

## Index

- accumulation of errors, *see* random walk  
 age class, 58, 60, 136, 146–7  
 aggregation, 107, 120–1, 126, 129, 137  
 analytical model, 268–9  
 apex of curve, *see* tracing of curves  
 autocorrelation, 161, 175, 201–2  
   function (ACF), 180, 201  
 autocovariance, 147, 149, 159, 161, 164–6, 178  
   function (ACVF), 166, 180  
 averages  
   ensemble, 165  
   time, 165  
 azuki bean weevil, *see* Utida's experiments
- binomial  
   coefficient, 103–4, 115  
   distribution, *see* probability distribution series, 102  
   trial, 100, 103  
 biotic-factor theory (school), *see* regulation of populations  
 birth and death, 35, 181  
 Brännström–Sumpter model, 114  
 breeding season, 35, 39, 139, 181  
 Brownian motion, 156
- carrying capacity (of environment), 38, 48–9, 91  
 census data, 33, 37, 71–4, 90  
 chaos (deterministic), 81–2, 84  
 climate changes, 86, 88, 154  
 climatic-control theory (school), *see* regulation of populations  
 climatic influences, 145, 171–2  
 closed process, 249  
 coexistence (of competing species), 228–32, 238, 241, 244–8, 269
- common version logistic model, *see* logistic models  
 competition  
   geometric model of, 40  
   intensity of (in), 42, 47, 49, 61, 63, 98, 105, 121, 127–8, 226, 261  
   interspecific, 225–51  
   intraspecific (within-population), 32, 40, 63, 85, 108, 113, 148, 183, 233  
   scramble and contest, 120, 125–6, 132, 135–40  
 competitive exclusion principle, 225, 227, 245, 247  
 complex numbers, 128, 140–2  
 complex of species  
   formation of, 248  
   of natural enemies, 220, 255, 258, 260–1, 266  
   of predators (parasitoids), 219–21, 248, 262, 265  
   of prey (hosts), 219, 248, 255, 260  
 complex-vs-complex interactions, 219–20  
 conditional reproduction curves, *see* reproduction curves  
 conditional reproductive rates, *see* reproductive rates  
 continuous-time process, 35–6, 39, 45, 47, 52, 63, 82–3, 113, 156, 181–2  
 continuum  
   competition–sociality, 131, 139  
   scramble–contest competition, 126, 132  
 correlation  
   between climate and population, 170–3  
   between reproductive rate and population density, 173  
   spurious (nonsense), 176  
 correlogram, 201–4  
 covariances, 147, 159, 161, 175  
 crypsis (mimesis), 26–9

