Index

abundance fluctuations in butterfly 194 of moths over time 148 Acacia mearnsii, as an alien 83 accumulation curve, of species 169, 170, 188 Acraea encedon 94 adaptations, conservation of 165 adaptive management 223, 224 adaptive radiation 176 Adonis blue butterfly 220 afforestation impact of 65-8 and indigenous species 68 reducing insect diversity 68 Aflexia rubranura 95 Africa 30 African savanna, and grasshoppers 46 aggression, in invasive ants 121 agricultural landscape, importance of heterogeneity 212 agriculture conversion to 65 impact of 65-8 agri-environment schemes 257 Agrius convolvuli 45 air pollution 61-2 aircraft stowaways 119 alien ants 119-22 alien fish predation 83 alien insects 119-23 and global climate change 140

alien patches, and edge effects 68 alien pines, effects of 68 alien plants 114-16 and dragonflies 83 and urban Australian butterflies 70 alien vertebrates 118-19 aliens (see also invasive aliens) 114-23 Allee effect 51 allopatric isolation 42 allopatric speciation, and rarity 50 Aloeides clarki 259 Aloeides dentatis 70, 221 alternative value system 7 Ambrosia beetle 24 amensalism 41 American burying beetle 99 angiosperm plants 19, 21 Angraecum 'longicalar' 45 Angraecum sesquipedale 45 animal surrogates 173, 174-5 Anoplolepis gracilipes 119, 120 ant, invasive alien impact 120 Anthocharis cardamines 140 anthropovicariance 107 ants as ecological engineers 41 and forest clearance in Cameroon 75 forest disturbance and energy recycling 76 impact of disturbance on 102 impacts of roads on 71 as indicators 201 invasive alien 119-22

as keystone species 41 in rainforest 42 and range retraction 170 in restoration 238, 239 restoration of 238 and roadsides 72 species richness and area 210 surviving deforestation 75 in undisturbed forest 77 Aonidiella aurantii 10, 126 Aphaenogaster longiceps 41 Aphantopus hyperantus 221 Aphelinus spp. 132 aphids and ecomorphs 24 and ethics 36 and global climate change 141 Aphytis africanus 126 Aphytis melinus 10, 126 Apis mellifera 122 Apollo butterfly and ethics 36 flight behaviour 22 and patches 92 and pollution 62 Aptera fusca 80, 81 aquatic diversity, and alien pines ecotones 83-4 insects, and canalization 72 - 3systems, deterioration of 80-4 Arctia caja 148 area of occupancy 182-5 Argentine ant and aggression 121 and genetic engineering 134 invasiveness of 120-21

Index 317

and trophic relationships 80 and urbanization 73 Argynnis adippe 256 Aricia agestis 145 Asclepias curassavica 131 Aspen blotch leaf-miner 173 Assisi interfaith conference 13 asymptote 169 atlas, of dragonfly geographical ranges 182 atlassing importance of fine scale 182 practicalities 182 atrazine 65 Atrophaneura luchti 254 attrition of landscape 91 of patch 217 Australia conserving urban butterflies 70 prickly pear in 125 Austrophasma rawsonvillensis 160 awareness of insect conservation 261 raising 36 trail, for dragonflies 258 trails 257 Bacillus thuringiensis and genetic engineering 131 israelensis 129 as a risk factor 127, 129 toxins on soil organisms 133 in transgenic crops 130,

132 bacteria, as insect pathogens 127 bacterium, *Wolbachia* 51 baculoviruses, genetic modification 129 Banana skipper 127 barriers, to dispersal in butterfly 219 baseline study 203 Basking malachite 12 bats, and cave insect survival 86 bauplan 22-3 bee condos 245 bee nesting sites 245 bees, as indicators of genetic engineering 133 beetle loss, with forest fragmentation 102 beetles in boreal forest 190 and canalization 73 effect of invasive alien plants on 115 and forest clearance in Cameroon 75 and forest disturbance 75 impacts of roads on 71 and pesticides 65 and the Quaternary 30 saproxylic 31 and size 29 Bemisia tabaci 142 Bessa remota 124 beta diversity 162, 163 Big-headed ant 119 bioaccumulation 63 BIOCLIM 186 biocontrol (see also biological control) agents, and disease 51 risk indices of 128 specificity 124 biodiversity bioindicators 200 compositional 52, 53 functional 52, 53 maintaining current levels of 165

surveys, necessity for including insects 175 biogeographic crossroads 162 bioindicators 199-200 functions of 200 testing of 199 and time scales 203 biological control (see also biocontrol) agents, screening of 126 agent, specificity of 126-8 as an insect service 9, 10 of insects, risks 124–5 positive effects 126 risk of over-regulation 126 risk/benefit analysis 126-8 risks of 124-8 biomass consumed by mice 118 of insects 42 plants and animals 46 of weeds, and genetic engineering 132 biome changes, in South Africa 161 Biosphere 2, 121 biotic contamination 124 BioTrack[™] 34 bird decline, with insect decline 42 birds in comparison with insect turnover 210 and insect recovery plans 247 as surrogates 174 birdwing butterflies 254 and CITES 253 park networks for 207 and trade 261 Biston betularia 61 black box approach 25 black box conservation 28 relative to landscape complexity 52

318 Index

Black hairstreak 101 black market, in insects 262 Black rat, eating insects 118 Bolivia, and transition zones 162 Boloria aquilonaris 250 borders, of farmland for bumblebees 226 boundaries for bumblebees 212 forest 102 insect reaction to 216 of reserves and patches 211 responses of butterflies to 93 boundary between game park and farms 244 of park for insects 209 of parks 208 of patches 219 boundary type 92 Brazilian rainforest 42 breeding insects 260 breeding stock 246 bridges, effects of 13, 71 Britain and fossil beetles 30 and insect extinctions 33 and interglacial 30 national recording scheme 182 and Neolithic landscape 31 British climate, Neolithic 31 British Large copper 86 Broad-bodied chaser dragonfly 183 Brown argus butterfly 145 Brown locust 46, 129 brownfield sites 231 Buchnera 51 Buddhist 13 Bufo marinus 118

bumblebees impacts of roads on 71 and landscape heterogeneity 212 burnets, and traffic 72 burning (see also fire) and ant biogeographical groups 227 and ant functional groups 226 and grassland 78 prairie 210 bush crickets, impacts of roads on 71 butterflies adaptive management of 224 and afforestation 68 in African corridors 227 atlassing in Britain 182 and birds as surrogates together 174 and boundaries 93 and bracken management 224 and British farmland 257 captively bred 263 change in geographical range 147 CITES-listed 254 in cities 70 and conservation headlands 225 deadstock of 263 declining fast at fine scale 182 different habitats of subpopulations 211 dispersal and habitat 43 in display houses 259-61 diversity on maps 191 and dragonflies, as icons 257 emigration from patches 95, 96 family surrogates for 164

first appearance of 141 as flagships 178 flight period of 141 flight response to landscape features 94 fluctuation in abundance 194 and forest clearance in Cameroon 75 and forest management 75 and forest patches 211 forest spatial heterogeneity of 76 and genetic engineering 131, 133 geographical range changes of 149 and global climate change 140 heliconiine 29 as indicators of fragmentation 201 as indicators of genetic engineering 133 intermediate mobility 68 isolated populations 43 and landscape edges 92 and landscape scale measures 190 loss of wetland species 82 managing for Borneo butterflies 224 managing prairie specialists 223 moving along corridors 228 patch quality for 219, 220, 222 perception of 36 and pesticides 64 population change and mobility 69 population change in Britain 69 in prairie 223

