

Index

A

Abundance, estimation, 17
Abundance model
 multinomial, 367
 Poisson, 367
Acoustic sampling, 7, 270, 288
 BUGS implementation, 273
 secr implementation, 273
 signal strength model, 272
Activity center, 129
 binomial point process model, 129
 in **BUGS**, 145
 concept, 16
 conditional intensity and, 135
 direct linkage to density, 17
 in distance sampling, 133
 initial values of, 142
 in MCMC, 162
 in state space, 131, 139, 158
 posterior prediction of, 166
 non-uniformity of, 158
 two-dimensional spatial coordinate, 127
 uniform distribution, 163
 unobserved random variable, 128–129
 in **WinBUGS**, 157, 159
Acoustic sampling, 7, 270–273
 in *secr*, 273
 in **BUGS**, 273–274
Adaptive rejection sampling, 448
AIC, 181, 195, 210
ArcGIS, 463
Akaike Information Criterion (AIC), 55, 181
 likelihood methods, 219
 model selection in, 198, 213, 220
 secr package, 202, 216, 222
Alternative movement model, 394
American shad
 Cormack-Jolly-Seber (CJS) models,
 416, 420
 SCR issues, 424
 stream flow, 427
Animal movement, 283
 see also Trap spacing, Movement models
Area search, 383, 389–390
Availability
Avian mist-netting example, 260

B

Basic capture-recapture method, 530
Bayesian analyses, 33, 50, 434, 509, 532
 Bayes' rule, 50–51, 434
 BUGS language for, 60–61
 confidence intervals, 54, 68
 inference principles, 51
 in **JAGS**, 200
 MCMC methods, 63
 model checking in, 80
 model selection in, 80, 83–84
 posterior inference, 54
 prior distributions, 53
 random variables in, 50
 selection, 80
 small sample inference, 55
Bayesian inference, 434
 sampling variance, 148
Bayesian p-value, 82–83
Behavioral response, 101
 in animal studies, 101
 BUGS code for, 208
 covariate effect, 203
 encounter probability, 205
 local or global, 207, 215
 to trapping, 101, 207
Bernoulli distributions, 29, 450
 encounter probability, 245
 M_0 model, 104
 observation model, 250
 prior distribution, 83
 probability distributions, 29
 Probability mass function (PMF), 29
 SCR0, 167
Binomial distributions, 450
 definition of
 M_0 model, 102
 notation, 27
 probability mass function (PMF), 23, 28–29, 37
Binomial GLMs, 49, 77–79
 in **WinBUGS**, 80
 parameter estimation, 77
Binomial integrated likelihood, 193
Binomial observation model, 126
Binomial point process model, 129–130
Binomial probability mass function, 23

Binomial regression
 waterfowl banding data, 79
 Bivariate normal distribution, 33, 136
 Bivariate normal model of space usage, 517–518
 Black bears
 SCR + RSF model, study on, 355
 space usage, 358
 convex hull, 9
 standard approach, 12
 BUGS implementation
 Stratified populations, 368
 Buffering, 9, 12
 Burn-in, 65, 75, 439, 444, 457, 460
BUGS language, 434

C

Camera trapping, 5
 historical overview, 5
 encounter probability, 8
 for sampling methods, 13
 Capture-recapture methods, 527
 Categorical distributions, 30
 Closed population models, 14
 assumptions, 90
 binomial observation model, 88
 data augmentation (DA), 92–93
 model M_h , 102
 model M_0 , 95
 Closed capture-recapture model M_h , 449
 Clustered detectors, 287–288
 Optimal design, 298–299
 Collared individuals, 519
 C++, 468–470
 coda, 457
 Computational speed, 465, 468, 470
 Conditional distribution, 37, 50–51, 57–59,
 437, 445, 450, 453, 455
 constructing rules, 59
 M_0 model, 91
 Markov chain Monte Carlo (MCMC), 59
 Metropolis-Hastings algorithm, 59
 Conditional likelihood, 91, 180
 in closed population model, 91
 full likelihood, 180
 SCR model, 296
 Convergence, 65–66, 439, 457
 Conjugacy, 435, 446, 453
 Convex hull
 buffering, 9
 density estimation, 9
 trapping array, 13

