The ConsNet Portal 1.0

Systematic Conservation Planning Primer

Range Shifts Due to Climate Change. Edith's Checkerspot Butterfly (*Euphydryas editha*), the range of which was shown by Camille Parmesan to be shifting northwards due to climate change in Mexico and the United States. © 2006 Camille Parmesan.

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M14: Conclusion and Review - Future Directions

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Learning Objectives: This module will focus on several areas which require more attention from both developers and practitioners of systematic conservation planning tools and protocols. Rather than summarize the previous modules, this module will discuss the stages of systematic conservation planning that require further research. Learners will be asked to reflect on the concepts learned in previous modules.

- Systematic conservation planning is a discipline of very recent vintage—many of its aspects will need to be modified as more is learned from attempts at implementing conservation plans and monitoring them in different regions of the world.
    - With very few exceptions, systematic conservation plans have not been implemented in full.
    - This situation already calls into question whether parts of the systematic planning protocol needs modification.
- There is a need to communicate to potential practitioners the value of systematic approaches, especially ones using the various computer-based tools that have become available.
    - In particular, computer-based tools should be viewed as decision support systems, not decision making systems.
    - Past misconceptions must be recognized and corrected:
        - There is the misconception that planning tools ignore local expertise. Rather, planning tools should ideally be used by those with local expertise to explore a large spectrum of possible plans effectively.
        - It may once have been the case that planning tools required data that were not easily available for many regions of the world. With advances in modeling and remote-sensing technologies this is no longer true for any terrestrial region. In the marine context, remote-sensed data are available for the epipelagic zone; for the meso- and bathypelagic zones,

    satellites can currently provide only indirect measurements.

    - Planning tools are sometimes believed to be expensive to use, diverting money that would have been better spent acquiring land for conservation. By now, computers have become relatively inexpensive and most software for biodiversity conservation planning is freely available.

  - This module will focus on several areas which require more attention from both developers and practitioners that use planning tools and protocols.
    - The emphasis will be on what still remains poorly understood, not a summary of what was already said in earlier modules.

- Choosing stakeholders: much more needs to be understood about how to identify and involve stakeholders effectively.
  - Stakeholder enthusiasm may well be the most salient factor for the successful implementation of a plan.
  - All appropriate stakeholders must be identified –see **M3: Stakeholder Identification and Involvement**.
    - While there are guidelines for ensuring inclusion of all relevant stakeholders (see **M3: Stakeholder Identification and Involvement**), there is no foolproof process to ensure that problems do not arise.
    - If planning experts are outsiders, then there is ample room for tension between experts and local stakeholders. There is no foolproof method for avoiding this problem.
  - However, not all stakeholders have the same ethical standing during negotiations.
    - For instance, multinational oil companies attempting to extract resources from a piece of land do not have ethical standing equal to villagers who have been living on that land for generations.
    - It is not ethically acceptable to prioritize stakeholders on the basis of their economic and political power. However, such power (e.g., economic and political) cannot be ignored during the planning process—it may act as a serious constraint on successful implementation.
    - Far too often, planning exercises have treated all stakeholders as having equal standing in the conservation planning process, hoping that consensus will emerge and irresoluble conflicts won’t derail the planning process.

    - However, when conflicts between stakeholders arise, the relevant ethical issues must be explicitly addressed.
    - This is where insights from philosophy and the humanities are important. Systematic conservation planning is yet to incorporate such insights broadly, and much remains to be explored to broaden its base in this way.

- Assessing vulnerability of areas and prognosis for biota: these are obviously important tasks because, ultimately, the goals of conservation planning include the persistence of biodiversity in addition to its representation in conservation area networks –see **M9: Vulnerability and Persistence Analysis**.
  - Rapid reliable methods for simultaneously assessing viabilities for hundreds of taxa do not exist.
    - Currently, no promising avenues of new research appear to exist for this purpose.
  - Models of threats and other ways to assess vulnerability of areas remain rudimentary.
    - Many other disciplines must also implicitly model such threats to biodiversity across landscapes, for instance, by modeling suitability of areas for industrial or urban development.
    - These models are mostly more reliable than biological models of viability analysis.
  - It may be that the problems of assessing viability and vulnerability are so difficult that adequate solutions will not be found in the near future. Meanwhile conservation planning and the designation of conservation area networks must proceed because, otherwise, much of biodiversity will be lost.
    - Currently, the only aspect that can be predicted with any reliability is the prognosis for some very general landscape-wide features.
    - Environmental threats may have to be addressed using legislative regulations based on strong precautionary principles, such as “always assume the worst for any potential irreversible undesirable change and act to prevent its occurrence.” However, such a principle may lead to poor use of scanty and limited resources, because the worst outcome may be very unlikely.

