

Index

Entries occurring in figures are followed by an f; those occurring in tables, by a t.

- Abatement programs, 337
 - emissions control, 275–285
 - at Falconbridge, 54f, 63–65
 - at Inco, 282–284
 - see also Air quality improvement
- Abies balsamea* (balsam fir), 17
- Acer rubrum*, see Red maple
- Acer saccharum* (sugar maple), 17, 115f
- Acid-generating wastes
 - acid rock drainage, 292–293
 - integrated management approach, 289, 290f, 291
 - tailings revegetation at Copper Cliff, 123–132
- Acidification
 - geological factors contributing to effects of, 14
 - GIS studies, 305–306
 - interacting factors in ecological damage, 25, 319
 - lakes
 - paleolimnology studies, 38–40, 41f
 - urban, 258, 259, 260f
 - nitrogen compounds and, 320
 - remote sensing surveys, 301–303, 304f
- Acid mine drainage, rehabilitation of, see Wetlands, engineered
- Acid rain, 320
 - control program, 56
 - geological factors contributing to effects of, 14
 - historical perspective, 29
 - interactions between stressors, 319
- Actinomycetes, 226
- Aerobic reactions
 - wetlands processes, 136–137
 - see also Redox processes
- Agricultural crops, 51, 58–59
- Agrostis gigantea*, see Redtop
- Agrostis scabra*, see Tickle grass
- Agrostis stolonifera*, 251t
- Air quality improvement, 51–65, 275–285
 - abatement at Falconbridge, 63–65
 - abatement at Inco, 282–284
 - decline in emissions, 56–57
 - future projections, 59–60
 - governmental regulations, 52–55
 - integrated management, 287–288
 - lichens as indicators, 89, 90; see also Lichens
 - particulate fallout, 58
 - recognition of problem, 51–52
 - recovery after, 47–49
 - of aquatic communities and lake water quality, 67–78;
 - of plant communities, 93–102;
 - regional and international transport of pollutants, 54–56
 - terrestrial effects, 57–59
 - see also Emission control technologies
- Aix sponsa* (Wood Duck), 206f, 207, 208t, 209t, 210f, 214
- Alders (*Alnus crispa*; *Alnus rugosa*), 226
- Algae
 - filamentous green, 74f, 75
 - lake liming effects, 200
 - lichen symbiont, 81
 - recovery after emissions abatement, 72–73
 - soil, 221–223;
- Algal mats, 70
- Alkaline lakes, 43
- Alnus crispa*, 226
- Alnus rugosa* (alders), 226
- Alsike clover (*Trifolium hybridum*), 113t, 174, 179, 180, 226
- Aluminum
 - interactions between stressors, 319
 - lake water
 - paleolimnology, 37–38, 39f, 40, 41f
 - sources of, 40
 - urban lakes, 261

- Aluminum (*cont.*)
 soil
 leaching of, 70
 liming effects, 173
 mobilization by acid rain, 319
 podzolization and, 10
 toxicity to plants, 25, 26, 27f
- American Black Duck (*Anas rubripes*), 206f, 207, 208t, 209t, 210f, 211f, 213f, 214
- American elm (*Ulmus americana*), 27
- Ammonia
 soil nitrogen cycling, 226–228
 wetlands processes, 136
- Ammonia removal, 296
- Amphibians, 67
- Anabaena*, 223t, 225
- Anaerobic processes
 sediments, *see* Anoxic-oxic conditions
 wetlands, 136, 137,
- Anaphalis margaritacea* (pearly everlasting), 100, 174, 175
- Anas platyrhynchos* (Mallard), 129, 206f, 207, 208t, 209t, 210f, 214–215
- Anas rubripes* (American Black Duck), 206f, 207, 208t, 209t, 210f, 211f, 213f, 214
- Anoxic-oxic conditions
 and iron and manganese oxyhydroxide solubility, 186
 lake sediments
 iron oxyhydroxides and, 186–188
 and trace element behavior, 184
 tailings revegetation barrier effect, 131–132
 wetlands, 136–137, 138, 140
see also Redox processes
- Antimony, 183
- Aquatic biota
 acidification effects, 69f
 lake liming effects, 197–202
 natural recovery after emissions reduction, 71–75
 paleolimnology, *see* Paleolimnology
 urban lakes, 264, 265f
see also Lake sediments
- Aquatic ecosystems
 rehabilitation of, 295
see also Catchment management; Lakes; Lake sediments
- Arctonais lomondi*, 75
- Arsenic, 183
 geological influences on geochemistry, 14
 lake sediments, 184, 185f, 187–188
 ore composition, 9
 soil, 220t, 223
- Aurora trout (*Salvelinus fontinalis*), 143–152, 195, 197, 318
 description of, 145
 evolution/speciation, 145, 147–149
 rehabilitation of native lakes, 149–151
 taxonomic classification, 147, 148
- Aythya collaris* (Ring-necked Duck), 206f, 207, 208t, 209t, 210f, 211f, 214
- Bacidia chlorococca*, 86
- Bacteria
 lake liming effects, 201
 soil, 223, 224–225
 wetlands processes, 136, 137, 138, 139, 140
- Balsam fir (*Abies balsamea*), 17
- Balsam poplar (*Populus balsamifera*) lichens, 83–87
- Balsam willow (*Salix pyrifolia*), 96, 175
- Bass (*Micropterus dolomieu*), 201, 268
- Bedrock, 5, 10
 geological influences on geochemistry, 13–14
 urban planning considerations, 327
- Benthic invertebrates, 67
 acidification effects, 69f
 liming effects, 200, 201
 recovery of, 74–75
 urban lakes, 265
- Bessemer matte, 279–280
- Betula alleghaniensis* (yellow birch), 17
- Betula papyrifera* (paper birch, white birch), 228; *see also* White birch; Birch coppice woodlands
- Betula pumila* (bog birch), 97
- Bicarbonate generation, wetlands processes, 136
- Bioavailability of metals in soil, 220
- Biodiversity
 arctic tundra, 238, 241t
 aurora trout restoration, 145–152
 birch coppice woodlands, 241–244
 Canadian species at risk, 146t
 land reclamation and, 178
 loss of, 143, 144–145
 municipal greening project and, 112
 soil microorganisms, 221–224
- Birch coppice woodlands, 233–244
 comparison with high arctic tundra, 239, 241
 definition, 233
 insect effects, 237–239, 240f
 long-term lack of change in, 240–244
 microclimate effects, 234–236
 site characteristics, 234–235
Vaccinium angustifolium, 235t, 248, 249
- Birch transition community, 27, 28f, 30
- Birdsfoot trefoil (*Lotus corniculatus*), 100, 174, 175f, 180, 226, 227f
 municipal greening project, 113t
 tailings revegetation project, 127, 128
- Black Duck (*Anas rubripes*), 206f, 207, 208t, 209t, 210f, 211f, 213f, 214
- Black locust (*Robinia pseudoacacia*), 113t, 115f, 116f, 127, 180, 226
- Black spruce (*Picea mariana*), 17, 115f
- Blueberry
 relict shrub species, 27
see also Lowbush blueberry; *Vaccinium* species
- Bog birch (*Betula pumila*), 97
- Bosminia longirostris*, 69f
- Bowland Lake, 196, 198f, 199f, 200, 201
- Bracken (*Pteridium aquilinum*), 27
- Brook trout (*Salvelinus fontinalis*), 67, 75f, 76; *see also* Aurora trout
- Bryophytes, birch transition forest, 235t