Cormack-Jolly-Seber (CJS) models, 415
 Cost-weighted distance, 331
 Cost-weighted paths
 calculation, 334
 computation, 333–334
 defined, 331, 336
 R code, 334
 in SCR model, 332
 Count data
 Count detector model (in *secr*), 253
 see Poisson observation model
 Counter detector, in *secr* package, 253
 Covariate effects
 in density, 307
 in encounter probability models, 203, 246
 landscape structure, 349
 in standard GLM or GLMM, 203
 see also Individual covariate model

D

Data augmentation, (DA), 92
 in closed population models, 92–93
 heuristic motivation, 94
 joint likelihood using, 109
 model-based analysis, 109
 M_h model, 104
 in M_0 model, 95
 occupancy parameter, 94
 in **WinBugs**, 145
 zero-inflated model, 95, 109
 Data format
 three-dimensional, 153
 two-dimensional, 140
 Data structure
 formatting, 140
 manipulating, 140
 sampling design and, 126
 Density estimation, 8–13, 17, 149, 162, 195
 covariate, using, 299, 307
 data simulation, 314
 intensity parameter, 323
 in M_0 model, 100
 parameter estimation, 317
 SCR definition of, 308
 Density maps, 162, 196
 effective sample area, 178
 individual prediction, 166
 Wolverine analysis, 164
 DENSITY, 171, 186
 DENSITY (software), 186
 Derived parameters, 68

Design criterion, 290, 294, 296, 298
 Optimal, 293, 296, 298
 For SCR, 293–294, 296
 Variance-based, 293
 Density covariate models, 299

Detection function
 behavioral response, 250
 conditional probability, 247
 in covariate influence, 108
 in distance sampling, 116
 models, 188
 signal strength, 272

Detection probability models, 128

Detector dogs, 398

DIC model selection, 225

Discrete habitat mask, 158
 coarseness, evaluation, 159

Discrete state-space, *see* habitat mask

Dispersal, 397

Dispersal dynamics, *see* Movement models

Distance function, *see* detection probability models

Distance sampling, 30, 41, 44, 116, 381, 384, 390
 desert tortoise example, 118
 in hierarchical model, 118, 120
 in SCR model, 116, 118, 121

DNA sampling, 6

Distribution of individuals, 529

Dummy variables, 79

E

Ecological distance
 Bayesian analysis, 339
 density covariate, 345
 likelihood analysis, 338
 SCR simulation, 335

Effective sample area, 167, 195
 density mapping, 178

Effective sample size, 67, 458

Efford, M.G., 15

Encounter data file, 151

Encounter device types, 188

Encounter probability
 Bayesian analysis, 200
 Bernoulli process, 245
 binary observation, 248
 covariate model, 203, 246
 Gaussian model, 198, 249, 255
 individual covariate, 208
 multinomial model, 267
 signal strength model, 272
 space usage, 248

 trapping interval, 267
 trap-specific covariate, 206

Euclidean distance
 in activity centers, 329
 cost-weight distance, 334
 encounter probability and, 330
 least-cost path model, 332, 338
 mis-specified model, 339, 341, 344
 in SCR model, 336
 shortcomings, 330

Exchange algorithm, 292, 298

Expected population size, 148

Explicit movement models, 534

F

Fitness model
 components, 233
 in encounter probability, 214
 individual trap frequencies, 237
 occupancy dynamics, 241

Fixed search path
 alternative movement models, 394
 encounter probability, 383
 intensity model, 393

Focal population, 280

Fort Drum black bear study, 8, 98, 106, 110

G

Gaussian distribution (*see* Normal Distribution)

