The ConsNet Portal 1.0

Systematic Conservation Planning Primer

Mangrove Swamps, Sundarbans National Park, India. The Sundarbans cover 10 000 sq km in India and Bangladesh in the Ganga delta. These are the largest mangrove forests in the world and are protected as a World Heritage Site in India. These forests contain the largest remaining population of Bengal tigers (*Panthera tigris tigris*). © 2003 Sahotra Sarkar.

M1: Introduction to Conservation Area Networks

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Learning Objective: This module is an introduction to the key concepts of biodiversity, conservation areas, systematic conservation planning, and to the software used for planning. Learners will draw on some previous knowledge of ecology and conservation biology.

- **Biodiversity** is the variety of living features and processes at all levels of structural, taxonomic, and functional organization. Biodiversity includes all diversity of life that exists on Earth.
  - Biodiversity processes include endangered biological phenomena such as species' migrations endangered by the building of fences and roads.
  - Biodiversity does not include ecosystem services (e.g., nutrient cycling, the movement of water or energy) or culturally-based categories (e.g., cultural, spiritual, or aesthetic objects) though it does not deny their importance.
- Planning for biodiversity conservation assumes that it is desirable (or good) to preserve biodiversity.
  - Conservation biology assumes that all components of biodiversity are important, not just charismatic species (animals that have great popular appeal).
  - Environmental ethics seeks to delineate the reasons for the conservation of biodiversity.
  - Biodiversity conservation has become important because human beings today are believed to be causing extinctions at a rate unprecedented in human history.
- Biodiversity can be measured in a variety of ways, depending on the purpose of the measurement.
  - Ecologists distinguish between:
    - Alpha diversity - diversity within an area;

- Beta diversity - diversity between areas;
- Gamma diversity - total diversity of a region.

- Biodiversity has been measured by:
  - Species richness: this measures the total number of species (or other biota) in an area. This particular measure of biodiversity is *not* used in systematic conservation planning.
  - Habitat/ structural diversity: this measures biodiversity through the diversity of composition or spatial configuration of habitats, the diversity of age classes (e.g., old vs. young trees), etc.
  - Functional and process diversity: biodiversity is measured using disturbance types and frequencies (e.g., fire regimes), seasonal migrations of animals, etc.
  - **Complementarity** is a measure of what new biodiversity features a new area brings relative to a group of already selected areas; Complementarity is thus a measure of beta diversity, measuring what is *different* about the new area.
    - The measure of complementarity is specific to systematic conservation planning.
    - Complementarity is a measure of the contribution that an area in a planning region makes to the full complement of biodiversity features (e.g., species).
    - In systematic conservation planning, it refers to the relative contribution an area within a larger region makes toward a particular conservation goal. For example, if a particular area has few species that do not occur widely in the conservation planning region, it may have higher complementarity than an area with many species that are widespread throughout the planning region. In other words, an area has high complementarity if it has a large number of unrepresented species relative to other areas in the planning region.
    - Complementarity supersedes (or preferentially replaces) other measures of biodiversity only in systematic conservation planning.
    - The use of complementarity allows the representation of all species in as few areas as possible. The concept of complementarity will become more familiar as we examine the methods of systematic conservation planning. For more on complementarity see **M8: Place Prioritization**.

- Conservation Areas: These are geographically delineated terrestrial or marine regions (places) managed for the persistence of biodiversity features (taxa, communities,

habitats, etc.) and processes.

- Conservation areas include but are not limited to traditional reserves and national parks.
- "Conservation area" replaces "reserve" because the name change is politically significant. A reserve that excludes human habitation or extractive use is but one in a continuum of different management options.
- **Empirical studies** must be used to determine whether or not a particular management option is adequate for the persistence of biodiversity in an area.
- "**Site**" is sometimes used to refer to a place (or area) being analyzed for conservation action.