- Bucephala clangula* (Common Goldeneye), 206f, 207, 208t, 209t, 210f, 211f, 212–213, 213f
- Buffering capacity, lakes, 12–13, 33, 37, 43, 67–68
- Burbot (*Lota lota*), 69f, 75
- Burrowing mayfly (*Hexagenia*), 265
- Cadmium, 183, 190
- Caenis*, 74
- Calcium
- acid rain and, 70
 - interactions between stressors, 319
 - lake water
 - buffering by, 12–13
 - and lake recovery, 76
 - reductions in, 68
 - soil
 - mobilization by acid rain, 319
 - podzolization and, 10
- see also Liming
- Calcium carbonate, wetlands processes, 140
- Calcium hydroxide, see Liming; Soil treatment
- Calcium oxide, see Liming; Soil treatment
- Calcium sulfate, 278, 283
- Calamagrostis canadensis*, 235t
- Canada bluegrass (*Poa compressa*), 94, 175, 179
- municipal greening project, 113t
 - tailings revegetation project, 127
- Candelaria concolor*, 86t
- Candelariella vitellina*, 86t
- Carbonate minerals, lake buffering, 13
- Carbon dioxide, water treatment with, 289
- Carbon dioxide fixation, soil microbes and, 224–225
- Carex*, 95, 96
- Carex aenea*, 95, 175
- Carex aquatilis*, 94f
- Carex retrorsa*, 94f, 96
- Carex scoparia*, 96
- Caribou lichen (*Cladina rangiferina*), 82f, 83, 84, 86t, 88
- Catostomus commersoni* (white sucker), 69f, 75, 145
- Catchment management, 313–321
- environmental protection model, 315–316
 - integrated approach, 313–315
 - Sudbury region issues, 316–321
 - external factors, 319–320
 - interaction between stresses, 319, 320–321
 - secondary and tertiary pollution, 317–318
 - time scale, 318–319
- Catchment planning, 293
- Cation pump, soil, 175
- Cattails (*Typha latifolia*), 97, 131f, 139, 140, 251t, 295
- Cetraria*, 84
- Cetraria ciliaris*, 82f, 86t
- Chalcopyrite, 9
- Chaoborus* (phantom midge), 37, 77
- Chaoborus americanus*, 37
- Chemical composition, Sudbury ore, 276, 277f
- Chernobyl, 83
- Chlamydomonas acidophila*, 222
- Chlorella*, 223t
- Chlorella saccharophila*, 222, 223t
- Chlorophytes, 222, 223t
- Chlorosarcina*, 223t
- Chydorus sphaericus*, 76
- Cisco (*Coregonus artedii*), 76, 77f
- City planning, see Urban planning
- Cladina mitis*, 88
- Cladina rangiferina* (reindeer/caribou lichen), 82f, 83, 84, 86t, 88, 307–308
- Cladotanytarsus*, 75
- Clay
- aluminum release from, 26
 - ion exchange mechanisms, 13
- Clearwater Lake, 36–38, 41f, 184, 186, 190, 258f, 265
- Climate, 10–11, 70, 75, 319–320
- Cobalt, 183
- bedrock chemical patterns, 14
 - ore composition, 9, 277f
 - soil, 25, 220t
- Cold climate urban design, 330
- Collembola*, 224
- Colonization
- municipal greening project, 112–113
 - plant community recovery, 93–102
- see also Plant community dynamics
- Colonization theory, lake liming results and, 201
- Common Goldeneye (*Bucephala clangula*), 206f, 207, 208t, 209t, 210f, 211f, 212–213, 213f
- Common Loon (*Gavia immer*), 206f, 207, 208t, 209t, 210–212, 210f, 295
- Common Merganser (*Mergus merganser*), 206f, 207, 208t, 209t, 210f, 211–212, 211f, 213f
- Common shiner, 69f
- Community energy efficiency, 330
- Community involvement, see Public participation
- Community transportation, 330–331
- Companion crops, 125
- Comptonia peregrina* (sweet fern), 27, 179, 180, 226, 235t, 251t
- Copper
- atmospheric deposition of, 25, 317–318
 - Bessemer matte, 279–280
 - catchment management issues, 318–319
 - geobotanical prospecting, 84
 - geological influences on geochemistry, 13
 - lake sediments, 189
 - ore composition, 9, 276, 277f
 - plant micronutrients, 250
 - soil, 25, 26, 27f, 223
 - toxicity to plants, 25, 26, 27f
 - urban lakes, 260f, 261
 - wetlands removal of, 138
- see also Metal contaminants
- Copper Cliff, 57
- abatement efforts, 278–281, 282f, 283f, 284f
 - recycled water use at, 288
 - revegetation of tailings area, 123–132
- Coppice woodland, see Birch coppice woodlands

- Coregonus artedii* (cisco), 76, 77f
Cornus canadensis, 235t
 Cost accounting for resource use, 331–332
 Costs, municipal land restoration, 116–117
Cottus cognatus (slimy sculpin), 70
 Crayfish (*Oronectes virilis*), 70
 Creeping red fescue (*Festuca rubra*), 113t, 127
 Crustaceans, 69f, 70
 opportunistic invasion, 76
 species richness, 73
 Cultural eutrophication, urban lakes, 260f, 261
 Cyanobacteria, soil, 221–223
Cyclotella ocellata, 39f
Cyclotella steligera, 37, 39f
- Daisy Lake, 306–307
Danthonia spicata (poverty grass), 101
Daphnia galeata mendotae (water flea), 69f, 201
Daphnia magna, 139
Daphnia pulex, 74
Dero nivea, 75
Deschampsia caespitosa, *see* Tufted hairgrass
Deschampsia flexuosa, 235t, 251t
Desmidium, 73
Desmococcus, 223t
Desulfovibrio, 136
 Diatoms
 acidification effects, 69f
 soil, 222
 see also Paleolimnology
Diervilla lonicera, 235t, 251t
 Dissolved organic carbon (DOC)
 remote sensing surveys, 301–303, 304f
 UV absorption, 320
 Wanapitei/Algoma study, 308–309
 Diversity, *see* Biodiversity
 Dolomitic limestone, 175
 Drainage, tailings revegetation project, 125–126
 Ducks, *see* Waterfowl population trends
 Dust emissions, tailings, 123–124, 125
 Dwarf birch (*Betula pumila*), 97
- Ecological ethic, 333, 335, 342
 Ecological values, 170
 Economic activity, *see* History of human activity
 Economic analysis
 benefits and costs, 340
 municipal land restoration, 116–119, 120f
 urban planning, 331–332
 Economic benefits, 273, 337
 Ecosystem management
 economic costs and benefits, 340
 ethics/social values, 342
 integrated land management approach, 294–295; *see also* Integrated management
 partnerships, role of, 340–341
 public pressure and policy, 338–339
 science, role of, 341–342
 Sudbury case history, 336
 Sudbury program elements, 335–337
 sustainability, 342–343
 Ecosystems
 catchments as, 313–315; *see also* Catchment management
 tailings revegetation effects, 127, 128, 295
 in urban planning, 325–329
 see also specific types of systems
 Ectomycorrhizae, 224, 228, 229
 Elliot Lake, 140, 307f
 Emission control technologies, 63–65, 275–285
 Falconbridge Ltd. program, 63–65
 improvements in Sudbury region, 287–288
 Inco Ltd. program, 276–285
 Copper Cliff smelting process changes, 278–279, 280f, 281f, 282f, 283f, 284f
 global comparisons, 285
 recent control technologies and strategies, 279–281
 recycling, 284
 sulfur emission reduction, 276–278
 proactive approach, 275
 public awareness and legislation, 275–276
 see also Air quality improvement
Empetrum hermaphroditum, 252, 253
 Energy efficiency, community, 330
 Engineered wetlands, *see* Wetlands, engineered
 Environmental chemistry, *see* Geochemistry
 Environmental impact assessment
 paleolimnology, 33–34
 progressive rehabilitation, 293
 urban planning, 331
 Environmental monitoring, *see* Monitoring
 Environmental protection models, catchment management, 315–316
Ephemerella, 74
Epilobium angustifolium (fireweed), 100
Epischura lacustris, 69f, 74
Equisetum arvense (field horsetail), 94f, 97
Equisetum sylvaticum (wood horsetail), 97, 251t
 Erosion, 27f, 94–95
 interacting factors in, 24–25, 319
 tailings, 123–124, 125, 126
 Ethic, environmental, 333, 335, 342
Eubosmina, 74
Euglena, 223t
Eunotia exigua, 37, 39f
 European larch, 115f
 Eutrophication, 260f, 261, 320–321
Evernia mesomorpha, 82f, 86, 86t
 E-ways, 329
 Exotic species, 144, 262, 264
- Falconbridge
 sulfur dioxide abatement system, 54f, 63–65
 wetlands rehabilitation, 138–140, 295
Falco peregrinus anatum, *see* Peregrine Falcons
 Fall rye (*Secale cereale*), 125, 126
 Fathead minnow (*Pimephales promelas*), 69f, 70, 319
 Fertilizer application, *see* Soil treatment
Festuca rubra (red fescue), 113t, 127
 Field horsetail (*Equisetum arvense*), 94f, 97
 Filamentous green algae, 74f, 75

