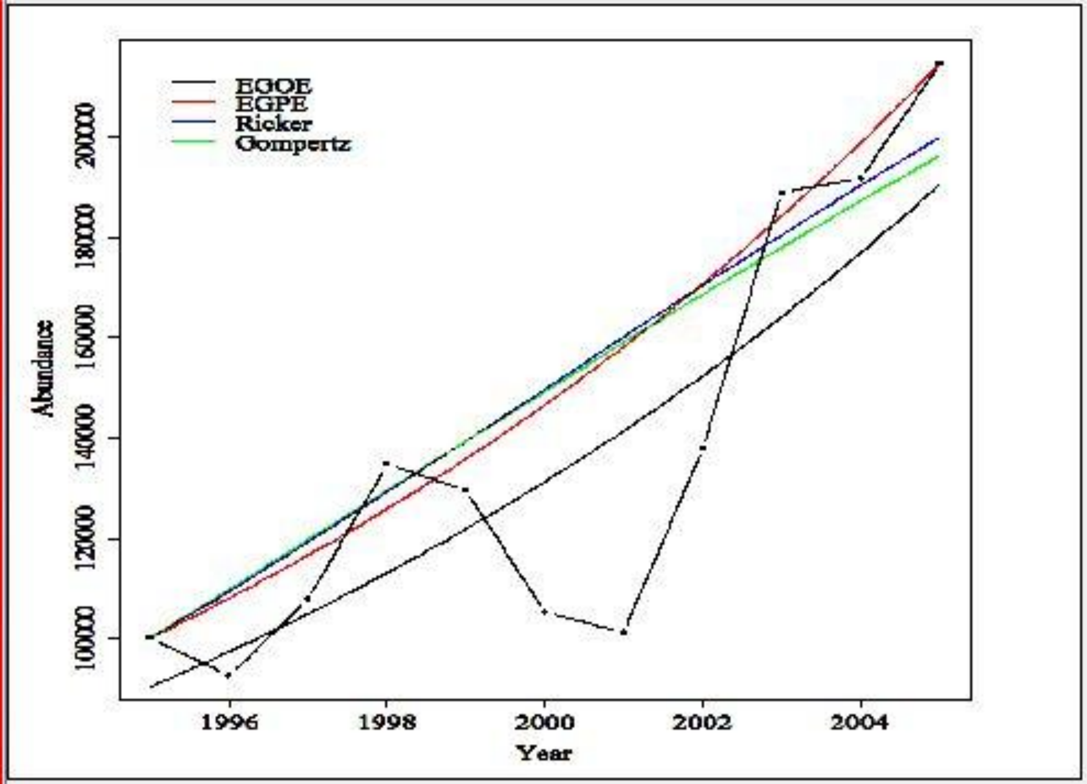
Parameter Estimates

Linear regression of log-abundance vs. time...

Mu_est 0.0743127831
SE(Mu_est) 0.0161119493
Obs_Var 0.0285554403
P_Var NA
=====================================
Model fit of exponential growth with process noise...

AICc -1.9537
Mu_est 0.0760153827
SE(Mu_est) 0.0549709572
Obs_Var NA
P_Var 0.0302180613
=====================================
Model fit of exponential growth with process noise and observation error...

Mu_est 0.0760153827
SE(Mu_est) 0.0549624276
Obs_Var 0
P_Var 0.0302086845
=====================================
OkDarter_TurkeyAndRockyAbundance.xls_Rocky Creek.Ricker



R Console Output

[[2]]
[,1]
[1,] 0.05496243

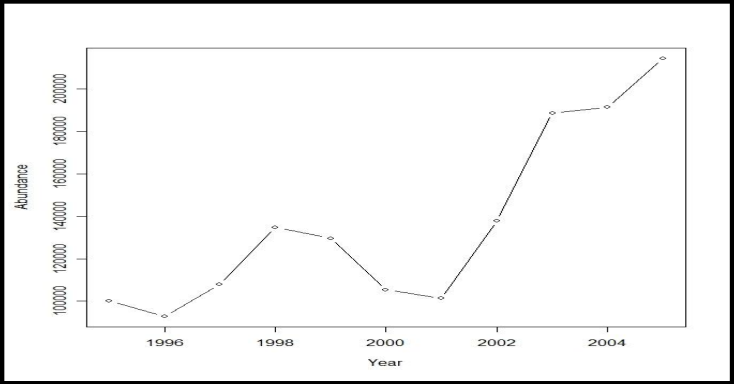
[[3]]
[1] 0

[[4]]
[1] 0.03020868

Input file: C:\JonsWork\Classes\448\448 Fall 2008\PopulationData\OkDarter_TurkeyAndRockyAbundance.xls

Which Model??

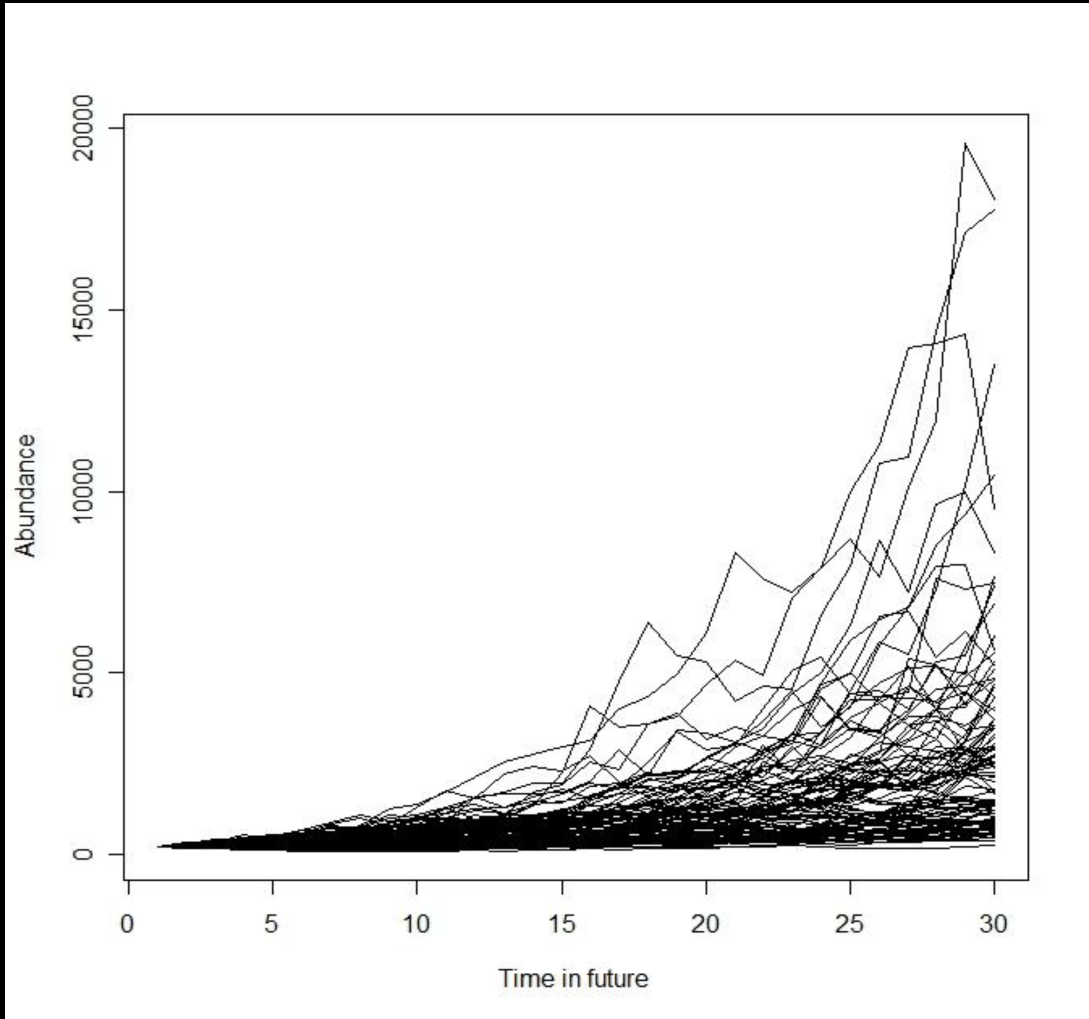
Model	AICc	DeltaAICc
Exponential	-1.953	0
Gompertz	2.21	4.19
Ricker	2.24	4.16
Theta-logistic	8.24	10.19