Gaussian kernel, 517

Gelman-Rubin statistic, 65–66, 461, 467

Generalized linear (mixed) models (GL(M)Ms), 48
 binomial, 84
 in Bayesian framework, 63

Generalized linear models (GLMs)
 binomial, 49, 77, 79
 components, 48
 in exponential family, 48
 in SCR, 48
 Poisson, 69, 71, 75
 random effects, 49

Gibbs sampling, 57, 59, 436–439
 in MCMC methods, 57
 MH sampling *vs.*, 441, 445
 Normal regression model, 57–58

Gompertz hazard, 385

Goodness-of fit, 55, 80–82, 232–241
 evaluation, 232
 in SCR, 181
 wolverine data, 238

Gregarious species, 533
 Group structure, *see also* Multi-session model
 in data augmentation, 372
 multi-catch model, 365
 single parameter, 370

H

Habitat mask, 158, 184, 186–187, 196
 Habitat selection
 space usage, 350
 landscape simulation, 359, 363
 non-uniform distribution, 307
 spatial variation, 312
 Hard plot boundaries, 389
 Heterogeneity
 in detection probability, 281–282
 model, 103, 106
 Hierarchical modeling
 defined, 40
 examples of, 41
 random variables, 21
 statistical analysis, 37
 statistical inference and, 40
 Home range area, 137, 147, 157
 Home range center, 129
 definition, 129
 implied model, 147
 space usage model, 134
 see also Activity center
 Homogeneous point process, 521
 in a subset of the state-space, 521
 spatial randomness, 308
 Huggins-Alho model, 108

I

Imperfect identification, 532
 Index of dispersion, 234
 Indicator variable
 detection function, 231
 wolverine data, 229
 Individual covariate mode, 108
 capture location, 109
 data augmentation, 92
 distance sampling, 87
 in SCR, 108, 115
 Individual heterogeneity
 defined, 197
 detection probability, 211
 for home range size, 198
 incorporation methods, 216

see also M_h model

Inhomogeneous point-process, 521, 523
 density model, 322
 discrete space, 320
 in SCR model, 310
 in spatial mark-resight, 503, 520
 intensity parameters, 311
 Poisson model, 308
 spatial variation, 307, 315
 Integrated likelihood, 172
 construction, 175
 data augmentation for, 180
 marginal distribution, 172
 MLE estimators, 171–172
 numerical calculations of, 179
 Poisson integrated likelihood, 192
 in SCR models, 176, 178
 under data augmentation, 180
 Invariance of density to state-space, 115, 132, 183, 194
 Irregular patches, 341

J

JAGS, 60, 433, 465, 506
 Bayesian analysis in, 60
 ecological introduction to, 60
 summary command for, 68
 Joint distribution, 37
 Joint likelihood, 91
 Jolly-Seber model, 404, 411
 data augmentation, 407
 spatial, 411

L

Lack-of-fit, 241
 Landscape connectivity
 geographical analysis, 341
 in SCR models, 329–330, 335
 Landscape structure
 covariate model, 349
 resource selection, 359
 simulated example, 352, 359
 space configuration, 350, 363
 Langevin algorithm, 442
 Latent encounter histories, 506
 Least-cost distance, 331–332
 Least-cost distance, likelihood analysis
 of, 338–339
 Least-cost distance, Bayesian analysis
 of, 339