- Fire, 18, 24, 25, 27t
 Fireweed (*Epilobium angustifolium*), 100
 Fish, 75
 acidification effects, 69f, 70
 catchment management issues, 318
 Falconbridge tailings settling pond, 295
 interactions between stressors, 319
 interactions with zooplankton, 77f
 lake liming effects, 200, 201
 loss of sport fish species, 67
 mercury levels in, 210
 paleolimnology, 33
 recovery after emissions abatement, 75
 restoration project, *see* Aurora trout (*Salvelinus fontinalis*)
 urban lakes
 changes in, 268
 exotic species, 262
 observed versus expected average, 264f
 species richness, 264
 waterfowl requirements, 207, 208t, 213f, 215
 wetlands species, 139
 Five hundred year planning, 327
 Flash furnace product, 279–280, 280f, 281f
 Flash furnace smelting, 52
 Forests
 denudation, 319
 history of human activity, 17–18, 19, 21, 22–23
 urban, 329–330
 see also Birch coppice woodlands; Tree planting
 Foxtail barley (*Hordeum jubatum*), 94
 Frankia, 226
 Frost action, 25, 26, 27f
 and birch coppice woodland, 235, 237f, 241t, 243–244
 tailings freeze-thaw cycles, 123–124, 125
Frustulia rhomboides, 37
Frustulia rhomboides v. saxonica, 39f
 Funding of restoration projects, 337
 Fungi
 carbon dioxide fixation, 224
 hyphae, 221
 lichen symbiont, 81, 83
 mycorrhizae, 179, 224, 228–229
 see also Soil biota
 Furnace matte, 63

 Garden crops, 58–59
Gastropus, 73
Gavia immer (Common Loon), 206f, 207, 208t, 209t, 210–212, 210f, 295
 Geobotanical prospecting, 96
 Geochemistry
 catchment mass balance, 320
 geological influence on, 12–14
 lake waters, 67–68, 70
 paleolimnology, *see* Paleolimnology
 tailings revegetation barrier effect, 131–132
 see also pH; Redox processes; *specific elements and ecosystems*
 Geographic information systems, 303, 305–307
 goals of monitoring, 299
 integration with remote sensing, 307–309

 Geography and geology, 5–14
 climate, 10–11
 geological effects on environmental chemistry, 12–14
 glaciation, 5, 9–10
 lakes, 11–12, 12f
 ore, 9
 soils, 11
 Sudbury Basin, 5–9
 vegetation, 11, 17
 Geology, 4t
 GIS thematic layers, 305f
 Sudbury Basin, 5–9
 urban planning considerations, 327
 see also Geography and geology
 GIS, *see* Geographic information systems
 Gleysols, 10
Gloeocapsa, 223t
Gloeocystis, 223t
Glyceria canadensis (rattlesnake grass), 97f
 Goals of restoration, 105–107
 catchment management, 313, 315
 municipal greening project, 112
 Gold, 9
 Government regulation, 4t, 342
 air quality improvement, 51, 52–54
 closure and rehabilitation standards, 203
 emission control, 275–276, 281–282, 284
 Grassing, 178
 municipal greening project, 112–113, 113t, 114f
 tailings revegetation project, 125, 126–127
 Green housing, 332
 Green space/greenways, 329–330
 Ground-level ozone, 58–59
 Groundwater, *see also* Water quality
 iron and manganese oxyhydroxides in, 186
 wetlands and, 140
 Gypsum, 278, 283

 Hair moss (*Polytrichum commune*), 27, 235t, 251t
 Hannah Lake, 40, 196, 197, 198f, 199f, 200, 200f, 201, 258f
Hantzchia, 223t
Hexagenia (mayfly), 69f, 74, 265
 High arctic tundra, 238, 241t
 History of human activity, 4t, 17–30
 damage to ecosystem, 22–30
 acid rain, 29
 factors in, 24–27
 plant communities, 27–30
 logging, 17–18
 mining, 18–19
 roast yards, 19–22
 History of Sudbury region, 3, 4t
Holopedium gibberum, 74
 Hooded Merganser (*Lophodytes cucullatus*), 206f, 207, 208t, 209t, 210f, 211f, 213–214, 213f
Hordeum jubatum (foxtail barley), 94
 Horsetail, 94f, 97
 Housing, green, 332
 Human values, 170