Index 319

in primary Bornean forest 77 reaction to landscape structures 44 and small calcareous grassland patches 217 stepping stone dispersal 213 and tallgrass prairie 173 threatened in Europe 223 threats from overcollecting 87 and tracking global climatic change 144 and traffic 72 and the United States Endangered Species Act 87 in urban areas 231 butterfly farming 262-3, 264 flight paths 228 gardening 244-6, 261 houses 259-61 houses, and public awareness 259 industry 262 long-distance gene flow in 43 range margins, and climate change 144, 145, 148 ranges, and global warming 144 recovery plans 247 reserve, and intermediate disturbance 70 reserve, dedicated 259 **Butterfly Conservation** 256 Cactoblastis cactorum 125 calcareous grasslands 223

calcareous grasslands 223 California 80 Calluna vulgaris 223 Calopteryx splendens 71 Cameroon, and butterflies 68 Canada 37 canalization 72-3 effects of 80-3 Cane toad 118 Cape bluet damselfly 33 Cape Floristic Region 49, 80, 158 and climate change 161 captive breeding 248-9 carabid beetles and brownfield sites 231 inter-habitat movement of 96 island colonization 101 large-bodied specialists 67 as poor biodiversity surrogates 175 and restoration 241 stepping stone dispersal in 214 in urban context 70 carbon dioxide atmospheric 138, 140 effects of changes in 161 elevated levels and insects 142 production by termites 41 carbon sequestering 138 Carboniferous airspace and insects 22 dragonfly 22 and insect radiation 18 Carduus nutans 124 Carterocephalus palaemon 144 Carulaspis minima 126 cascade effect, in food web 99 cascade effects, through loss of parasitoids 49 catastrophic regime shift (see also discontinuity) 55 Categories of threat, global **IUCN 197**

caterpillar, and its parasitoids 25 caterpillar rearing 35 cattle grazing, impacts on insects 78-80 cave cricket 86 cavernicolous species 85 caves in Table Mountain 83 threats to 85-6 Centinelan extinctions 53 Cercyonis sthenele 73 Ceres stream damsel 193 Ceroplastes brevicauda 12 Chaetocnema ectypa 142 Chalk-hill butterfly 107 chanelization (see also canalization) 72-3 change, inevitability of 52, 157 chaos 28 charismatic taxa, in reserve selection 165 chemical resistance 64 Chequered skipper butterfly 144 Chestnut heath butterfly 223 children, and insect icons 257 Chilocorus nigritus 23, 126 China, and fighting crickets 36 Chlorolestes apricans 12 Chlorolestes conspicuus 80, 81 Chlorolestes fasciatus 186 Chorthippus spp. 247 Christian 14 Christmas island 119 Chromolaena odorata 129 Chrysoperla carnea 132 Chrysoritis aureus 211 Cinnabar moth 32 Cirsium arvense 27 Cirsium thistle 125 CITES 253, 262 CITES-listed beetle 262

320 Index

CITES-listed butterflies 254 cities and insect management 231 - 2and threats to insects 68-73 Citrus wax scale 12 Cladosporium oxysporum 129 classical biological control (see also biocontrol and biological control) 124, 126. 127 climate, and the Quaternary 30 climate change (see also global climate change) and European butterflies 149 integrated conservation strategy 158 prehistorical 29-30 synergistic with habitat loss 146 climate models 137 climatic oscillations 30 Clossiana euphrosyne 256 coarse filter complementary with fine filter 25, 177, 181, 190 in conservation planning 167-73 and long-term conservation 45 and management 221 necessity of fine filter as well 224 and plant surrogates 173 and prairie conservation 174 Coccinella septempunctata 127 cockroach as food for threatened bird 42 giant flightless 80, 81 and perceptions 35 in undisturbed forest 77

Coega copper butterfly 259 Coenagrion mercuriale 214 Coenonympha glycerion 223 Coenonympha tullia 221 co-evolution, of host and parasite 50, 51 coffee plantations, and insects 68 Coleoptera development polymorphism in 21 and Neolithic impacts 31 radiation of 21 collaborative national conservation 256 collecting of Colophon 253 commercial 263 naïve 187 as a threat 86-7 for trade 253, 256 Collembola densities 42 as indicators of genetic engineering 133 and pesticides 64 colonization (see also movement, dispersal) of islands by carabids 101 of patches by bush cricket 97 of remote locations 43 Colophon primosi 262 Colophon species 150, 253, 255, 261 Comma butterfly 144 commercial collecting, in Papua New Guinea 263 commercial trade 253 Commidendrum robustum 126 common blue butterfly 240 common names, importance of 257 common species decline of 66

decrease in area of occupancy of 101 importance of sampling 173 Common wasp 123 community structure 40 competition 40-1 complementarity among reserves 162 lack of between taxa 164 over wide geographical areas 162 complementary areas, for richness and endemism complementary measures 176 complexity ecosystems and insect diversity 52 temporal and spatial 40 compositional biodiversity 52, 53 Compsilura concinnata 124 concordance, lack of 175 conduits (see movement corridors) connectance ecological 53-4 maintaining ecological 54 connectedness, in nature 14 connectivity (see also corridors, linkages) among reserve networks 163 between forest patches 214 of habitats 226-31 of urban forest patches 232 conservancies 165 conservation headlands as a conservation measure 64, 225, 229 and genetic engineering 131, 133

Index 321

conservation planning 176-8 and inventorying 186 and rare moths 189 taxonomic underpinning of 187 and threatened organisms 177 in urban areas 232 conservation strategy maps 246 Conspicuous malachite damselfly 81 consumer rarity hypothesis 62 contact zones 162 contamination, environmental 61-3 contemporary evolution 192 and global climate change 144 and management 225 context, of landscape 211-12 contrast, of landscape 92, 97 Convention on Biological Diversity 253 Convention on International Trade in Endangered Species (see also CITES) 253 conventions, and insect diversity conservation 124, 253-6 Convolvulus hawkmoth 45 Copsychus sechellarum 42 Corn-rootworm beetles 78 corridor functions 229 movement 92 quality of, for butterflies 227 width 228 corridors and bush cricket movement 228 for butterflies 208 and butterfly flight 228

for butterfly movement 2.28 and butterfly response 93 for carabid movement 228 connecting seral stages 213 for conservation of evolutionary lineages 230 and differential filter 228 edges of 228 functions 226 as habitats 227-30 having positive effect on moths 228 for insect diversity conservation 226-31 and long-term survival 229 in management 231 movement 228 network of habitat for leafminer 228 networks of 256 planting for fig-wasps 227 remnant 6 riparian 228 spatial scale of 230-1 sunny 212-13 in urban areas 232 Corsican swallowtail 254 Costa Rica, butterfly farms in 261 Cotesia marginiventris 132 countryside stewardship 257 countryside-wide conservation, in reserves in Karoo 257 management 215-17 and butterflies 229 Cranberry fritillary 250 Crazy ant, as a threat 119, 121 Cretaceous extinction 22

and insect-plant associations 21 and plant radiation 21 criteria, IUCN 197 Critically Endangered (CR) 197 crop plants, and pollinators 46 Cry toxins 127 cultivated landscape, in Switzerland 67 culture, as a evolutionary path 157 current extinctions 32–3 cutworm species 130

DNA 36 damselflies Hawaiian 42, 83 in Seychelles 43 damselfly and bridges 71 narrow endemic 80 Danaus plexippus and genetic engineering 131 and migration 23 and road deaths 72 Data Deficient (DD) 197 databases 185 DDT 64 dead wood 77 deadstock, butterflies 263 deadstock trade 261-2 Decticus verrucivorus captive breeding of 248 extinction frequency of 99 as a flagship 36 and patch size 98 as a pest 37 re-introduction of 248 deep ecology 7 deforestation and biodiversity 75 effect on bees 102

322 Index

deforestation (cont.) and termites 75 as a threat 37, 73-7 Deinacrida sp. 247 deleterious alleles 108 deltamethrin 64 Dendroctonus frontalis 142 Denmark, Maculinea alcon in 43 Dermolepida albohirtum 118 detector species 202 detritivores, and canalization 73 developmental polymorphism 11, 21, 24 Diabrotica 78 Diacheila arctica 31 Diacheila polita 31 Diamondback moth, and resistance 130 differential filter corridor as a 228 and global climate change 144 the landscape as a 44 and urbanization 70 digital images 34 digital technology 34 Diloba caeruleocephala 148 Diptera developmental polymorphism in 21 radiation of 21 discontinuity (see also catastrophic regime shift) 53 disease and insects 50-2 disease organisms, and stress 51 dispersal in butterflies 213 in Comma butterfly 217 and differential extinction 68 diffusive 43

distances in British dragonflies 50 to found new populations 101 in Glanville fritillary 219 importance over long term 229 in insects 22-3, 42-5 and like seral stages 213 limited in stream faunas 83 and management of damselfly 214 in marginal populations 199 of moths along corridors 228 powers of relative to fragmentation 67 relative to management action 213 relative to structures 68 saproxylic insects 77 and stepping stones 94 and successional habitats 213 in urban environment 70 dispersal ability, relative to conservation 43 display trade 261-2 dissection, of landscape 91 disturbance forest 76 increasing some species 68 and loss of insects 100 from megaherbivores 224 natural 208 and restoration 235 severity on ants 102 in streams 82 and tropical forests 75 disturbed habitat ability to colonize 211 colonization of 211 diversity compositional 25

functional 25 structural 25 Dociostaurus maroccanus 37 dot maps 182, 183 dragonflies and butterflies, as icons 257 and canalization 73 dispersal 49 effects of pollution on 62 as flagships 178 giant Carboniferous 22 impacts on 83 and landscape heterogeneity 212 national Red Listing of 199 and reservoirs 73 richness and island area 218 threatening processes to 83 and trout 83, 118 and urbanization 70 dragonfly diversity, Seychelles 50 ranges, and global warming 144 trail 257, 258 drainage, for agriculture 84 Drosophila species, and transfer genes 29 on temperature regimes 142 Drosophila melanogaster 10 dry forests 77 Dryococelus australis 118, 196 dung beetles and forest edges 211 as indicators 202 mapping of 185 and pesticides 64 and recovery from insecticide 65 surviving deforestation 75 Dysauxes ancilla 228, 230