Least-cost distance, habitat corridor, 341

Least-cost path, *see* least-cost distance

in **BUGS**, 339

computation, 343

covariate matrix, 336

encounter probability, 330

SCR example, 338

Lincoln-Petersen estimator, 500

of abundance, 532

Link function, 49

Cloglog, 78

Log, 49

Logit, 49, 77–78

Logistic regression, 49, 77

Live-trapping study, 498

Logit-normal model, 442–443

M

Marginal distribution, 37, 52, 60, 434

Marginal likelihood, 172

binomial form, 192

calculation, 184

point process density, 192

Marginal probability of encounter, 293, 295

MARK, 501

Markov chain Monte Carlo (MCMC), 56, 65, 433, 435

algorithm, 59, 72, 82, 506

in Bayesian analysis, 60, 63

building own algorithm, 433

closed capture-recapture model M_h , 449

convergence analysis, 65

manipulating state-space, 462

posterior distributions, 56, 434

in SCR models, 57, 452

in **WinBUGS**, 64, 67

Marked individuals

homogeneous point process, 521

imperfect identification of, 512

inhomogeneous point processes, 523

known number of, 499

unknown number of, 500

Markov random fields, 531

Mark-resight models, 497

data types, 499–500

Known number of marks, 500

techniques, 499

Unknown marked status, 500

Unknown number of marks, 500

Maximum likelihood, 35

in **R**, 36

M_b model

global trap response, 215

in non-spatial capture-recapture, 197

MCMC Diagnostics

Mean maximum distance moved (MMDM), 282, 287

home range radius, 100

Metropolis-Hastings algorithm

Acceptance rate, 443–444, 447, 461

Acceptance ratio, 60, 73, 441–442

Adaptive phase, 444

Candidate distribution, 59, 441, 443

Independent, 442

Langevin, 442

Parameters with bounded support, 441

Proposal distribution, *see* candidate distribution

Random walk, 73, 441–442

Tuning, 442–444, 457, 461

Metropolis-Hastings (MH) sampling,

58–60, 441

vs. Gibbs sampling, 443

Metropolis-within-Gibbs, 444–445, 449

M_h model

analysis, 104

MCMC for, 449

random effect, 212

SCR, relevance to, 211

Misidentification, 532

in capture-recapture, 500

in mark-resight, 500

Mist-netting, 260

MLE with known N, 171

MLE with unknown N, 177

MMDM, 13

M_h model, 102

relevance to SCR, 133

M_0 model, 95

binomial observation, 102

N-mixture model

in black bear study, 98

in Bernoulli, 104

in **BUGS**, 95

capture-recapture assumptions, 90

closed population model, 88

conditional distribution, 91

occupancy type, 97

Modeling territoriality, 531

Model selection

using AIC, 213, 216

Bayesian, 83

issues, 80

- in SCR model, 84
 - indicator variables, 65
- Model output
 - commands, 461
 - posterior density plots, 457
 - rejection and slice sampling, 448
 - serial autocorrelation and effective
 - sample size, 458
 - summary results, 460
 - time series plots, 457
- Model SCR0
 - data structure, 126, 141, 151
 - binomial observation model, 126
 - assumptions, 150
- Model selection
 - classical, *see* AIC
 - Bayesian, 224–232
 - indicator variables, 227
 - Kuo and Mallick, 231
- Monte Carlo error, 67–68, 460
- Mountain lions, 391
- Movement model, 17–18, 386–387, 394–395
 - alternatives, 394
 - auto-regression, 395
 - data simulation, 394
 - dispersal, 404, 426–429
 - encounter frequency, 381
 - open population, 397
 - outcomes, 386
 - transients, 403–404, 429
 - transition matrix, 419–420
- Moving activity centers, 524
- Multi-catch traps, 254,
 - see* multinomial observation model
- Multi-catch device, 245–254, 275
- Multi-catch independent multinomial
 - model, 534
- Multi-session models, 193, 261, 372–373
 - BUGS** language, 378
 - data augmentation, 365
 - landscape variation, 379
 - multi-catch observation, 373
 - other approaches, 372
 - secr* analysis, 373
 - sex effects in, 215, 365
- Multi-state model
 - spatial states, 401, 422
 - transition matrix, 419–420
- Multinomial abundance models
 - stratified populations, 367
- Multinomial distributions, 30
- Multinomial observation model, 254–259,
 - 373–374

- relationship to Poisson model, 263
- Multinomial model
 - density estimators, 267
 - encounter devices, 254
 - in Gaussian methods, 255
 - in single-catch trap, 267
 - resource selection, 256
 - in **WinBugs**, 256
- Multivariate normal distribution
- M_x model
 - density invariance, 115

