# Riparian bird survey

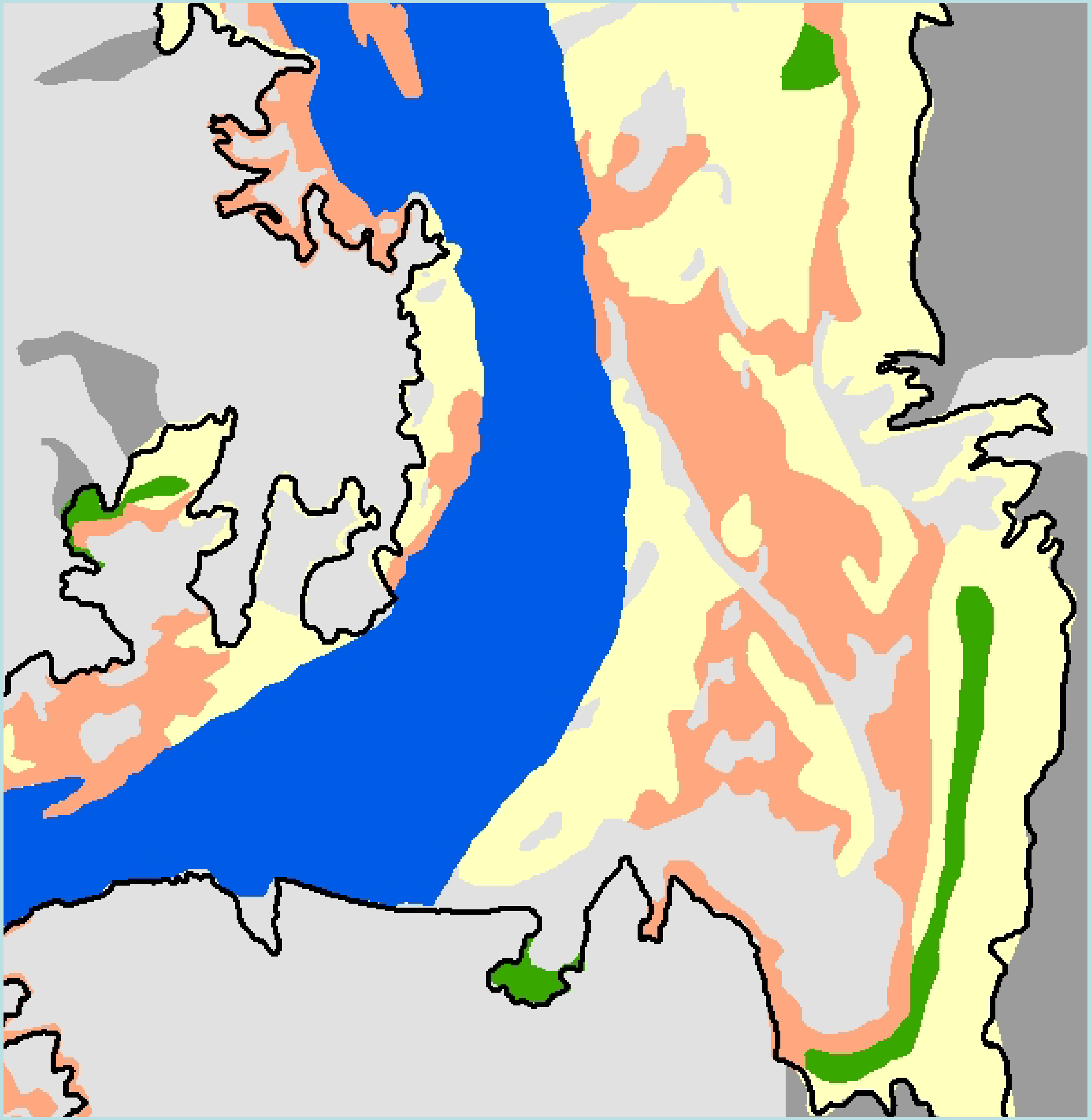

Sampling plan

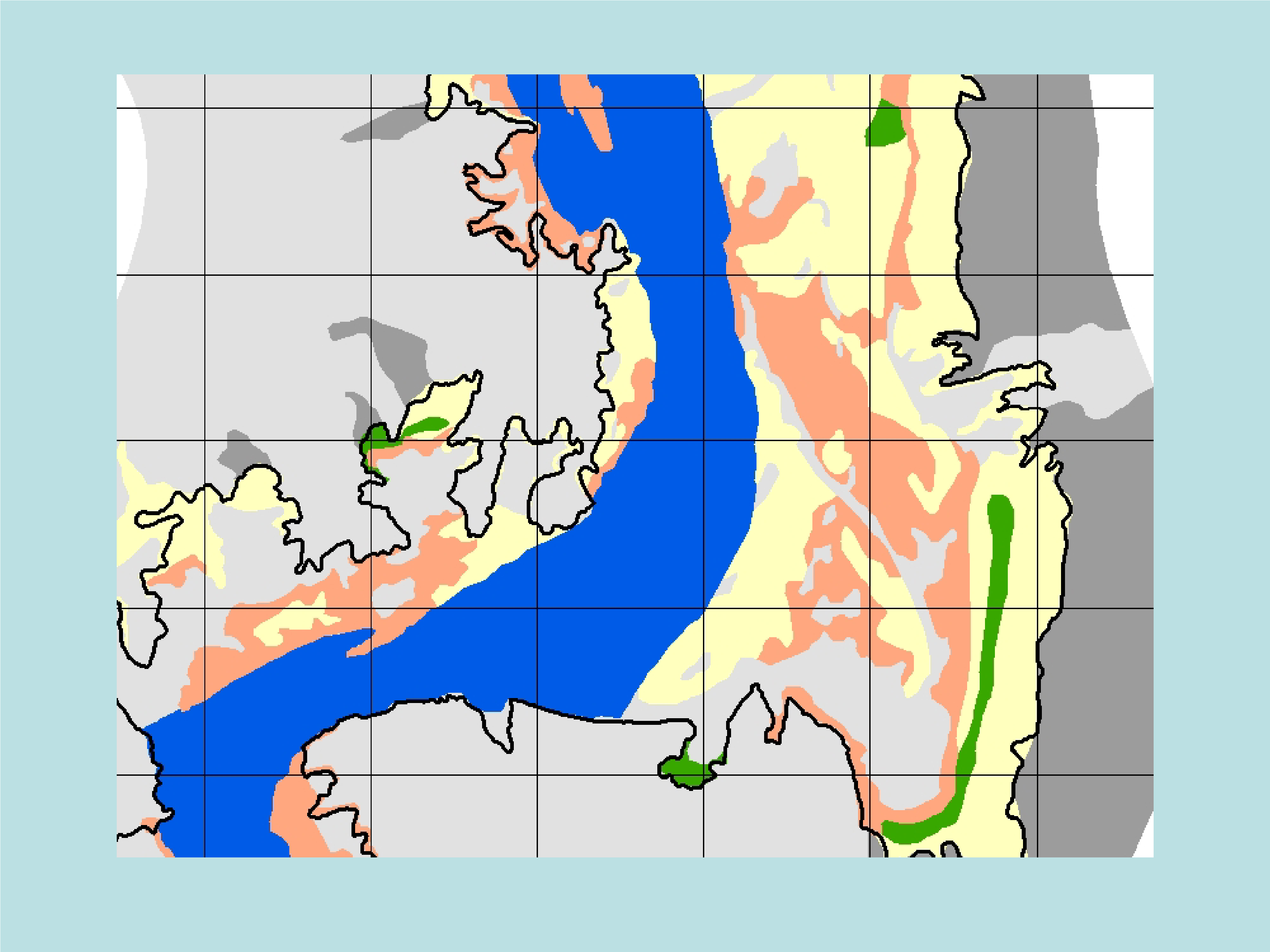
Estimation methods

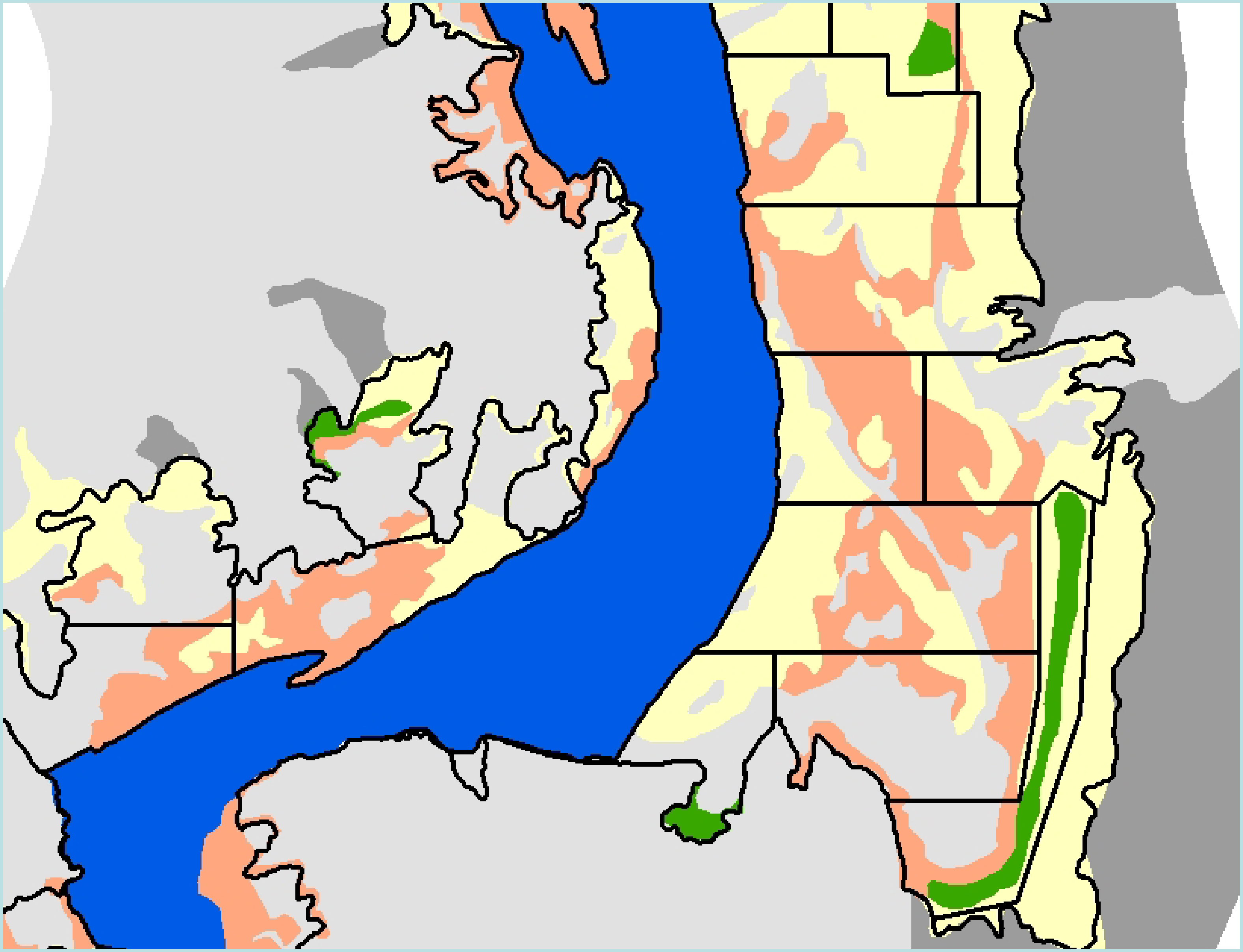
Power analysis

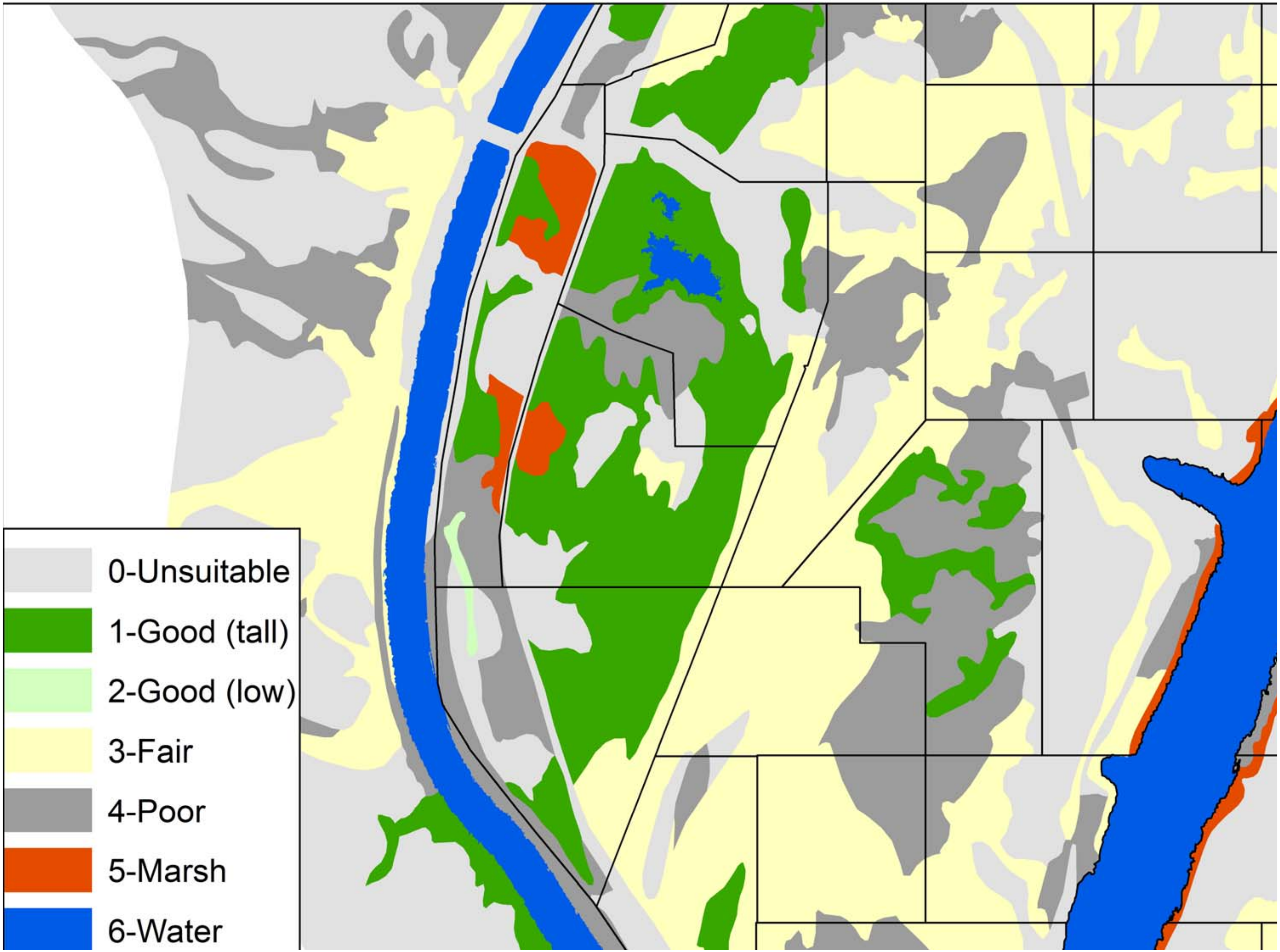
