

Notes: Italicized page numbers indicate boxes, tables, or figures. The following abbreviations have been used throughout the index: EBM for ecosystem-based management, TK for traditional ecological knowledge, and LK for local knowledge.

- Activist-scientists, 123–26
- Adaptive management: barriers to implementation, 86–87; in Chesapeake Bay Program, 284–85; in EBM, 177, 311; forms of, 116; framework for, 63, 66–67; in IEA, 212; incrementalist strategies, 151; modeling in, 86, 284; monitoring in, 116–20, 284; phases of, 86; and resilience, 77, 88, 115–16, 175; role of science in, 220; in social-ecological systems, 79; TEK in, 147, 150–51
- ALCOSTA (*Alianza para la Sustentabilidad del Noroeste Costero Mexicano*), 237, 245
- Aleutian Islands, reefs in, 55
- Allowance trading, 281–82
- Alto Golfo de California y Delta del Río Colorado*, 238–40
- Antagonistic services, 107
- Anthropocentric moral framework, 329, 334–36
- Aquaculture, xvi, 138–41, 234
- Arctic Ocean, xi–xiv
- Asian blue swimming crab (*Portunus pelagicus*), 279
- Atlantic cod (*Gadus morhua*), 36
- Atlantis (model), 122
- Australia, 258–59, 295–97, 308–9, 314, 348–49
- Baja California, 227–30
- Baselines, ecological, 22, 45, 65
- Before-after, control-impact comparisons (BACI), 117, 123
- Benthic communities, 56, 79, 236, 259–63
- Best management practices (BMPs), 103–4, 283
- Biocentric moral theory, 331–32
- Biodiversity, 24, 35–36, 68, 227, 234
- Biodiversity Strategy, New Zealand, 301–2
- Bioeconomic models, 105
- Bioeconomic studies, 191
- Biogeophysical processes, 61
- Biological indicators, 190–96
- Biological monitoring, 216–17
- Biological opinions, 170
- Biophysical complexity, 76, 103
- Biophysical metrics, 97–98
- Biophysical models, 101–2
- Biophysical world, 47
- Bioregional planning, 295–97, 314
- Biosphere people, 149
- Biosphere reserves, 241
- Biotic vs. abiotic control, 76–77
- Bi-State Blue Crab Advisory Committee (BBCAC), 278, 280–81
- Blue crab (*Callinectes sapidus*), 276, 278–79, 280–81
- Bottom trawling, 35, 236, 301–2
- Bottom-up drivers, 280, 283–84
- Bryozoan, 197–98
- Bycatch of nontarget species, 27–28, 35, 262, 301, 334
- California Ocean Protection Act (2004), 185, 198, 304–5
- Canada: elements of EBM in national policy of, 258, 259, 297–99, 308–9; large ocean management areas (LOMAS), 254, 255, 297–98; Oceans Act, 253–54, 263, 297; policy context for EBM in, 253; regional planning in, 314–15. *See also* Eastern Scotian Shelf entries
- Cap and trade allowances, 281–82
- Case studies: Australia, 258–59, 295–97, 308–9, 314, 348–49; of ecosystem-based conservation measures, 237–43; European Union, 299–301, 314–15; in implementation of EBM, 294; Marine Management Area Science (MMAS) Program, 124–25; New Zealand, 146, 301–3; Thailand, 137–42. *See also* Canada; Chesapeake Bay, USA; Eastern Scotian Shelf entries; Gulf of California, Mexico; Morro Bay, California, USA; Puget Sound, Washington, USA; United States (USA)
- Causal relationships, 75, 78, 83, 86, 97, 103
- Center for Applied Biodiversity Science, 124–25
- Cheating the outcomes, 333, 334
- Chesapeake 2000 Agreement, 273, 274–75, 284, 318–19
- Chesapeake Bay, USA: overview, 268–71; challenges to implementation of EBM in, 282–86; current state of, 8, 273–76; degradation of, 271–73; ecological resilience of, 276–78; floods of, 68, 271;

- Chesapeake Bay, USA (*continued*): geographic region evaluation, 285–86; integration of bottom-up and top-down efforts, 316; loss of ecosystem services in, 56, 289; map of, 269; paths forward for, 286–89; resilience framework for, 277; restoration of, 273, 288, 319; science in management and restoration of, 279–82; social and institutional resilience, 278–79; as test bed for EBM, 270; watershed management eras, 272–73
- Chesapeake Bay Program (CBP), 68, 268, 271–76, 280, 289, 319
- Chisasibi Cree fishing practices, 146, 151
- Climate change, xi–xii, 15, 37, 67, 289
- Coalition for the Sustainability of the Gulf of California, 243–46
- Coastal ecosystems: conversion of, to commercial development, 131–34; cross-scale phenomena in, 78–83; cumulative impacts of human activities on, 62; defined, 34; ecological theories of, 76–78; single-aspect management practices, 74; small-scale fisheries as proxies for health of, 242; wetlands, 141, 238, 244
- Collaborations: cross-disciplinary, 103; cross-jurisdictional, 171, 176, 259; incentives for, 344–46; in MMAS Program, 124; planning model for, 256–57; relationship building and, 317
- Collective vision: for Gulf of California, 245–46; as key concept of EBM, 344, 350; for Morro Bay, 189, 342; for Puget Sound, 201–5, 332, 341–42
- Comanagement approaches, 87–88, 152, 155, 157
- Communication: by Chesapeake Bay Program, 283; of ecosystem benefits, 95; in governance structures, 83, 264; in MMAS Program, 124; in science and practice of EBM, 69; of science to nonscientists, 98–99, 105, 215–17; by SLOSEA with stakeholders, 188–89; transdisciplinary, as key path forward, 317–18; in translating science into action, 125
- Comunidad y Biodiversidad* (DOBI), 240–41
- Conflict resolution, 85, 281
- Connectivity, 78, 81
- Consequentialism, 326–29, 331–32, 333, 334–36, 337. *See also* Utilitarianism
- Conservation: in Australia, 295–96; in Canada, 259, 263, 298; community-based, 49; ecosystem-based, 7–8, 237–43; in New Zealand, 302; regional agenda for, 243–46; requirements for, under ESA, 169; traditional, impacts of Westernization on, 152. *See also* Magnuson-Stevens Fishery Conservation and Management Act (MSA); *specific acts and organizations*
