

Table 4.1. A general list of issues that need to be considered for implementing ecosystem considerations into fisheries management (Adapted from Link 2002b).

Geography of the Ecosystem

- What are the key features of the ecosystem under consideration? For example, is the system relatively open (e.g. mid-sea, continental shelf) or closed (e.g. river, small lake, bay)?
- How big is the ecosystem?
- What are the important, dominant, and unusual physiochemical factors in a system?
- Is there a prominent geographic, bathymetric, or similar feature that defines and dominates the system?
- What are the political boundaries and jurisdictions that govern the resources in a system?
- How dense is the human population in or near the ecosystem?

Key Species

- What are the key species in the ecosystem? Certainly a list of commercially exploited species is required, but non-commercial yet ecologically valuable species should also be included.
- What are the key attributes of these species?
- Are the species involved relatively slow-growing with a long lifespan, or are they more r-selected?
- What is the size of the species in the system?
- What is the extent or range of the species of interest in a system? How are they spatially distributed?
- How economically valuable are the exploitable species?
- Are there any keystone species? Are there any dominant species?
- What is the functional role of the key species?
- Have the life history parameters for a species changed over time (e.g. faster growth, earlier age-at-maturity, etc.)? Have they even been determined?
- Are there any species particularly susceptible to an ecological process?
- Are there any specialists?
- Are there any species that are near extinction?
- Are there any species that have an excessively high linkage density (high number of predators or competitors)?
- Are there any species that have sensitive or low-output reproduction?

Table 4.1. continued.

Abiotic Factors

- Are there certain spawning or nursery grounds that merit protection?
- Is there a particular habitat feature (e.g. stacked cobble, sea grass or oyster beds) that enhance the survivability of juvenile fish?
- Is there a particular area that is optimal for growth?
- Are there particular features such as a thermocline or frontal boundary that aggregate prey for fish feeding?
- Has the habitat been altered in any way?
- Are there any toxins in the system that can kill or chronically impair a species?
- Is the system susceptible to large scale perturbations such as a hurricane?
- Is there the possibility that a hypoxic zone could develop?
- Are other forms of pollution prevalent and significant?
- Could harmful algal blooms develop, and if so, what effect would they have on key species?
- Is there evidence of a long-term regime shift in temperature, salinity, atmospheric pressure, upwelling, or similar meteorological factors? Have circulation and current patterns changed across time?
- How strong are tidal influences? Have they changed?
- Are certain life stages or certain species particularly susceptible to environmental change?

Species Interactions

- Have the interactions between species been identified? If so, can they be quantified?
- What is the amount of food required to maintain a predator population at a certain size structure and abundance?
- What is the total number of individuals removed by all predators of a particular species?
- Are the interactions between species strong and tightly coupled, or is it a system of generalists with weak species interactions?
- Is there one species that is clearly a competitive dominant?
- Is there evidence of dietary, spatial, or other resource overlap?
- Is there an indication that resources may be limiting?
- What are the key resources in a system for fish, plankton, benthos, etc.?
- Is there a potential for conflict among fisheries targeting different species?
- Are there management protocols in place to objectively resolve these conflicts?

Table 4.1. continued

Aggregate Properties

- What is the productivity of the ecosystem? Has it changed across the lifespan of key species? How does this affect carrying capacity for upper trophic levels?
- Similarly, have there been changes in secondary production in the system?
- Is an understanding of the dynamics of lower trophic levels such as benthos or zooplankton essential for the key fisheries?
- Is the food web tightly connected to the nutrient dynamics of a system such as an estuary or small lake?
- Are there significant guilds in the system?
- How is the energy and biomass of the ecosystem partitioned amongst different functional or aggregate groups?
- What is the dominant group?
- Has this group remained dominant across time? If not, what caused the changes?

System-Level Properties

- Are there other ecosystem goods and services that compete with a fishery or a particular species? Conversely, are there synergisms between different user sectors?
- How does a fishery interact with other sectors that use an ecosystem (e.g. tourism)?
- Are there protocols to address these potential conflicts or encourage possible collaborations?

The Fisheries Context

- What type of fisheries have been in the system (commercial, recreational, artisanal, etc.)?
- What type of gear has been and is being used?
- What is the historical level of fishing effort on key species in the system?
- What is the current level of fishing on key species in the system? How does this influence non-target species, trophic structure, habitat, etc.?
- What are current landings and discards?
- Can we adapt gear or else choose to target species as a group that have high technological interactions?
- Where are stocks relative to historical levels of abundance (declining, collapsed, or recovering)?