# Introduction

- No chance of selecting points randomly
- Area searches seemed the only feasible survey method
- Intensive searches of a sub-sample of plots to obtain detection ratios
- Therefore needed to partition the study area into plots

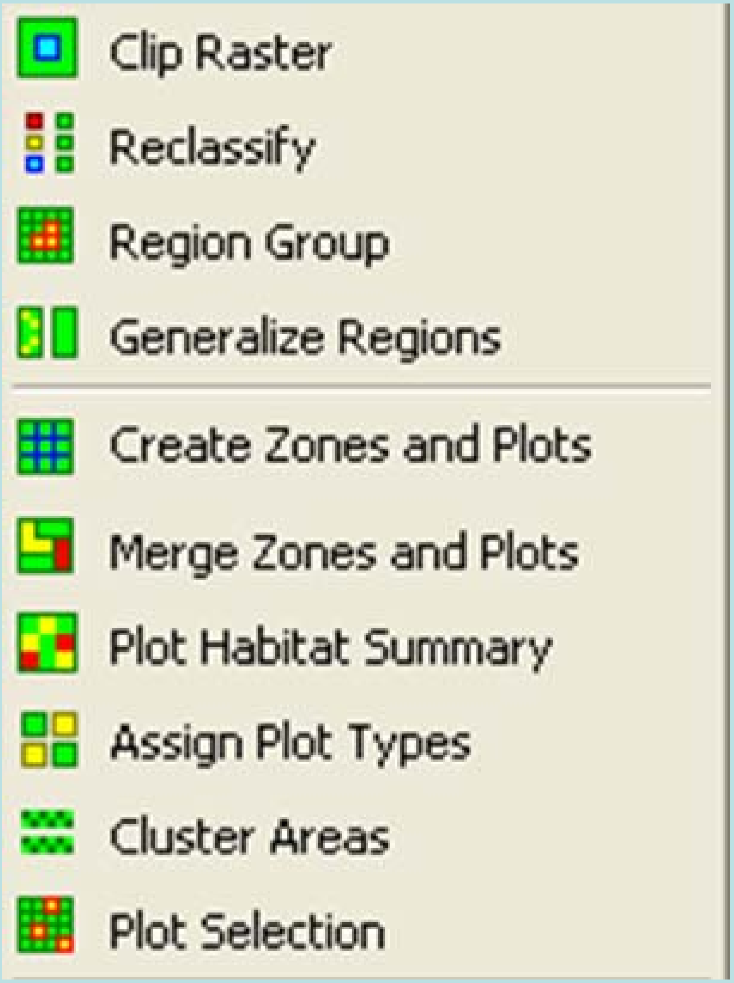







0-Unsuitable
1-Good (tall)
2-Good (low)
3-Fair
4-Poor
5-Marsh
6-Water

## PRISM: Program for Regional and International Shorebird Monitoring



# Wanted to use stratified sampling

- Concentrate surveys in good habitat or areas of high interest
- Obtain estimates for single strata and domains
- Improve area-wide estimates
- Decided to stratify by habitat and region (ie, strata would be groups of plots in the same habitat and region)
- Thus each plot had to be assigned to a single habitat

