Handling Missing Data in Environmental Surveys

Ruben A. Smith

Virginia M. Lesser

Department of Statistics
Oregon State University

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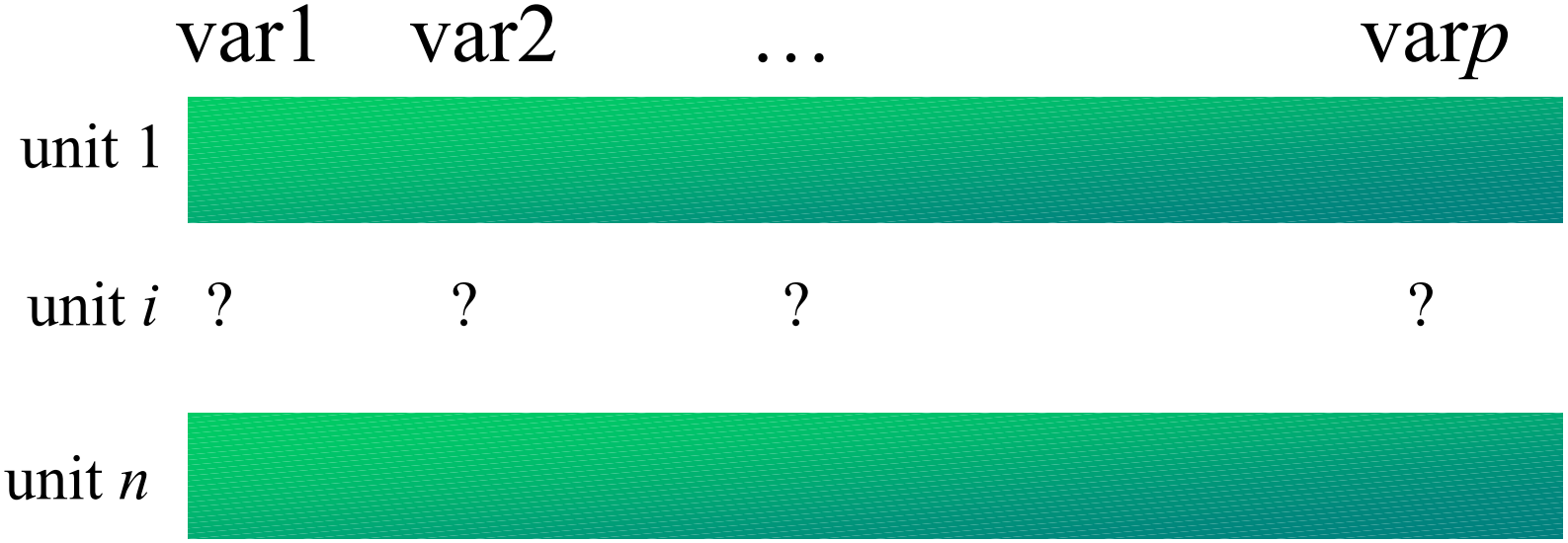
Outline

- Missing data problem in environmental surveys.
- Methods for handling missing data.
- Illustration of missing data in environmental surveys.
- Future Activities.