Example 1.1

IUCN Classification of Protected Area Management Categories

The IUCN (World Conservation Union) is the world's largest conservation network and is comprised of scientists, governments, conservation experts, and non-governmental organizations from around the world. In order to implement effective conservation management and planning, the IUCN classifies protected area management into 6 categories with specific objectives, guidelines and responsibilities for each protected area:

I.Strict Nature Reserve/ Wilderness Area: a protected area managed mainly for science and wilderness protection. A protected area managed mainly for science is defined as an "area of land and/ or sea possessing some outstanding or representative ecosystems, geological or physiological features and/ or species, available primarily for scientific research and/ or environmental monitoring." A protected area managed mainly for wilderness protection is defined as a "large area of unmodified or slightly modified land, and/ or sea, retaining its natural character and influence, without permanent or significant habitation, which is protected and managed so as to preserve its natural condition."

II.National Park: a protected area managed mainly for ecosystem protection and recreation. This area is defined as a "natural area of land and/ or sea, designated to (a) protect the ecological integrity of one or more ecosystems for present and future generations, (b) exclude exploitation or occupation inimical [detrimental] to the purposes of designation of the area and (c) provide foundation for spiritual, scientific, educational, recreational and visitor opportunities, all of which must be environmentally and culturally compatible."

III.Natural Monument: a protected area managed mainly for conservation of specific natural features. This is an "area containing one, or more, specific natural or natural/ cultural features which is outstanding or [of] unique value because of its inherent rarity, representative or aesthetic qualities or cultural significance."

IV.Habitat/ Species Management Area: a protected area managed mainly for conservation

through management intervention. This protected area is an "area of land and/ or sea subject to active intervention for management purposes so as to ensure the maintenance of habitats and/ or to meet the requirements of specific species."

V.Protected Landscape/ Seascape: a protected area managed mainly for landscape/ seascape conservation and recreation. This is defined as an "area of land, with coast and sea as appropriate, where the interaction of people and nature over time has produced an area of distinct character with significant aesthetic, ecological and/ or cultural value, and often with high biological diversity. Safeguarding the integrity of this traditional interaction is vital to the protection, maintenance, and evolution of such an area."

VI.Managed Resource Protected Area: a protected area managed mainly for the sustainable use of natural ecosystems. This area contains "predominantly, unmodified natural systems, managed to ensure long term protection and maintenance of biological diversity, while providing at the same time a sustainable flow of natural products and services to meet community needs."

- Conservation Planning Goals:
  - The two major goals are the representation and persistence of biodiversity within **Conservation Area Networks (CANs)**.
  - Another goal is economy or the cost-effectiveness of a plan. Conservation planning attempts to make the cost of a plan as little as possible.
    - It is common practice to establish conservation areas on land with little economic value. Gaps in the Conservation Area Networks (CANs) are therefore often in economically productive areas or close to urbanization. In these areas, species then compete with human populations for natural resources.
  - Conservation planning must incorporate socio-political, economic, and other such factors, besides purely biological ones.
  - Conservation planning must be systematic: traditional *ad hoc* (improvised or used for specific/ immediate problems/ needs) methods lead to inefficient deployment of limited resources (Pressey 1994).

Example 1.2

Pressey's Review of *Ad Hoc* Reserves
(Pressey 1994)

As stated earlier among the goals of conservation planning, conservation areas such as reserves should provide as much of a complete representation of biodiversity within a region as possible. Pressey shows that decisions in conservation planning often depend on demands of the moment or other particular purposes (most often not with the representation of biodiversity in mind): "The resources for conservation are limited and activities that are destructive to nature are expanding. The success of eventual reserve networks in representing the elements of biodiversity will therefore depend largely on how carefully the individual reserves have been located (663)." Achieving this goal is a driving force of Systematic Conservation Planning.

Pressey classifies the types of ad hoc reserves as: "lands nobody wanted" - e.g., unsuitable for agriculture, mining, forestry, and commercial development; or reserves for reasons not associated with biodiversity - recreational value, beautiful scenery, potential for tourism and revenue, originally set aside for private hunting, preventing soil erosion into agricultural lands, etc. These biases of *ad hoc* reservation design cause concern over what Pressey calls "the uncertain fate of the unreserved natural features. . .Once they disappeared, declined, or degraded the potential to protect their biodiversity is forgone or reduced (664)." Populations such as metapopulations (a population of species consisting of subpopulations linked by immigration and emigration) occupy a habitat matrix (a mosaic of habitat patches across which organisms move, settle, reproduce and eventually die.) This matrix consists of suitable and unsuitable patches. If biased *ad hoc* reserves lead to the division of habitat matrices, this will cause species to decline. Moreover, in many cases conservation planning algorithms (such as those used in systematic conservation planning), which are designed to protect the minimum total reserve area needed to represent biodiversity features, demonstrate that fewer areas are needed to represent all biodiversity features than in *ad hoc* reserve networks, thus decreasing cost of potential reserves.