# Assignment of plots to habitats

- Software set up to vary vegetation definitions and rules for assigning plots to habitats
- Used surveys for years 1-2 to evaluate different schemes

# Final vegetation types

| Vegetation type | Vegetation codes |
|---|---|
| Tall Woody (TW) | CW 1-3 |
| Low Woody (LW) | CR, CW 4-6. HM 3-6, SC 1-6, SH 1-6, SM 3-6 |
| Herbaceous (H) | AG, ATX, MA 1-7 |
| Unvegetated (U) | BW, NC, UD |

# Final rule for habitats

Determined coverage of each plot by each vegetation type.  Then,

If Tall Woody >0.05 then Tall Woody habitat

If Tall Woody + Low Woody > 0.5 then Low Woody habitat

If Herbaceous > 0.3 then Herbaceous habitat

If Unvegetated > 0.3 then Unvegetated habitat

Otherwise, most common type determined habitat

| | Surveyed plots | | | All plots | | | |
|---|---|---|---|---|---|---|---|
| Habitat | Birds | Plots | Bds/ plot | N plots | P(plots) | Est'd birds | P(birds) |
| Tall Woody | 549 | 73 | 7.5 | 264 | 0.03 | 1980 | 0.08 |
| Low Woody | 249 | 70 | 3.6 | 4565 | 0.52 | 16434 | 0.69 |
| Herbaceous | 104 | 58 | 1.8 | 2831 | 0.32 | 5096 | 0.21 |
| Unvegetated | 13 | 36 | 0.4 | 1106 | 0.13 | 442 | 0.02 |
| Totals | 915 | 237 | | 8766 | | 23952 | |

| Region | TW | LW | H | U | Total |
|---|---|---|---|---|---|
| 1 | 61 | 244 | 30 | 75 | 410 |
| 2 | | 183 | 44 | | 227 |
| 3 | | 625 | 93 | 570 | 1288 |
| 5 | | 586 | 274 | 184 | 1044 |
| 6 | 29 | 271 | 126 | | 426 |
| 7 | 41 | 275 | 178 | 162 | 656 |
| 8 | | 224 | 385 | 52 | 661 |
| 9 | 9 | 938 | 874 | 31 | 1852 |
| 10 | | 569 | 200 | | 769 |
| 11 | 18 | 279 | 143 | 14 | 454 |
| 12 | 53 | 229 | 315 | | 597 |
| 13 | 53 | 142 | 169 | 18 | 382 |
| Total | 264 | 4565 | 2831 | 1106 | 8766 |

# Estimation methods

Density $$d = \frac{\hat{\bar{\bar{X}}}}{\hat{R}}$$

$$\hat{V}(d) = d^2\left(\frac{\hat{V}(\hat{\bar{\bar{X}}})}{\hat{\bar{\bar{X}}}^2} + \frac{\hat{V}(\hat{R})}{\hat{R}^2} - \frac{2C\hat{o}v(\hat{\bar{\bar{X}}},\hat{R})}{\hat{\bar{\bar{X}}}\hat{R}}\right)$$