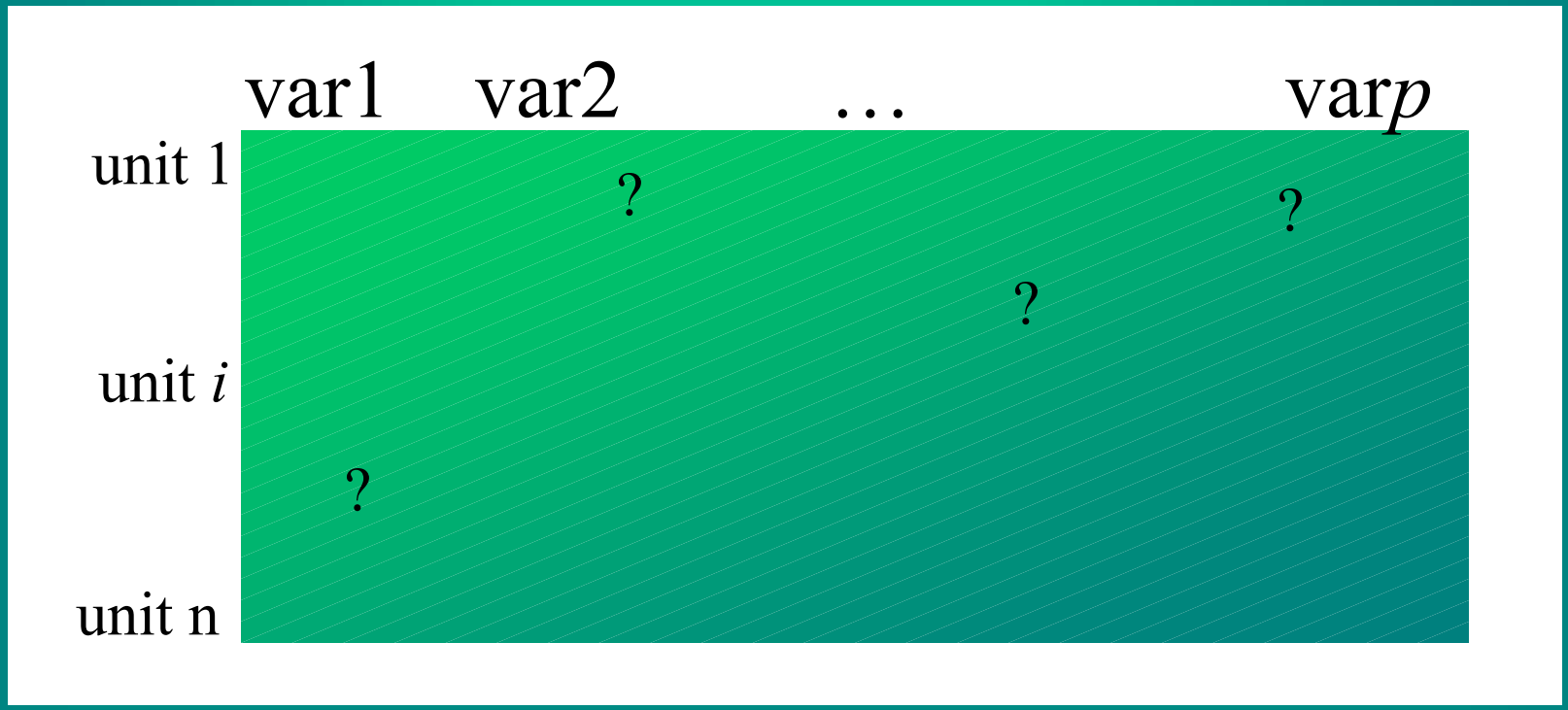
Types of Missing Data

- Missing data ≡ Nonresponse
- Unit nonresponse



Types of Missing Data

- Item nonresponse



Missing Data

- In environmental surveys missing data may occur for different reasons.
- Unit nonresponse:
  - Inaccessibility of the site
  - Access denial
- Item or unit nonresponse
  - Data is lost or damaged
  - Failure of the measuring instruments
  - Addition of new sites to existing monitoring program

Mechanisms for Nonresponse

- Missing Completely at Random **(MCAR)**
  - Expect respondents and nonrespondents to be similar.
- Missing at Random **(MAR)**
  - Given covariates a model can be used to account for the nonresponse.
- Not Missing at Random **(NMAR)**
  - Complicated. The probability of being a nonrespondent depends on the unobserved response. Given covariates a model cannot completely adjust for the nonresponse.

Nonresponse Bias

- Combination:
  - Nonresponse rate, λ
  - Difference between respondents-nonrespondents

$$\text{Bias} \approx \lambda(\bar{Y}_{\text{resp}} - \bar{Y}_{\text{nonresp}})$$

- Adjustment procedures to reduce nonresponse bias.

Adjustment for Unit Nonresponse

- Weighting Methods

The weight for a respondent: $\frac{1}{\pi_i \phi_i}$

π_i Inclusion probability

ϕ_i Probability of response

Weighting Methods for Unit Nonresponse

Weighting class adjustment:

- ϕ_i is estimated by dividing the sample into classes using auxiliary variables, which are known for all units in the selected sample.

- Assumption: within each class the units have the same response probability.

Weighting Methods for Unit Nonresponse

Poststratification:

- ϕ_i is estimated by dividing the population into classes (poststratum) using auxiliary variables (known only for respondents), and population counts.