## 274 · Index

- density dependence, 152–4, 167–8, 177, 188  
 density-dependent  
   factors, 145–6, 152  
   processes, 153, 163, 168, 173  
   regulation, *see* regulation of populations  
 density-independent  
   factors, 145–6  
   processes, 154–5, 158, 173, 175–6  
   regulation, *see* regulation of populations  
 derivatives, 36, 44–5, 52, 55–6, 64–6, 77,  
   92–6, 123, 142–3, 217  
 descriptive models (device), 39, 52, 90–1, 99,  
   106, 114, 127, 219, 268  
 detrending (differencing) of series, 204  
 developmental stadium (stage), 35, 109, 124,  
   220, 246, 254, 262, 265, 267  
 difference (recurrence) equation, 182, 218  
 differential, 36, 46, 55, 83  
 differential equation, 32–4, 37, 47, 49, 52–4,  
   88, 182, 217–18  
   solution of, 53  
 discrete experiment, 132–6, 217  
 discrete-time processes (models, schemes),  
   35, 39–41, 45, 47, 63, 82–3, 98, 112,  
   181–2  
 dispersal, *see* spruce budworm  
 distribution, *see* probability (spatial)  
   distribution  
 dynamical (time-dependent) processes  
   (pattern), 52, 75, 78–83, 98, 154, 168,  
   182, 186, 189–95, 205, 217, 232,  
   237–8, 255, 258, 268  
 egg/moth (E/M) ratio, 263–6  
 elimination of competing species, 227–8,  
   230, 233, 238, 241, 244–7, 269  
 emigration and immigration, 34, 263–4, 266  
 empirical ecology, 270  
 endemic–epidemic dichotomy, *see* spruce  
   budworm  
 endogenous processes, 85–9, 181, 192,  
   197–201, 236, 241–4, 260  
   attributes of, 149, 152, 154, 186, 197, 201,  
   204, 206, 209  
   models (curve, form) of, 85–9, 152–5,  
   172, 177, 181, 202, 206, 212, 215, 218  
   parameters of, 85–6, 153, 163, 206, 216  
 endogenous and exogenous processes, 85–6,  
   89  
 ensemble  
   averages, 165  
   of series, 149, 158, 161–2, 164  
 environmental influences, 51, 85, 170, 198  
 environmental resistance, 38  
 equilibrium density, 49, 62, 84, 152, 154,  
   167–8, 174, 232–3, 238, 259  
   of logistic models, *see* logistic models  
 ergodicity, 165  
 errors, *see* exogenous influences, random  
   walk  
 Euler’s number and formula, 56, 65, 141–2  
 exogenous  
   processes (factors), 75, 85, 89, 162  
   influences, *see* environmental influences  
 expectations (expected values), 44, 101,  
   116–17, 147–54, 159, 164–5, 177–8  
 exponential rate of (population) increase, *see*  
   Malthusian  
 extinction of populations, 48, 50–1, 84, 126,  
   130, 145, 153, 155, 160, 162, 168, 196,  
   218, 233  
 factorial (as mathematical operation),  
   43, 102  
 facultative and catastrophic factors, 145  
 feasibility of population attributes  
   ecological feasibility, 83–4, 113, 129, 195,  
   260  
   physical (mathematical) feasibility, 129,  
   195–6, 233  
 fecundity, *see* life cycle in spruce budworm  
 first principles, 89, 219, 245  
 fitness, 25, 84, 129, 249  
 food webs, 177, 219  
 formulation of models, 41, 44, 108, 110, 183,  
   186, 225  
 functional vs regression relationships, 174,  
   176  
 fur–return statistics, *see* lynx cycle  
 game of trapshooting, 100, 105–10, 113, 128  
 Gause’s law, *see* competitive exclusion  
   principle  
 genetic traits, 30, 84, 126, 130  
 geometric models of competition, 40  
   individual-centred, 106, 108, 110  
   quadrat-scheme, 106–8  
 geometric progression, *see* Malthusian  
 great tit (*Parus major, minor*), 7–8, 11, 27  
 Green River Project, *see* spruce budworm  
 Hassell model (of single-species population  
   process), 99, 113, 127–8, 137  
 host (alternative), 248