- Systematic Conservation Planning is the selection of **biodiversity** conservation area networks (CANs) and the formulation of management plans for these networks, using explicit step-wise protocols.
  - The main purpose is to identify priority areas for biodiversity and separate them from processes which threaten their persistence.
  - It is a structured step-wise approach with several stages with feedback, revision, and reiteration, where needed, at any stage.
  - Systematic Conservation Planning is usually implemented with software tools using electronic geo-referenced data sets and area selection mathematical algorithms.

- Under the umbrella of systematic conservation planning is **conservation assessment**, a term used to refer only to assessment of the potential value of conservation areas. Such assessment is a necessary stage for the selection of CANs (see **M7: Review Existing Conservation Areas**).

Example 1.3

Kirkpatrick's Plan for Tasmania
(Kirkpatrick 1983; Justus and Sarkar 2002)

Kirkpatrick provided a plan to conserve the **biodiversity** of Tasmania that involved the first use of **complementarity**. This makes it one of the most significant developments in the history of systematic conservation planning. Kirkpatrick searched for unreserved and badly reserved populations of 34 vascular plant species endemic only to Tasmania. The endemics already adequately reserved in Tasmania came from previous examples of *ad hoc* reserves, as they are found mostly in western and montane regions in scenic national parks.

Kirkpatrick pointed out that the **non-iterative procedure** (just using species richness as a factor) for place or region selection in a CAN was inefficient. He shows that a non-iterative procedure would have been inadequate in achieving biodiversity representation while minimizing the amount of conservation sites: "A major drawback of a listing of priority areas on the basis of a single application formula is that there is no guarantee that the priority area second or third on the list might not duplicate the species, communities, habitats that could successfully be preserved in the first priority area (Justus and Sarkar 2002, 128)." The non-iterative procedure would have over-represented some species and possible under-represented many other species. This is unacceptable in planning conservation area networks.

Kirkpatrick then used an iterative procedure combined with an implicit notion of complementarity. Complementarity was measured at each step of the **iterative planning procedure** as the number of unrepresented species (Margules and Sarkar 2007). If a particular area has few species that do not occur widely in the conservation planning region (CAN), it may have higher complementarity than an area with many species that are widespread throughout the planning region (CAN). Kirkpatrick began by giving numerical values of 100, 50, or 0 to species depending on their presence in conservation areas. The value a species receives depends on complementarity. As Kirkpatrick puts it: "Thus, species, communities or habitats that had high weightings because of their poor preservation status, and that are in the first priority reserve, will not merit the same weightings in the selection of a second priority reserve. Thus, in the first round the presence of a particular species may add 100 to the value of a site, because the species was totally unpreserved. In the second round the same species could only be worth 50 because it is now within one notional reserve. If this species also occurs in the second priority area, its worth in the third round could be assessed at zero (Kirkpatrick 1983, 128)." (The numbers are arbitrary, but the use of complementarity is clear.) The

unreserved/ badly reserved species turned out to be located in areas of low to non-existent agricultural grazing and intense fire regime presence. Seven small regions were required to represent all species in the network.

- For effective protection of nature, biodiversity conservation must be accompanied by sustainable natural resource management and ecological reconstruction.
  - Sustainability is needed to ensure that future generations may lead lives of acceptable quality. In particular, the health of future generations must not be compromised because of the over-consumption of the present generation.
  - Ecological reconstruction (also called restoration in many contexts) is necessary because many areas of the world have been biologically degraded by human activities.

Assess Your Knowledge

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M9: Vulnerability and Persistence Analysis
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M11: Multiple Criteria Analysis
M12: Implementation of Conservation Plan
M13: Periodic Network Reassessment
M14: Conclusion and Review - Future Directions

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