- Conventional wisdom, 43, 48
- Convention on Biological Diversity, 302–5, 308–9, 316
- Cooperative management, 150, 152, 171
- Coral reef ecosystems: bleaching and shifts in composition of, 38, 63; conservation plan for, in Canada, 263; degradation of, 34; Eastern Scotian Shelf, 263; functional diversity of, 60; and global climate change, 37; reserves, 49, 155; states of, 56, 57
- Coupled social-ecological systems: dynamic nature of, 58–59; ecosystem services of, 5; focus on, in resilience framework, 55; resilience in, 64, 66, 116, 123
- Critical habitat, 167, 169–70
- Cross-scale interactions, 4, 74–75, 77, 78–83, 84, 88
- Cross-sector integration, 15–16, 25, 302–3
- Cumulative impacts: consideration of, in EISs, 172; control of, across sectors, 298; of human activities, 16–17, 61, 62, 305, 317; as key element of EBM, 4; on oyster production, 196–97
- Data gaps, 42, 48, 123, 153
- Decision-making processes, 17, 108, 122, 310, 316, 327
- Decisions, and mismatch of scales, 64, 83, 86, 284
- Deontological moral theories, 327, 328, 336, 337
- Distribution of organisms, 76, 78
- Disturbance regimes, 61–63
- Diversity: in ecosystem health, 202; genetic, 262; as key concept of EBM, 317, 343; as source of resilience, 59–61, 88. *See also* Biodiversity
- Dredging, 197, 301–2
- Drivers of change: consideration of, at scales other than focal scale, 314; direct and indirect, 35–36; integration of top-down and bottom-up, 280, 284, 287; in Puget Sound ecosystem, 210; social and political, 316; synergistic effects of, 38–39
- Drivers of multistate dynamics, 56, 57

- Duty of anticipation, 331
- Eastern Scotian Shelf, Canada, 253, 255–56, 262–63, 298
- Eastern Scotian Shelf Integrated Management (ESSIM) Initiative: conceptual objectives in, 258–59, 260; progress to date, 259–63; regional implementation of, 254–57
- EBM Tools Network, 121
- Ecocentric moral theory, 332, 337
- Ecological and social systems. *See* Social-ecological systems (SESS)
- Ecological baselines, 22, 45, 65
- Ecological-economic modeling, 142
- Ecological endpoints, 96–101, 102, 105–7
- Ecologically and biologically significant areas (EBSAs), 298
- Ecological management in social-ecological systems, 79
- Ecological models, 75–81
- Ecological outcomes, analysis of, 201
- Ecological processes, controllability of, 85–86, 88
- Ecological shifts: in Chesapeake Bay, 271; coastal zone development and, 131; comparison of, to assess trade-offs, 59; in coral reef ecosystems, 63; in Gulf of California, 231–33; irreversible, 58, 132–34, 232–33; at large spatial scales, 57–58; in mangrove ecosystems, 235; in Morro Bay, 183; perturbations and, 56; prediction of, 66, 151
- Ecological theories of coastal ecosystems, 76–78
- Ecological worldviews, 39, 333, 334–38
- Economic activities, and ecosystem services, 190–93
- Economic analysis: in Chesapeake Bay, 280–82; concerns of, 92; framework for, 94, 102; limitations of, 96; marginal, 93–94; potential for, 105–6; social values in, 100–101; and trade-offs, 98–99, 191; valuation assumptions, 108
- Economic and social monitoring, 119–20
- Economic demand functions, 101–3
- Economic indicators, 190–96
- Economics, 93–94
- Economic structures, 58, 230
- Economic valuation. *See* Valuation of ecosystem services
- Ecosystem approaches, benefits of, 217–20
- Ecosystem-based management (EBM): overview of, 115–16; across scales and levels, 83–88; authority for, 164–77; conceptual backbone of, 8–9; conceptual map for, 326–27; context of, 325; debates about, 190; defined, 295, 329; foundations of, 116; guidelines for, 119; hierarchy of goals and objectives, 257–59, 306, 307, 315; key concepts of, 341–43; key elements of, 55, 257, 305–7, 308–9, 310; legacy of, on land, 6–8; as management of people, 264; mission statements, 329; morally justifiable policy for, 338–39; moral reasoning in, 328–29; new ethic for, 336–38; principles of, 13–17, 145; sciences, support of, 25; site-specific information in, 153; transition to, 314; vision for, 344, 350
- Ecosystem conversions. *See* Ecological shifts
- Ecosystem-derived benefits, 95, 102
- Ecosystem health, 153, 191–93, 202, 342
- Ecosystem monitoring and management review, 306–7
- Ecosystem Overview and Assessment Report (EOAR), Canada, 297–98
- Ecosystem patterns, 33, 35
- Ecosystem people, 149
- Ecosystem planning and management regions, 306
- Ecosystem responses, 64, 83, 86, 284, 299. *See also* Ecological shifts
- Ecosystems: assessments of, 22, 25, 211–12, 221; boundaries of, 14–15; causes of complexity of, 76; conceptual models of, 186–87, 188; connections between marine, 21; cumulative impacts of human activities on, 62; degradation of, xii, 6, 28; ecosystem services provided by, 56; holistic view of, 316; human dimensions of, as key knowledge gap, 42; instrumental value of, 330; large marine (LMEs), 14–15, 231, 304; large ocean management areas (LOMAS), 254, 255, 297–98; limitations of data on, 45; linkages between social and ecological components of, 320; managing variability within, 77; measurability of features, 101; Millennium Ecosystem Assessment (MA), 6, 318; natural, 130; noncatastrophic changes in, 190–91; offshore waters, 163; open coastal embayments, 183; opportunity costs of maintaining, 131–33; processes of, 35, 118; protection of, in Gulf of California, 241; regional, 16; resilience in, 60; sectoral approaches to, 28; small-scale fisheries as proxies for health of, 242; status of, 33–39.