Past Abundance Data

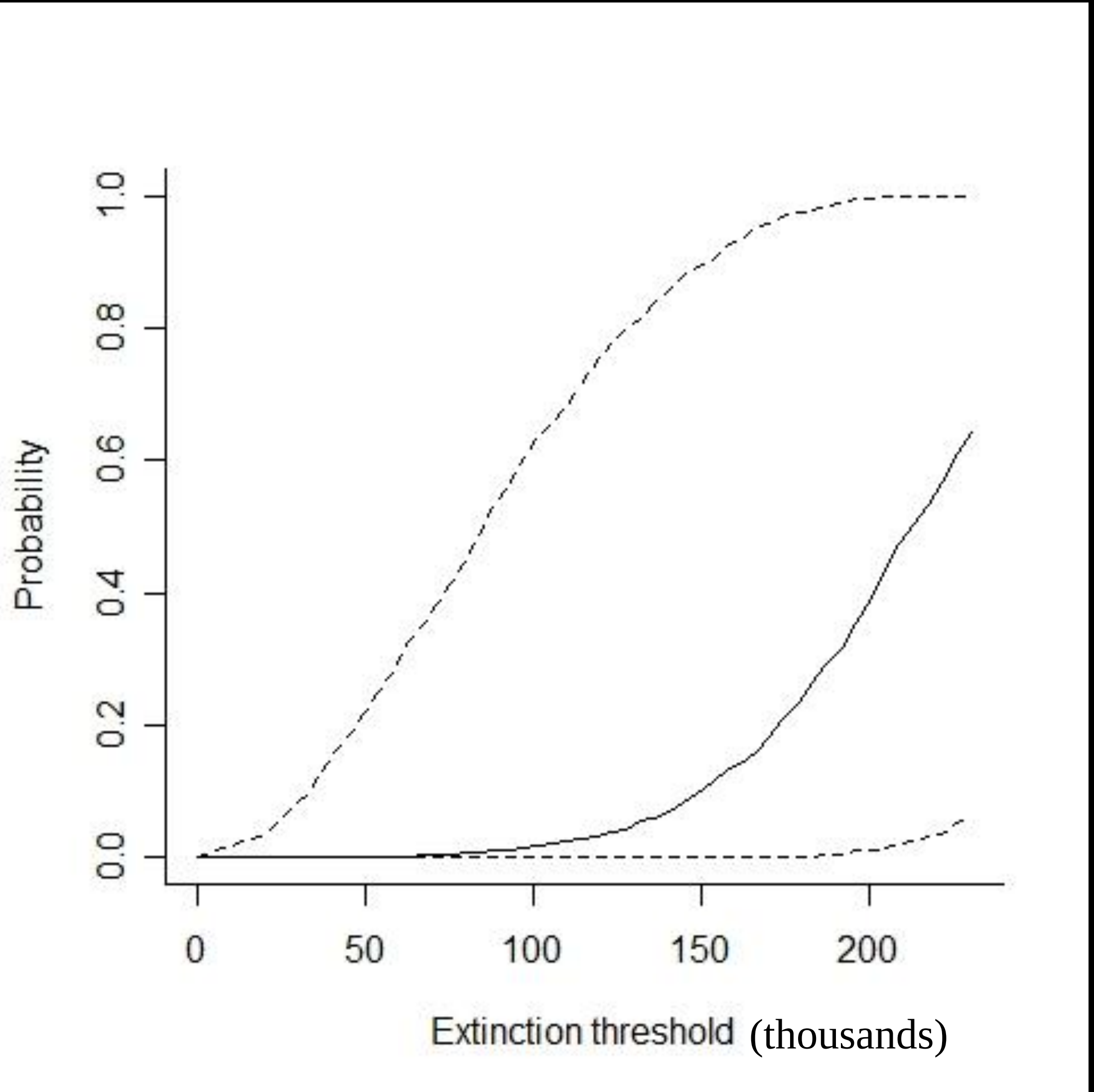
Future Projection

-Based on past data and an assumed model of growth

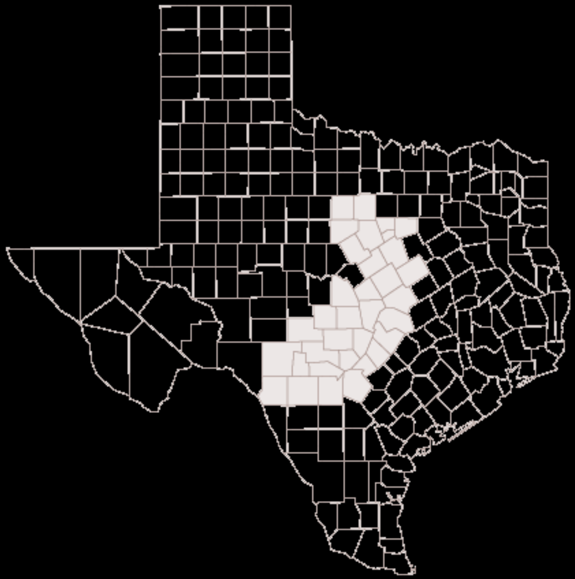


OK, Now What?

- Probability of Declining



Golden-Cheeked Warbler (*Dendroica chrysoparia*)



- Breeds in closed-canopy woodlands, primarily Ashe juniper and oak
- Declined due to habitat loss and fragmentation from clearing of juniper for urban expansion, agriculture, and commercial harvest

MULTIPLE POPULATION MODELS

- Inputs
  - Demographics (age-specific)
    - Survival
    - Reproduction
  - Population parameters
    - Number of populations (habitat patches)
    - Initial abundance
    - Size of habitat patch (K)
  - Metapopulation dynamics
    - Dispersal among habitat patches
    - Correlated demographics among patches
- Output
  - Metapopulation viability (e.g., probability of persistence)

MULTIPLE POPULATION MODELS

- How can we evaluate how changes in the inputs (e.g., management actions across space) relate to changes in output (i.e., metapopulation viability), in the face of uncertainty?