Index 323

Earth ethic 156-8 Easter Island 55 ecological bioindicators 200 connectance 53 engineers, generating diversity 42 integrity, and keystone species 40 integrity, conservation of 8.9 integrity, restoration of 235, 240, 244 landscaping 236, 237 relaxation, and forest patches 76 relaxation, and parks 207 relaxation, and synergistic impacts 66 transition areas 162 ecomorphs 23, 24 ecophilosophy (ecosophy) 7, ecoregions, global 158-62 ecosystem diversity relative to insect diversity 52 as a surrogate for insect diversity 52 ecosystem, and keystone species 40 ecosystem engineers 41-2 ecotones, aquatic 83-4 ecotourism 261 Ectemnorhinus 118 ectoparasites 50 edge landscape 90 permeability of 92 edge effect and butterflies 93, 94 and changing trophic relationships 80 and parasitism 98 wind mediated 227 edge impacts 216

edges and butterfly behaviour 93 of corridors 228 of farmland for bumblebees 226 insect reaction to 216 and natural enemies 92 of parks 208 preferences for in moth 230 receding, of forests 217 of reserves and patches 211 responses to 92 soft 97 education educational exposure to weedy species in urban areas 232 and ponds 232 educational perspective 13 El Niño effects of 199 effects on reserves 208 and savanna streams 83 elaiosomes 49 elevational gradients 163 emigration, from patches 219 Empoasca 142 enclosures, for re-introduction 247 Endangered (EN) 197 endemic hotspots 162 endemics in caves 85 concentrations of 159 in global hotspots 158 in grasshoppers 78 in Mediterranean-type ecosystems 80 for prioritizing areas 176 refugium in city 81 relative to contact zones 162

in Spanish dung beetles 185 in Vietnam butterflies 208 endophagous insects 49 Enemy Release Hypothesis 127 energy transfer, in grasshoppers 46 English Nature 256 entomopathogenic fungus 129 Entry Level Agri-Environment Scheme 257 environmental bioindicators 200 conditions, adverse (see also weather, El Niño) 221 contamination 61-3 gradients, conservation of 165.176 surrogate measures 164, 165 ephemeral habitats, and butterflies 211 Epirrita autumnata 61 Erionata thrax 127 Eriophora pustulosa 122 Erynnis comyntas 127 establishment, reasons for success 246 ESU (see also evolutionarily significant units) 11, 23, 28, 33, 43, 197 ethical issues, and biocontrol 124 ethics 4-9 eucalypt remnants 221 Eulophus pennicornis 132 Euphydryas aurinia 246, 256 Europe loss of species in 67 and Quaternary insects 30 eutrophication evaluation, for Red List 197

324 Index

evolution active areas of 162 from extinction events 118 rapid 144 evolutionarily potent insect diversity 53 evolutionarily significant units and anthropovicariance 107 and global insect species richness 28 and historically isolated lineages 176 and movement 43 and polymorphism 23, 28 and Red Listing 197 and the taxonomic challenge 33 uniqueness of 11 evolutionary change from stress 117 stress-induced 116 evolutionary component, of biodiversity 175 evolutionary potential 8 conservation of 176 evolutionary processes 106 evolutionary success 21 Evolutionary-Ecological Land Ethic 6 ex situ conservation 248 extent of occurrence 182-5 Extinct (EX) 32, 196, 197 Extinct in the Wild (EW) 32, 33. 197 extinction avoidance of by focused management 225 avoiding local 228 avoiding on islands 84 avoiding using flight 43 of British Large copper 84, 87 Centinelan 53

from climate change and habitat loss 146 close to and habitat variance 211 declaration of 32 deterministic 99 even in large patches 53, 250 following population crash 37 in forests 32 of froghoppers in patches 218 in the future 99 and greenhouse effect 139 of insects following plants 49 local 98-100 local at range margins 107 local in butterflies 53, 250 local in a grasshopper 43 local in bush cricket 217 local in froghopper in patches 217 and loss of heterozygosity 108 national 33 natural 98 from overcollecting 86 and phylogenetic measures 175 population 32 of populations 68 probability of 109 reducing by farming 263 regional 33, 101 regional in a bush cricket 92 relative to habitat destruction 100 risk in Fender's blue 250 risks in different taxa 211 Satyr butterfly 73 in small patches 92 of specialists 101 and stress events 118

from synergism of global climate change and fragmentation 145 and time delays 99 and urbanization 73 extinction debt 99, 207 extinction rates current 32 reduction as a goal 156 extinction risk, in hotspots 158 extinctions cascades of 54 current 32-3 role of natural enemies in 126 time delays and 54 extirpation 37 families, as surrogates 164 family turnover 19 family-level diversity, over time 19, 20 Farm Scale Evaluations 131 farming, of butterflies 262-3, 264 farming insects 253 farmland, and British butterflies 257 Fender's blue butterfly 249

Fender's blue butterfly 249 Field cricket 248 field margins, and parasitism 98 fighting crickets 36 Figure of eight moth 148 Fiji, and biocontrol 124 fine filter complementary with coarse filter 27, 177, 181, 190 in conservation planning 167-73 and habitat management 221

Index 325

and insect icons 257 and plant surrogates 174 and Red Listing 195 fire and ant biogeographical groups 227 and ant functional groups 226 and Australian ants 225 and grassland 78 importance of patch burning 223 and prairie butterflies 223 simulating natural 223 Fire ant 121 fire regimes, in urban context 70 fish, as predators of insects 42 fish, impacts of 83 flagship species 176, 177-8 fleas, and extinction of host 50 flight and insect success 22-3 in Meadow brown 213 origin 22 flight behaviour of butterfly 214 effect of bridges on 71 flight constraints 22 flight period, changes in butterflies 141 flight response, of butterflies 94 floodplain gravel bars 73 flowers and insect evolution 21 and pollinators 45 and specialized pollinators 45 fluctuations, in environmental conditions 43 flying insects 22-3

food chains, and genetic engineering 132, 134 food web depiction of 190 and keystone species 40 of Nothofagus forest 85 food webs change of in New Zealand 85 complexity of 49 connectance in 53 insects and vertebrates 42 and insects morphs 25 mediating interactions 54 as a sampling protocol 189 foraging 22-3 forest (see also primary forest) clearance, Neolithic 31 disturbance, and energy recycling 76 edge (see also edge and primary forest) 68 fires 74 floor 73 function 74 gap 102 loss (see also deforestation, habitat loss and fragmentation) 73-7 Forest Stewardship Council 256 Forest tent caterpillar 102, 126 Formica exsecta 170 fossil beetles in Britain 31 and Quaternary 30 fossil insect diversity 18 fossil insects in Britain 31 diversity of 20 fragmentation beneficial to some species 104 of forests 102

and gene flow 108 geometry of 103 and global climate change 144, 145 of habitats 66, 67, 68 of landscape 67, 91 and species loss 103 and species-area relationship 105, 106 fragments, value of small 210 France 31 Frankliniella 142 frass, and nutrient turnover 41.46.79 fugitive radiation 84 fugitive species 43 functional biodiversity 52, 53 correlations, of species 202 diversity, gardening for 246 groups, and restoration 238, 239, 240, 241-2 groups, comparative indicators of 203 surrogates 175 types, in urban context 71 functionally dominant species 173 fungi, as insect pathogens 127 Funnel ant 41 fuzzy edges (see also halos and boundaries) 90 fynbos and ant invasive 120 and insect endemism 80 and stem borers 223