# Numerator

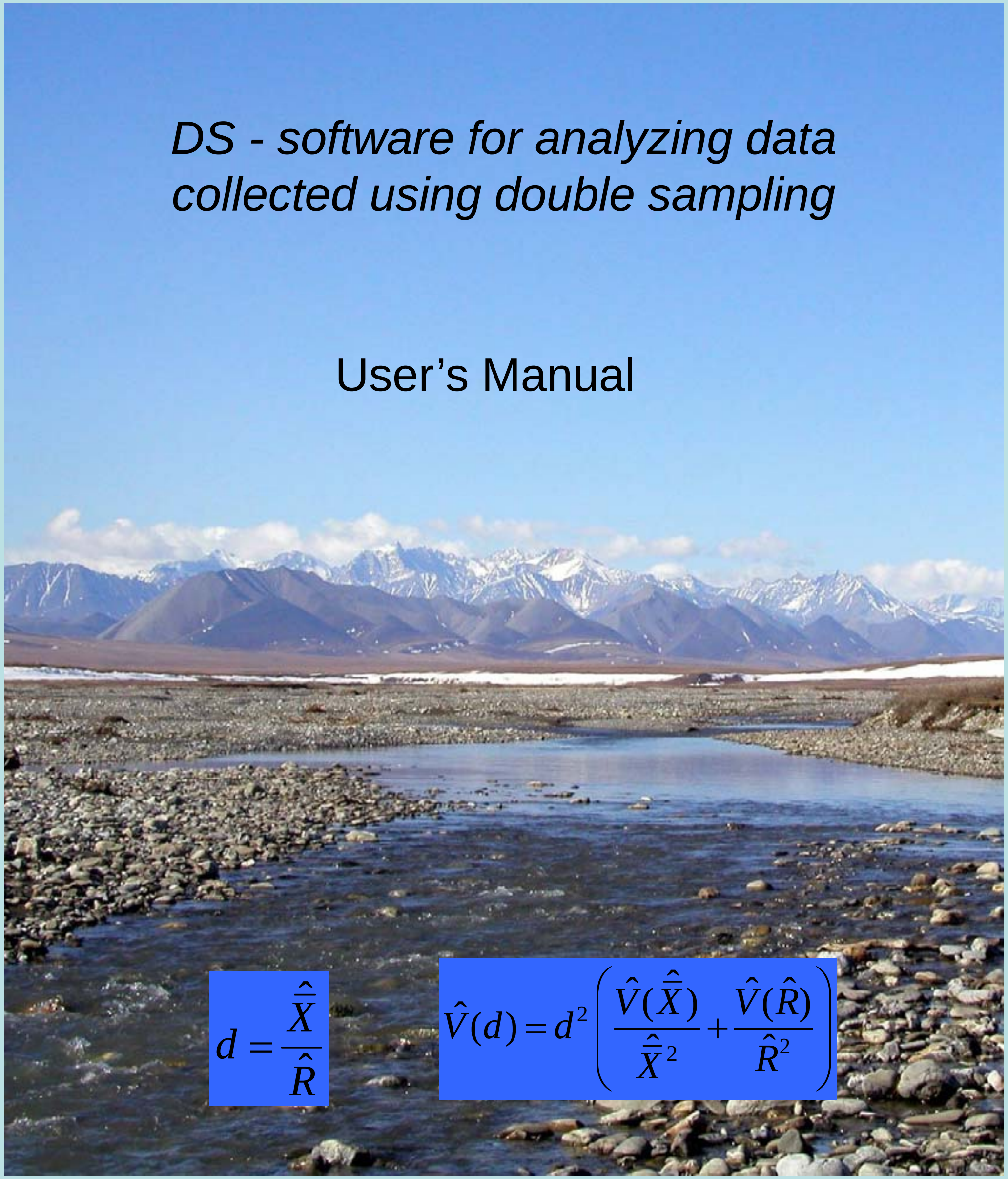
$$\hat{\bar{X}} = \frac{\hat{X}}{a} = \frac{\sum_u^U \sum_h^H N_{uh} \left( \sum_i^{n_h} x_{uhi} / n_{uh} \right)}{\sum_u^U \sum_h^H N_{uh} \left( \sum_i^{n_h} a_{uhi} / n_{uh} \right)} = \frac{\sum_u^U \sum_h^H N_{uh} \bar{x}_{uh}}{\sum_u^U \sum_h^H N_{uh} \bar{a}_{uh}}$$

$$\hat{V}(\hat{\bar{X}}) = \left( \frac{\hat{X}}{a} \right)^2 \left( \frac{\hat{V}\left(\hat{X}\right)}{\hat{X}^2} + \frac{\hat{V}(a)}{a^2} - \frac{2C\hat{o}v(\hat{X}, a)}{\hat{X}a} \right)$$

# Denominator

$$\hat{R} = \frac{\overline{x}}{\overline{y}}$$

$$\hat{V}(\hat{R}) = \hat{R}^2 \left( \frac{\hat{V}(\overline{x})}{\overline{x}^2} + \frac{\hat{V}(\overline{y})}{\overline{y}^2} - \frac{2C\hat{o}v(\overline{x}, \overline{y})}{\overline{xy}} \right)$$