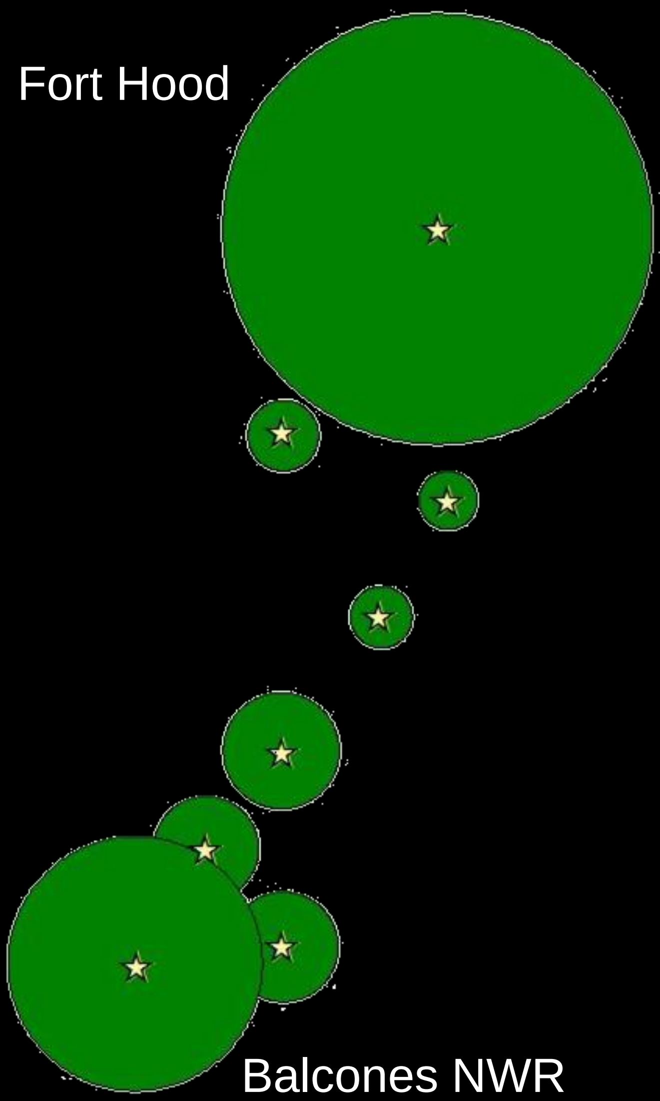
- Very complex model
  - Large number of input parameters (e.g., 100s)
  - Management affects parameters differently
  - Non-linear response to changes
  - Interactions among input parameters

The Model

- Stochastic, demographic-based, metapopulation projection model (e.g., RAMAS MetaPop)*
- Projection matrix

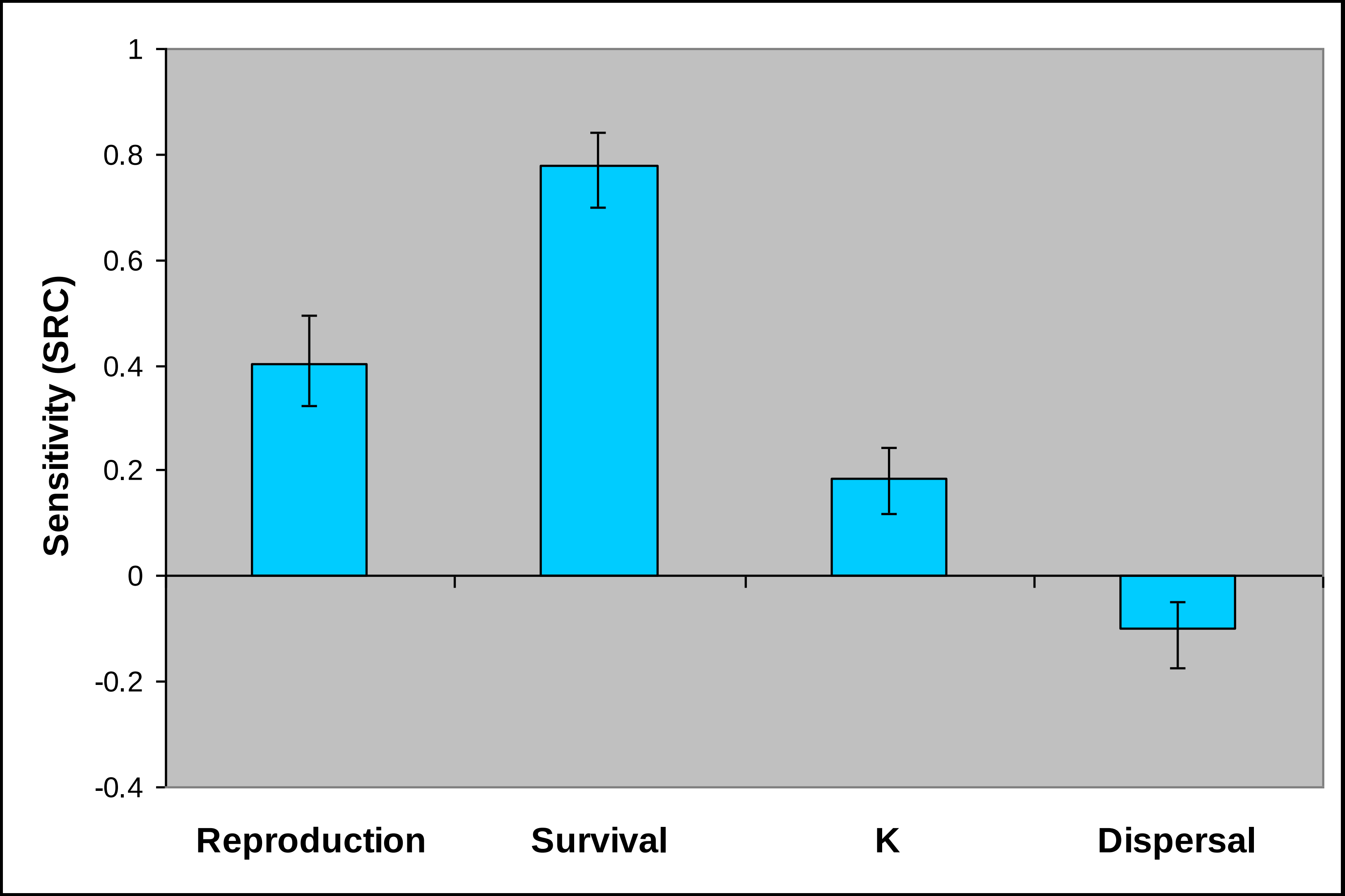
	HY	AHY
HY	0.48 (0.3)	0.74 (0.14)
AHY	0.4 (0.24)	0.57 (0.1)

- Ceiling carrying capacity (K)
- HY only, symmetric dispersal (15%)