- host complex, *see* complex of species  
 host–parasitoid interactions, *see* predator–prey interactions  
 hyperparasitism, 262
- immigration, *see* emigration and immigration  
 increase (in populations)  
   innate capacity for, 38  
   instantaneous rate of, 36, 48–9  
   intrinsic (potential) rate of (natural increase), 38, 48  
 independent, identically distributed (iid)  
   random numbers, *see* random numbers  
 index (coefficient) of dispersion  
   (aggregation), 107  
 industrial melanism, 26–7  
 infestation map, 255, 258  
 inflection point of curve, *see* tracing of curves  
 initial state, 54, 81, 156, 192, 218, 236  
 initial-state (value) dependence, 218, 236  
 instantaneous rate of change (increase), *see* rate of change (in population)  
 intensity of competition, *see* competition  
 interactions among competing species, 221, 225, 227
- lags, *see* autocorrelation, autocovariance, phase lag  
 l'Hôpital's rule, 57, 65, 96, 118  
 Life cycle, 40, 253–4, 263  
 limit cycles, *see* population cycles  
 logarithmic transformation, 68, 71, 95, 98, 255–8  
 logarithms  
   common, 72–3, 183  
   natural, 37, 43, 46, 53, 56, 65, 68, 121, 183, 230, 251  
   of negative number, 128, 130, 140  
 logistic curve, 39, 73, 90  
 logistic law, 31, 39, 46, 49, 51, 90, 267  
 logistic models  
   classical, 32–3, 46, 63, 68, 82–3, 88, 98, 113, 182  
   common version of, 33, 36–7, 47, 49–56, 82  
   equilibrium of, 49–50, 52  
   generalization of, 98  
   Pearl–Reed version of, 33, 36–8, 47, 73–4, 88, 90–1  
   Verhulst version of, 33, 37, 45, 52  
 logistic processes  
   continuous-time, 63, 113  
   discrete-time, *see* discrete-time processes  
   generalization of, 69  
   theory of, 50, 52, 83, 92, 98, 182  
 Lotka–Volterra model, 182, 188, 217–18, 241  
 lynx cycle, 187–8, 190, 221, 266
- Malthusian  
   geometric progression, 32, 35–8, 50–1, 72, 91, 130–1, 140, 155, 217  
   theory of population, 32  
 matrix  
   variance–covariance, 159, 166–7, 179  
   the Leslie, 60  
 measure of aggregation, *see* index of dispersion  
 micro-niches, 9, 12, 246, 249  
 mimesis, *see* crypsis  
 models of competition, *see* geometric models of competition  
 model parameters  
   ecological meanings of, 36, 49, 51, 63, 99, 113, 127, 184–5, 204, 226, 239  
   mathematical roles of, 63, 66  
 moments (statistical), 105, 147, 149–50, 164–5, 204  
 Moran effect (of population synchrony), 266  
 Moran plot, *see* reproduction curves  
 multiple-species interactions, *see* complex-vs-complex interactions
- negative binomial distribution, *see* probability distributions  
 net rate of change in population, 39–40, 45, 61, 121  
 Nicholson–Bailey model, 218–19  
 niche segregation, 246–8  
 niche selection, 25  
 non-negative entity (counts, quantity, series), 66, 68, 71, 73, 89, 102, 107, 187, 230, 267  
 nonsense correlation, *see* correlation (spurious)  
 non-stationary process, *see* stationary process  
 numerical response, 220
- open system, 249  
 outbreak process, *see* spruce budworm
- parasitoid–host interaction, *see* predator–prey interaction