- Ecosystems (*continued*): See also Coastal ecosystems; Coral reef ecosystems
- Ecosystem services: causes of risks to delivery of, 341; changes in values of, 104; as concept, 92; connections among, 4–5; conservation of, 5–6; in coupled social-ecological systems, 5; cultural, 6; delivery of, 317; economic activities and indicators of, 193; focus on, 6; global degradation of, 6; land use value of, 139; location dependence in value of, 96; loss value of, 134; of Morro Bay ecosystem, 183; in multistate marine ecosystems, 56; provided by coastal and marine systems, 7; provided by mangrove wetlands, 138; as public goods, 94; in Puget Sound region, xvi; social benefits of, 130–31; and status of marine ecosystems, 34; uncertain future value of, 132; undervaluation of, 129; water filtration, 59
- Ecosystem status, geographic differentiation of, 33–34
- Ecosystem view, 147–50
- Eelgrass (*Zostera marina*), 196–97
- Endangered Species Act (ESA), 165, 169–71
- Endpoints. See Ecological endpoints
- Environmental heterogeneity, 80, 82
- Environmental impact statements (EISs), 172–73
- Environmental Protection Agency (EPA), 24, 304
- Environment Protection and Biodiversity Conservation Act, Australia, 295–96, 349
- Equilibrium theories, 77, 77–78, 82
- Escalera Náutica* (Nautical Stairway), 237, 245
- Essential fish habitat (EFH), 166–68
- ESSIM. See Eastern Scotian Shelf Integrated Management (ESSIM) Initiative
- Estero Bay, 183, 185
- Ethical landscape of EBM, 326–36, 337
- European Union (EU), 299–301, 308–9, 314–15
- Eutrophication: in Chesapeake Bay, 269–71, 273, 276–77, 283–84; of coastal waters, 57; moderate and extreme levels, 36–37; restoration of oyster populations and reduction of, 287
- FAO Code of Conduct for Responsible Fisheries, 308–9
- Fecundity, 80–81, 82
- Federal government. See Governance; *specific governmental agencies*
- Federalism, and development of EBM, 310–11
- Feedbacks: bioeconomic models and, 105; for Chesapeake Bay, 284, 286–87, 288; cross-scale phenomena and, 74, 85; delayed effects of, 38; and problems of scale, 83; resilient social systems and, 264; types of, 65
- Fisheries: blue crab, 276, 278–81; chinook salmon, xvii, 218; closures of, 263; cod, 36, 150, 253, 262, 265; commercial vs. recreational, 281–82; ESSIM and institutional changes to, 257; in Gulf of California, 228–29, 234–37; and habitat linkage, land use value of, 139; haddock, 256, 262; landings in coastal zone, 34; lingcod, 214; local context and sustainability of, 47; mapping of, 43; in Puget Sound region, xvi; research on, 154; salmon, 61, 217–18; shrimp, 229, 231–33, 236, 244–45; small-scale, 242–43; spatial distribution of, 35, 82–83; in Thailand, 140. See also Overfishing
- Fisheries acts, 253, 264, 301–3. See also Magnuson-Stevens Fishery Conservation and Management Act (MSA)
- Fisheries management, 22–23, 27, 64–65, 121, 289, 346. See also Magnuson-Stevens Fishery Conservation and Management Act (MSA)
- Fishers, 40–41, 43, 46, 150–51, 236, 278
- Fishery management councils, regional, 16, 165–68
- Fishing, 35–36, 103
- Fishing practices, 146, 151, 185, 240
- Fish kills, 38, 216
- FishResearch.org, 154
- Food webs, xvi, 38, 209, 218–19, 236, 335
- Functional diversity, 60–61, 88
- Funding for EBM, 20, 305
- Future options maintenance, 342–43
- Genetic integrity, 260–62
- Global climate change, xi–xii, 15, 37, 67, 289
- Goals: common, in key concepts for EBM, 341–42, 344; conflicting, as moral quandry, 332–33; and consequentialist moral reasoning, 327–28; in development of EBM approach, 13–15; of EBM, 3–5, 27, 59, 129; hierarchy of, and objectives for EBM, 257–59, 306, 307, 315; values and, 326. See also Case studies
- Governance: collaborative, 259; communication and resilience in structures of, 264; dynamics of, 122; existing, 123, 303; federal, 173;

- Governance (*continued*): framework for integrated policymaking in EU, 299; integration of, across scales, 83; interactions across levels of, 86; of regional fishery management councils, 165–66; requirements for implementation of EBM, 199; and resilience, 175, 177; science-policy structure of, 220–21; subnational, and development of EBM, 310; suggested reforms, 174–77
- Gregoire, Christine, 202, 332
- Gulf of California, Mexico, 68; overview, 227; common goals for, 342; degradation of coastal mangroves, 56–57; interaction of scientists and managers in, 317; marine resources in regional history of, 227–29; place-based efforts in, 315; regional vision for, 245–46; satellite view of, 228; socioeconomic dynamics, 229–31
- Gulf of Maine, USA, 18–19, 315
- Gulf of Mexico, 37, 315
- Harbor porpoise (*Phocoena sinus*), 227, 234–35, 239
- Hatchery salmon, 217–18
- Hawaiian coastal system mosaic, 40–41
- Hawaiian managed watershed (*ahupua'a*), 147
- Hawaiian traditional fishponds, 149
- Hierarchy of EBM goals and objectives, 257–59, 306, 307, 315
- Historical ecology, 44, 345