- Humic acids, 136–137
Hyaella azteca, 74, 265
 Hydrogen sulfide generation, 186, 187–188
 Hydrology
 urban lakes, 262–263
 see also Watershed
- Inco Ltd., 4t
 Copper Cliff revegetation project, 123–132
 emission control program, 276–285
 Superstack, 53f, 54
 Index of atmospheric purity (IAP), 83, 87
 Indicator species
 diatoms, *see* Paleolimnology
 lichens, *see* Lichens
 urban lakes, 264
 Industry
 role of, 342
 see also Partnerships
- Insects
 aquatic, 33, 200, *see also* Aquatic biota
 defoliation by
 birch coppice woodlands, 236–238, 240–241f, 242–243
 Vaccinium angustifolium, 249
 lake liming effects, 200
- Integrated management
 acid rock drainage, 292–293
 aerial treatment program, 293–294
 air and water quality improvement, 287–288
 catchments, 313–321
 future challenges, 295, 296
 industrial lands, 289–291
 progressive rehabilitation, 293–296
 self-sustaining ecosystem development, 294–295
 water management and treatment, 288–289
- Invertebrates, 70
 aquatic
 lake liming effects, 200, 201
 urban lakes, 265
 zooplankton interaction, 77f
 see also Benthic invertebrates
 soil, 224; *see also* Soil biota
 waterfowl requirements, 207, 208t, 212
- Ion activity product (IAP), 188–189
 Ion exchange mechanisms
 clay, 13
 lichens, 82–83
 wetlands, 135–136
- Iridium, 9, 191, 261
 Iron, 51
 lake sediments, 184, 186–188, 189–190
 ore composition, 276, 277f
 particulate fallout, 58
 pH effects
 on metal sorption, 189–190
 on solubility, 288
 process technology, 278, 279
 soil
 mobilization by acid rain, 319
 podzolization and, 10
 wetlands processes, 136, 137, 139–140
 Iron oxides, phosphate fixation, 127
 Iron/titanium ratios, 88
- Jack pine (*Pinus banksiana*), 179, 180, 226
 logging of, 17
 municipal greening project, 113t, 115, 115f, 116f, 117f
 tailings revegetation project, 127, 128, 129, 130f
 Japanese larch, 115f
Juncus brevicaudatus, 96, 97f
Juniperus virginiana (red cedar), 178
- Kelly Lake, 177f, 191, 258f, 261, 320
 Kentucky bluegrass (*Poa pratensis*), 113t, 127
Keratella cochlearis, 73
Keratella taurocephala, 73
- Laccaria laccaria*, 228
Lactarius rufus, 229
 Lakes, 11–12, 12f
 aurora trout restoration, 149–151
 geological influences on geochemistry, 12–13
 GIS studies, 305–306
 liming
 experiments, 196–197
 GIS studies, 306–307
 recovery of aquatic biota, 197–202
 natural recovery of, *see* Lake water quality improvement
 paleolimnology, *see* Paleolimnology
 remote sensing surveys, 301–303, 304f
 urban, 257–268; *see also* Urban lakes
 water chemistry, 68, 70–71
 waterfowl, *see* Waterfowl population trends
 water quality improvements, *see* Lake water quality improvement
- Lake sediments, 183–191
 chemical element profiles, 183–186
 geological influences on geochemistry, 14
 iron oxyhydroxides, 186–188
 management implications, 191
 metal deposition, 70
 ore grade, 191
 sorption on iron oxide surfaces, 189–190, 191f
 sulfide precipitation, 188–189
 transformations within, 186
 transport processes, 186
 urban lakes, 261, 265
 see also Paleolimnology
- Lake Timiskaming, 12
 Lake trout (*Salvelinus namaycush*), 67, 69f, 75, 76, 77f, 196, 200, 201, 202, 268
 Lake Wanapitei, 207, 208f
 Lake water quality improvement, 67–78
 biological recovery, 71–75
 complications, 75–76
 expectations of, 75
 lake chemistry, 68–71
 reversibility of damage, 67–68

- Land reclamation
 integrated management and progressive rehabilitation, 287–297
 minimal treatment approach, 337
see also Regreening process; Revegetation
- Landsat satellites, 300–303, 304f
- Land use planning, 327–329
- Larix laricina* (tamarack), 113t, 115f, 116f
- Laundrie Lake, 74, 74f
- Leaching
 acid precipitation and, 319
 from slag piles, 296
 watershed soils, 68
- Lead, 183
 bedrock chemical patterns, 14
 lake sediments, sorption on oxide surfaces, 190
 ore composition, 9
 soil, 220t, 223
- Lecanora*, 84, 86, 87
- Lecidea*, 87
- Legislation, 4t, 51, 275–276, 281–282, 284, 293, 337, 342–343
- Legumes
 forest species, 179–180; *see also* Black locust
 nitrogen fixation, 226
 tailings revegetation project, 125
see also specific legumes
- Lepraria aeruginosa*, 86
- Leptodiptomus minutus*, 69f
- Lichens, 24, 57, 81–90
 as biomonitor, 82–83
 distribution changes over time, 83–87
 epiphytic versus rock- and soil-inhabiting, 87–88
 metal particulates in, 88–89
 species observed on balsam poplar, 86t
 Sudbury studies, 83–87
- Life-cycle costing of resource use, 331–332
- Limestone, 12
- Liming
 lakes, 195–203
 recovery of aquatic biota, 195–203
 and trace element concentrations, 191
 trout restoration, 149–151
 soil
 and algae and cyanobacteria, 222–223
 birch coppice woodlands, 242–244
 and nitrogen fixation, 225
 and plant community dynamics, *see* Plant community dynamics
see also Soil treatment
 waste water treatment, 288–289
 wetlands processes, 137, 140
- Little Whitepine Lake, 149, 197, 199f
- Logging, 17–18, 24, 27f
- Lohi Lake, 196, 197, 199f, 200, 201
- Loons, *see* Waterfowl population trends
- Lophodytes cucullatus* (Hooded Merganser), 206f, 207, 208t, 209t, 210f, 211f, 213–214, 213f
- Lota lota* (burbot), 69f, 75
- Lotus corniculatus*, *see* Birdsfoot trefoil
- Lowbush blueberry (*Vaccinium angustifolium*), 247–254
 biology of, 248–250
 birch transition forest, 235t, 248
 metal accumulation, 247–248
 levels in fruit, 252–253
 levels in plant species, 251t
 mechanisms of tolerance, 247–248
 Sudbury site, 250–253, 251t
- Lower Swansea Valley project, 110
- Lumbering, 2f, 7
- Lupine (*Lupinus lepidus*), 100
- Lyngbya*, 223t
- Magnesium
 acid rain and, 71
 lake water
 buffering by, 12–13
 reductions in, 68
 mobilization by acid rain, 319
 podzolization and, 10
see also Liming
- Mallard (*Anas platyrhynchos*), 129, 206f, 207, 208t, 209t, 210f, 214–215
- Mammals, *see* Wildlife
- Management approaches, *see* Integrated management
- Management objectives, *see* Goals of restoration
- Manganese
 lake sediments, 184, 189–190
 soil
 leaching from, 70
 mobilization by acid rain, 319
 wetlands processes, 136, 137–138
- Maple transition community, 27, 28f, 30; *see also* Red maple
- Mapping, *see* Geographic information systems; Remote sensing
- Matteuccia struthiopteris* (ostrich fern), 251t
- Mayfly (*Hexagenia*), 69f, 74, 265
- McFarlane Lake, 184, 185f
- Meadow willow (*Salix gracilis*), 94f, 96
- Mercury, 210, 319
- Mergus merganser* (Common Merganser), 206f, 207, 208t, 209t, 210f, 211–212, 211f, 213f
- Metal contaminants
 accumulation in vegetation, 58
 atmospheric release, tonnage, 51, 58–59
 interacting factors in ecological damage, 25, 319
 interactions between stressors, 319
 lakes
 levels of, 70–71
 urban, 258, 259, 260f, 261, 266f
 lake sediments
 chemical processes controlling, 183, 184, 185f, 186–190
 depth distributions, 187f, 187
 ore grade, 191
 paleolimnology, 37–38, 39f, 40, 41f
 sorption on oxide surfaces, 190
 urban lakes, 265
 in lowbush blueberry, 247–253