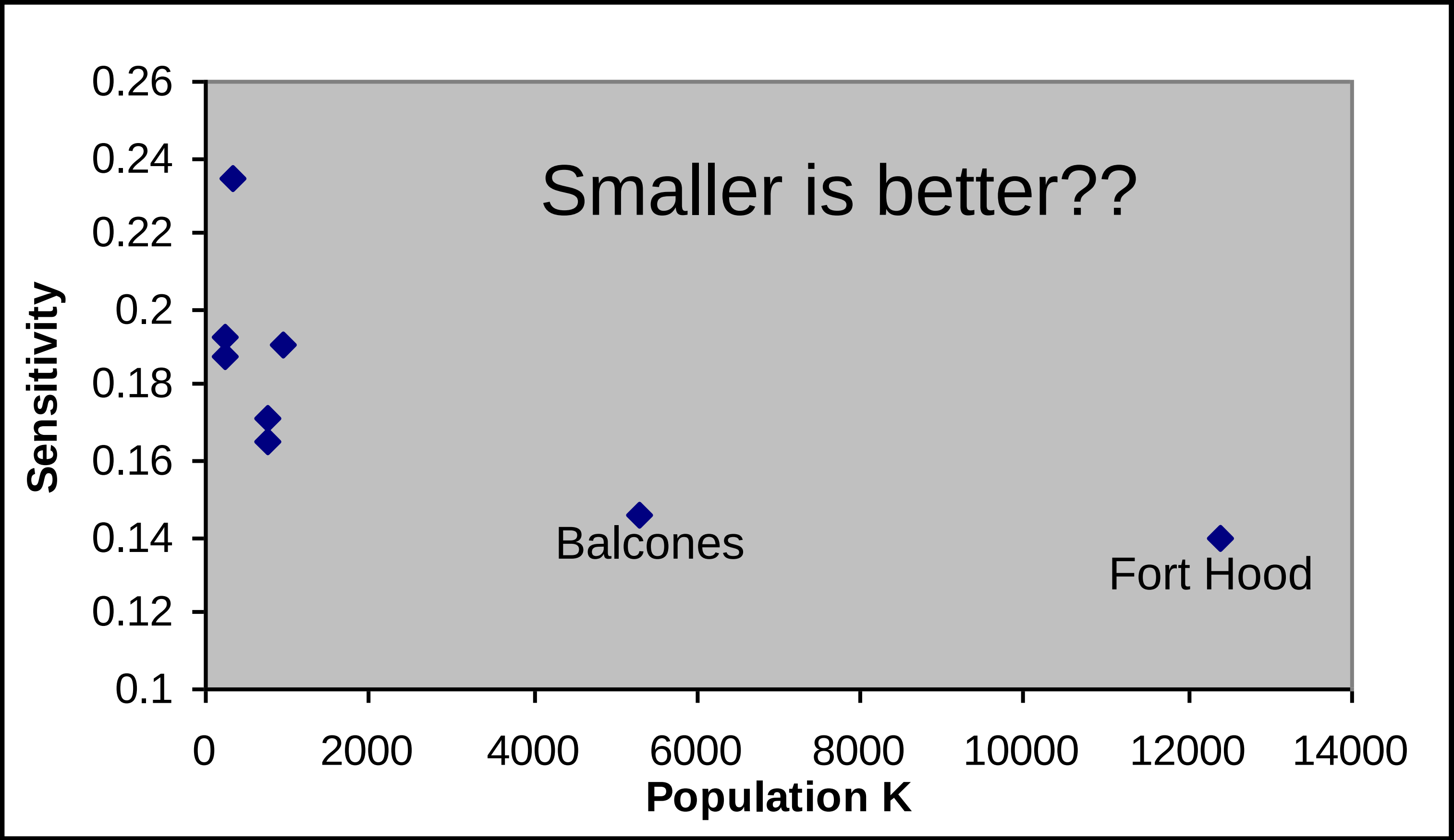
* Alldredge et al. (2004)

Important Drivers of Metapopulation Viability



Sensitivity to Individual Populations

- What about the importance of individual populations?
- Input values: Each population's K +/- 200



Wolf Reintroduction to Northern Rockies

- What impact are wolves having on elk and deer populations in Idaho?
- What impact in future? – decreasing elk and deer, stable numbers or oscillations?
- How answer?
  - Ask experts and check scientific literature
  - Gather important data
  - Synthesize data and test possibilities with a model

Why model predator-prey interactions?

- Models help us
  1. Define our problem
  2. Identify what might be important
  3. Understand our data
  4. Communicate and test that understanding
  5. Make predictions

Modeling Wolf Effects

- What is important?
- What would determine their effect on elk and deer?
- Is there a theory of predator-prey interactions that will help us understand, predict and manage wolf predation on deer and elk?

Predicting effects of wolf reintroductions on ungulate populations: Comparing model predictions to observations for elk and wolves in Yellowstone.

- by Edward O. Garton[1], Douglas W. Smith[2], Bob Crabtree[1], Bruce Ackerman[1], and Gerry Wright[1]
- 1. Fish and Wildlife Dept., University of Idaho, Moscow, ID 83844,
- 2. National Park Service, Yellowstone Center for Resources, P.O. Box 168, Yellowstone National Park, WY 82190

1990 Approach

- Evaluate dynamics of Northern Yellowstone Elk Herd using available data
- Predict characteristics of wolf population growth and predation from literature
- Build an empirically based projection model
- Validate portions of the model by comparing predictions to observed data in 1990

- 1990’s predicted success for wolves
- Northern Yellowstone elk herd projected to be stable with high chance of persistence but average abundance depends on
  - Hunter harvest
  - Winter severity

Implications: Hunter Harvest

- Population trend for Northern Yellowstone Elk herd at current size is very sensitive to
- Human harvest rate:
- @ 9% harvest (‘70-’80s) - Stable with wolves
- @ 11% harvest (’95-’05) - Declines with wolves
- @ 7% harvest - Increases with wolves
- @ 9% harvest - Increases without wolves

Implications: Winter Severity

- Population trend for Northern Yellowstone Elk herd at current size is very sensitive to winter severity:
  - Average severity: population stable
  - Mild winters: population increases 10% / year
  - Severe winters: population decreases 10% /year
- In 1/3 of years, population either increases or decreases at least 10%

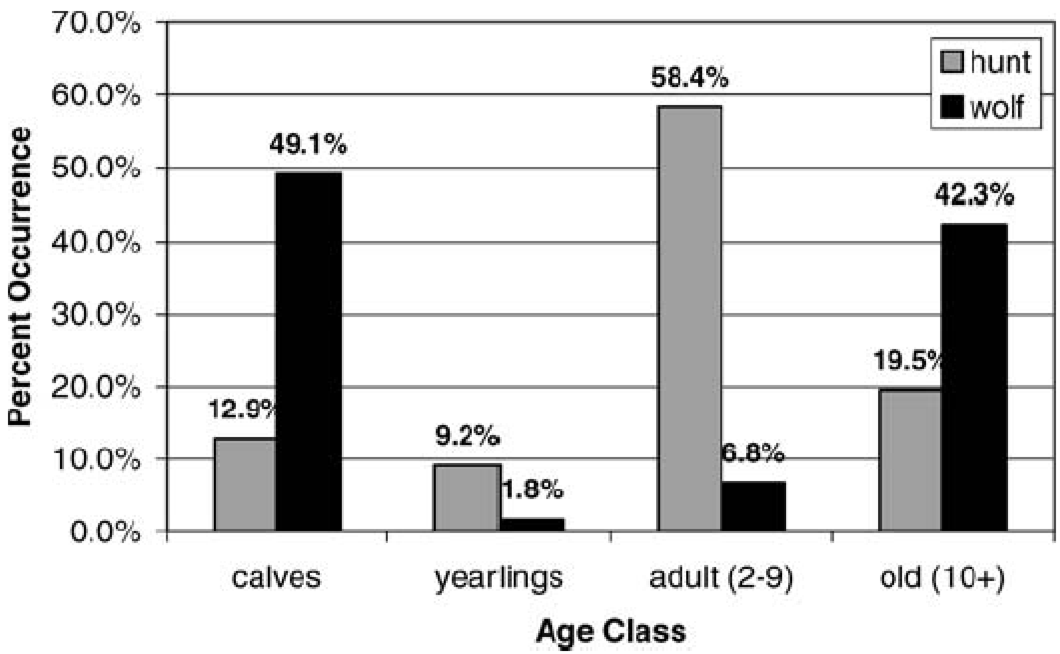


Figure 2. Age distributions of female northern Yellowstone elk killed by hunters in the Gardiner Late Hunt (1996–2001) and by wolves (1995–2001).

From Wright et al. 2006. Selection of Northern Yellowstone Elk by Gray Wolves and Hunters. JWM, 70(4).