- Historical map for EBM, 327–32
- Human activities: areas of potentially high sensitivity to, 261; cumulative impacts of, 16–17, 61, 62, 305, 317, 345; EBM of, 5; in ESSIM planning area, 256; evaluation of, in delivery of ecosystem services, 316–17; and food web function, 208; nexus of ecosystem dynamics and, 123; predictability of effects on ecosystems, 115
- Human-environment interactions, 39, 42–44, 45, 196. *See also* Human activities
- Humans: biologists' view of, 39; as citizens of the biotic world, 339; as deterrents vs. coevolved, 42–43; ecological view of, 336; and ecosystem health, 153; place of, in ecosystems, 119–20, 149, 335; population of, in coastal areas, 36; population of, in Morro Bay, 184, 185; preferences of, and economic value, 94–95; reflexivity of, and ecological policy, 84–85
- Human well-being, 93–94, 208, 345
- Hypoxia, 34, 37, 215–17, 276–77
- Ice-dependent ecosystems, xi–xiv
- Implementation of EBM: adaptive management in, 347; challenges to, 18–20, 282–86, 296–303, 314; connections between, and monitoring, 287; coordination mode for, 296–300, 304–5, 311; current efforts in, 13; economic value of, 191; expanded monitoring and evaluation in, 347; forums for comprehensive ocean planning, 27; frameworks for, 211–12, 305–7; functional units for, 186; funding for, 20, 305; governance requirements for, 199; hierarchy of goals and objectives, 257–59, 306, 307, 315; key messages for national-level, 311–12; key paths forward for, 315, 317–18; lack of legal basis for, 310; local-scale management practices as context for, 46; mandates for, 8, 26, 263–64, 304, 349–50; medical analogy for, 125–26; national-level, 294–95; resilience science in, 66, 67–68; road map for managers in, 26; science in, 125–26; shift in mindset as requirement of, 319–20; social acceptance and, 123; strategies for, 344–50; top-down approaches to, 295; trade-offs entailed in, 174–76; translating science into action, 125
- Incentives for stewardship and collaboration, 18–20, 344–46
- Indicators: biological and economic, 190–96; in decision framework, 108; of desirable ecosystem attributes, 207; development of, 99–101, 221; development of, as challenge, 206; of ecological mechanisms, 208–9; economic, 190–96; of ecosystem health and human well-being, 345; of ecosystem services, 193; guidelines for, 119; of health, 318; of human well-being, 208; in IEA, 211; importance of, and utilitarianism, 326; with predictive power, 123; of resilience, 68, 319; social and economic, 119–20; of trophic cascades, 118; whole-ecosystem, 118–19
- Indigenous knowledge. *See* Traditional ecological knowledge (TEK)
- Indigenous peoples: of Gulf of California, 227–28; involvement of, with EBM, 310; Native American tribes, xvi; Native Hawaiian people, 41, 49, 155; predictions of change in ecosystems by, 151; worldviews of, 39
- Indirect use values, 135
- Institutional innovation, 173

- Institutional structures, existing, 173–74
Institutions, attributes of, and effective ecological management, 85–86
Integrated ecosystem assessment (IEA), 211–12
Integrated management (IM), 311
Integrated Ocean Observing System (IOOS), 25
Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST), 349
Intention, in moral actions, 326–27, 337
Interagency consultation, under ESA, 170–71
Interdisciplinary engagement, 39–42, 44–46, 66, 154, 317–18
International agreements, 47, 164–65
Invasive marine species, 37, 197–98, 262
Islas Marias Archipelago biosphere reserve, 240
- Joint Ocean Commission Initiative, xix, 176
Justice, questions of, in moral actions, 326
- Kamilo Beach, Hawaii Island, 40
Kelp forests, 34, 56, 57
Knowledge base of EBM, 48, 66, 154. *See also* Local knowledge (LK); Traditional ecological knowledge (TEK)
Knowledge gaps, 42, 48, 123, 153
Knowledge-practice-belief complex, 146, 152
- Lake systems, sources of resilience in, 64
Land conservation and management, 6–8
Landscape of ethical inquiry, 326
Land use values comparison, 139
Large marine ecosystems (LMEs), 14–15, 231, 304
Large ocean management areas (LOMAS), 254, 255, 297–98
Large-scale ecosystems, 82–83, 202–5, 304
Leopold, Aldo, 331, 337
Local knowledge (LK): collection and incorporation of, 195; in contrast to TEK, 146–47; contributions of, to marine science and management, 47; and knowledge of place, 342; legitimacy of, 48–49; lessons for EBM, 147–51; in ocean and coastal ecosystems, 145–47; outlook for integration of, with EBM, 153–57; and TEK innovative approaches, 154
Local scale: connectivity between populations, 79; as context for implementation of EBM, 46–47; in ecological models, 80; efforts at, and Western science-based agencies, 152; focus on, in key concepts of EBM, 344; interaction of scientists and managers at, 317; knitting together efforts at, 315
Lo'i systems, 147, 149
LOMAs (large ocean management areas), 254, 255, 297–98
Loreto Bay cooperative (*Mujeres del Golfo*), 240