- Conservation planning decisions are often made by groups of stakeholders, not individuals. Yet the decision analysis tools that are in common use, for instance multicriteria analysis (see **M11: Multi-Criteria Analysis**) assume decisions are being made by individuals.

- In general, group decision analysis has not been systematically explored by decision theorists.
    - It is not even clear whether the conservation decision making process should be viewed as one of conflict resolution between fundamentally opposed interests, or as co-operative planning by individuals with ultimate shared goals but with different strategies.
    - Different decision models apply to different situations.
    - Social choice theory has recorded many paradoxes and problems faced by group decisions
    - With very few exceptions (e.g., Regan et al. 2006) group decisions have not even been theoretically explored in the conservation planning context.
- Even when groups have jointly tried to make decisions using conservation planning tools, the tools used were for individual decision making—see **Example 14.1**.
- Group decision analysis protocols remain to be developed for use in systematic conservation planning.

Example 14.1

Group Negotiations in New South Wales (Pressey 1998)

This example has already been partly discussed in **M12: Implementation of Conservation Plan** –see **Example 12.2**. The general goal was to ensure adequate protection of a large set of surrogates in forest conservation areas by regulating logging practices. It was generally accepted that the logging industry had legitimate interests in harvesting part of the extensive forests. There were seven recognized stakeholders: the Resource and Conservation Assessment Council (which was also the designated referee in the case of disputes), the forestry industry, the forestry workers union, State Forests of New South Wales, the National Parks and Wildlife Service, conservation activists, and the Commonwealth of Australia. It was accepted that negotiations would continue even if one of the parties stopped participating. Each stakeholder had access to a GIS system that allowed it to analyze data provided by the other stakeholders. The group agreed that convergence to a single desirable scenario by all stakeholders was unlikely—so it decided to produce four scenarios corresponding to different amounts of logging (see **M12: Implementation of Conservation Plan**—**Example 12.2**). The negotiations were designed to draw up specific plans, that is, the configuration of land units that would be reserved from logging in each scenario. Existing software tools were modified to ensure transparent analysis with these specific goals—this entire process, even before formal negotiations began, took over nine months.

Formal negotiations began in April 1996 at the head office of the National Parks and Wildlife Service. Negotiators were accompanied by support teams, computer hardware and software, maps, and reports. Parallel negotiations in two separate rooms, corresponding to different geographical regions, took place for four weeks. An interactive software system was operated by a single individual who turned out to be a key player in the negotiations; this individual used the software to evaluate different settings for parameters which determined final outcomes. These settings were suggested by the other stakeholders in the room. The first set of such negotiations produced results that were acceptable to all in what turned out to be a fairly relaxed setting, and these results were partially implemented. Thus, group decision analysis was incorporated by interaction and repeated used of a decision support system (the interactive software system) which did not itself incorporate multiple agents.

- The problem of uncertainty: every stage of the systematic conservation planning protocol (see **M2: Systematic Conservation Planning Overview**) suffers from uncertainties.
    - It is not clear that all of these uncertainties can be modeled, and thus quantified (Sarkar 2005).
    - Scientific uncertainties that should be emphasized in systematic conservation planning include:
        - The quality of data is often heterogeneous. Data collection is often biased in unrecognized ways –see **M4: Data Compilation, Assessment, and Treatment**.
        - Data treatment methods, for instance, to predict ranges of taxa have large uncertainties associated with them –see **M4: Data Compilation, Assessment, and Treatment**.
        - Determining adequate surrogate sets for biodiversity is also fraught with uncertainty –see **M3: Stakeholder Identification and Involvement**.
        - As mentioned earlier, viability and vulnerability estimates remain a major source of uncertainty –see **M9: Vulnerability and Persistence Analysis**.
        - Finally, all the planning methods that have so far been devised have arisen from terrestrial contexts. Marine conservation is now becoming increasingly important. Further research is needed to determine the extent to which assumptions appropriate for terrestrial planning are also suitable in the marine context.
    - Sociopolitical assumptions are almost always uncertain. Moreover:

        - Stakeholder preferences may change in unpredictable ways –see **M11: Multi-Criteria Analysis**.
        - Sociopolitical criteria and their relative rankings are often only known imperfectly (see **M11: Multi-Criteria Analysis**). (The criteria are imperfectly known in the sense it is often not clear that a measurable feature adequately captures the real criterion of interest. For instance, is the number of people affected an adequate measure of social cost?)
        - Even budgets may be uncertain, especially for future years.
    - How these uncertainties propagate, amplify, and feed back through the planning stages remains unknown.
    - The important point to remember is that systematic conservation planning actions must be taken in the face of these uncertainties. There is no option for putting off conservation planning decisions until all uncertainties have been resolved.
    - Both theoretical work and practical insights are needed to figure out how to cope with uncertainties in planning.
        - However, the adaptive nature of the planning and management process explicitly recognizes the existence of such uncertainties.