## 276 · Index

- Pearl–Reed (logistic) model, *see* logistic models
- persistence of populations, 146, 148–54, 158, 162, 164, 167–8, 170, 173
- persistent state of populations  
 requirements for (stipulations of), 151, 160–2, 166–8, 170–1  
 fragile state, 170, 176, 218, 241
- phase lag, 220
- phase-space representation (orbit), 189–92, 201, 204, 213, 218
- Poisson distribution, *see* probability distributions
- population (ensemble) averages, *see* averages
- population cycles, 192, 260, 262, 265  
 broad (or narrow) sense, 193  
 chaotic cycles, 82  
 limit cycles, 80–4, 189–90, 195, 199, 202, 218, 221
- population extinction, 48–51, 84, 126, 130, 145, 153, 155, 160, 162, 168, 196, 218, 233
- population oscillation, 76, 80, 153, 189–90, 192–5
- population processes, *see* continuous-time processes, discrete-time processes
- population synchrony, *see* Moran effect
- potential (maximum) reproductive rate, 42, 45, 48–51, 61, 63, 83–5, 88, 98, 109, 121, 134, 148, 168, 183–4, 188, 190, 193, 195–6, 226
- potential rate of (population) increase, *see* increase (in populations)
- predation, 181, 192  
 absence of, 193, 195  
 by birds, 26–8, 30, 252, 262  
 effect of, 185, 193  
 model of, 266  
 rate of, 226  
 pressure, 29  
 visual, 26, 28–30
- predator complex, *see* complex of species
- predator–prey interaction process, 84, 181–3, 186–7, 196–7, 206, 210, 216–18, 225–6
- prey complex, *see* complex of species
- probability distributions  
 binomial, 43, 99–103, 115  
 negative binomial, 99–100, 103–7, 112, 114–15  
 normal, 103, 149, 156, 163, 198  
 Poisson, 43, 100, 105, 107, 112, 222  
 uniform, 43, 149
- probability distribution functions  
 density function, 103  
 mass function, 103–6, 116
- profitability, 11, 13, 18–25, 249
- profitability curve, 21–3, 184
- quadrat scheme (model, system), 106–10, 114, 127
- random numbers  
 correlated series of, 198–9, 201, 223, 241, 251  
 generator, 148, 156, 198  
 iid, 148–9, 153–6, 161, 163, 168–9, 175, 198, 200–2, 223, 241, 251  
 independent (uncorrelated), 43, 149, 158, 162, 170, 175, 178, 198, 224  
 sum of, *see* random walk
- random processes, *see* stochastic processes
- random search (postulation of), *see* search image theory
- random walk, 156–8, 161–2, 168, 170, 175–6, 218
- rate of change (in population), 34–7, 50, 54, 67, 74, 130, 147–8, 151–2, 155, 175, 182, 204, 206, 222, 254, 260  
 gross rate, 34  
 instantaneous rate, 36, 48–9, 217  
 net (intergeneration) rate, 35, 39–42, 45, 121  
 per-capita rate, 34–5, 37–8, 67–8, 71, 151  
 per-unit time rate (of increase), 34, 66–8, 91
- regulation of populations, 145–6, 160–1, 168, 171, 175  
 biotic(–factor) control theory (school), 145, 168, 172–3  
 climatic-control theory (school), 145–6, 169–72  
 density-dependent regulation, 162, 167–8, 173–6  
 density-independent regulation, 169–73, 175–6  
 essence of regulation, 160–1  
 testing by regression, 174, 177
- reproduction curves, 58–63, 66–88, 123–4, 127, 130–77, 206, 208
- Moran plot, 59–61, 69, 137
- Ricker's curves, 60
- conditional, *see* reproduction surfaces

- reproduction surfaces, 206–16, 260
- reproductive rate, 40–1
  - conditional, 207–8
  - formulation of, 185
  - potential, *see* potential (maximum)
  - reproductive rate
- resource
  - depletion (recovery) of, 181, 192
  - limit, 51
  - requirements, 41, 49, 61, 63
  - supply, 40–1, 47, 85, 91
- search image (theory), 8–9
- series experiment, *see* Utida experiments
- sigmoid growth curve, 32, 37, 63, 66–8, 90–1
- sigmoidality, 66–7, 72, 90, 267
- single-species populations (processes), 60, 84, 98–9, 113, 120, 139, 171, 181, 183, 190, 193, 195–6, 206, 215, 218, 226, 230
- slope of curve, *see* derivatives, tracing of curves
- sociality (socialness), 128–32, 136–40
- spatial distribution, 42, 99, 105–9, 125
- species complex, *see* complex of species
- spruce budworm, 165
  - endemic–epidemic dichotomy, 253–9, 267
  - epicentre hypothesis, 253–5, 258
  - Green River Project, 252, 254, 260, 263, 265, 267
  - life cycle, 253–4, 263
  - moth dispersal, 262–6
    - outbreaks, 31, 174, 196, 254–62, 266
  - stationary processes (series, etc.), 164–6, 171, 174, 180, 202, 204
  - stochastic processes, 31, 146–8, 165, 202, 204, 270
  - struggle for existence, 225, 245, 249
- Taylor–Maclaurin series, 44–5
- theoretical ecology, 269–70
- time-dependent processes, *see* stochastic processes
- tracing of curves, 63–4, 89, 215
  - apex (trough), 63–6, 94
  - inflection point, 66, 68, 91, 94–5
  - slope, *see* derivatives
- uniform distribution, *see* probability distributions
- Utida experiments, 98–9, 132–4, 217
- variance–covariance matrix, *see* matrix
- variance–mean ratio, *see* index of dispersion
- Verhulst logistic model, *see* logistic models
- wandering path, *see* random walk
- wildlife
  - management, 89, 219
  - ten-year cycle, 220