Los Cabos, Mexico, 230
Los Osos, Mexico, 184, 185
- Magnuson-Stevens Fishery Conservation and Management Act (MSA): amendments to, 18, 166; consultation requirement of, 167–68; essential fish habitat mandate, 166–67; evaluation of EBM required by, 24–25; and fisheries management, 20; focus of, on resource category, 164; national standards in, 23; reauthorization of, 346; recognition of TEK in, 49; resilience theory in, 165; sectoral goals in, 14
Maine lobster fishery, 47
Management practices: attributes of effective ecological, 85–86; best (BMPs), 103–4, 283; comanagement approaches, 87–88, 152, 155, 157; context for implementation of, 46, 48; cooperative, 150, 152, 171; cumulative impacts of, 21; current, 162–64, 341; dual-strategy approach to, 67; evaluation of effectiveness, 319; failure of, for single ecosystem aspects, 74; focus on ecological patterns and/or processes, 84; integrated, 15–16, 311; mismatch between scales of ecosystem responses and, 64, 83, 86, 284; multisectoral, 310; place-based, 47, 173; for regional persistence and abundance, 81; sectoral approach, xiii, xvii, 14, 17, 19–20, 27–28; selection of approach, 66–67; Western science-based, 151–53. *See also* Adaptive management
Management tools, area-based, 347–48
Mandates: and implementation of EBM, 8, 26, 263–64, 304; as motivator for engagement of multiple stakeholders, 315; need for, 176–77, 347, 349–50; role of, in EBM, 346
Mangrove ecosystems: benefits of, compared those of shrimp farming, 140–41; catastrophic regime shift in, 235; destruction of, 34, 56–57, 227, 232, 238; ecosystem services provided by, 138; land use value of rehabilitation of, 139; trade-offs with aquaculture, 137–40
Maori boundaries, 302–3

- Maori people, 146–47, 301
Marginal analysis, 93–94
Marginal user cost, 133–34
Marginal vs. total value, 93–94
Marine debris on Kamilo Beach, 40
Marine-dependent species, xvii, 34, 209, 330
Marine ecosystems. *See* Ecosystems
Marine Interests Group (MIG) of San Luis Obispo County, 186, 187, 198
Marine Mammal Protection Act, 14, 164
Marine Management Area Science (MMAS) Program, 124–25
Marine protected areas (MPAs): criteria for, 177; in ecological model, 80; evaluation of, 44–46; food web effects of, 213–15; in Gulf of California, 239–40, 241, 244; implementation of, 64, 82; mandatory vs. nonbinding, 301; social factors of, 120
Marine reserves, design of, 82
Marine Strategy Directive, EU, 299–300, 314–15
Massachusetts, 164, 173
Maximum sustained yield (MSY), 79, 118
Maximum yield, controlling for, 57
Mexico, collaboration between US and, 246–47
MIG. *See* Marine Interests Group (MIG) of San Luis Obispo County
Millennium Ecosystem Assessment (MA), 6, 318, 342
MIMES (Multiscale Integrated Models of Ecosystem Services), 349
Missing prices problem, 96
Models and modeling: and adaptive management, 86, 284; Atlantis, 122; bioeconomic, 105; biophysical, 101–2; for collaborations, 256–57; and consequentialist moral reasoning, 328–29; of cross-scale phenomena, 78; cultural, 281; ecological, 75–78; ecological, simple, 79–81; ecological-economic, 142; ecosystem, conceptual, 186–87, 188; to engage policymakers, 219; linked, 280; mathematical, 83–85; MIMES, 349; social-ecological, 120–22; statistical, 104; time-to-recovery, 215; for valuation of recreational fishing, 103; visual, 199
Monitoring: in adaptive management, 116–20; in Australia, 296–97; in Chesapeake Bay, 284; in IEA, 212; integration of, with modeling, 284; of Puget Sound, 208
Monitoring programs, 68, 83, 120, 280
Moral actions, stages in, 326
Moral and ethical context of EBM, 325
Moral discourse, 337
Moral framework, anthropocentric, 334–36
Moral imperative for consistency, 334
Morally justifiable policy for EBM, 338–39
Moral quandries of EBM, at present, 332–36
Moral reasoning in EBM, 328–29
Moral responsibilities, 337, 339, 343
Moral theories: biocentric, 331–32; categories of, in Western ethics, 326–27; consequentialism, 327–29, 331–32, 333, 334–36, 337; deontological ethics, 327, 328, 336, 337; ecocentric, 332; virtue ethics, 327, 328, 336, 337. *See also* Utilitarianism
Morro Bay, California, USA: collective vision for, 189, 342; conceptual model of, 186–87, 188; designation of, as State Estuary, 185–86; as EBM pilot project, 198–99, 316–17, 344; ecosystem response time, 197; ecosystem shifts, 183; intervention in fouling community of, 197–98; online survey on biological and economic data, 194–95; oyster production in, 196–97, 198; water quality arrays in, 184. *See also* San Luis Obispo Science and Ecosystem Alliance (SLOSEA)
Morro Bay National Estuary Program, 186, 187, 198
Motivations, in virtue ethics, 327
MPAs. *See* Marine protected areas (MPAs)
MSA. *See* Magnuson-Stevens Fishery Conservation and Management Act (MSA)
Mudflat ecosystems, 232, 235
Multiplicity of perspectives, 47–49
Multiscale Integrated Models of Ecosystem Services (MIMES), 349
Multisectoral planning and management, 310