- Scheduling conservation action: Entire conservation plans will almost never be implemented in one shot.
    - To some extent, the representation maximization problem (of **M8: Place Prioritization**) tries to address this fact.
        - It assumes that there is a limited budget and tries to maximize the number of surrogates that achieve their targets of representation within potential conservation areas that fall within the budget.
    - However, most planning situations call for future years also to be taken into account.
    - Incorporation of both economical representation of biodiversity and the likely fate of areas that are not selected in a particular year must be taken into account.
        - This is known as the “scheduling problem”.
        - The likelihood that an area will be transformed due to agriculture, human settlement, industrialization, etc., if it is left unprotected must be included in the planning process.
        - One possible method of accomplishing this is to find non-dominated

solutions (see **M11: Multi-Criteria Analysis**) using complementarity and vulnerability as criteria. While this has not been done, something similar has been attempted—see **Example 14.2**.

- Climate change is another source of large-scale transformation of landscapes. It can also be incorporated into the methods of assessing planning solution timelines.
- Mathematically, most versions of scheduling problems can also be represented as optimization problems.
    - Simple versions can be solved using a technique called dynamic programming.
    - One way to solve multiperiod planning problems is to use backward recursion.
    - For some multi-period planning problems, obtaining an optimal solution may require a great deal of computer time and memory.
    - There has been some progress in finding efficient heuristic methods for solving the scheduling problem—see **Example 14.3**.
    - However, much more remains to be done. Currently, this is an area of active research.

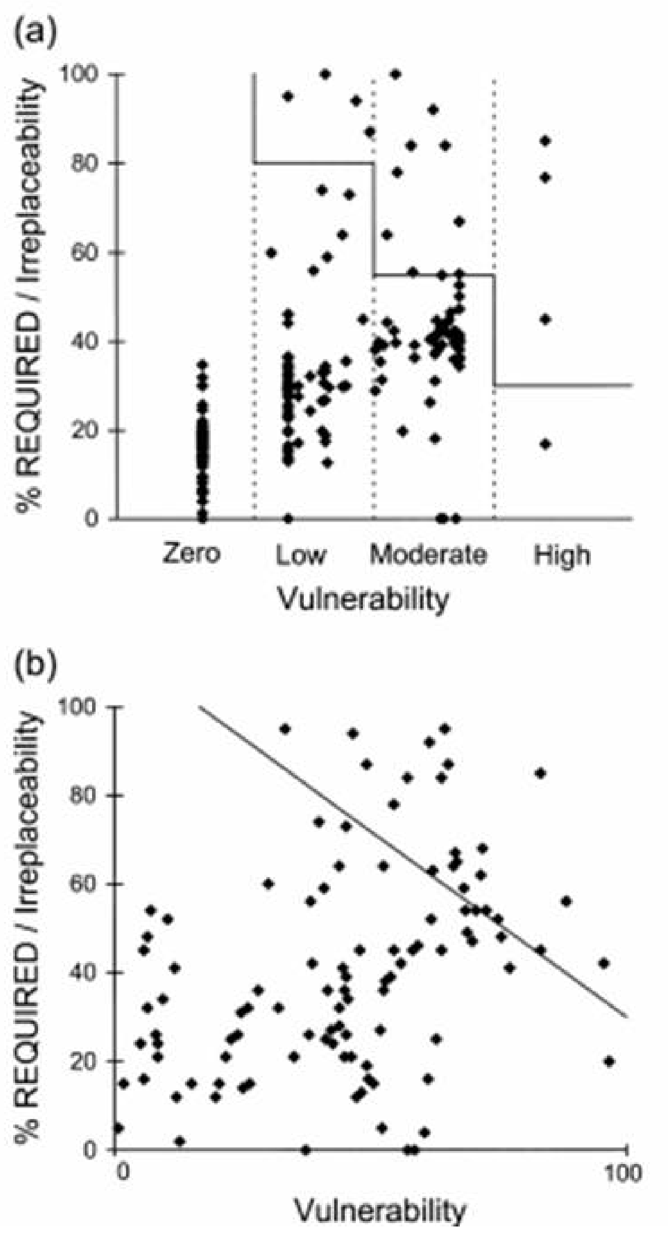
Example 14.2

Using Vulnerability and Irreplaceability to Prioritize Areas (Pressey and Taffs 2001)

Pressey and Taffs (2001) analyzed the irreplaceability and vulnerability of areas from western New South Wales. 248 land systems (recurring patterns of landforms, soils, and vegetation) were used as biodiversity surrogates. Targets of representation were set using a formula, based on the pre-European extent of each land system (that is, before European colonization), that also took into account the rarity and vulnerability of the land systems. Some of the analyses were done using individual areas, others using the land systems themselves. Vulnerability assessment was based on the likelihood of clearing and cutting. For land systems, irreplaceability was estimated as the percentage of the remaining area which is required to achieve the conservation targets. In the analyses of the individual conservation areas, there were 803 grid cells with an average area of about 400 sq km. The irreplaceability value of an area was estimated by the likelihood of its being needed to achieve the conservation targets.