- Assumption: within each class, the population elements have the same response probability.

Other Adjustment Procedures for Unit Nonresponse

- Model-based methods
  - A model is proposed for the complete data, accounting for the nonresponse mechanism.
  - Utility of model-based inferences depends on how closely the assumed model reflects the reality.

Adjustment for Item Nonresponse

- Delete observation
- Imputation methods:
  - Cell mean imputation
  - Hot/cold-deck imputation
  - Regression imputation
  - Multiple imputation
  - Neural networks.

Illustration

- Background:
  Lesser, M. Virginia, (2001), “Applying Survey Research methods to account for denied access to research sites on private property”

  - 1995-1996 EMAP North Dakota prairie wetlands survey.

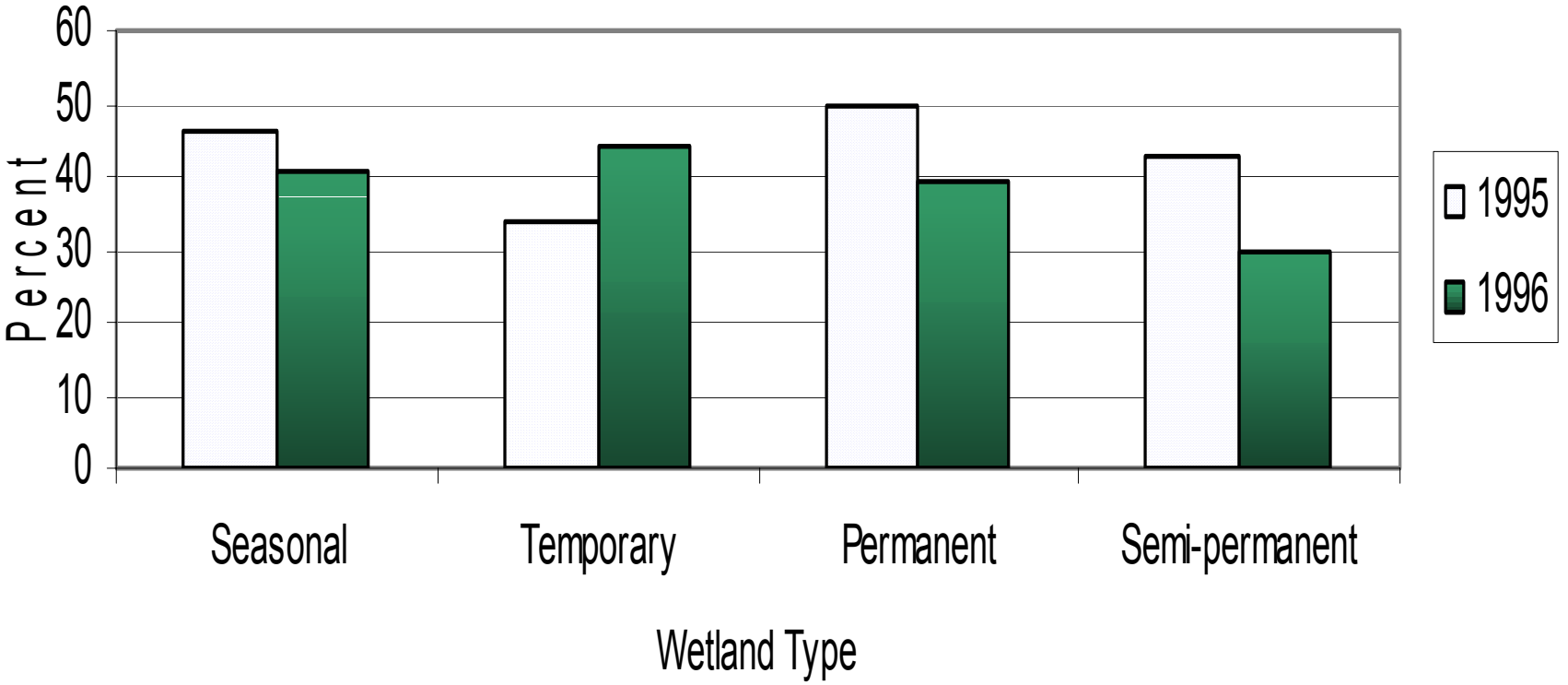
Illustration - Background

- A stratified random sample was selected for each year.
- Objective: Provide estimates of prairie wetland condition and status by wetland class.
- On-site visits were necessary to obtain information on condition indicators.