The Ecology of Fear

- Predators may also have an effect on the *behavior* of potential prey, in which prey respond to the mere presence of predators (and risk of predation) by altering their:
  - patterns of foraging, including diet and time feeding;
  - use of patches where they might be more vulnerable to predators;
  - care of young;
  - grouping patterns and social interactions;
  - courtship displays.

  All of these may impact overall survival and reproductive success

Before & After Wolves

Restoring wolves to Yellowstone after a 70-year absence as a top predator—especially of elk—set off a cascade of changes that is restoring the park's habitat as well.

YELLOWSTONE
WITHOUT WOLVES
1926-1995

ELK overbrowsed the stream side willows, cotton-woods, and shrubs that prevent erosion. Birds lost nesting space. Habitat for fish and other aquatic species declined as waters becam broader and shallower and, without shade from streamside vegetation, warmer.

ASPEN trees in Yellowstone's northern valleys, where elk winter, were seldom able to reach full height. Elk ate nearly all the new sprouts.

COYOTE numbers climbed. Though they often kill elk calves, they prey mainly on small mammals like ground squirrels and voles, reducing the food available for foxes, badgers, and raptors.

ART BY FERNANDO G. BAPTISTA, NG STAFF; AMANDA HOBBS, NG STAFF
SOURCES: ROBERT L. BESCHTA AND WILLIAM J. RIPPLE, OREGON STATE UNIVERSITY; DOUGLAS W. SMITH, YELLOWSTONE NATIONAL PARK

YELLOWSTONE
WITH WOLVES
1995-PRESENT

ELK population has been halved. Severe winters early in the reintroduction and drought contributed to the decline. A healthy fear of wolves also keeps elk from lingering at streamsides, where it can be harder to escape attack.

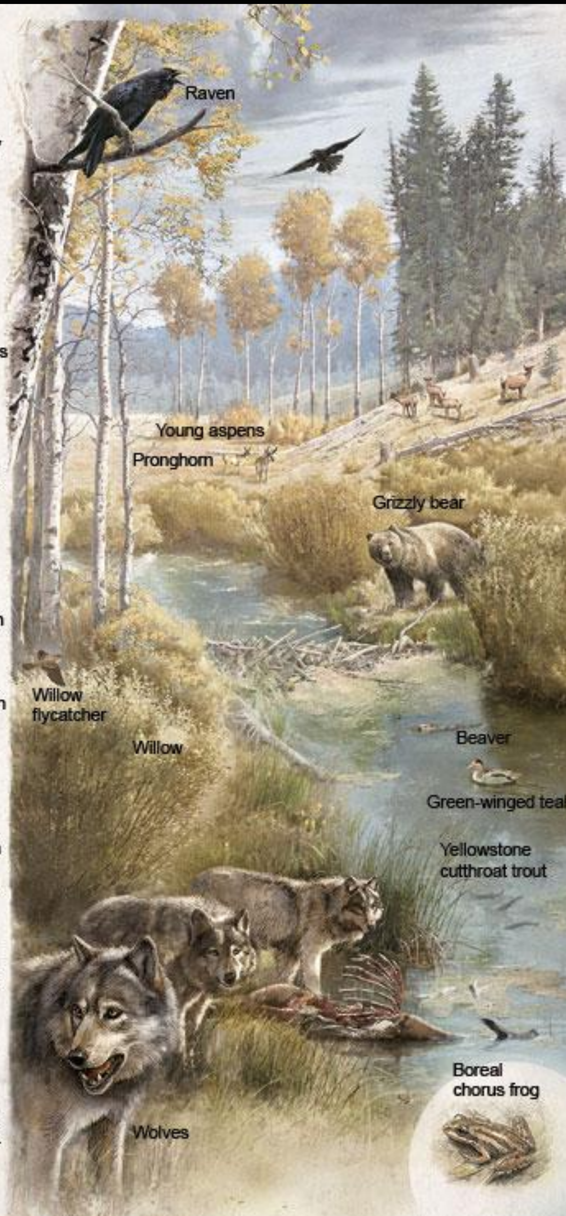
ASPENS The number of new sprouts eaten by elk has dropped dramatcally. New groves in some areas now reach 10 to 15 feet tall.

COYOTES Wolf predation has reduced their num bers. Fewer coyote attacks may be a factor in the resurgence of the park's pronghorn.

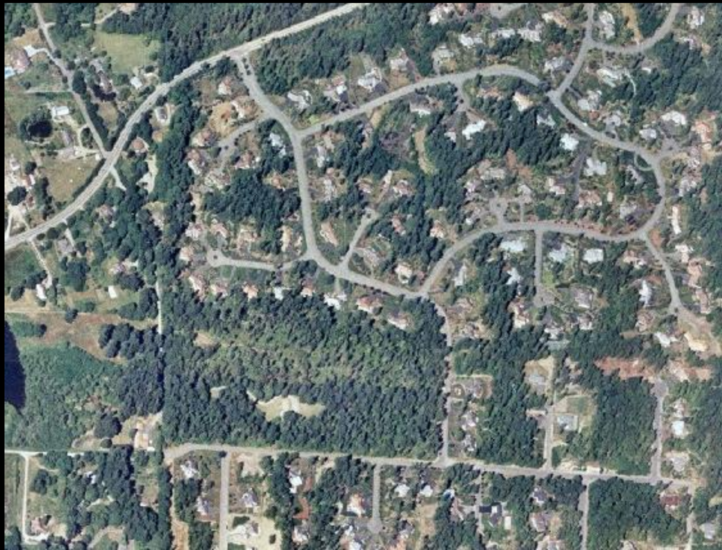
WILLOWS, cottonwoods, and other riparian vegetation have begun to sta bilize stream banks, helping restore natural water flow. Overhanging branches again shade the water and welcome birds.

BEAVER colonies in north Yellowstone have risen from one to 12, now that some stream banks are lush with vegetation, especially willows (a key beaver food). Beaver dams create ponds and marshes, supporting fish, amphiians, birds, small mammals, and a rich insect population to feed them.

CARRION Wolves don't cover their kill, so they've boosted the food supply for scavengers, notably bald and golden eagles, coyotes, ravens, magpies, and bears.