Points in Figure 14 are either individual conservation areas or land systems. Irreplaceability and vulnerability provide the two axes. The line with steps (Figure 14.1a) was used in their study to identify priority areas. A more general approach would be to use a simple diagonal line (Figure 14.b). The step-line and diagonal line is drawn on the diagram in such a way because a high irreplaceability value is favored as well as a high vulnerability value. However, the solutions do not favor a high vulnerability value if it can easily be replaced, and vice versa. The plot is similar to a plot to when finding non-dominated solutions in two dimensions (see **M11: Multi-Criteria Analysis**—**Example 11.3**). However, if one set of non-dominated points are selected, the plot should be recalculated since the irreplaceability of the remaining areas change.

Figure 14.2


(a)
100
80
60
40
20
0
% REQUIRED / Irreplaceability
Zero
Low
Moderate
High
Vulnerability
(b)
100
80
60
40
20
0
% REQUIRED / Irreplaceability
0
100
Vulnerability

Example 14.3

Prioritizing Conservation Efforts (Wilson et al. 2006)

Wilson et al. (2006) analyzed data from five regions in Wallacea and Sundaland (the transition zone between Australia and Australasia): Sumatra, Borneo, Sulawesi, Java/Bali, and southern peninsular Malaysia. The goal was to maximize the number of endemic species remaining across all regions once habitat conversion ceased, that is, all the land had either been converted to other uses or placed under a conservation plan. A species-area curve was used to calculate the number of species remaining in a region as habitat conversion occurred. A fixed annual budget was assumed and different policy options corresponded to the possible distribution of this fixed amount of resources across the five regions. For simplicity, it was assumed that this amount was to be used to acquire land for conservation. Threat was modeled by assuming that a fixed percentage of non-conserved land gets converted every year. Conversion was modeled as a stochastic process to incorporate the uncertainty about habitat conversion in any region.

An optimal solution was found using stochastic dynamic programming. Two heuristic algorithms were also used: (1) a maximize short-term gain heuristic, which selects conservation areas that result in the largest number of endemic species represented and (2) a minimize short-term loss heuristic, which selects areas to minimize the expected number of species that are likely to be lost in the next time step. Some recommendations were unexpected. For instance, when only Borneo and Sumatra were considered, the results suggested that all resources first be spent in Sumatra for ten years to represent all endemic species there, before turning to Borneo. The promising result was that both of these heuristic algorithms gave similar results to the optimal algorithm. The heuristic algorithms are computationally tractable (the problems are easy to solve on a computer)—so it is likely that such analyses can be performed with realistically-sized data sets.

- Integrative Landscape Planning: ideally, managing landscapes for biodiversity conservation should be integrated with managing them for human habitation and use, and for ecological restoration. This is the agenda of a new discipline called Integrative Landscape Planning.
  - Landscapes belong to three types: natural landscapes, production landscapes, habitation landscapes.
    - Natural landscapes are to be managed primarily for biodiversity and other natural values (scenic beauty, important geological formations, etc.)—strategies include conservation and ecological restoration.
    - Production landscapes are primarily of two types: industrial landscapes and agricultural landscapes. Both must be managed for productivity.
    - Habitation landscapes can be rural or urban. A new environment of “green” urbanism should be developed and encouraged.
  - These are not exclusive categories.

  - Good habitation landscapes may also be productive, e.g., family farms.
  - Although the definitions of these landscapes are described compartmentally, the general concept is to avoid compartmentalized landscapes, not encourage them. Global factors such as climate change or spread of disease will not respect such compartmentalization.
  - Human needs and desires must also be incorporated into the process.
- The challenge is to develop integrated plans that can encompass all these types of landscape.

Assess Your Knowledge

M1: Introduction to Conservation Area Networks
M2: Systematic Conservation Planning Overview
M3: Stakeholder Identification and Involvement
M4: Data Compilation, Assessment, and Treatment
M5: Surrogacy Identification and Analysis
M6: Conservation Targets and Goals
M7: Review Existing Conservation Areas
M8: Place Prioritization
M9: Vulnerability and Persistence Analysis
M10: Network Refinement Protocol
M11: Multiple Criteria Analysis
M12: Implementation of Conservation Plan
M13: Periodic Network Reassessment
M14: Conclusion and Review - Future Directions

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