N

- N-mixture model, 78
- Non-spatial capture-recapture, 87, 532
- Non-spatial mark-resight models, 501, 505, 512
- NOREMARK, 501
- Normal distribution, 434
- Numerical integration
 - integration grid spacing, 183
- R** code, 179

O

- Objective function, 290
- Observation model
 - alternative methods, 245
 - in Bernoulli, 250
 - in Poisson, 245
 - JAGS**, using, 245
 - multinomial distribution, 245, 267
 - single catch trap, 266
- Observed point processes, 314
- OpenBUGS**, 433
- Open populations
 - apparent survival, 403
 - Cormack Jolly Seber models, 415–426
 - Jolly Seber models, 404–415
 - movements, *see* Movement models
 - recruitment, 406
- Optimal design, 289–290
 - detector configuration, 289
 - in SCR model, 283, 293
 - swapping algorithm, 297
 - trap spacing, 285, 299, 303
- Ordinary capture-recapture models
 - N estimation, 18
 - non-spatial aspect, 11–12
 - technical problems, 17
- Ovenbird data, 260–266, 374–376
- Ovenbird mist-netting study, 408, 412

P

- Parallel computing, 465–467
- Parallel processing
- Parameter estimation
 - in maximum likelihood estimates (MLEs), 36
 - statistical inference, 34
- Partial information designs, 398
- Point process aggregation, 15
- Point process model, 15
 - binomial, 129
 - in spatial mark-resight, 521, 524
 - state-space, 131
 - for homogeneous point process, 521
 - for inhomogeneous point processes, 523
- Poisson cluster process, 16
- Poisson distribution, 31, 69
- Poisson GLMs, 69
 - in **WinBugs**, 71, 76
 - MCMC algorithm for, 73–74, 447
 - Log-Normal mixture, 75–76
 - random effects, 75–76
- Poisson integrated likelihood
 - binomial form of, 192
 - development, 192
- Poisson Model
 - in **BUGS**, 250
 - data simulation, 251
 - encounter probability, 245, 505, 513
 - GLMM, 447
 - multinomial relationship, 259
 - regression, 450
 - in SCR, 245
 - in *secr*, 261
 - space usage, 247
 - zero-inflated, 250
- Poisson observation model, 245–247
 - relationship to Bernoulli model, 248
 - relationship to multinomial model, 249
- Population closure, 300
 - violation of, 300–301
 - Test of, 301
- Population dynamics
 - animal movement, 403
- Possum data, 268–272
- Posterior density plot, 457
- Posterior distribution, 52, 54, 436, 439–441
 - Bayesian inference, 52
 - Characterization of, 56
 - discrepancy measures, 82
 - inference, 54–55
 - joint, 439, 450
 - marginal, 439
 - mass of, 75
 - MCMC simulation, 56, 65, 68, 434
 - parameter estimation, 54, 83
- Posterior inference, 54
- Prior distribution, 52–53
 - choices, 63–64
 - conjugate, 58
 - diffuse, 53, 61, 63
 - flat, 53
 - improper, 53, 63, 453
 - Lack of invariance to transformation, 54, 64
 - non-informative, 53, 63–64, 453
- Prior information, 53–54
- Prior sensitivity
- Probability density function, 22
 - resource selection, 25
 - see also* Probability mass function (PMF)
- Probability distributions
 - common distributions, 27–34
 - conditional,
 - definition, 22
 - joint,
 - marginal,
 - notation,
 - Bernoulli, 29
 - binomial, 27
 - different notations for, 22
 - hierarchical model, 40
 - properties, 24–25
 - random variable, 21–22
- Probability mass function (PMF)
 - Bernoulli distribution and, 29
 - binomial, 23, 28–29, 37
 - issues, 22
 - parameters, 22, 37
 - properties, 24
 - random variable values, 23
- Proposal distribution, 441
 - random walk, 441
- Proximity detector
 - density estimators, 245
 - in signal strength, 270