# *DS - software for analyzing data collected using double sampling*

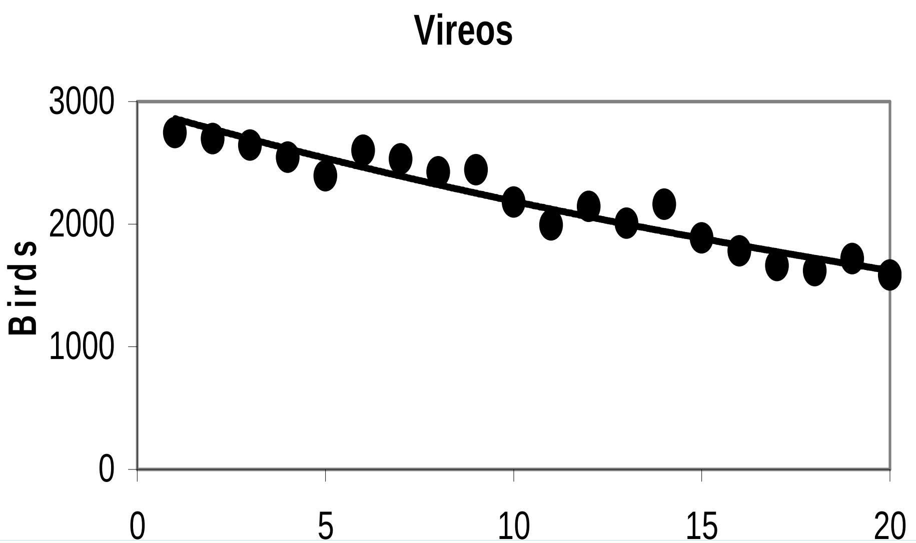
## User's Manual

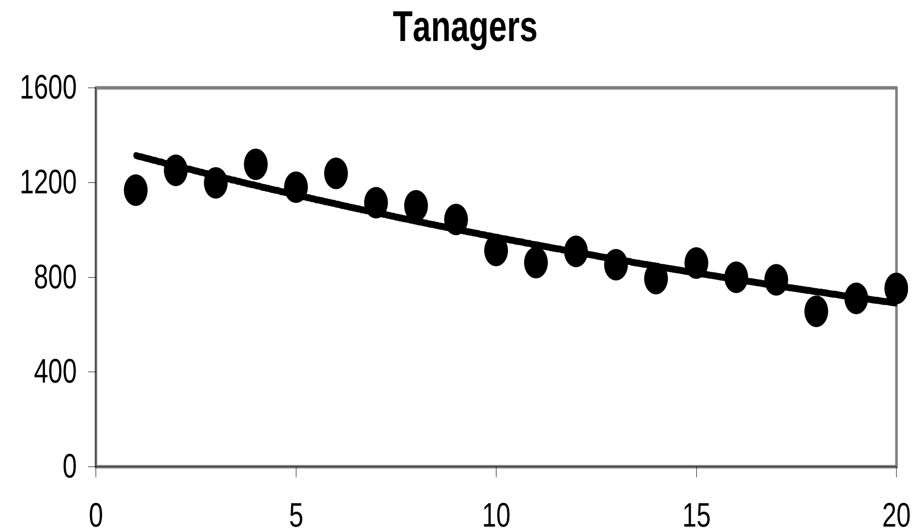
$$d = \frac{\hat{\bar{X}}}{\hat{R}}$$

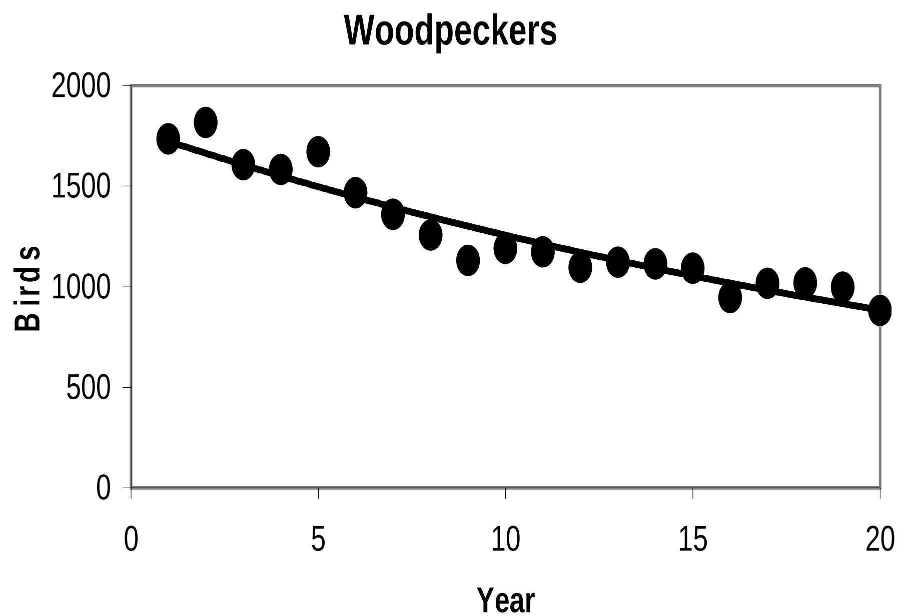
$$\hat{V}(d) = d^2 \left( \frac{\hat{V}(\hat{\bar{X}})}{\hat{\bar{X}}^2} + \frac{\hat{V}(\hat{R})}{\hat{R}^2} \right)$$