- particulate
 - fallout, 51, 58
 - in lichens, 88–89
- plant tissue concentrations, 251t
- soil, 220t, 220–221
 - accumulation in, 58
 - amelioration effects on plant nutrients, 175
 - liming effects, 173
 - mycorrhizal associations and, 228
 - plant uptake in revegetated sites, 180–181
 - water management and treatment, 288
- Metallothioneins, 247
- Metal recycling, 284
- Metal tolerance, vegetation, 93, 95
- Metazoans, soil, 224
- Methanogenesis, 137
- Microbial activity
 - lake sediments, 186
 - see also* Bacteria; Fungi; Soil biota
- Microbial polysaccharides, 220
- Microclimate
 - arctic tundra, 239, 241
 - birch coppice woodlands, 235–236, 244
- Micropterus* (bass), 268
- Micropterus dolomieu* (smallmouth bass), 67, 201
- Middle Lake, 41f, 196, 197, 199f, 200, 200f, 258f
- Mine drainage, rehabilitation of, *see* Wetlands, engineered
- Mine Environment Neutral Drainage (MEND), 138, 140
- Mining, history of activity, 18–19
- Mixed land use planning, 327–329
- Models/modeling
 - catchment management, 315–316
 - remote sensing and GIS studies, 307–308
 - urban planning, *see* Urban planning
- Monitoring, 297
 - catchment management, 314–316
 - Inco emissions, 281–282
 - municipal greening project, 116
 - paleolimnology, *see* Paleolimnology
 - progressive rehabilitation, 293
 - remote sensing and GIS, 299–310; *see also* Geographic information systems; Remote sensing
 - urban planning considerations, 331
- Monoculture, forest, *see* Birch coppice woodlands
- Moose Lake facility, 289
- Mosses, 27, 88, 93, 174, 175, 221, 224
 - birch coppice woodlands, 242
 - birch transition forest, 235t
 - wetland construction, 136
- Multispectral scanner, Landsat, 300–301
- Municipal land restoration, *see* Regreening process
- Musculum securis*, 75
- Mycorrhizae, 224
 - and metal tolerance, 228–229, 247
 - and phosphorus nutrition, 179
- Myrica asplenifolia*, (same as *Comptonia peregrina*) (sweet fern), 251t
- Mysis relicta* (opossum shrimp), 70, 201
- Natural recovery
 - of lakes, 67–78
 - trends in, 47–49
 - vascular plant communities, 93–102
- Navicula*, 223t
- Navicula mediocris*, 39f
- Nelson Lake, 196, 197, 199f, 200, 200f
- Neo-traditional development, 329
- Nepahwin Lake, 258f
- Neutralization reactions
 - lake buffering capacity, 12–13, 33, 37, 43, 67–68
 - wetlands processes, 136
- Nickel, 183
 - atmospheric deposition of, 25, 317–318
 - Bessemer matte, 279–280
 - geobotanical prospecting, 84
 - history of production, 19, 21
 - lake water
 - paleolimnology, 37–38, 39f, 40, 41f
 - sources of, 40
 - urban lakes, 261
 - ore composition, 9, 276, 277f
 - reduction in emissions, 56–57
 - soil
 - and nitrogen cycling, 227
 - toxicity to plants, 25, 26, 27f
 - soil microbe tolerance, 223, 224
 - solubility, pH effects, 288
 - Superstack distribution of, 317–318
 - wetlands processes, 139
 - see also* Metal contaminants
- Nickel smelters and refineries, worldwide location of, 18f
- Nitrate
 - catchment release of, 320
 - fertilizer, *see* Soil treatment
- Nitrobacter*, 226–227
- Nitrogen
 - land reclamation and, 179–180
 - toxic metal amelioration and, 175
 - urban lake eutrophication, 260f, 261
- Nitrogen cycle, soil processes, 226–228
- Nitrogen fixation
 - soil microbes, 225–226
 - tailings revegetation project, 125
 - see also* Birdsfoot trefoil
- Nitrosomonas*, 226–227
- Noril'sk, 7f, 8f, 18, 60, 339t
- Norway spruce, 115f
- Nostoc*, 225, 225f
- Nostoc muscorum*, 223t
- Nurse crops, 178
- Nutrient limitation
 - land reclamation and, 179–180
 - toxic metal amelioration and, 175
- Oedogonium*, 73
- Oocystis*, 223t
- Opossum shrimp (*Mysis relicta*), 70, 201
- Ores
 - composition, 9, 276, 277f

- pyrrhotite, 9, 52, 63, 140, 292
- Ore grade lake sediments, 191
- Organic matter
 - DOC, *see* Dissolved organic carbon
 - lake sediments, 185
 - soil, 220
 - wetlands, ion exchange mechanisms, 135–136
- Oriabittids, 224
- Oronectes virilis* (crayfish), 70
- Orthocyclops modestus*, 76
- Oryzopsis asperifolia* (rice grass), 101
- Oscillatoria*, 223t
- Osmerus mordax* (rainbow smelt), 262
- Osmium, 9
- Osmunda claytoniana* (sensitive fern), 251t
- Osprey (*Pandion haliaetus*), 295
- Ovales*, 95, 96
- Oxidation, *see* Redox processes
- Oxides
 - lake sediments, pH effects on metal sorption, 189–190
 - metal particulates in lichens, 88–89
- Oxygen
 - lake sediments, 184, 186–188
 - tailings revegetation barrier effect, 131–132
 - wetlands aerobic processes, 136–137
 - see also* Anaerobic processes; Anoxic-oxic conditions
- Oxygen flash furnace smelting, 52
- Oxyhydrides, lake sediments, 186–190
- Ozone levels, 58–59, 320
- Paleolimnology
 - changes in lake water chemistry since preindustrial times, 38–40
 - Clearwater Lake, 36–38
 - diatom calibration, 36
 - environmental assessment, 33–34
 - field and laboratory methods, 34–36
 - pH, temporal and spatial patterns, 40–43
- Palladium
 - lake sediments
 - ore grade, 191
 - urban lakes, 261
 - ore composition, 9, 277f
- Pandion haliaetus* (osprey), 295
- Paper birch (*Betula papyrifera*), 228; *see also* White birch
- Parmelia conspersa*, 24
- Parmelia physodes*, 24
- Parmelia saxatilis*, 24
- Parmelia sulcata*, 82f, 86, 86t
- Particulate fallout, 58
- Partnerships, 337
 - peregrine falcon restoration, 158
 - role of, 340–341
- Pearly everlasting (*Anaphalis margaritacea*), 100, 174, 175
- Penicillium waksmanii*, 224
- Pentlandite, 9
- Perca flavescens* (yellow perch), 69f, 75, 76, 77f, 207
- Peregrine falcons (*Falco peregrinus anatum*), 155–165, 295
 - benefits of partnership, 163–165
 - hacking period, 160
 - North American monitoring, 162–163
 - partnership, 158
 - recovery program in North America, 156
 - release process
 - procedure and follow-up, 160–162
 - urban, Sudbury, 158–160
 - wilderness, 162, 163f
 - species description, 155–156
 - Sudbury project, 156–158
- pH
 - acid mine drainage, 135
 - GIS studies, 306
 - interactions between stressors, 319
 - lakes
 - generation of alkalinity, 189
 - paleolimnology studies, 38–40, 41f
 - temporal and spatial patterns of, 40–43
 - urban, 258, 259, 260f, 266f
 - and waterfowl, *see* Waterfowl population trends
 - lake sediments
 - depth distributions, 187
 - iron and manganese oxyhydroxide solubility, 186
 - and metal sorption on oxide surfaces, 189–190
 - and solubility of trace elements, 184
 - and metal solubility, 173, 186–190, 288
 - and metal toxicity, 289, 319
 - and roast bed revegetation, 95
 - soil, 221
 - and nitrogen cycling, 226–227
 - and nitrogen fixation, 225
 - wetlands processes, 137, 138
 - see also* Acidification
 - Phantom midge (*Chaoborus*), 37, 76
 - Phleum pratense* (timothy), 113t, 127
 - Phosphates
 - fertilizer, *see* Soil treatment
 - iron oxide fixation of, 127
 - Phosphorus
 - release from sediments, 320–321
 - soil, liming and, 173
 - urban lake eutrophication, 260f, 261
 - Phosphorus limitation
 - land reclamation and, 179
 - toxic metal amelioration and, 175
 - Phytochelatin, 247
 - Phytoplankton, 67
 - acidification effects, 69f
 - lake liming effects, 200, 201
 - recovery after emissions abatement, 71, 75
 - Picea glauca* (white spruce), 17, 20f, 115f, 116f
 - Picea mariana* (black spruce), 17, 115f
 - Pimephales promelas* (fathead minnow), 69f, 70, 319
 - Pinus banksiana*, *see* Jack pine
 - Pinus resinosa*, *see* Red pine
 - Pinus strobus* (white pine), 17, 20f, 24, 57, 59, 113t, 115, 115f, 116f, 179
 - Pisidium*, 75
 - Planning, 271–273
 - Plant communities
 - recovery of, 93–102