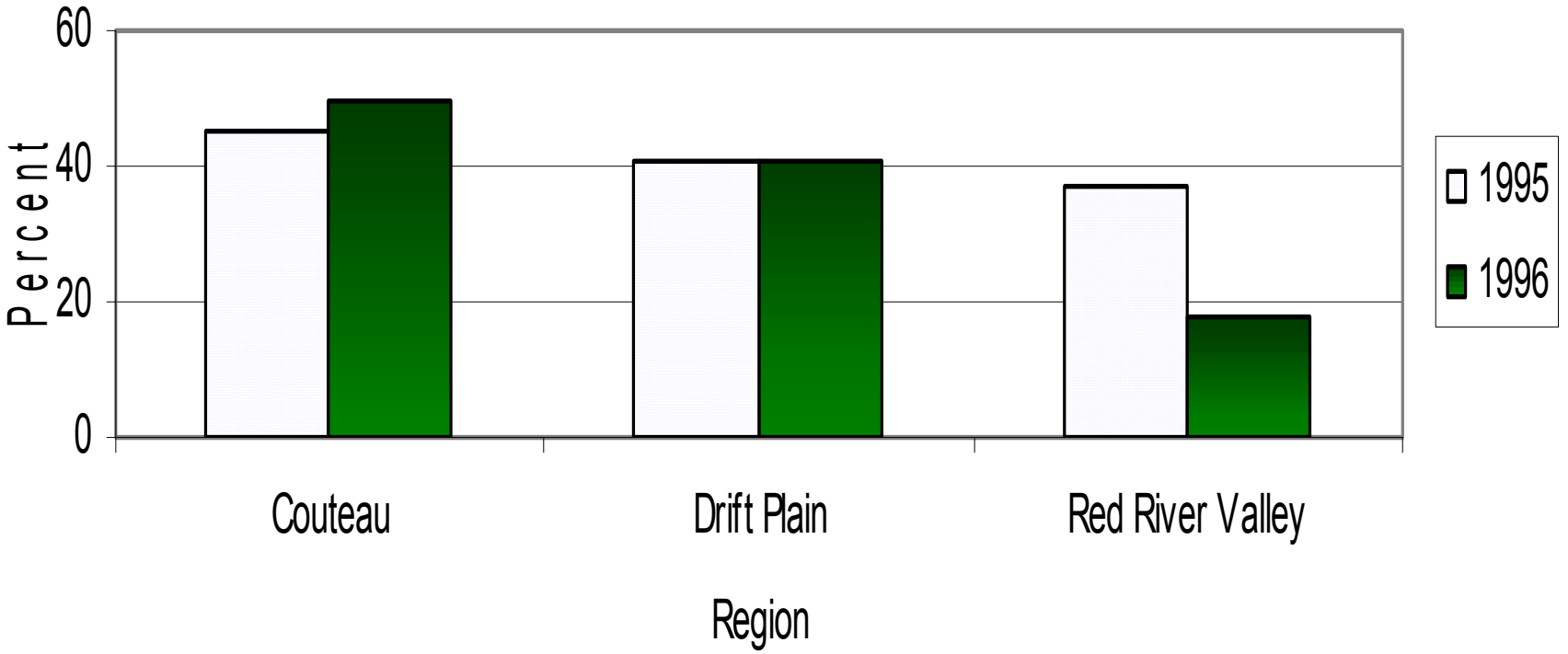
Response Disposition 1995/1996 EMAP North Dakota Prairie Wetlands Studies

Result	1995	1996
Private Landowners		
Agreed to access	43%	40%
Refused access	36%	37%
Undeliverable	2%	2%
Not returned/no contact	16%	14%
Public Land	3%	7%
Total	100%	100%