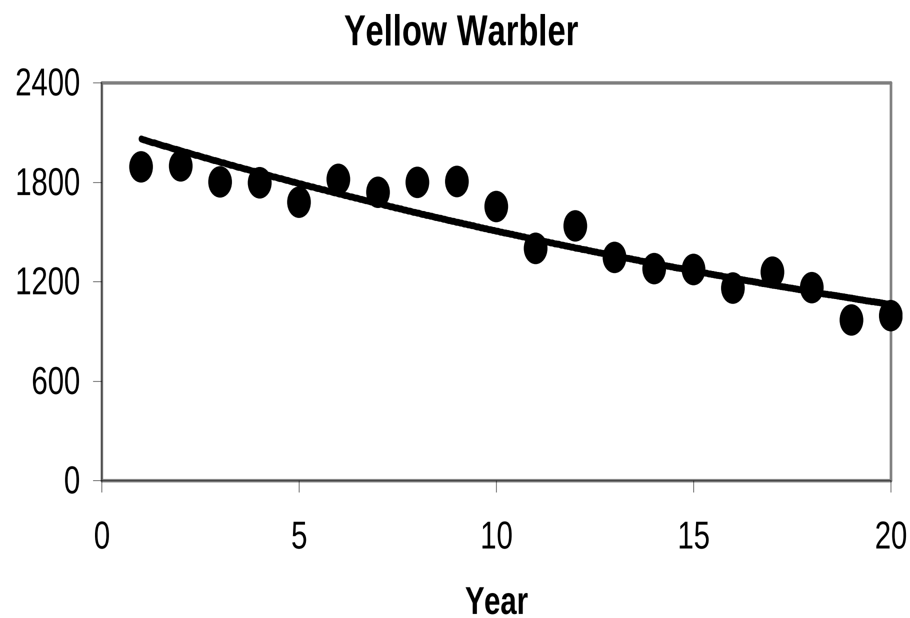
# Power analysis

- Probability of “detecting” a 50% decline during 20 years
- Different sampling plans and sample sizes
- Power depends critically on spatial variation in the trend within and between strata
- Very difficult to simulate reliably; real data needed


Vireos
Birds
3000
2000
1000
0
0
5
10
15
20


Tanagers
1600
1200
800
400
0
0
5
10
15
20


Woodpeckers
Birds
2000
1500
1000
500
0
0
5
10
15
20
Year


Yellow Warbler
2400
1800
1200
600
0
0
5
10
15
20
Year

# Variance for the trend estimator

- Bootstrap
- Well-recognized
- Permits great flexibility in sampling plan
  - Sample sizes
  - Field methods
  - Stratum definitions

# Lack of bias in the parameter estimates

| | GIWO | | BEVI | | YWAR | | SUTA | |
|---|---|---|---|---|---|---|---|---|
| | Estimate | Actual | Estimate | Actual | Estimate | Actual | Estimate | Actual |
| Pop size | 12103 | 12138 | 19497 | 19510 | 13509 | 13511 | 4050 | 4009 |
| Trend | 0.967 | 0.968 | 0.966 | 0.966 | 0.952 | 0.951 | 0.964 | 0.964 |
| V(trend | 0.00014 | 0.00014 | 0.00008 | 0.00009 | 0.00015 | 0.00015 | 0.00022 | 0.00022 |

| Sampling Plan (n=80) | GIWO | BEVI | YWAR | SUTA |
| --- | --- | --- | --- | --- |
| 1. Panel design | 0.80 | 0.97 | 0.97 | 0.67 |
| 2. New plots, every year | 0.97 | 0.99 | 1.00 | 0.61 |
| 3. Same plots, every year | 0.66 | 0.87 | 0.91 | 0.59 |
| 4. New plots, every other year | 0.68 | 0.73 | 0.80 | 0.51 |
| 5. Same plots, every other year | 0.45 | 0.70 | 0.77 | 0.64 |
| N recorded on LCR surveys | 358 | 169 | 324 | 64 |

# Power in relation to sample size

| Sample size | GIWO | BEVI | YWAR | SUTA |
|---|---|---|---|---|
| 40 | 0.74 | 0.89 | 0.89 | 0.24 |
| 60 | 0.89 | 0.97 | 0.98 | 0.49 |
| 80 | 0.97 | 0.99 | 1.00 | 0.61 |
| 100 | 0.99 | 1.00 | 1.00 | 0.74 |
| 120 | 1.00 | 1.00 | 1.00 | 0.85 |

# Conclusions

- Rigorous sampling frame established
  - Covers entire study area
  - Best habitat in fewest number of plots
- Plots assigned to strata
- Estimation methods well-developed
- Optimal sampling plan identified
- High power demonstrated
- (Sampling plan for restoration plots)