- Planr communities (*cont.*)
 Sudbury area, 27–28, 30
- Plant community dynamics
 ecological damage, descriptions of, 27–30
 limestone detoxification, 173
 native species, 178
 nutrient cycling, 179–180
 pH and base effect of limed soil, 174–175
 species changes after liming, 175–178
 succession, acceleration of, 178–179
 toxic metals, 180–181
 trigger factor effect, 173
- Plant residues
 soil microbes and, 224–225
 tailings revegetation project and, 131
- Plant roots, 220
- Plants
 metallophytes, 84
 nutrition, toxic metal amelioration and, 175
 restoration projects, *see* Revegetation
 urban lake introductions, 262
 waterfowl requirements, 208t
 wetland construction, 136
see also Vegetation
- Plant species
 birch transition forest, 235t
 Copper Cliff tailings area, 295
- Plasmids, 220, 223
- Platinum
 lake sediments, 191, 261
 ore composition, 9, 277f
- Poa compressa*, *see* Canada bluegrass
Poa pratensis (Kentucky bluegrass), 113t, 127
- Podzolization, 10
- Podzols, 10, 221
- Pohlia*, 224
- Pohlia cruda*, 242
- Pohlia nutans*, 27, 88, 93, 235t, 242
- Political action, 337, 338–339
- Polyarthra*, 73
- Polygonum cilinode*, 251t
- Polysaccharides, microbial, 220
- Polytrichum commune* (hair moss), 27, 235t, 251t
- Populus balsamifera* (balsam poplar), 175
- Populus tremuloides*, *see* Trembling aspen
- Porpidia*, 87
- Potassium fertilizer, *see* Soil treatment
- Poverty grass (*Danthonia spicata*), 101
- Prairie willow (*Salix humilis*), 94f, 96, 235t, 251t
- Precious metals
 ore composition, 9, 277f
 urban lake sediments, 261
- Precipitation, acid, *see* Acid rain
- Precipitation/solubility
 lake sediments
 iron oxyhydroxides and, 186–188
 sulfides, 188–189
 liming and, 173
- Private sector role, 342
- Progressive rehabilitation, 293–296; *see also* Integrated management
- Prospecting, geobotanical, 84, 96
- Protozoa, soil, 224
- Pteridium aquilinum* (bracken), 27
- Public opinion
 early government responses, 51
 political action, 337, 338–339
- Public participation, 337
 municipal land restoration, 109–111, 119–120
 and success of restoration, 107
- Public policy, 342
- Public pressure, 338–339
- Public relations, 342
- Pyrrhotite, 9, 52, 63, 139, 292
- Quercus borealis* (same as *Quercus rubra*) (red oak), 27, 30, 98, 113t, 115f, 116f, 239, 251t
- Rainbow smelt (*Osmers mordax*), 262
- RAIN project, 71
- Ramsey Lake, 41f, 267f, 316
- Ramsey Lake Community Improvement Plan, 327, 328
- Rattlesnake grass (*Glyceria canadensis*), 97f
- Recycling, metals, 284
- Recycling, water, 288–289
- Red cedar (*Juniperus virginiana*), 178
- Red elderberry (*Sambucus pubens*), 27
- Red fescue (*Festuca rubra*), 113t, 127
- Red maple (*Acer rubrum*), 27, 109, 224, 233, 235t
 copper and nickel levels in tissues; 251t
 regressive dieback, 93, 98, 99f
 in transition communities, 30
- Red oak community, 30
- Red oak (*Quercus borealis* or *Quercus rubra*), 27, 30, 98, 113t, 115f, 116f, 238, 251t
- Redox processes
 bacterial-catalyzed sulfate reduction, 136
 lake sediments, iron oxyhydroxides and, 186–188
 plant micronutrients, 250
 pyrrhotite tailings, 292
 wetlands, 136, 139–140
- Red pine (*Pinus resinosa*), 113t, 115f, 116f, 179, 251t
 tailings revegetation project, 127, 128, 129, 130f
 vegetation zone, 17
- Red Pine Lake, 295
- Redtop (*Agrostis gigantea*), 94, 95, 175
 municipal greening project, 113t
 tailings revegetation project, 127
- Regreening process
 benefits of, 118–119, 120f
 costs of, 116–117
 future initiatives, 117–118
 lessons of, 120–121
 restoration process, 112–117
 grassing, 112–113
 monitoring, 116
 results, 116–117
 tree planting, 113–116
 scientific basis, 111–112

- Regressive dieback, 27, 28f, 93
 Regulation, *see* Government regulation
 Reindeer/caribou lichen (*Cladina rangiferina*), 24, 82f, 83, 84, 86t, 88, 307–308
 Remote sensing, 6f
 counts and measures, 307–308
 DOC measurement study, 308–309, 310f
 future applications, 309–310
 goals of monitoring, 299
 integration with GIS, 307–309
 lake water quality study, 301–303, 304f
 Sudbury area plant communities, 27
 vegetation surveys, 301, 302f
 Reporting, environmental, 331
 Research topics in restoration ecology, 169–172
 Respiration, soil, 225f
 Restoration ecology, 341–342
 goals of, 105–107
 prevention versus, 342–343
 research topics, 169–172
 Revegetation
 aerial treatment program, 293–294
 birch coppice woodlands, 233–244
 municipal land restoration, *see* Regreening process
 see also Lowbush blueberry; Plant community dynamics
 Revegetation of tailings area
 current program, 126–127
 ecosystem development, 128
 environmental concerns, 128–130, 131f
 history of problem, 124
 physical processes, 123–124
 soil development, 127–128
 technique, 124–126
 tree planting, 128, 129, 130f
 water quality effects, 131–132
Rhizobium, 226, 227
Rhizocarpon, 87
 Rhizoplane, 220
 Rhizosphere, 220
 Rhodium, 9
 Rice grass (*Oryzopsis asperifolia*), 101
 Ring-necked Duck (*Aythya collaris*), 206f, 207, 208t, 209t, 210f, 211f, 214
 Roast yards, 19–22, 25, 26, 27
Robinia pseudoacacia (black locust), 113t, 115f, 116f, 127, 180, 226
 Root growth, toxic metals and, 26
 Root zone, 220
Rubus chamaemorus, 252
Rumex acetosella (sorrel), 93, 95f, 96, 125
 Rushes, 96, 97f
 Ruthenium, 9