National Environmental Policy Act (NEPA), 165, 171–73, 346–47
National Marine Fisheries Service (NMFS), 22–23, 166–68, 170–71
National Marine Sanctuary Program, 154–55
National Oceanic and Atmospheric Administration (NOAA), xix, 22, 231, 304
Native Hawaiian people, 39, 41, 49, 155
Natural capital, 130–31, 349
Natural gas-fired power plant, 185
Natural resource extraction and management, 93–94, 230–33

- Natural resource policy, holistic vs. myopic, 217–20
- Natural science, 123, 190–96, 279–80
- Natural systems, 15, 56. *See also* Coupled social-ecological systems
- Nature Conservancy, The, 63, 121–22
- Nearshore waters, 163–64. *See also* Coastal ecosystems
- NEPA (National Environmental Policy Act), 165, 171–73, 346–47
- New Jersey's hard clam spawner sanctuaries, 151
- New York's Great South Bay, 346
- New Zealand, 146, 301–3, 308–9
- NMFS (National Marine Fisheries Service), 22–23, 166–68, 170–71
- NOAA (National Oceanic and Atmospheric Administration), xix, 22, 231, 304
- Noise studies, 263
- Nonequilibrium systems, 74, 82–83
- Nonmarketed ecological services, 131, 134
- Nonuniformity, biophysical, 103
- Nonuse values, 135, 136
- Noroeste Sustentable* (NOS), 68, 234, 245–46, 316
- Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve, 49
- Northwestern Hawaiian Islands Marine National Monument, 303
- No-take marine reserves, 64, 80, 82, 240–41, 241, 301
- Nutrient reduction strategies, 103–4
- Nutrient trading programs, point-source to nonpoint-source, 282
- Objectives: to build system resilience, 67; for Gulf of California, 336; hierarchical structure of, in ESSIM, 264; hierarchy of goals and, for EBM, 257–59, 306, 307, 315; in hierarchy of planning tools for LOMAs, 298; multiple, as key element of EBM for oceans, 4–5; overarching conceptual, 300; socioeconomic conceptual, in ESSIM, 260. *See also* Case studies
- Objective-setting process in EBM, 264
- Oceanic vs. terrestrial ecosystems, 45
- Ocean management legislation, pending, 304–5
- Oceans: circulation patterns, 37; current system of governance, 349; defining features of, 44; ecosystem disruption, xii; federal policy on, 163, 174, 176–77; human dimensions of, 42–43; LOMAs, 254, 255, 297–98; as peopled seascapes, 39–49; traditional approaches to management of, xiii. *See also* Coastal ecosystems; Ecosystems; *specific acts and organizations*
- Oceans Act, Canada, 253–54, 263, 297
- Ocean-society relationships, 42–43
- Oceans Policy, Australia, 295, 297, 349
- Ocean temperatures, 37
- Offshore petroleum activities, impacts of, 262
- Offshore waters, 163. *See also* Ecosystems
- Oil wells, 262–63
- Olympic Coast National Marine Sanctuary, 156–57, 157
- Open systems, 34–35, 77, 183
- Opportunity costs of maintaining coastal and marine ecosystems, 131–33
- Orange roughy (*Hoplostethus atlanticus*), 35
- Orcas, in Puget Sound, xvi–xvii, 218
- Ordenamiento Ecológico* (Ecological Planning of the Territory), 231, 237, 245
- Overfishing, 35–36. *See also* Case studies
- Oyster leases, 184, 278–79
- Oyster production: in Chesapeake Bay, 270, 271, 276, 279, 287; in Morro Bay, 185, 196–97, 198
- Pacific Decadal Oscillation, 58
- Paleocology, 345
- PANGAS (*Pesca Artesanal del Norte del Golfo de California: Ambiente y Sociedad*), 242–43, 316–17
- Papahānaumokuākea Marine National Monument, 155–56
- Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO), xiii–xiv
- Pastoralists, 48–49
- Peer reviews, 23, 25
- Pelagic species, 34–35, 256, 258
- Perspectives, multiplicity of, as key concept of EBM, 343
- Perturbations, 56, 63, 75, 272–73
- Petrochemical period, 268–69, 271
- Pew Oceans Commission (POC), 176, 303–4, 325
- PISCO (Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO), xiii–xiv
- Place-based management, 47, 173, 346
- Polar bears, xi–xiv
- Policy approaches: changes in, 299, 330–31; comprehensiveness in, 18; and consequentialist moral reasoning, 329;

- Policy approaches (*continued*): in framework for EBM implementation, 305–6; within narrowly consequential paradigm, 333; overarching, at large geographic scales, 314; timeline of, 326; toward future generations, guidelines for, 331
- Political ecology, 43–44
- Pollution, 183, 268–71
- blue swimming crab), 279
- Power relations, 47–49
- Precautionary approach: in international agreements, 164–65; in key concepts of EBM, 17, 342; lack of scientific certainty and, 59; and management for general resilience, 63; in model for EBM, 331; in morally justifiable policy for EBM, 338; and prevention of threshold crossing, 117; in TEK, 150
- Predation-related mortality, 214–15
- Predictions and predictability: of ecosystem responses, 66, 151, 299, 329; effect of human activities on ecosystems, 115; in equilibrium theory, 77–78; of social dynamics, 84–85
- Prey-field habitat requirements, 167
- Production function (PF) approach to valuation of ecosystem services, 101–5, 108, 135, 136–37, 142