R

- Radio-tagged individuals, 500
- Random effect
 - in Bayesian analysis, 84
 - in GLMMs, 47, 49
 - in hierarchical models, 83
 - in MCMC, 47
 - in Poisson GLMM, 75

- in **WinBUGS** model, 61, 84
 - Random sample assumption, 497, 502
 - demographic, 498
 - spatial, 498, 502–504, 521–522
 - Random variable
 - definition of, 22
 - examples
 - Random walk proposal distribution, 441
 - Realized population size, 148
 - Recruitment
 - data augmentation, 407
 - JS model, 404, 410, 414
 - time dependent, 409
 - Regular capture-recapture models, 500
 - Rejection sampling, 315, 448
 - Resighting techniques, 499
 - Resource selection
 - bivariate normal space usage, 136, 256, 350–351
 - multinomial resource selection model, 256, 350–351
 - Poisson model of space usage, 247, 353
 - SCR as a model of, 134, 354
 - encounter probability, 350, 355
 - in Poisson model, 353
 - in SCR model, 349
 - mis-specification, 359
 - population estimate, 350
 - second-order scale, 357
 - telemetry data, 359, 361
 - Resource selection function (RSF)
 - independence assumption, 361
 - R-hat statistic, *see* Gelman-Rubin statistic
 - Rotating traps, 287–288, 300
- S**
- Sample size
 - encounter probability, 287
 - estimation parameters, 285, 303
 - generation techniques, 281
 - in conditional probability, 293
 - in SCR model, 288
 - spatial problems, 277
 - trap clusters, 298
 - Sampling design, 126
 - design-based, 278
 - focal population vs. state-space, 280
 - for capture-recapture, 281
 - for SCR, 282–283
 - model based, 278, 289
 - population closure, 300
 - spatial, 288
 - Sampling duration, 300
 - Sampling methods
 - non-invasive, 13
 - Sampling techniques, 527
 - Scenario analysis, 277–278, 283
 - SCR0
 - Bayesian analysis of, 131
 - Bernoulli model, 167
 - BUGS** analysis, 125, 146
 - fitting model, 141, 154–155
 - home range area, 147
 - MCMC for, 452, 455
 - statistical assumptions, 150
 - SCR models
 - activity center, 294
 - Bayesian analysis, 148
 - binomial encounter process, 455
 - characterization, 41
 - construct full conditionals, 453
 - core assumption, 150
 - data simulation, 257–258
 - distance sampling, 133
 - effective sample area, 167
 - encounter probability, 292
 - independence assumption, 361
 - model M_{th} , 133
 - optimal design criteria for, 293
 - Poisson observation model, 295
 - population closure, 301
 - sex-specific encounter, 286
 - study design, 281
 - Search-encounter designs
 - fixed search path, 382–383
 - total hazard, 384
 - uniform intensity, 383
 - Search-encounter sampling, 7
 - fixed search path, 382
 - area-search, 383
 - uniform search intensity, 383, 392
 - Search encounter models
 - secr* package, 186–187, 262
 - additional capabilities, 194
 - analysis, 189
 - covariate models, 195
 - density mapping, 195
 - encounter device, 188
 - in likelihood analysis, 191, 213
 - multi-session model, 193
 - ovenbird data, 262
 - population closure test, 195
 - sex specificity, 262
 - state-space buffer, 194