Gaia 157 galling insects 49 gambling, with insects 36 *Gambusia* species 118 garden status, of parks 208

326 Index

Garden tiger moth 148 gardening, of insects 244-6 gardens, as refugia for wildlife 231 gene flow and anthropovicariance 107 in contemporary evolution 193 and genetic engineering 133 importance of 108-10 long-distance 43 within populations 108 gene transfer 29 genes, incorporation into crop plants 127 genetic adaptation, to captive environments 249 bottleneck, of Argentine ant 120 bottlenecks, and islands 86 change, in biocontrol agents 126 changes, and the landscape mosaic 107-10 divergence, in isolated populations 107 diversity across geographical range 107 active zones of 162 maintenance in captivity 249 maintenance of 176 engineering and development of resistance 130 ecological risk of 130 and large-scale experiments 131-2 and loss of rainforest 132

and management activities 133 and non-targets 131-3 and pesticide use 130 and pollinators 132-3 risks of 130-4 similarities with biocontrol 134 as weed management regimes 131 heterogeneity, reduction of 107 mixing, Quaternary 30 similarity, in Argentine ant nests 121 variance, and stress 117 variation, and polymorphisms 23-4 variation, in Fender's blue 250 variety, importance of conserving 165 viability, of mainland populations 110, 111 genetically modified organisms 130-4 genotype-phenotype symbiosis 11 geographical range changes in British butterflies 147 changes, and European butterflies 149 and extent of occurrence 183 and genetic diversity 107 and mapping 181 mapping of 183 Germany, and canalization 73 glaciation, and insect range changes 30, 31 Glanville fritillary 95, 108, 109, 218, 219, 220 global hotspots 159

insect species richness 28 - 9mean temperatures 137 precipitation, changes in 137 sea-level 30 warming 137, 147 global carbon fluxes 41 global climate change and butterfly phenology 140 and community changes 138 and contemporary evolution 144 direct effect on insects 138 - 40effects of flooding 147 effects on plants 138 and elevational range 145, 148 and European butterflies 149 and flight times 140 and geographical range changes 143-5 and habitat loss 146 and hotspots 158 and insect diversity conservation 136-51 and medical insects 143 on moths 146 and mountain specialists 150 and pollution 62 and range changes 142-3 and range margins 145, 148 and Red Listing 145 and sea levels 147 synergistic with habitat change 144 and trophic interactions 140-3 Globe skimmer 44 GMOs 130-4

Index 327

goals, conservation 4, 157 Gonimbrasia belina 5 Gough Island global change on 138 and insect, invasions 85 introduction on 119 grasshoppers consuming grass 46 as ecosystem engineers 41 endemism 78 impacts of roads on 71 as indicators 201 inside and outside parks 208 and invasive alien plants 116 local extinction in 43 non-targets of pathogens 129 in partially logged forest 77 and pine patches 211 recycling nutrients 41, 46, 79 restoration of 243 grassland from clearance of wildwood 101 condition, monitoring using grasshoppers 201 island reserves 80 loss 78 remnants, for Japanese insects 210 swards, improvement of 247 transformation 78-80 grasslands ant indicators of 201 conversion 37 impact of afforestation on 68 and rare species 78 Grayling butterfly 99 grazing

of European grasslands 223 impact on trophic guilds 79 intensity of 225 management of for grasshoppers 224 and succession 225 variety of 225 green areas, in cities 231 green lanes, and bumblebees 71 green nodes 70 greenhouse effect, and community change (see also global climate change) 139 greenhouse gas concentrations 137 Green-veined white 141 Greenways (see also corridors) 226 - 31Gross Domestic Product 61 Gryllus campestris 248 Guam, invasion of 85 guilds Middle Jurassic 21 and restoration 243 Gypsy moth 23

habitat (see patch, and landscape) destruction, and species dynamics 100 fragmentation 66, 67, 68 fragments, and Argentine ant 121 heterogeneity (see also landscape heterogeneity) 210, 212-15 heterogeneity, in quarries 71 loss, and global climate change 145

loss, and species-area relationship 105, 106 loss, synergistic with climate change 146 loss, versus fragmentation 66 network, protecting (see also patches) 250 persistence, and macroptery 43 quality (see also patch quality) 217-21 quality, for bush cricket 99 quality, for Fender's blue 250 quality, importance of 219 quality, relative to isolation and metapopulation 221 tolerance, in rare butterfly 223 tolerance, of threatened butterflies 211, 223 HadCM2 model 161 Halobates sp. 18 halos, of high species diversity 68 Hamadryas februa 92 Hawaii and biological control 126 damselflies in 42 invasion of 85 and moth extinctions 49 heat island effect 70 Heath fritillary 84, 247, 256 heathland carabids hedgerow and bumblebees 71 insects, and pesticides 64 matrix of 227 and parasitism 98 heliconiine butterflies 29 Helius 19 Hemicordulia tau 118 herbicides, impact on insects 65

328 Index

herbivore diversity and plants 104 and predators 104 herbivores and developmental polymorphism 25 and elevated levels and carbon dioxide 142 and feedback loops 47 and global climate change 140, 141 insect 46-9 and parasitism 25 on plant surrogates 173 and pollution 62 and pressure on plants 21 in urban context 71 Hesperia comma 96, 217 heterogeneity and environmental surrogates 164 landscape (see also landscape heterogeneity and habitat heterogeneity) 25, 212-15 of landscape 167 maintaining in urban areas 231 management for maximum 215-17 managing for landscape 223 patch 210 patch for bush cricket 215 patch quality and 222 of stream habitats 168 Heteropan dolens 124 heterozygosity loss of 108 maintenance in captivity 249 heuristic value, of insects 10

High brown fritillary 256 Hindu 14 Hipparchia semele 99 historical data 185, 198 history of insects 18-22 Holly leaf-miner 92 honeybees and genetic engineering 133 as invasives 122 providing services 5, 9 host insect 40 insects 40, 49-50 plant quality 92 plants, importance for butterflies 231 plants, importance of 92 specificity 49 switching 49 hotspots of butterfly rarity and threat 190 global 158 location of 185 and taxonomy 175 human genome 6 human impact, early 30-2 human value systems 4-9 hummingbird hawkmoths 246 Hurricane Andrew 261 hydrologic drought 73 Hydromedion sparsutum 115 Hydropsyche tobiasi 61 Hymenoptera 21 Hyperaspis pantherina 126

Icaricia icarioides 249 iconic species 36 iconization, of insects 258 icons, butterflies and dragonflies 257 Inachis io 144 inbreeding 108 depression 108

indicator species 199-200 indicators choosing for task in hand 201 of disturbance (butterfly guilds) 201 functions of 200 or responders? 199 and time scales 203 indigenous vegetation, establishing in urban areas 232 individuals, rights of 11 industrial melanism 61 IndVal 202 insect gardening 244-6 herbivores 46-9 houses 259-61 mariners 18 pathogens, risks of 127-30 plant relationships (see also herbivores, insect herbivores and insect plant interactions) 21 pollinators 45-6 prey 42 radiation 18-22 rearing 259-61 rights 11 services 9 utility 9-11 insect decline, and birds 42 insect diversity conservation, and plant conservation 46 and plant diversity 41 relative to ecosystem diversity 52 and rise of plant diversity 19 insect-plant interactions, herbivory 46-9 insect-plant relationship 21