 Salinity, urban lakes, 263
Salix (willow), 100, 127, 173, 175f
Salix bebbiana, 235t
Salix commutata, 100
Salix discolor, 235t
Salix gracilis (meadow willow), 94f, 96
Salix humilis (prairie willow), 94f, 96, 235t, 251t
Salix lucida (shining willow), 96
Salix pyrifolia (balsam willow), 96, 175
Salvelinus fontinalis (aurora trout), 143–152, 195, 197, 318
Salvelinus fontinalis (brook trout), 67, 75f, 77
Salvelinus namaycush (lake trout), 67, 69f, 74, 75, 76f, 77, 196, 200, 201, 202, 268
Sambucus pubens (red elderberry), 27
 Saturation indices, lake water, 188–189
 Science
 regreening project, 111–112
 research topics in restoration ecology, 169–172
 role of, 341–342
Scirpus cyperinus (wool sedge), 95, 96, 97f
Scleroderma flavidum, 228, 229
Secale cereale (fall rye), 125, 126
 Sedges, 95–96
 Sediments
 catchment management problems, 317
 lake, *see* Lake sediments; Paleolimnology
 Seeding
 plant recolonization, 99, 101
 Vaccinium angustifolium, 249
 see also Regreening process; Revegetation
 Selenium
 interactions between stressors, 319
 lake sediments, 183, 184, 185f
 ore composition, 9, 277f
 Self-sustaining ecosystem development, 294–296
 Sewage, 261, 320
 Shining willow (*Salix lucida*), 96
 Shoreline alterations, urban lakes, 260f, 261–262
Sida crystallina, 76
 Silver, 9, 277f
 Silver Lake, 184, 258f, 261
 Silver maple, 115f
Simocephalus serrulatus, 76
Skistodiaptomus oregonensis, 74
 Slag
 environmental impacts of, 296
 land management, 289, 290f, 291
 Smallmouth bass (*Micropterus dolomieu*), 67
 Smelter emissions, *see* Air quality improvement
 Societal values, 118–119, 333, 335, 342
 Soil
 birch coppice woodlands, 234, 236
 glacial deposition, 10
 interacting factors ecological damage, 24–26
 interactions between stressors, 319
 metal accumulation in, 58
 metal leaching from, 68, 71
 roast bed emissions and, 21
 sulfur dioxide effects, 57–58
 tailings revegetation project, 127–128
 types of, 11
 Soil amelioration, *see* Soil treatment
 Soil biota
 algae and cyanobacteria, 221–223
 bacteria, 223

- Soil biota (*cont.*)
 carbon dioxide fixation and litter decomposition, 224–225
 fauna, 224
 fungi, 224
 habitat, 219–220
 mycorrhizae, 228–229
 nitrogen cycling, 226–228
 nitrogen fixation, 225–226, 227f
 Sudbury soils, 221
 toxic metals and acid conditions, 220–221
- Soil erosion, 319
- Soil treatment, 93
 birch coppice woodlands, 242–243
 catchment management issues, 318
 integrated management and progressive rehabilitation, 293–294
 municipal greening project, 112–113, 113t
 and plant community dynamics, 173–181
 tailings revegetation project, 125, 126, 127–128
- Solidago canadensis*, 251t
- Solidago graminifolia*, 94f
- Sorrel (*Rumex acetosella*), 93, 95f, 96, 125
- Species diversity, *see* Biodiversity
- Species richness, water acidity and, 71, 73, 74f
- Spectral bandwidths, Landsat, 300t
- Spirogyra*, 73
- Springtails, 224
- Stereocaulon*, 24, 82f, 87, 89, 89f, 235t
- Stichococcus subtilis*, 223t
- Stizostedion vitreum* (walleye), 67, 295
- Stylaria lacrustis*, 75
- Sudbury Basin geology, 5–9
- Sugar maple (*Acer saccharum*), 17, 115f
- Sulfate-reducing bacteria, wetlands, 136, 137
- Sulfates, sulfides, and sulfur chemistry
 atmospheric deposition, *see* Air quality improvement;
 Emission control technologies
 catchment management issues, 319
 interactions between stressors, 25, 26, 27f, 319
 lake sediments, 186, 319
 arsenic precipitation, 187–188
 chemical processes controlling, 184, 185f
 and phosphorus release, 320–321
 saturation indices, 188–189
 metal particulates in lichens, 88–89
 ore composition, 9, 276, 277f
 and phosphorus release from sediments, 320–321
 pyrrhotite, 9, 52, 63, 140, 292
 soil, metal binding enhancement, 27
 storage and release, 70
 Superstack distribution of, 317–318
 tailings, 123
 wetlands processes, 136, 137, 139, 140
see also specific ecosystems and remediation projects
- Sulfur dioxide emissions
 comparison of, 339t
 control technology, 275–285
 history of land use, 19–22
 improvements in Sudbury region, 287–288
 interacting factors, 25, 26, 27f
 lake acidification, 259
 legislated reduction targets, 56
 quantification, Sudbury area, 54f, 55f, 56f, 69f
see also Air quality improvement
- Sulfuric acid, 52
- Sulfuric acid production, Inco facility, 278, 279
- Sulfur trioxide, 58
- Superstack, 53f, 54, 317, 318
- Surface complexation theory, 189–190
- Surface stabilization
 aerial soil treatment program, 293–294
 tailings revegetation project, 125–126, 127f
- Surveys, *see* Geographic information systems; Monitoring; Remote sensing
- Sustainability, 287, 336, 342–343; *see also* Integrated management
- Swan Lake, 73
- Swansea Valley project, 110
- Sweet fern (*Comptonia peregrina*), 27, 179, 180, 226, 235t, 251t
- Synergisms, 319
- Tabellaria quadriseptata*, 37, 39f
- Tailings
 land management, 289, 290f, 291f, 292
 rehabilitation of, *see* Wetlands, engineered
 revegetation project at Copper Cliff, 123–132
 urban lake infilling, 263, 263f
- Tamarack (*Larix laricina*), 113t, 115f, 116f
- Tellurium, ore composition, 9, 277f
- Temperature, 10–11
 arctic tundra, 239, 241
 birch coppice woodlands, 235–236
- Thematic mapper radiance measurements, 300, 304f
- Thuja occidentalis* (white cedar), 17, 20f, 115f
- Tickle grass (*Agrostis scabra*), 235t, 244
 colonization by, 93, 95f, 96, 97f
 plant community dynamics, 173, 175, 175f
- Timothy (*Phleum pratense*), 113t, 127
- Titanium/iron ratios, 88
- Topography, 111, 305f
- Toxicity
 aluminum, 25, 26, 27f
 pH and, 289, 319
 tolerant species, 93, 95, 247–248
- Toxic metals, *see* Metal contaminants
- Tree planting
 municipal greening project, 113–116, 113t, 114f
 tailings revegetation project, 128, 129, 130f
- Trembling aspen (*Populus tremuloides*), 173, 175, 175f, 176, 177f, 179, 235t
 copper and nickel levels in tissues, 251t
 insect defoliation, 238
 recolonization after logging, 18
 tailings revegetation project, 127
- Trifolium hybridum* (Alsike clover), 113t, 174, 179, 180, 226
- Trigger factor, 173, 176
- Tropocyclops extensus*, 73