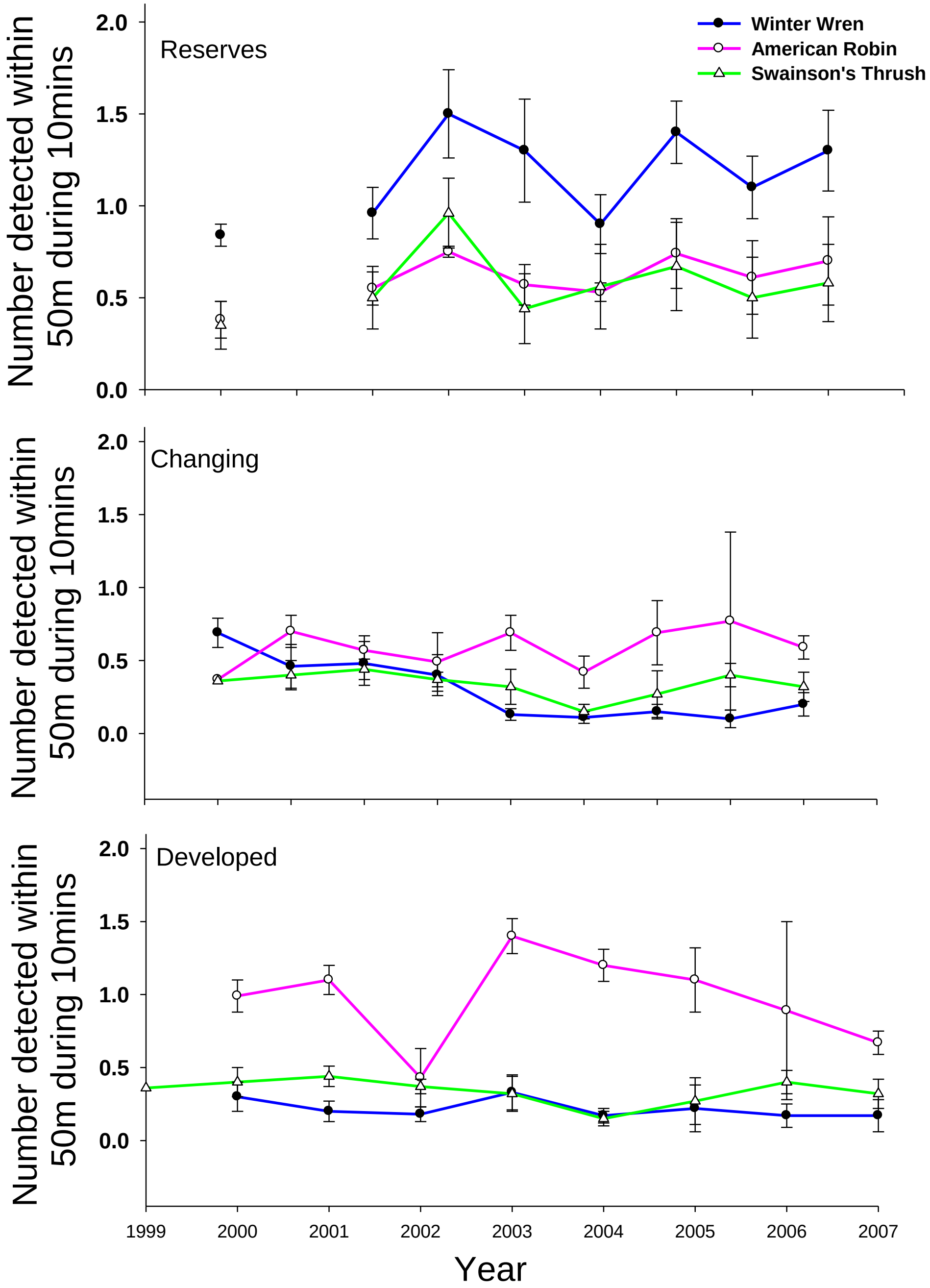

How do population dynamics and community make-up change in different urban landscapes?

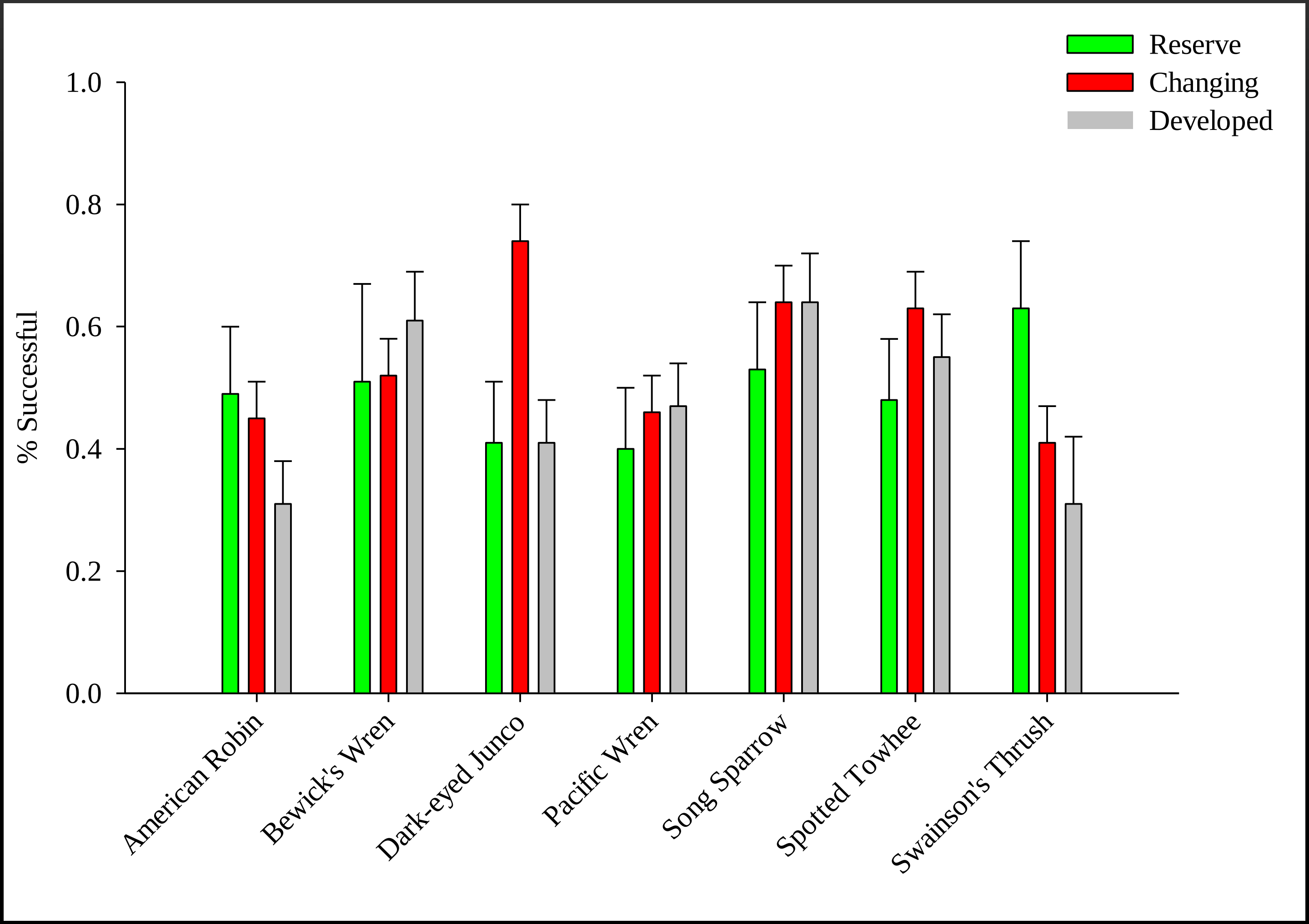



Are changes in avian community patterns associated with urban development explained by population ecology?

- Point count survey data from 8 locations within a 1km^2 landscape

- Turnover in dominant species as you go from forested to developed landscapes.



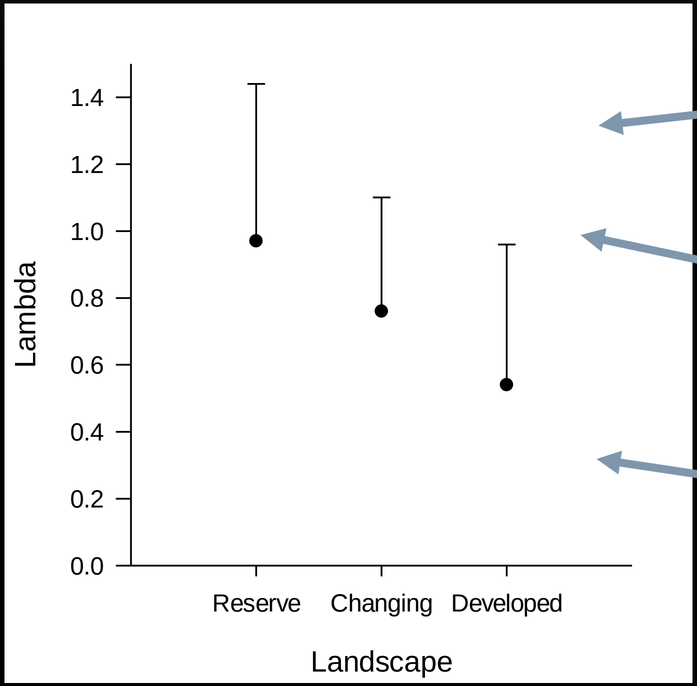


Breeding success varied by species and landscape ($F_{12,167} = 1.785$, $p = 0.05$)

Estimating survival in different landscapes:

- Yearly encounter histories based on recapture and resighting of colorbanded individuals.
- Used Cormack-Jolly-Seber model in Program MARK and RMARK. Best model based on AICc included: species, landscape, and age (juvenile and adult).