Index 329

insects and angiosperms 19-22 food for other animal 42 and vertebrates 42 insolation for dragonflies 83 in forests 77 for insect species richness 212 reduced effect on dragonflies 116 instrumental value 5 intelligent tinkering 157 interaction strengths, ecological 40, 41 Interglacial 30 intermediate disturbance in forests 76 generating diversity 100 in urban context 70 intrinsic value, and the Red List 195 introductions, on islands 119 invasion, of islands 85 invasion biology, of natural enemy 127 invasion process, model of 123 invasive alien ants 119-22 alien aquatic plants 116 alien insects 119-23 alien plants 114-16 alien plants, and insect diversity 115 alien plants, cost of control 115 alien plants, increasing common insects 116 alien plants, species sensitivity to 116 alien plants, stress on natural systems 116 alien psylla 125 alien trees, shading out dragonflies 116

alien vertebrates 118-19 alien wasp 122 aliens, control strategies 115 aliens, impact on Nothofagus forest 85 aliens, threats from 114 - 23plants, and nectar for rare species 246 invasiveness characters of 122 of insects 123 inventorying 186-90 methods and approaches 187 irreplaceability 165, 186 irreplaceable insect diversity irreplaceable lineages 176 Island Biogeography Theory, and island dragonflies 50, 217 island populations, and gene flow 108 islands area and species richness 218 carabid movement between 101 colonization by dragonflies in Seychelles 217 colonizing 23 and genetic viability 111 and global climate change 142 importance of small ones 163 and invasive ants 119 isolation of 99 for maintaining regional set of species 163 and metapopulation dynamics 218 oceanic 84-5

prioritization for 163 as refugia 163 risks of biocontrol agents 124 and species-area relationship 167 and stochastic events 167 vertebrate impacts on 118 isolation, of patches and occupancy 220 **IUCN** categories of threat, global 197 categories, regional or national 198 criteria, global 197 Red List of Threatened Species 195, 196 ivermectin 64, 65

Jewish 14 Juniperus bermudiana 126 Junonia coenia 227 Jurassic 18, 21

Karkloof blue 259 Karner blue butterfly 247 Karoo 46, 79 Key Centre for Biodiversity and Bioresources 34 keys taxonomic 34 user-friendly 35 keystone organisms 40-1 role 40 species 40-1 and connectance 54 parasitoids as 49 and pollination 46 Krakatau arrival of arthropods on reassembly of pollinators on 52 Kubusi stream damsel 193

330 Index

Lacanobia oleracea 132 Lackey moth 148 ladybirds foraging in 23 and global climate change 143 as regulators 49 lag period, of invasive aliens 116 land mosaics, evolutionarily significant 53 landscape attrition 90 changes and fluxes 52 complexity, and parasitism 98 conservation 28 context 211-12 contrast, in urban areas 231 descriptors of 96 as a differential filter 44 dissection 90 features of 96 fragmentation 90 heterogeneity (see also habitat heterogeneity) 25, 167, 212-15 measurable parameters of 216 mosaic 90 dynamics of 216 management of 215-17 natural changes and insect diversity 52-3 perforation 90 perforation, and beetles 102 planning 208 transformation 90 transformation, and adaptively equipped insects 53 variegated 52 landscape-scale study 66

land-use intensity, impacts on bees 69 Lantana camara 246 Large blue butterfly 247 Large copper 84, 86, 247 Large heath butterfly 221 large-scale spatial considerations 212 Larinus planus 125 late successional stages, importance of 222 Least Concern (LC) 197 legal restrictions 254 Lepidoptera 21 and air pollution 61 in display houses 259-61 larvae, in partially logged forest 77 Neolithic grassland 32 as non-targets of pathogens 129 road kills 72 and traffic deaths 72 urban gall-inhabiting 70 Lepidosaphes newsteadi 126 Lepidota frenchi 118 Leprous grasshopper 12 Leptidea sinapsis 227 Lestes barbarus 68 Levuana iridescens 124 Libellula depressa 183 liberation thinning 75 lice, and extinction of host 50 linear strips 226-31 Linepithema humile 73, 80, 120-1, 134 linkages (see also corridors) 226-31 for butterflies 208 and butterfly response 93 in food webs 54 remnant 6 Listronotus bonariensis 124

livestock and grasshoppers 224 simulating game 78 lobbying, for insect conservation 262 local extinction 217 local processes, importance of 101 Locustana pardalina 46, 129 log-normal distribution, of species 188 log-normal statistical distribution, of species 188 logging and collateral damage 74 relative to reserve areas 74 as a threat 73-7 Lopinga achine 213 Lord Howe Island stick insect 118, 196 Lulworth skipper 220 Lycaeides melissa samuelis 247 Lycaena dispar batavus 247 Lycaena dispar dispar 84, 86 Lycaena helle 211 Lycaena phlaeas 101 Lymantria dispar 23

Mabuya 42 Macrocentris cingulum 132 macroptery 43 Maculinea alcon 43 Maculinea arion 247 mainland populations 108 mainlands, and genetic viability 110 maize, and genetic engineering 130 Malacosoma disstria 102, 126 Malacosoma neustria 148 malaria, and global climate change 143 management adaptive 223, 224 of African grassland 224

and bioindicators 199

Index 331

for butterfly recovery 247 and contemporary evolution 225 and deep time 225 focused for rare species 225 and higher trophic groups 224 involving corridors 231 involving some disturbance 221 and monitoring 192 multiple approaches 221 outside reserves 221 practical recommendations for 226 of prairie butterflies 223 to prevent succession 211 for a range of species 224 and the Red List 195 regulation of 224-6 and restoration of particular species 247 rotational 224 and selection of reserves 162 sensitivity to different species 210 of succession 222 in urban areas 231-2 using burning for ants 226, 227 using grazed mosaic 225 of wider countryside 216 managing, for successional habitats 213 Maniola jurtina 213, 214 Mantophasmatodea 158, 160 mapping butterfly diversity 191 complementing with reference sites 203 of dragonflies in Britain 183

and insect diversity conservation 181-5 overcoming biases in 203 and phylogeny 185 significance of scale 182 using presence/absence records 186 marginal populations 108 species 198 colonizing wide range of habitats 199 marginality 198 margins, around fields with genetically modified crops 131 Marion Island 118 Marsh fritillary 246, 256 marshland 83–4 mass extinction 18 matrix around patches 211 importance of quality 217 influence on patch 96 landscape 215 quality of 214 quality of, for butterfly 218 Mayotte, dragonflies 62, 116 Meadow brown butterfly 213, 214 Mediterranean, and Neolithic impact 31 Mediterranean islands. threats to 116, 118 Mediterranean-type ecosystems 80 meek inheritors, definition of 36 meek inheritors, and food web connectance 54 Megalagrion 119 Meganeura 22 Meganeura monyi 22 Melanagromyza geneoventris 27 Melanoplus spretus 37

Melipona bees 102 Melitaea cinxia 95, 108, 109, 218, 219, 220 Mellicta athalia 84, 247, 256 Metacnemis angusta 193 Metacnemis valida 193 metals, in food 62, 63 metapopulation on an archipelago 99 break up of 98 as a conceptual tool for interactions 43 of Cranberry fritillary 250 dispersal in 213 Fender's blue 250 and genetic load 108 illustration of models 216 and intermediate mobility 68 and island effects 218 and isolation and habitat quality 221 and landscape mosaic 215 in large patches 219 and long-term survival 250 models of 213 and movement 32 and movement between islands 96 and pioneers 217 and population cohesion 96 and population viability analysis 250 and regional perspectives 101 and stepping stone dispersal 213 with respect to oceanic islands 86 Metarhizium anisopliae 127, 129 methane 41 Metrioptera bicolor 92, 97, 98, 215, 217

332 Index

Metrioptera roeseli 199, 228 Metropolitan Open Space Systems 231 mice, impact on insects 118 Microctonus aethiopoides 124 microlepidoptera, in the Netherlands 145 Microplitis rufiventris 132 microsporidian 129 Microtylopteryx hebardi 102 migrants and genetic viability 110, 111 in reserve selection 164 migration (see also movement and mobility) 43 and gene flow 108 and successional habitats 213 migrations 23 minimum population growth 250 mining, restoration from 239, 240, 241 mobility differential in insects 42 - 5at edges 92 relative to ecosystem diversity 52 and species decline 68 model BIOCLIM-type 186 climate change and species loss 146 of extinction probability 109 HadCM2 161 of invasion process 123 Pressure-State-Response 193 of regional conservation planning 172 of restoration 236

of species accumulation curves 170 of species surrogates 171 modelling of Fender's blue 250 global climate change and range changes 143-5 invasiveness 123 models of gene flow 108 and genetic engineering 134 for geographic patterns 185 of global climate change and fragmentation 145 of movement in corridors 228 of range retraction 170 of species accumulation curves 169 of species loss 103-4 Monarch butterfly and genetic engineering 131 and migration 23 overwintering sites 261 and road deaths 72 roosts 76 monitoring 192-5 aims 192 approaches 192-5 coarse filter 194 genetic changes 192 surrogates 193 threats to Red Listed species 194 water quality using insects 201 monkey beetles 79 Mopane 'worm' 5 moral guidelines 4-9 moral tools 157 Moroccan locust 37 morphospecies 34, 175 morphs 11, 23