- Protected area networks, terrestrial principles of, 44
- Provisioning services, of coastal and marine systems, 6
- Proyecto Mar de Cortés*, 245. *See also Escalera Náutica* (Nautical Stairway)
- Public involvement. *See Stakeholder involvement*
- Puget Sound, Washington, USA: overview of, xv–xix; ecosystem goals and outcomes for, 204–5; interrelationships in eelgrass-based food web, 209; measurable outcomes in, 205–9; ongoing role of science in, 220–21; priority strategies for, 209–20; restoration of, 314; time-to-recovery model for rockfish population, 215; vision for, 201–5
- Puget Sound-Georgia Basin ecosystem, 203
- Puget Sound Partnership: Action Agenda for, 221; collective vision for, 332, 341–42; creation of, xviii, 205; goals of, 202; map of, 203; science-policy governance structure of, 220–21; scientific advisory group and, 210; stakeholder involvement, 315–16; and windows of opportunity, 67–68
- Reciprocal causality, 75
- Redundancy, 60–61, 202
- Regional advisory councils, 176–77, 302
- Regional fishery management councils, 22–23, 165–68
- Regional fishery science centers, 22, 24
- Regional ocean councils, 17
- Regional planning, 295, 298, 306, 314
- Regional variability, large-scale, 76
- Regulating services of coastal and marine systems, 6
- Relationship building, and productive collaborations, 317
- Repeated-measures BACI design, 117
- Research: beyond monitoring and modeling, 122–23; components of, in translating science into action, 125; fisheries, 154; interdisciplinary, 43–44, 319; MMAS agenda for, 124; needs for future, 343–44, 345; by SLOSEA, 189–90; small-scale fisheries, 242–43; and social contract with stakeholders, 116; translation of, into management outcomes, 243
- Reserve network theories, 78
- Resilience: addressed by ESA, 169; building, 87–88, 115–16, 242–43; characteristics of, 60, 115; of Chesapeake Bay, 276–79, 287; in coupled social-ecological systems, 64, 66, 116, 123; defined, 8; in ecological endpoints, 106–7; in ecosystem health, 202; framework for, 55, 59, 277; general vs. specific, 62–63; as goal of EBM, 129; in governance structures, 264; indicators of, 68, 100, 319; maintenance costs, 107; managing for, 66, 339; in model for EBM, 331; response diversity and, 60–61; in social-ecological systems, 59–65, 60, 88; trade-off between local and regional, 81; of undesirable states, 58, 276–77; value of preserving, 134
- Resilience loss, 129–30, 134, 142
- Resilience science: in EBM, 65–69, 162; in Gulf of California, 231–33; as interdisciplinary research field, 44; in international agreements, 164–65; key characteristics of, 8–9; key elements of, 55–56, 57; lessons from, 342; in Morro Bay, 196–98; in new ocean governance mandate, 175, 177
- Resource extraction statutes, and ESA, 170
- Resource management agencies, culture and policies of, 153
- Response diversity, 60–61, 88

- Rhode Island, 58, 164
Rightness, questions of, in moral actions, 326–27
Rio Declaration on Environment and Development, 164–65
Risk assessment, 212, 258–59, 296
Risk management, 106–7
Rockfish, 194–95, 214, 215
- Salmon consumption advisory, 202
San Luis Obispo Science and Ecosystem Alliance (SLOSEA): activities of, 187; communication with stakeholders, 188–89; creation of, 183; goals of, 187; integrated ecosystem group of, 186; management of human-environment interactions, 196; and Morro Bay, 316, 342, 344; organization of, 185; research and monitoring by, 189–90; resilience thinking in study by, 197–98. *See also* Morro Bay, California, USA
Scale dependence, 75, 76–78
Scales: competing, as moral quandry, 333–34; determination of, in development of EBM approach, 15; disparity in, between drivers and management, 38; in EBM for oceans, 4, 9; in ecological model, 80; local, in global-scale change, 46–47; mismatch of, in ecosystem responses and management decisions, 64, 83, 86, 284; for monitoring and modeling EBM, 121; multiple, in implementation strategies, 314; of underlying process vs. of patterns of abundance, 82. *See also* Local scale
Science: in adaptive management, 220; in Chesapeake Bay restoration, 279–82; in decision making, 316; in EBM, 123–26, 201, 287, 316–17, 344; in environmental policy and management, 48; as guide to policymakers, 217–20; translation of, into action, 123–25. *See also* Resilience science; Social sciences
Science and statistical committees (SSCs), 23
Scientific advisory structure for EBM, 21–24, 27
Scientific information, cross-sectoral, 27
Scientific knowledge, 48–49, 147, 283, 346
Scientists, independent committee of, 176
Sea of Cortés. *See* Gulf of California
Sectoral management approach, xiii, xvii, 14, 17, 19–20, 27–28
Sectoral reform, 305, 346
Sector-specific agencies and industries, 296–97
Sedimentation, 196–97, 271
Sense of place, 39, 278–79
Shrimp farming, 138–40, 139, 141, 234
Sixth Environmental Action Programme (6EAP), 299, 301
SLOSEA. *See* San Luis Obispo Science and Ecosystem Alliance (SLOSEA)
