

**Cerulean Warbler population  
projections based on Breeding  
Bird Survey data**

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**Count Data**

- Breeding Bird Survey provides annual estimates of an index of relative abundance
- Yields **index** of total National population size and population sizes within Bird Conservation Region polygons (as well as states & state x BCR polygons)

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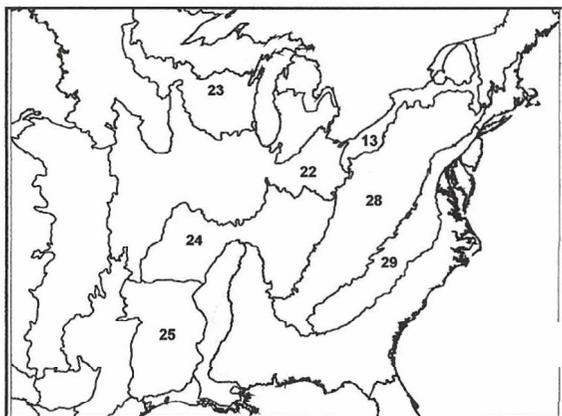
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### BBS Indices

- Indices of relative abundance in a time series  
⇒ reconstructing t.s. of population sizes
- Assumption: changes in index reflect changes in population

YEAR	ESTIMATE of RELATIVE ABUNDANCE
1966	0.850
1967	0.761
1968	0.825
1969	0.799
1970	0.829
1971	0.755
1972	0.729
1973	0.687
1974	0.625
1975	0.588
1976	0.658
⋮	
1995	0.348
1996	0.367
1997	0.336
1998	0.280
1999	0.261
2000	0.257
2001	0.253
2002	0.255
2003	0.281
2004	0.260
2005	0.243

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### Rosenberg and Blancher population estimate

- North American Landbird Conservation Plan provides population size estimates for 448 landbirds

*After adjustment: scaling down to include females*

$$Population = \sum_{i=1}^m \sum_{j=1}^n \frac{Y_{ij}}{n}$$

*Route count averaged over time and space*

*Detectability adjustment: accounting for imperfect detection over distance*

*Time of day adjustment*

560,000 circa 1995

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### Reconstructing Time Series

- Ratio of index in 1995 to index at time t

YEAR	ESTIMATE of RELATIVE ABUNDANCE	TOTAL POPULATION SIZE (Rosenberg and Blancher)	Adjustment Factor
1966	0.850	1365935.6	2.439
1967	0.761	1223536.7	2.185
1968	0.825	1225883.0	2.368
1969	0.799	1283967.3	2.293
1970	0.829	1331935.5	2.378
1971	0.755	1219942.9	2.166
1972	0.729	1172557.9	2.094
1973	0.687	1103628.5	1.971
1974	0.625	1004833.6	1.794
1975	0.588	944715.5	1.687
1976	0.658	1058190.6	1.890
⋮			
1995	0.348	560000.0	1.000
1996	0.367	590341.3	1.054
1997	0.336	540719.0	0.964
1998	0.290	466786.7	0.834
1999	0.261	419557.9	0.749
2000	0.257	412438.0	0.736
2001	0.253	408489.6	0.728
2002	0.255	409745.3	0.732
2003	0.281	451212.6	0.806
2004	0.260	417685.1	0.746
2005	0.243	390954.4	0.698

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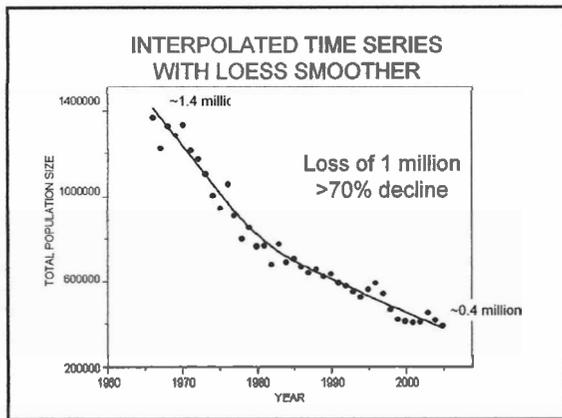
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### Count-based PVA

- Projecting pop. size based upon trend and variability in trend
- Trend: Mean pop.  $\uparrow$  or  $\downarrow$  depending upon stochastic realization of pop. growth process
- Variability: Strictly increases as prediction becomes less certain with time

Figure 2.3 Several stochastic realizations of the log population size over time, illustrating increasing variability over time.