mortality, from traffic 71, 72 mosquito fishes 118 moth pollinator 45 moths in agricultural habitats 67 and air pollution 61 change in abundance over time 148 and forest disturbance 75 and forest patches 211 importance of sampling common species 170 as indicators 203 island colonization 101 North American forest 188 recent decline in 146 Mountain malachite damselfly 186 mouthparts 21 movement between habitats (see also mobility) 95-8 between patches 95-8 of carabids on islands 101 impact of structures on 71 impacts of roads on 71 in insects (see also migration and mobility) 42-5, 92 movement corridors 228 multispecies plans 247 Mus musculus 118 museum specimens 34 Muslim 14 mutualism, aphids and endosymbionts 51 mutualisms, plant and insect 46 mycoinsecticide 129 Myrmecophilus sp. 120 Myzus persicae 132

names

common 257 scientific 33 narrow endemics 80

Index 333

overgrazing

national conservation issues 256-7 mapping schemes 182 Red Listing 198-9 natural conditions, simulating 222-6 natural disturbance 208 from megaherbivores 224 natural enemies and genetic engineering 132 host range 127 number of insect host 40 and pesticides 64 pools of 9 release from 127 risk indices of 128 risks of introducing 124-8 screening of 127 in urban context 71 natural habitat, importance of 105-6 Near Threatened (NT) 197 nectar importance of configuration of 92 provision, by invasive alien plants 246 sources, restoration of 241 sufficiency of 96 nematodes, as insect pathogens 127 Neolithic human impact 31 Neophilaenus albipennis 217, 219, 241 Neoptera 22 nesting blocks 245 New Zealand invasion of 85 and invasive alien ragwort 115 wasp in 123 weed biocontrol risks Niche Opportunity Hypothesis 127 Nicrophorus americanus 99

Nodding thistle 124 non-target impacts, around prickly pear 125 lepidopteran 129 moth 124 non-targets 124 Nosema locusteae 127 Nosema sp. 129 Nothofagus 68, 85, 123 nutrient cycling 46, 47 and frass 41, 46, 79 and primary productivity 47 nutrients, for plants 41

oceanic islands 84-5 Oedipoda caerulescens 43 oilseed-rape 132 Okavango 83 old-growth forest (see primary forest) for longicorn beetles 208 Ooencyrtus erionotae 127 Operophtera brumata 129, 141 Opuntia maxima 116 Opuntia species 125 Orachrysops ariadne 259 Orachrysops species 225 Orange tip butterfly 140, 141 orchid 45 Ornithoptera 'allottei' 261 Ornithoptera alexandrae 253 Ornithoptera meridionalis 261 Ornithoptera richmondia 36 Ornithoptera victoria regis 254 Orthezia insignis 126 Orthoptera, as pests and conservation subjects 37 Orthosia gothica 140 Osmia lignaria 245 Osmoderma eremita 177, 247 outbreaks, from overgrazing 78 overcollecting 86-7 of Large copper 86

and insect population dynamics 78 effects on insects in Argentina 79 and pollinators 79 stimulating locust increase 37 ozone depletion 138 palaeodiversity, in Switzerland 67 Panaxia quadripunctaria 78 Pantala flavescens 44 Papaipema eryngii 95 Papilio aristodemus ponceanus 261 Papilio dardanus 94 Papilio homerus 261 Papilio hospiton 254 Papua New Guinea and Banana skipper 127 butterfly farming in 263 Pararge aegeria 228 parasites, as impacting on biodiversity 50 parasitism as an opportunistic way of life 49 and pollution 61 parasitoid, as a service provider 10 parasitoids 49-50 as biocontrol agents 124 as cryptic species 33 and genetic engineering 132 and global climate change 140 and habitat destruction 102 isolation in urban context 71 number attacking caterpillars 25 and patch quality 96

334 Index

parasitoids (cont.) prone to extinction 49 and spatial scale 126 parataxonomists 34 Paratrechina longicornis 121 Pareuchaetes 129 park boundary, and grasshoppers 209 parks 207-12 effectiveness of 207-8 vegetation change in 207 Parnassius apollo flight behaviour of 22 and patches 92 and pollution 62 Passenger pigeon phenomenon 37 patch area and extinction rate 218 and islands 99 patch attrition 101 connectivity 99 fragments, becoming depauperate 102 heterogeneity 210 isolation 98 isolation, and occupancy 220 quality for bush cricket 99 importance of 66, 96, 210, 219, 220 relative to patch size 217-21 remaining 102 response to 102-3 and special attributes 98 in urban areas 231 selection 92-5 size 210-11 as a critical factor 98 and host plant 92 importance of 96 and pollinators 211

relative to patch quality 217 - 21relative to quality 66, 96 patch-matrix, reducing contrast 217 patch-scale study 66 patches colonization by bush cricket 97 heterogeneity of 212 and the landscape mosaic 67.216 and the matrix 211 mosaic of for grasshoppers 224 of primary habitat 216 remnant 102, 207-12 small 94 small, certain value of 217 with host plants 102 pathogens 50-2 commercial 129 and global climate change 140 non-targets effects of 129 past impacts 129-30 risks of 127-30 Peacock butterfly 144 Pearl-bordered fritillary 256 peat bogs 211 Pectinophora gossypiella 142 pentachlorophenol 65 Peppered moth 61 perception challenge magnitude of 35-6 overcoming the 257-9 perforation, of landscape 91 permanent monitoring sites 182 permeability of edges 92 of landscape 92 Permian 18 pest definition of 36

in a conservation context 23 insect species as a 23 insects 36-7 management, and genetic engineering 131 pesticides effect on insect populations 64 effects of 63-5 and food chains 63 hazards of 63 increase in usage 65 and natural enemies 64 quantities used 63 reduced input 64 reducing fitness 64 reducing grasshopper populations 64 synergistic impacts 64, 65 and urban context 63 Pheidole megacephala 119 philosophy, environmental 4-9 Phragmatobia fuliginosa 146, 148 Phyllonorycter salicifoliella 173 phylogenetic diversity measures 175-6 species concept 28 Phymateus leprosus 12 Phytomyza ilicus 92 Pieris napi 141 pines and dragonflies 83 reducing grasshoppers 116 place, sense of 25 plague 36 planning process, and consultation 157 plant architecture (see also plant structure and vegetation structure) 21 plant assemblages, and insects 173 plant diversity

Index 335

conservation, and insects 103 increasing relative to herbivore pressure 21 and insect diversity 104 plant species, as determinant of insect diversity 103 plant species richness and dragonfly species richness 173 plant stress, and disease 51 plant structure (see also vegetation structure) and insect diversity 49, 116 plant surrogates, for insects 173-4, 201 plant-animal associations, framework for 48 plant-insect interactions 25-7 plantation trees, and biodiversity 256 planthoppers, dispersal in 43 plants insects feeding on 46 as predictors of insects 173 Plasmodium falciparum 143 Platycleis fedtshenkoi 92 Platypus cylindrus 24 Pleistocene, and southern hemisphere 78 Plutella xylostella 130 poaching 253 poeciliid fish, as predators 42 poleward shift in geographical ranges 144 pollination, and weed set being affected 211 pollinator, specialist 45 pollinator effectiveness 46 pollinators 45-6

and developmental polymorphism 25 fig wasps 52 and genetic engineering 132-3 maintaining indigenous plants 9 monkey beetles 79 in parks 208 and plant diversity 21 and restoration 240 as service providers 9 pollution 61-3 and disruption of ecological processes 63 gaseous 63 and global climate change 62 gradients, and insect diversity 62 lack of negative effect 62 levels, in water 61 long-term effects of 62, 63 and predators 62 pulsing of 62 as a synergistic factor in streams 83 in soil 62, 63 tolerance of 62 Polygonia c-album 144 polymorphisms abundance in insect world 11, 23-5, 28, 43 developmental 11, 21, 24 relative to ecosystem diversity 52 and sense of place 25 and the taxonomic challenge 33 Polyommatus bellargus 220 Polyommatus coridon 107 Polyommatus icarus 240 ponds educational value 232 and spatial scale 212

population change, from stress 117 crashes 36-7 viability analysis 249-50 populations at edge of range 199 importance of conserving a variety of 165 prairie butterflies, management for 210 fragments 78 and insect specialists 174 insects, management for 210loss of 78 management of 223 quality of patches 222 remnants 210 and sedentary species 95 type and quality 221 pre-agricultural impacts 29-30 precautionary approach, and the Red List 195 precautionary principle and ethics 11 and landscape triage 53 and maintaining heterogeneity 215 and primary forest 76 precipitation, global changes in 137 predation, by alien fish 83 predators and genetic engineering 132 and global climate change 140 insect 49-50 isolation in urban context 71 and the landscape 49 large home range of 62 risks of in biocontrol 127