Social-ecological systems (SEs): as coupled system, 39; drivers of change in, 42–49; ecological management in, 79; features of, in Hawaiian coastal system, 40; linkages in, 317, 320; resilience in, 59–65, 60, 88. *See also* Coupled social-ecological systems
Social ethic of care, 337
Social learning, through adaptive management, 86
Social sciences, 39, 46, 154, 280–82, 317
Social values, in economic analysis, 100–101, 102
Sociocultural dynamics, 122
Sound Science (Ruckelshaus and McClure), 206, 221
Spatial management tools, 264, 347–48
Species at Risk Act, Canada, 253, 260
Species richness, as type of diversity, 60
Spiritual values, 330
Stakeholder involvement: in Canada, 298–99; in conduct of natural science, 123; in ESSIM initiative, 256–57, 259; in establishment of MPAs, 120; as key aspect of EBM, 66, 69, 116, 154, 310, 315; in MMAS Program, 124; sector-based, 298; in SLOSEA, 188–89; in translating science into action, 125
State-level regulatory regimes, 164
Steinbeck, John, 336
Storm protection services of coastal wetlands, 139, 140–41
Stressors, interactions among multiple, 317
Success, assessment of, 318–19, 345
Susquehanna River Valley, 269, 277, 287
Sustainability: as component of ecosystem values, 330; as goal in national forest management, 176; in Gulf of California, 233–37, 336; long-term, in key concepts of EBM, 342–43; resilience as proxy for, 107
Sustainable Fisheries Act (1996), 166
Synchronic data, 147
Taro terraces (lo'i), 147
Terrestrial vs. oceanic ecosystems, 45
Thailand case study, 137–42
Threatened and endangered species, 183, 202, 218, 238, 260–62

- Thresholds: between alternative states, 55;
crossings, 68, 106–7, 117, 134; identification
of, 66; in IEA, 211
- Time-to-recovery model for rockfish population,
215
- Top-down drivers, 280, 287
- Totoaba (giant sea bass), 227, 229, 238–39
- Tourism, xvi, 237, 245
- Trade-offs: among ecosystem services, 16–17, 20;
among multiple objectives, 5; assessment of,
59, 129, 345, 348–49; economic, 98–99; in
economic development, 141; in
implementation of EBM, 174–76; between
local and regional resilience, 81; mangrove-
aquaculture, in Thailand, 137–40; in sectoral
management approach, 17; transparency in,
316, 320, 343, 348–49
- Traditional ecological knowledge (TEK): belief
component in, 147–49; contemporary
application of, 152; definition and examples of,
146; holders of, and rights of access and/or
ownership, 155; integration of, 153–57; and
knowledge of place, 342; in ocean and coastal
ecosystems, 145–47; as resilient management
system, 150–51; and traditional tenure
practices, 49
- Tragedy of the commons, 43
- Transparency in EBM, 264, 316, 320, 343, 348–49
- Trophic cascades, indicators of, 118
- Tropical Storm Agnes, 268, 272–73, 277, 287
- Tsunami disasters, 61, 138
- Uncertainty: consideration of, in EIS, 172–73;
decision-making under, 17; in future value of
ecosystem services, 132; mathematical
models and, 83–85; in resilience thinking, 175;
risks of ignoring, 134; in scientific process,
284, 286; in TEK, 150
- United Nations Convention on the Law of the Sea
(UNCLOS), 163, 303–5, 308–9
- United States (USA): challenges to
implementation of EBM, 305; collaboration
between Mexico and, 246–47; elements of
EBM in state and national legislation, 308–9;
need for overarching mandate in, 349–50;
Ocean Action Plan, 24–25, 303; policy context
for EBM, 303–4
- Upper Gulf of California and Colorado River Delta
Biosphere Reserve, 238–40
- US Commission on Ocean Policy (USCOP), 16,
154, 176, 303–4, 330
- Utilitarianism, 94–95, 327, 329–30, 334. *See also*
Consequentialism
- Valuation of ecosystem services: challenges of,
130–34; ecological endpoints in, 96–98;
framework for, 107; historical focus of, 92;
irreplacability as metric in, 97; of mangrove-
aquaculture trade-offs, 137–40; methods for,
93–95, 96, 98, 134–40; models for, 103;
nonmarketed, 141–42; nonuse values in, 99;
options for, 24; production function approach
to, 101–5, 108, 135, 136–37, 142; and trade-
offs, 129, 348–49
- Values, 326–27, 331
- Vaquita (*Phocoena sinus*), 227, 234–35, 239
- Virtue ethics, 326–27, 328, 336, 337
- Vision for EBM, 344, 350
- Waikiki surfers, 41
- Washington State, 202, 216. *See also* Puget
Sound, Washington, USA; Puget Sound
Partnership
- Water quality: focus on, by Chesapeake Bay
Program, 280; impact of, in Morro Bay, 196–
97; in Puget Sound region, xvi–xvii; research
and monitoring by SLOSEA, 190; study on
value of, to Chesapeake Bay boaters, 282
- West Coast Governor's Agreement on Ocean
Health (2006), 173, 315, 346
- Western ethics, 326–27, 331
- Western science-based management, 145, 151–
53
- Wetlands: coastal, 138, 139, 140–41, 238, 244;
modification of, 16–17; restoration of, in
southern Sweden, 136
- Willingness to pay, 93, 130–31
- Windows of opportunity, 67–68, 174, 178
- Wisdom of the crowd, 122
- Worldviews, 39, 333, 334–38