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### Count-based PVA: $\mu$

- Trend: Stochastic population growth rate on a logistic scale =  $\mu$  = mean of the  $\log\lambda$ s

$$\mu = \log\lambda_G \approx (\log\lambda_t + \log\lambda_{t-1} + \dots + \log\lambda_1 + \log\lambda_0) / t$$

- $\mu > 0$  (and  $\lambda > 1$ ), pop. *generally*  $\uparrow$
- $\mu < 0$  (and  $\lambda < 1$ ), pop. *generally*  $\downarrow$

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**Count-based PVA:  $\sigma^2$**

- Even if the population is currently decreasing, there is often a non-negligible probability of an increase

Figure 2.3 Stochasticity effects on the long-term distribution of the population (A) Population distribution

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**Projecting Populations to Determine Extinction Risk**

- If we know  $\mu$  and  $\sigma^2$  then we can calculate probability of (quasi-)extinction
- Diffusion Approximation approach
  - Elizabeth Holmes, NOAA/NMFS
  - Attempt to model observation error
- Calculated **Probability of a 90% decline within a Century from the 40-yr time series (1966-2005) of reconstructed continental population size**

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**Sensitivity Analysis**

- Assess effects of space, **time interval** and initial population size estimate on probability of a 90% decline within the next century

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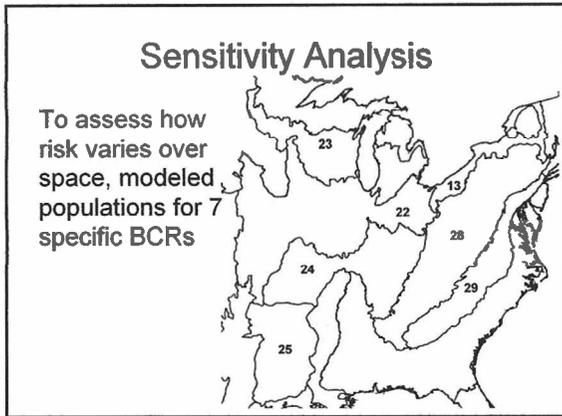
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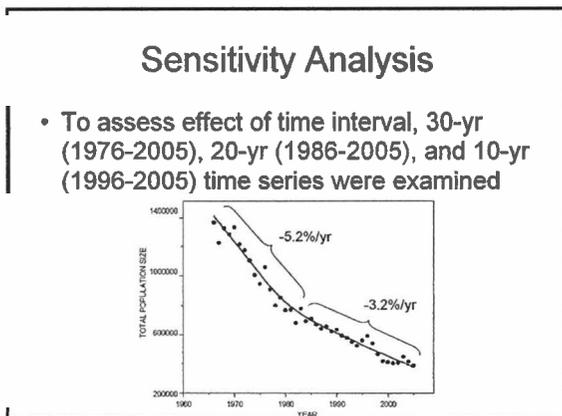
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### Sensitivity Analysis

- Rosenberg & Blancher in the North American Landbird Conservation Plan suggested that their estimate of population size was **Moderately** Accurate and **Highly** Precise
- This translates to an estimate with  $\pm 50\%$  precision
- 960,000 (480,000, 1,440,000)

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### Results

- Growth rate **negative** for entire population and for subpopulations defined by BCR

Region	$\lambda$ (%/yr)
BCR29	0.990 (-1.0)
BCR28	0.970 (-3.0)
BCR25	0.831 (-16.9)
BCR24	0.968 (-3.3)
BCR23	0.957 (-4.4)
BCR22	0.934 (-6.6)
BCR13	0.979 (-2.1)
Survey-wide	0.969 (-3.1)

