

---

# Contents

---

|                                                                          |           |
|--------------------------------------------------------------------------|-----------|
| <b>Part I History, Concepts, Models, and Goals</b>                       | <b>1</b>  |
| <b>1 Introduction</b>                                                    | <b>3</b>  |
| 1.1 History of the habitat concept                                       | 3         |
| 1.2 Definitions and terminology                                          | 22        |
| 1.3 Conclusion                                                           | 24        |
| <i>References</i>                                                        | 24        |
| <b>2 Ecology and Wildlife Ecology as Distinct Academic Disciplines</b>   | <b>29</b> |
| <i>References</i>                                                        | 37        |
| <b>3 The Primacy of Habitat</b>                                          | <b>39</b> |
| 3.1 Habitat cueing in barnacles and reef fishes                          | 46        |
| 3.2 Models of habitat selection                                          | 50        |
| 3.3 Physical features and structure as habitat cues                      | 53        |
| 3.4 Strength and efficacy of environmental cues                          | 57        |
| 3.5 Scaling of environmental cueing                                      | 58        |
| 3.6 Settling versus sampling of habitat                                  | 59        |
| 3.7 From neon gobies to kangaroo rats: the generality of the DSE process | 61        |
| 3.8 Heuristic predictions                                                | 62        |
| 3.9 Summary                                                              | 65        |
| <i>References</i>                                                        | 66        |
| <b>4 Goals of Characterizing a Species Habitat</b>                       | <b>73</b> |
| 4.1 Habitat management                                                   | 73        |
| 4.2 Carrying capacity and population dynamics                            | 74        |
| 4.3 Species interactions                                                 | 75        |
| 4.4 Habitat preference and selection                                     | 76        |
| 4.5 Species distribution models                                          | 77        |
| 4.6 Conclusion                                                           | 77        |
| <i>References</i>                                                        | 78        |

|                                                                                                |            |
|------------------------------------------------------------------------------------------------|------------|
| <b>PART II Statistical Methods of Analysis</b>                                                 | <b>81</b>  |
| <b>5 Types of Data and the General Framework of Analysis</b>                                   | <b>83</b>  |
| <i>References</i>                                                                              | 87         |
| <b>6 Issues Based on Species Life History and Behavior</b>                                     | <b>89</b>  |
| 6.1 Difference between breeding and foraging habitat                                           | 89         |
| 6.2 Use of different types of habitat during different life stages                             | 90         |
| 6.3 Seasonality of habitat use                                                                 | 91         |
| 6.4 Individual movement and the scale of habitat use                                           | 91         |
| <i>References</i>                                                                              | 92         |
| <b>7 Design and Statistical Issues Related to Habitat Analysis</b>                             | <b>95</b>  |
| 7.1 Area to include in the study                                                               | 95         |
| 7.2 How to handle absence data                                                                 | 96         |
| 7.3 Imperfect detection probability                                                            | 96         |
| 7.4 Presence, absence, and availability                                                        | 97         |
| 7.5 Non-count data indicating habitat use or activity                                          | 98         |
| 7.6 Habitat sampling plots established a posteriori                                            | 99         |
| 7.7 Effect of background density                                                               | 99         |
| 7.8 Normality of the response and predictor variables                                          | 101        |
| 7.9 Multicollinearity among predictor variables                                                | 103        |
| 7.10 Spatial and temporal autocorrelation                                                      | 105        |
| 7.11 Standardization of predictor variables                                                    | 107        |
| 7.12 Number of predictor variables to include in the analysis                                  | 108        |
| 7.13 Home range analysis                                                                       | 109        |
| 7.14 Difference between measuring habitat preference/<br>selection versus habitat associations | 110        |
| <i>References</i>                                                                              | 111        |
| <b>8 Analysis of the Habitat Associations of a Hypothetical Beetle Species</b>                 | <b>117</b> |
| 8.1 Survey design and data collected                                                           | 117        |
| 8.2 Checking for normality of the response and predictor variables                             | 119        |
| 8.3 Checking for multicollinearity among the predictor variables                               | 120        |
| 8.4 Methods of habitat analysis as applied to the hypothetical<br>beetle species               | 122        |
| 8.4.1 Comparison among group means—beetle example                                              | 122        |
| 8.4.2 Multiple linear regression—beetle example                                                | 123        |
| 8.4.3 Multiple logistic regression—beetle example                                              | 125        |
| 8.4.4 Classification and regression trees (CART)—beetle example                                | 126        |
| 8.4.5 Multivariate analysis—beetle example                                                     | 129        |
| 8.5 Inference from the beetle example                                                          | 130        |
| <i>Appendix 8.1 Dataset of hypothetical beetle species</i>                                     | 132        |
| <i>References</i>                                                                              | 134        |