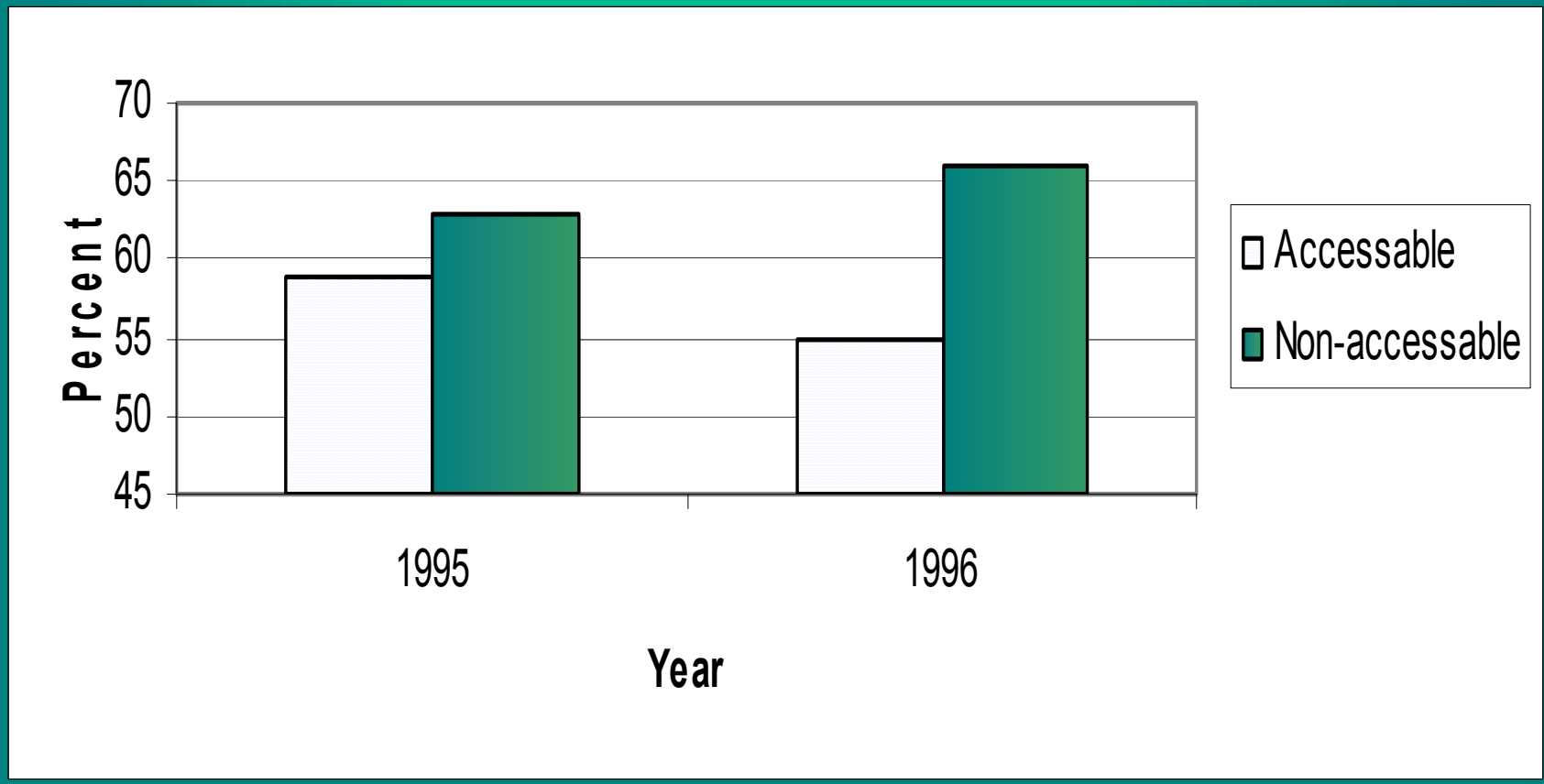
Access Rate for 1995/1996 North Dakota Prairie Wetlands Survey by Wetland Type



Access Rate for 1995/1996 North Dakota Prairie Wetlands Survey by Region



Percent of Cropland Bordering Wetlands for 1995/1996 North Dakota Prairie Wetlands Survey



Future Activities

- Evaluate classical and model based adjustment procedures to account for missing data.
- Consider some spatial interpolation techniques within the context of single and multiple imputation.
- Data from Oregon Department of Fish & Wildlife (ODFW).

Future Activities

- Develop an user-friendly manual to deal with missing data in environmental surveys.