Adult survival, juvenile survival, and fecundity are the parameters needed to estimate λ, the intrinsic population growth rate, for each species in these three landscapes.



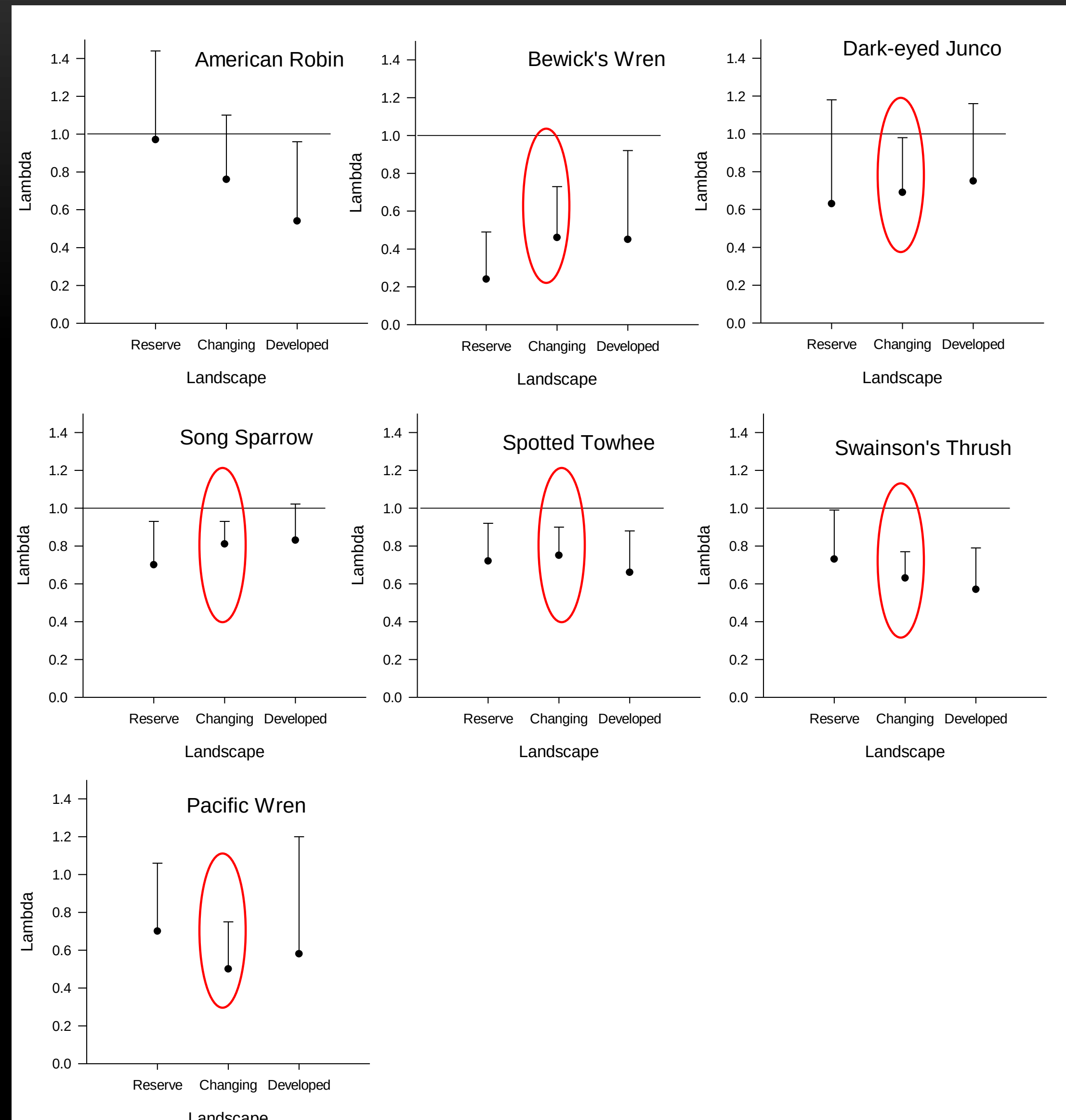
Source/ growing populations

Stable population

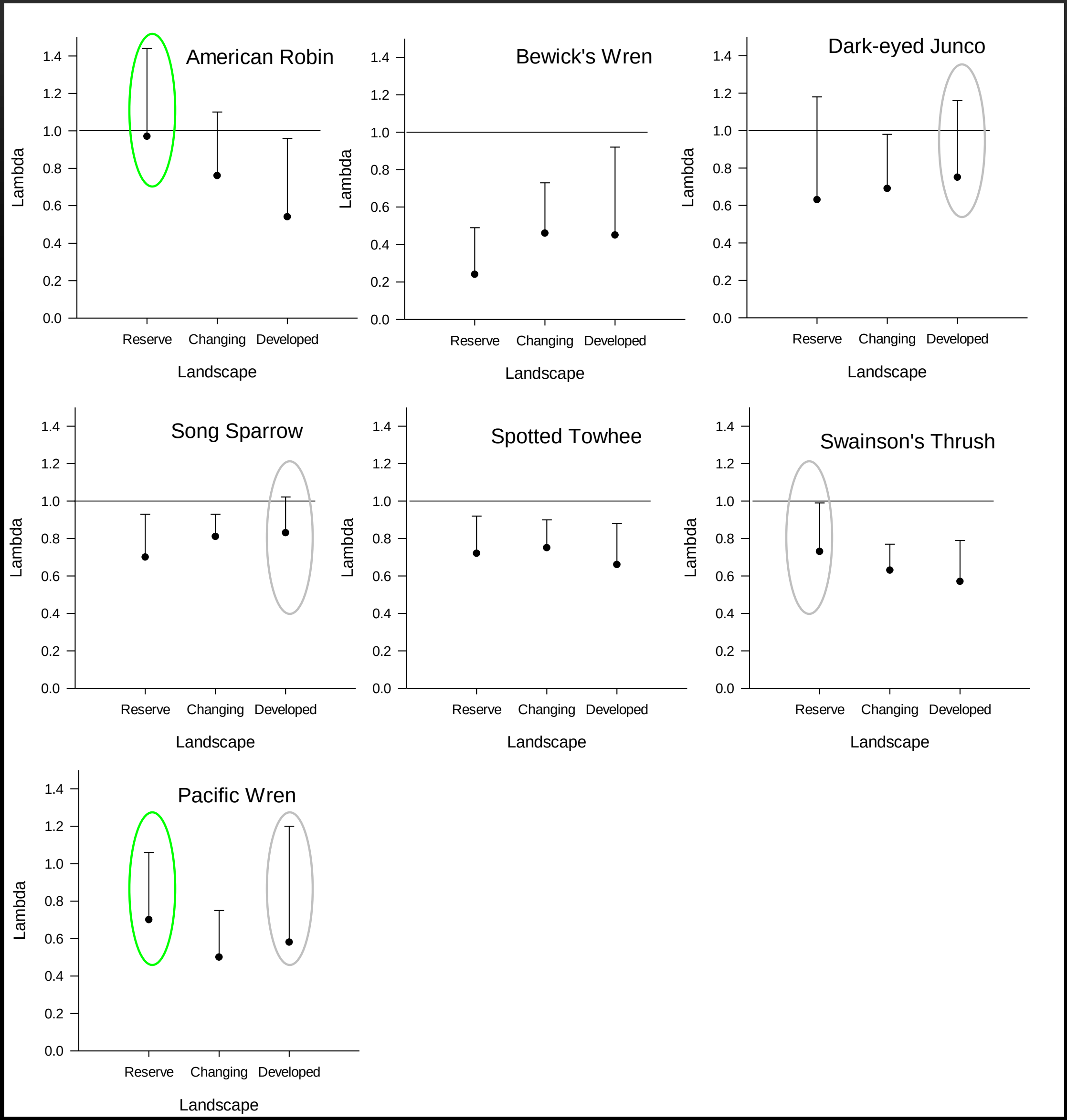
Sink / declining

Are different species stable, growing, or declining during different development stages (landscapes)?

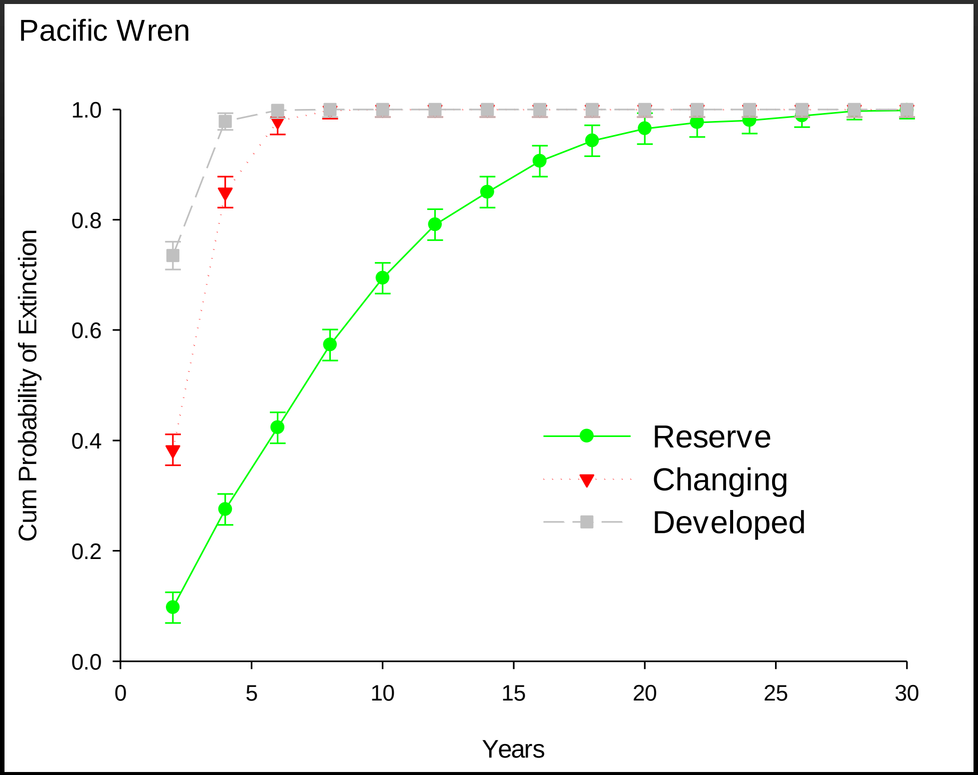
6 of 7 species unstable in changing landscapes



Some species appear stable in Developed and Reserve landscapes, but species differ.



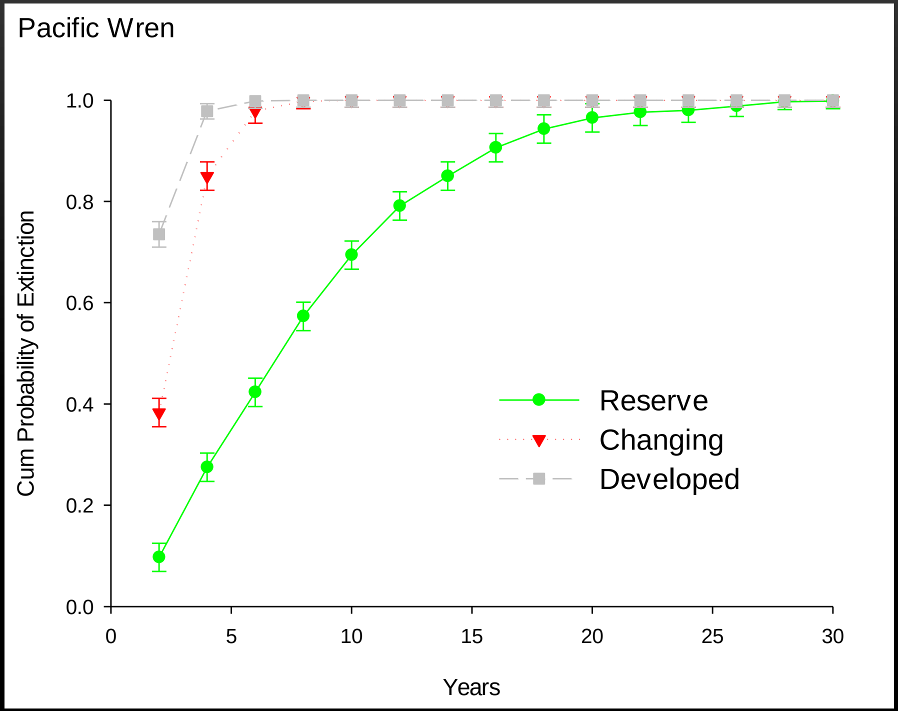
Population size and variation in demographic parameters can influence population persistence