- Serial autocorrelation, 458–459
 - Sex specificity
 - effects, 215
 - uncaptured individuals, 181
 - multi-session models, 365
 - secr* package, 262
 - shapefile, in least-cost distance, 345
 - Sierra National Forest fisher study, 392
 - Single-catch trap, 266–268, 533–534
 - multiple sample session, 261
 - observation model, 266
 - Slice sampling, 448
 - Small sample inference
 - Bayesian analysis, 55
 - SMR model. *See* Spatial mark-resight model
 - Sonoran desert tortoise data, 118
 - Southwest New York Black Bear Study, 355
 - Space-filling designs, 297
 - Space usage, *see* resource selection
 - Space usage model, 350
 - empirical analysis, 136
 - home range center, 134
 - Poisson distribution, 353
 - Spatial capture-recapture (SCR) methods
 - in animal population, 5
 - construction of, 14
 - defined, 4
 - density estimation, 5
 - ecological theories and, 18
 - historical context, 12
 - non-spatial aspects, 8, 11
 - technical problems, resolving, 3
 - Spatial correlation
 - Spatial design
 - construction, 303
 - formal analysis, 277
 - issues, 278, 290, 296
 - model-based, 289
 - optimization criteria, 296
 - temporal aspects, 299
 - Spatial distribution, 498
 - Spatial mark-resight (SMR) model, 498
 - data simulation, 506
 - imperfect identification of marked individuals, 512–514
 - implementation, 505–506, 508
 - inhomogeneous point processes, 523
 - known number of marks, 504–505
 - precision of estimates, 521
 - random sample assumption, 502
 - resighting techniques, 499
 - telemetry data, incorporating, 516–519
 - Unknown number of marks, 508–509
 - Spatial randomness, 307–308
 - homogeneous point process and, 308
 - observation model, 237
 - uniform distribution, 234
 - Spatial randomness, testing, 233
 - sensitivity to bin size, 235
 - sensitivity to state-space extent, 236
 - Spatial recaptures, 283, 285, 288
 - Spatial sampling
 - in SCR model, 279
 - issues, 277, 299
 - trap location, 279
 - State-space, 16
 - in spatial mark-resight, 503
 - manipulating, 463–464
 - shapefile, 464
 - size sensitivity, 236
 - State-space model
 - invariance, 132
 - point process, 131
 - prescribing, 131
 - state space (of point process), 16, 131
 - Stationary distribution, 439
 - Statistical inference
 - fundamentals of, 21
 - hierarchical models and, 40
 - parameter estimation and, 34
 - role in probability laws, 22
 - Stratified populations, *see also* multi-session models
 - BUGS** implementation, 368
 - data simulation, 371
 - hierarchical model, 367
 - multinomial abundance models, 367
 - in SCR model, 365
 - Strauss model, 530
 - Study area, 280
 - Survival
 - American shad, 416, 424
 - Cormack-Jolly-Seber (CJS) models, 415, 418
 - demographic parameters, 410
 - vs emigration, 403
 - in spatial model, 402
 - Jolly Seber (JS) models, 404
 - in open population, 406
- ## T
- Telemetry data
 - activity centers, 351
 - in spatial mark-resight, 516–519

- resource selection model, 349
- RSF model, 361
- SCR model, 350, 361
- space sampling, 354
- Temporal dependence
 - multi-session formulation, 377
- Temporary emigration, 13, 103, 379, 403–404
- Thinning, 67
- Time series plots, 65, 439–440, 457
- Total hazard,
 - encounter model, 384–385, 390
- Trap arrangement, 288
- Trap array, 281
 - holes in the, 281–282
 - size, 282–283, 285–286
- Trap spacing
 - and home range size, 281–282
 - movement estimates, 282, 285
 - Relative to animal movement, 283–285
 - study design, 281, 287
- Trap-specific covariate
 - encounter probability models, 206, 513

U

- Unequal probability sampling, 284
- Uniform distribution, 32

- Uniform search intensity
 - design 2, 392
 - search-encounter designs, 383
- Unmarked individuals
 - estimated number of, 505
 - information, 514
- Unstructured spatial surveys, 390

W

- Weibull hazard, 386
- WinBUGS**, 60, 433–434, 460–461, 465
 - fitting model, 154
 - in linear regression, 60
 - in markov chain Monte Carlo (MCMC), 64, 67
 - in random effect, 61, 84
- Wolverine analysis
 - camera trapping, 161, 182
 - density map, 164
 - space usage, 157
 - wolverine camera trapping data, 151, 182, 221

Z

- Zero-inflated, Poisson model, 250