- Tufted hairgrass (*Deschampsia caespitosa*), 27, 174, 251t
 colonization by, 93, 94, 95f, 97, 98
 metal-tolerant strains, 180
- Tundra, arctic, 239, 241
- Typha latifolia* (cattails), 97f, 131f, 139, 140, 251t, 295
- Ulmus americana* (American elm), 27
- Ultraviolet radiation, 320
- Umbilicaria*, 83
- Umbilicaria mulhenbergia*, 82f
- Uranium, 13, 14, 84
- Uranium tailings, 140
- Urban forestry, 329–330
- Urban lakes, 257–268
 acidification, 259, 260f
 altered hydrology, 262–263
 eutrophication, 260f, 261
 exotic species, 262
 integrators of ecosystem health and function, 263–266, 267f
 biological time lag, 265–266
 miscellaneous stressors, 263
 metal contaminants, 259f, 260f, 261
 shoreline and watershed alterations, 260f, 261–262
 stress factors, 258–263
 watershed structure, 257, 258f
- Urban planning
 ecosystem planning in, 325–327
 evaluation tools, 331–333
 long-term, 327–331
 bioclimatic design, 330
 community energy efficiency, 330
 design with nature, 327
 green space, 329–330
 mixed land use, 327–329
 transit-friendly communities, 330–331
- Urban restoration, *see* Regreening process
- Usnea hirta*, 82f, 86
- Vaccinium angustifolium*, *see* Lowbush blueberry
- Vaccinium myrtilloides*, 24, 24f
- Vaccinium myrtilus*, 252
- Vaccinium vitis-idaea*, 252
- Vegetation
 arctic tundra, 239, 241
 atmospheric fallout damage, 59
 birch coppice woodlands
 dormant seedbank, 244
see also Birch coppice woodlands
 birch transition forest, 235t
 Copper Cliff tailings area, 295
 forestry resources, nineteenth century, 17–18
 GIS thematic layers, 305f
 oxygen barrier effect, 131–132
 postglacial changes, 10
 recovery of vascular plants, 93–102
 regressive dieback, 27, 28f
 remote sensing surveys, 301, 302f
 restoration projects, *see* Revegetation
 sulfur dioxide fumigation effects, 57–58
 survey of damage to, 23–24
 toxic soil and, 25, 26
see also Lowbush blueberry; Plant community dynamics
- Vegetation zone, 17
- Vesicular-arbuscular mycorrhizae, 179, 224, 228, 229
- Viburnum cassinoides* (witherod), 27
- Volcano recolonization, 100–101
- Walleye (*Stizostedion vitreum*), 67, 295
- Wanapitei Lake, 12, 42f
- Wanapitei study, 207, 208f, 308–309
- Waste rock management, 289, 290f, 291, 292–293
- Waste water treatment
 at Copper Cliff, 288–289
 surface run-off, 293
- Water
 acid rock drainage, 292–293
 nitrogen compounds and, 320
- Water chemistry, lakes, 68, 70
- Water flea (*Daphnia galeata mendotae*), 69f, 201
- Waterfowl, 67
 Falconbridge tailings settling pond, 295
 tailings revegetation project and, 127, 128, 131f
- Waterfowl Acidification Response Modeling System (WARMS), 215
- Waterfowl population trends, 205–215
 density and distribution of species, 209t, 210–215
 Black Duck, 210f, 211f, 213f, 214
 Common Goldeneye, 210f, 211f, 212–213
 Common Loon, 210–212
 Common Merganser, 210f, 211–212, 211f, 213f
 Hooded Merganser, 210f, 211f, 213–214, 213f
 Mallard, 210f, 214–215
 Ring-necked Duck, 210f, 211f, 214
 Wood Duck, 210f, 214
 habitat requirements, 208t, 208f
 species of breeding populations, 206f, 207
 wetlands distribution and quality, 209f
- Water management and treatment, improvements in
 Sudbury region, 288–289, 293
- Water quality
 improvements in
 municipal regreening project and, 118
 revegetation of tailings and, 131–132
 Sudbury region, 287–288
see also Lake water quality improvement
- paleolimnology, *see* Paleolimnology
- remote sensing surveys, 301–303, 304f
- Watershed
 alterations of, and urban lakes, 260f, 261–262
 catchment management issues, 318–319
 GIS studies, 305f, 306–307
 Inco management plan, 293
 revegetation, aerial treatment program, 293–294
 Wanapitei/Algoma study, 308–309
- Wavy hairgrass, 100
- Weather
 climate of Sudbury area, 10–11, 70, 75, 319–320
 tailings freeze-dry process, 123–124, 125
- Weathering, and lake recovery, 67–68

- Wetlands, engineered, 135–140, 295
 benefits and mechanisms, 135–136
 natural versus constructed, 135–138
- Whirligig Lake, 145, 149, 150, 151, 197, 198f, 199f
- White ash, 115f
- White birch (*Betula papyrifera*), 109, 173, 175, 175f, 177f, 228, 235t, 248
 copper and nickel levels in tissues, 251t
 phosphorus cycle, 179
 recolonization of barrens, 97f, 98, 99f
 recolonization after logging, 18
 sulfur dioxide effects, 57
 tailings revegetation project, 127
 in transition communities, 27, 28f, 30
see also Birch coppice woodlands
- White cedar (*Thuja occidentalis*), 17, 20f, 115f
- White pine (*Pinus strobus*), 17, 20f, 24, 57, 60, 113t, 115, 115f, 116f, 179
- Whitepine Lake, 74, 74f, 145, 151
- White spruce (*Picea glauca*), 17, 20f, 115f, 116f
- White sucker (*Catostomus commersoni*), 69f, 75, 145
- Wildlife
 birch coppice woodland, 241
 greenway functions, 329
 tailings revegetation project and, 127, 128
see also Fish
- Wildlife habitat
 Copper Cliff tailings area, 295
 urban planning considerations, 327
- Wildlife restoration
 aurora trout, 143–152
 Peregrine Falcon program, 155–165
- Willow (*Salix*), 100, 127, 173, 175f
- Wind erosion, tailings, 123–124, 125
- Winds, prevailing, 5, 10
- Winter cities, 330
- Witherod (*Viburnum cassinoides*), 27
- Wood Duck (*Aix sponsa*), 206f, 207, 208t, 209t, 210f, 214
- Wood horsetail (*Equisetum sylvaticum*), 97, 251t
- Woodlands, birch coppice, *see* Birch coppice woodlands
- Wool sedge (*Scirpus cyperinus*), 95, 96, 97f
- Yellow birch (*Betula alleghaniensis*), 17
- Yellow perch (*Perca flavescens*), 69f, 76, 77f, 207
- Zinc, 183
 bedrock chemical patterns, 14
 geological influences on geochemistry, 13–14
 lake sediments
 depth distributions, 187f
 sorption on oxide surfaces, 190, 191f
 urban lakes, 261
 mobilization by acid rain, 319
 ore composition, 9
 soil, 223
 solubility, pH effects, 288
 wetlands removal of, 138
- Zooplankton, 67
 acidification effects, 69f
 fish and invertebrate predation, 77f
 lake liming effects, 197–200
 recovery after emissions abatement, 71, 73, 75
 urban lakes, 264f
see also Aquatic biota
- Zygonium*, 73