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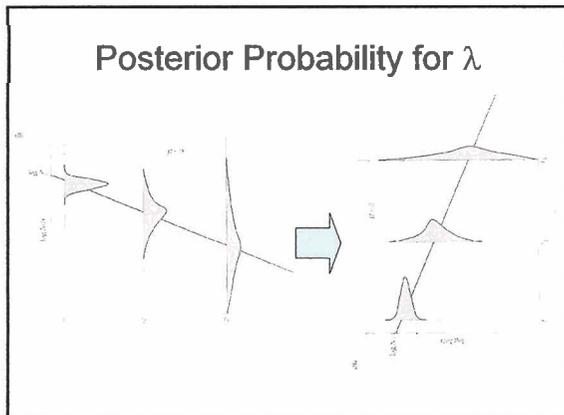
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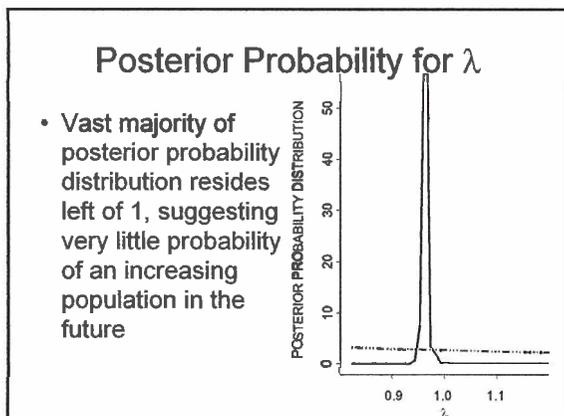
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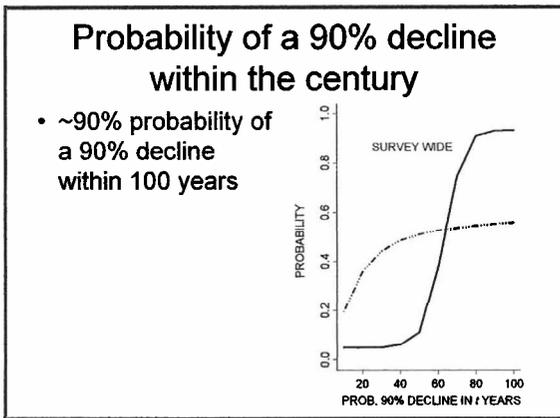
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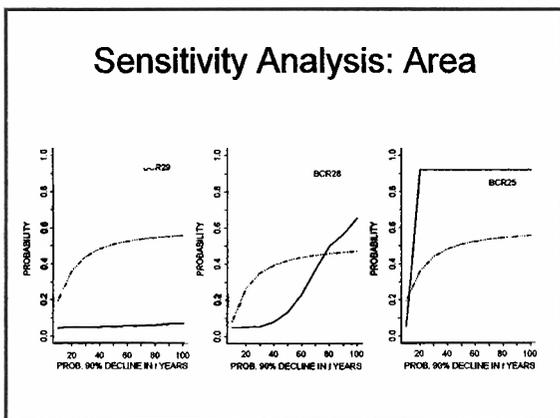
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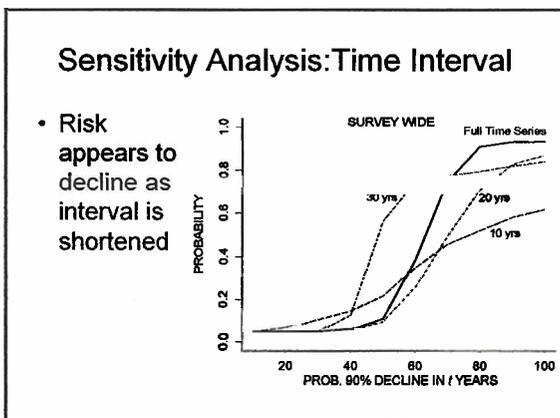
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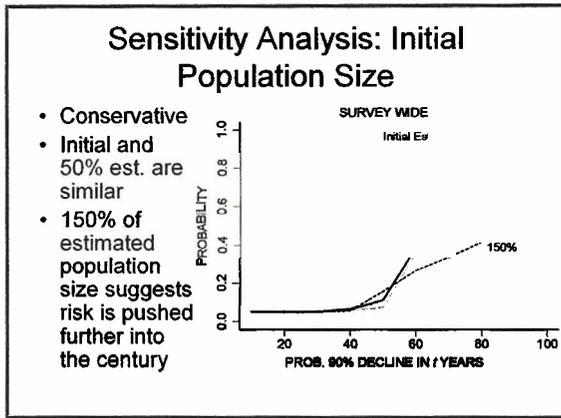
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