|                                                                                                                    |            |
|--------------------------------------------------------------------------------------------------------------------|------------|
| <b>9 Statistical Methods for Analyzing Species–Habitat Associations</b>                                            | <b>135</b> |
| 9.1 Comparison of group means                                                                                      | 135        |
| 9.1.1 Different types of ANOVA                                                                                     | 136        |
| 9.1.2 Multi-way ANOVA applied to beetle data                                                                       | 137        |
| 9.1.3 ANOVA on groups defined by an environmental variable                                                         | 139        |
| 9.1.4 Creating groups for an ANOVA                                                                                 | 140        |
| 9.2 Multiple linear regression                                                                                     | 140        |
| 9.2.1 Negative binomial regression                                                                                 | 143        |
| 9.2.2 Zero-inflated regression models                                                                              | 147        |
| 9.2.3 Interpreting regression coefficients                                                                         | 149        |
| 9.3 Multiple logistic regression                                                                                   | 149        |
| 9.3.1 Logistic population growth as a logistic regression                                                          | 152        |
| 9.3.2 Multiple logistic regression as the method of choice                                                         | 152        |
| 9.4 Classification and regression trees                                                                            | 153        |
| 9.4.1 Splitting of groups                                                                                          | 154        |
| 9.4.2 Pruning of trees                                                                                             | 155        |
| 9.4.3 Using CART for habitat analysis                                                                              | 156        |
| 9.5 Multivariate techniques                                                                                        | 157        |
| 9.5.1 Principal components analysis                                                                                | 157        |
| 9.5.2 Discriminant function analysis                                                                               | 160        |
| 9.6 Occupancy modeling                                                                                             | 165        |
| 9.7 Conclusion                                                                                                     | 170        |
| <i>Appendix 9.1 R code and packages useful in conducting habitat analyses</i>                                      | 171        |
| <i>References</i>                                                                                                  | 171        |
| <b>10 Post-analysis Procedures</b>                                                                                 | <b>175</b> |
| 10.1 Assessing model fit                                                                                           | 175        |
| 10.2 Comparing models                                                                                              | 180        |
| 10.3 Assessing predictive accuracy                                                                                 | 183        |
| <i>Appendix 10.1 Two hypothetical datasets for testing</i><br><i>the accuracy of the logistic regression model</i> | 189        |
| <i>References</i>                                                                                                  | 191        |
| <b>11 Other Techniques Related to Habitat Analysis</b>                                                             | <b>193</b> |
| 11.1 Resource selection functions                                                                                  | 193        |
| 11.2 Selectivity and preference indices                                                                            | 196        |
| 11.3 Compositional data analysis                                                                                   | 197        |
| 11.4 Habitat suitability models                                                                                    | 199        |
| 11.5 Species distribution models                                                                                   | 202        |
| <i>References</i>                                                                                                  | 204        |
| <b>12 Conclusion</b>                                                                                               | <b>209</b> |
| <i>References</i>                                                                                                  | 212        |
| Index                                                                                                              | 213        |