336 Index

predators (cont.) susceptibility to pesticides 64 vertebrate 42 predicting alien invasions 115 prehistorical times 29-32 presence/absence data 185 Pressure-State-Response model 192, 193 prickly pear cacti 125 primary forest (see also forest, patch quality, patches, remnant, reserves and wilderness) 101 and ants and termites and butterflies 76, 77 importance for ants 210 importance of 75, 76 for longicorn beetles 208 representation of 76 and saproxylic insects 77 as source area 98, 211, 238 for specialists 76 for Vietnam butterflies 208 primary production, and intensity of phytophagy 47 primary productivity, and nutrient cycling 47 prioritization global 158-62 and inventorying 186 need for 163 of reserve areas 166, 174 taxonomic 34 processes, conservation of 176 processes, valuing 8 Proclossiana eunomia 96, 230 Proctolaelaps regalis 29 productivity and food webs 54 and ponds 212

Proischnura polychromatica 33 Prokelisia 43 Prosopis glandulosa 115 protected areas, and off-reserve areas 165 protoctistans, as insect pathogens 127 Pseudaletia unipunctata 98 public and flagships 178 perception, of insects 257 understanding, of keystone species 41 viewing of insects 260 Pycnoscelus indicus 42 quality control, of sampling 175 quality habitat (see also habitat quality and patch quality) 212, 219, 220, 221 quality of habitat for bush cricket 99 of patch 220 quarries, and butterflies 71 Quaternary 29, 30 radiation, of insect families 21 Ragwort 115 rainbow trout 83 rainfall, global changes in 137 rainforest (see primary forest, reserves and wilderness) RAMAS software 196 ranching insects 253 ranges, small 103 rapid species assessment 200 rare insects 173 non-inclusion of 173 trade in 253 rare moths 189

rare species and habitat tolerance 211 in late successional stages 223 and restoration 238, 240 special consideration of 2.2.4 rarity, and parasitism 50 rat fleas 36 Rattus rattus 118 reaction-diffusion models 92 rearing, of insects 32, 248-9 Recent 18 recolonization, of patches by bush cricket 217 recovery, of species 246-7 recruitment, as a limiting factor 101 Red admiral 140, 141 Red imported fire ant 119, 121 Red List Authorities 196 Categories 195-7, 198-9 criteria, at the regional level 198-9 and fine filter 27 its value 195 and overexploitation 9 species verification on 187 and uncertainty 196 Red Listed butterflies 254 species, correlation with indicators 174 Red Listing 195-7 and global climate change 145 process 196-7 Red scale 10 re-establishment of ants 238, 239 of moths 240, 241 reference sites 203

Index 337

regional categories 198 conservation planning, model of 172 pool 212 processes, in temperate areas 101 Red Listing 198-9 species richness 101 regionally threatened 24 regreening 236, 238 rehabilitation 236, 237 re-introduction 246-7 breeding for 260 of British butterflies 246 of British Lepidoptera 246 of crickets 248 importance of habitat quality 246 using multiple genetic lines 249 relational spatial databases 185 religion 15 remnant forest, importance for ants 210 patch size 210-11 patches 207-12 woodland 94 representation, of biodiversity 176 reserve boundary, and grasshoppers 209 for butterfly 259 networks 162, 163 selection 144, 162-3, 166, 174 reserves 207-12 effectiveness of 207-8 importance of for dragonflies 208 important for weevils 208 important qualities of 211 for particular species 259

vegetation change in 207 wildlife 235, 243 reservoirs, impacts on insect diversity conservation 73 resilience, of stream faunas resistance, to invasive species 54 **Resource Conservation Ethic** 5,6 resources, consumption of global 61 restoration of African savanna 243 ants as indicators of 238, 239 and appropriate food plants 240 for bees 242 of birds and insects 247 of breeding conditions 245 of calcareous grasslands 241 and the coarse filter 240-4 and constraints 239 countryside-wide scale 243 and degraded systems 239 and ecological dynamics 239, 240 of ecological integrity 235, 240. 244 and the fine filter 240-4 of functional groups 238, 239, 241-2 in game reserve 243 of grasshoppers 244 and guilds 243 of insect diversity 234-50 model of 236 and moths 240, 241 and multispecies plans 247 of nectar sources 241 and park boundaries 244 of pollinators 240

of saproxylic biota 215 and severe disturbance 241 and specialist species 239 of streams 243 and synergistic impacts 247 and trajectories 240 triage 235–7 and trophic levels 239 while maintaining successional processes 238 and wildflower swards 241-2 Réunion island 124 Rhine 61 Rhinocyllus conicus 124 Rhizobius lophanthae 126 Rhopalosiphum padi 132 Rhus 126 Richmond birdwing butterfly 36 rides, and forests 212, 227 Ringlet butterfly 221 riparian corridors 228 woodland, restoration of 238 risk indices, of biocontrol agents 128 risks of natural enemies 126 - 8river systems, contamination of 61 road kills, of Lepidoptera 72 roads and collecting 86 impacts of 71-2 road-zone effect 72 Rocky Mountain grasshopper 37 Romantic-Transcendental Preservation Ethic 5 rotational grazing 224 logging 76 management 224 Ruby tiger moth 146, 148

338 Index

sampling efficiency 167-9 food webs 189 historical factors 190 and home ranges 189 intensity 188 and inventorying 187 protocol 189 protocols for monitoring 194 representative 189 subsets 189 for threatened species 190 a wide range of taxonomic and functional groups 189 saproxylic beetles Neolithic 31 Norwegian Red-Listed 174 biota, restoration of 215 insects, as a functional group 77 invertebrates, combining sampling approaches 175 species, and importance of late succession 222 saturniid moths, as non-targets 125 Satyr butterfly 73 Satyrium pruni 101 Scarab beetles 162 Scarabaeidae 79 scarcity, and parasitism 51 Schaus swallowtail 261 secondary pest problems 125 pest resurgence 64 succession (see also succession) 47 sedentary species, and movement 95 sedimentation of rivers, Neolithic 31

seed production 46 seedling recruitment, impact of insects 49 seeds, ant burial of 47 selection procedures, for reserves 165 selective logging 76 Senecio jacobaea 115 sense of place 7 seral stages (see also succession) 222-3 management 213 services, ecological 9 sex, as a means of avoiding disease 51 sexual morphism 24 Seychelles dragonflies 50, 116 fugitive damselflies in 43 and invasive ant 119 magpie robin 42 shading out, of dragonfly habitat 116 sheep, distributing grasshoppers 241 shelter, and quality habitat 217 shelter belts 227 ship stowaways 119 silk moths, sustainable utilization of 87 silk products 10 Silver-spotted skipper 96, 217 simulation, of natural conditions 225 Simulium 73 sink population 32 Sites of Special Scientific Interest 86, 257 Sitona discoideus 124 skink 42 Small copper 101 small worlds 54 smelter pollution 61 snow, decrease in 138

social factors, in urban conservation 232 socio-economic role of flagships 177 soft edges 217 soil erosion, Neolithic 31 soil fauna and ecological engineers 41 and successional stages 213 soil fertility, and grasshoppers 79 soil modifiers 41-2 Solenopsis geminata 121 Solenopsis invicta 119, 121 source area, for restoration 238 source habitats provided by unlogged forest 98 reserves as 211 various types 216 source population South Africa alteration of insect diversity by alien plants 115 and Brown locust 46 invasive alien plants 116 and soil nutrients 41 South Asian Invertebrates Specialist Group 196 South Georgia 115 Southern African Invertebrates Specialist Group 196 Southern pine beetle 142 sowing plants, for bees 242 Spain, hotspots within 185 spatial heterogeneity of butterflies in primary forest 76 in tropical forest 75 spatial resolution 185 spatial scale(s) 25, 44, 101-2