Modeled persistence of species/landscape using RAMAS GIS.

- Starting population sizes extrapolated to #/km2 from point count surveys
- Ran 1000 iterations of model for 100 yrs each.
- Stochasticity of population parameters included

Population size and variation in demographic parameters can influence population persistence



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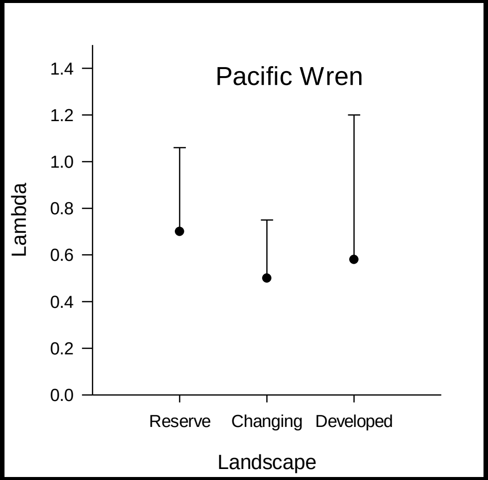

How do these projections match up with what we see out there?

- Pacific Wren numbers high and ‘stable’ in reserves, low and/or declining elsewhere
- Robin numbers ‘stable’ but low in reserves, highest in developed residential areas
- Are developed landscapes ecological traps for Robins?
  - Numbers highest
  - Growth rate and persistence are low