and attributes 24

Index 339

and bioindicators 200 and corridors 230-1 large 212 and parasitism 27 significance of small 211 and species numbers spatially explicit heterogeneity 212 special conditions, for insects 173 Specialist Groups, IUCN/SSC 196 specialist, vulnerability of a 99 specialists ant 226 being lost most 67 carabid 101 of forests 76 as heralds in wetlands 84 impact of global change on 145, 146 maintaining nodes for 106 managing for grasshopper 224 most affected 104 restoration of 239 specialization hypothesis 62 species concepts 29 conservation, and the Red List 196 cryptic 33 data, and mapping 181 definition 28 diversity, estimating 188 dynamics, and habitat destruction 100 extinction 11 loss, and fragmentation 103-4 modelling 170 of particular habitats 164 richness

correlations between functional groups 202 correlations between insect taxa 201 estimation of 34, 188 in different insect taxa 200 on Earth 29 and island area 218 relative to area 210 turnover in moths 188 rights of 11 surrogate measures 164, 165 surrogates and accumulation curves 170 various taxa 171 weakness of 169 species accumulation curve(s) 169, 170, 188 Species Information Service 196 Species Survival Commission 196 species' response to landscape change 90 species-area relationship 105, 106, 167 and species loss 103 species-scape 17 species-specific recovery plans 246–7 Speckled wood butterfly 228 Speleiacris tabulae 86 spiders attacked by wasps 123 impact of ants on 119 perception of 36 and pesticides 65 in urban context 70 spiritual awareness 11 spiritual conceptions 15 Spodoptera littoralis 132 stability, in food webs 53, 54 state, changes in ecological 54 Steinernema feltiae 127 steppes 78 stepping stone corridors 227 habitat 213–14 patches 94, 102 Stigmella 19 stochastic environmental effects, and patches 221 stochasticity demographic 108 environmental 108 stonefly 22 stowaways, insect 119 stream faunas resilience of 82 in USA 168 stress and insect susceptibility 102 from invasive aliens 116 structural biodiversity 52 structural features, of landscape 68 structures impacts of 68-73 and insect diversity 71 of landscape 96 succession 212-13 among plants 47 and insect gardening 246 natural 222-3 in quarries 71 and reservoirs 73 and restoration 238, 243 successional stages, maintenance of 76-7 Succulent Karoo and climate change 161 as a hotspot 158 sunlight (see insolation) surrogate combinations 165 data 164

340 Index

surrogate (cont.) measures environmental 164, 165 species 164, 165 species, relative to landscape complexity 52 surrogates animal 173, 174-5 birds versus insects 210 in conservation planning 163-5 functional 175 higher-level taxonomic 21 insect taxa 200 and inventory data 190 large-sized ants 175 monitoring 193 plants for insects 201 taxonomic 173, 174-5 threatened organisms as 177-8 and umbrellas 177 using species accumulation curves 169 surveys (see sampling) sustainable use 11 sustainable utilization, of silk moths 87 Swallowtail butterflies on display 260 and farming 262 Swiss Alps, and snow season 138 Switzerland, and landscape change 67 symbiotic organisms 41 synergistic impacts and disease 51 and fragmentation 67 from alien vertebrates 118 of genetic engineering 133, 134 and global climate changes 145

and grassland 78 of human population 66 involving biocontrol agents 126 on islands 84 and prioritization 163 and restoration 247 in streams 82 in tropics 67 and urbanization 70, 73 with pollution 62 systematic reserve selection 162-3, 166, 174 systematics 33 Table Mountain, Cape Town 81 Taiwan butterfly sales in 261 and butterfly tourists 261 Tamarixia dryi 124, 125 Tasmania, threats to indigenous bees 122 taxa lack of concordance between 175 one as a surrogate for another 164 taxonomic challenge 33–5 distinctness 176 expertise, importance of 34, 187

expertise, importance of 34, 187 groups, comparative indicators of 203 impediment 33 indicator groups 177 knowledge 29 scale 21 surrogates 173, 174–5 taxonomy, importance of 34, 175 temporal considerations, for management 212–13

temporal scales 101-2

termite assemblage, restoration of 238 termites and deforestation 75 as ecological engineers 41 as gas producers 41 and nutrient cycling 46 Quaternary 30 in rainforest 42 Tertiary 30 Tetranychus urticae 132 Tetraphalerus 19 tettigoniids, impacts of roads on 71 Texas, and fire ant 119, 121 threat category 23 threatened butterflies, and rare ones 190 Lepidoptera, in grasslands 80 organisms, as surrogates 177-8 Orthoptera, in grasslands 80 species and butterfly houses 260 and importance of taxonomic expertees 187 in caves 86 increase in 32 monitoring of 194 relative to pest status 37 taxa, and species surrogates 170 tree 126 threats, and multispecies plans 247 threats, and the Red List 195 - 7Thymelicus acteon 220 timber extraction (see also deforestation) 75 Tobias' caddis-fly 61

Index 341

Tomato moth, and genetic engineering 132 topography in habitat remnants 105 importance of 163 total species curve 188 tourism 261 tourist impact, on moth 78 tourists, collecting moths 86 tracking resources 43 Trade Fairs 256 trade in Colophon 253 in dead specimens 261-2 traditional agricultural practices 222-6 traffic, impacts of 71-2 traffic impact, on Lepidoptera 72 trail, for dragonflies 257, 258 trails, awareness 257 transformation, of grassland 78-80 transgenes 130-4 transgenic crops 130-4 transition areas 162 translocation 246-7 of weta 247 transmission, of endosymbionts in aphids 51 tree canopy and dragonflies 83 and great insect loss 80 and insect diversity (see also primary forest) 73 tree diversity 41 tree hollows 177, 247 tree-holes 76 triage landscape 53 in restoration 235-7 species 259 taxonomic 34 Trialeurodes vaporariorum 142

Triassic 11, 18, 21 Trichilia 126 Trioza erytraea 51, 124, 125 Trioza litseae 124 trophic cascades, and global climate change 140 trophic diversity, gardening for 246 trophic guilds, and grazing impacts 79 trophic interactions, and global climate change 140-3 trophic levels and connectance 53 depiction of 190 and genetic engineering 132.134 increase in with vegetation structure 213 trophic relationships, change of 80 tropical forest (see primary forest and reserves) trout, impact of 83, 118 'tyranny of numbers' 36 Tyria jacobaea 32

umbrella species 163, 176-7 relative to landscape complexity 52 umbrella taxon 36 umbrellas caution when using 190 plants as 173 United States, and Rocky Mountain grasshopper 37 United States Endangered Species Act 87 urban area management 231 - 2urban disturbance, in California 174 urbanization, impact of 68 - 73

USA and butterfly road kills 72 and grasshoppers 47 utilitarian value 5 utilization, of insects 86 **UV-B 138** value instrumental 5 utilitarian 5 values, diversity of 9 Vanessa atalanta 140, 141 variegated landscape 52 variegation model, of landscape 90 vector, of plant disease 51 vectors and global climate change 143 insect 50, 51 vegetation change, in parks 207 vegetation changes, to climate 30 vegetation structure variation for dragonflies 212 variation for various insects 212 vertebrate impact, on tenebrionids 118 vertebrates depending on insects 42 invasive alien 118-19 as poor surrogates of insects 175 Vespula vulgaris 122, 123 vicariance 176 Violet copper 211 virgin patches (see primary forest) virtual reality, risks of 157 viruses, as insect pathogens 127 volunteer recorders 182, 185

Vulnerable (VU) 197

342 Index

Wart-biter bush cricket weather, catering for captive breeding of 248 extremes of 214-15, 221 extinction of populations webmasters, ecological 36 of 99 weed biocontrol as a flagship 36 and accidental and patch size 98 introduction of small changes in DNA of pathogens 129 37 risk-to-benefit ratio 125 wasps risks of 125-6 and estimates of insect weevil pests, and biocontrol species richness 29 124 impact on spiders 122 West Africa 41 invasive 122 wetlands loss of 82 predation on spiders 123 threats to 83-4 water levels, changes in 83, wild areas, value of (see also 84 wilderness) 8-9, 243 water monitoring wild game, simulated by programmes 61 cattle 208 waterholes, and insect wilderness, value of (see also wild areas) 207-8 conservation 78

wildlife parks 207-12 wildlife reserves 235, 243 wildwood 181 wind currents 23 wings, and origin of flight 2.2 Winter moth 129, 141 Wolbachia 51 Wood white butterfly 227 woodland, remnants of (see also forest, primary forest and patches) 101 world conservation strategy 10 world crisis 6 Xanthopan morgani praedicta 45 Yucca moths 21