Australia's national parks, conservation reserves and marine protected areas

Senate Environment, Communications, Information Technology and the Arts References Committee

CSIRO submission

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Acronyms used

CAR	Comprehensive adequate and representative
CBD	Convention on Biological Diversity
COP	Conference of the Parties
CSIRO	Commonwealth Scientific and Industrial Research Organisation
EPBC Act	Environment Protection and Biodiversity Conservation Act
GBR	Great Barrier Reef
MBI	Market-based Instruments
MPA	Marine Protected Area
NGOs	Non-government organisations
NMBIPP	National Market-based Instruments Pilots Program

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Executive Summary

Australia's national parks, conservation reserves and marine protected areas (called protected areas in this submission) have two distinct and overlapping objectives. One is to provide recreational opportunities and inspirational values to the people of Australia while the other, which is the focus of this submission, is to conserve biodiversity by promoting the protection of ecosystems, natural habitats and viable populations of species.

CSIRO has developed methods and protocols for identifying new protected areas, and conducts research into how landscapes and seascapes can support production and the generation of livelihoods while at the same time supporting protected areas by maintaining ecosystem processes. CSIRO also has the skills to improve the knowledge base on which decisions to protect areas are made and management prescriptions are determined.

Protected area networks generally contain a biased sample of biodiversity because they have been established in areas that were unsuited to production. New protected areas should complement existing protected areas by sampling species and habitats not represented, or only poorly represented, in existing protected areas.

A key approach to protecting biodiversity is understanding what human activities are compatible with it. Protecting an area's biodiversity does not have to mean that all other uses are excluded.

Establishing and managing protected areas is expensive. It is imperative that ongoing management needs are recognised and funded to avoid protected areas becoming "paper parks" that do not meet the conservation objectives they were established for.

Currently, there are insufficient resources to establish and maintain a network of protected areas that is comprehensive, adequate and representative (CAR) at the national level.

If governments accept the responsibility of providing a CAR network of protected areas, then this can be pursued through a variety of complementary means; the direct allocation of resources, the development and implementation of policy instruments, the development and support of planning protocols and market based instruments; and the integration of activities at all levels of government, as well as government/NGO initiatives.

A number of biophysical processes threaten protected areas, such as climate change, invasive species, pollution, and human population growth.

There are also less tangible threats such as;

- poorly specified goals
- lack of scientific understanding of what is required for adequate protection
- lack of adequate knowledge of biological patterns and processes
- insufficient resources
- failure of management arrangements to meet multiple objectives
- imperatives of economic development
- lack of coordination of efforts of governments
- lack of monitoring to see whether the network is achieving its objectives

In summary, existing protected areas contain a biased representation of biodiversity, which is not secure. There are two ways of addressing this situation. The first is to ensure that new protected areas are created in areas that contain species and habitats that either are not represented, or are only poorly represented, in existing protected areas. CSIRO and collaborators have developed planning tools to help achieve this goal

The second is to take a holistic view of landscapes and seascapes and ensure that they are managed both for production and to support the role of protected areas in conserving biodiversity. Improved coordination and collaboration between government departments, and between governments and the private sector, is required. Policy instruments and planning tools can assist this process.

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Introduction

The funding and resources available to meet the objectives of Australia's national parks, other conservation reserves and marine protected areas

The term "protected areas" is used here to cover national parks, other conservation reserves and marine protected areas.

In considering the funding and resources available, the inquiry should take a broad systems view so that:

- funding considerations include not only the amount of funding available, but the effectiveness of the methods by which priorities are set and funds are distributed; and
- resources include those human, social and financial resources within and outside protected areas which contribute to the values and objectives of protected areas.

CSIRO's role and relevance

CSIRO has a long history of developing strategic and systematic approaches for identifying protected areas and for separating those areas from processes which threaten their persistence (see Appendix 1). Identifying and securing protected areas will not alone be sufficient to protect biodiversity in the long term, but networks of protected areas within regions should form the framework upon which other conservation actions build. These methods are now used in numerous jurisdictions throughout the world.

CSIRO also conducts research into how landscapes and seascapes can support production and the generation of livelihoods, while maintaining ecosystem processes and biodiversity. This includes research into ecosystem functions and ecosystem services, institutional and governance arrangements, planning instruments and community attitudes and aspirations. By understanding ecosystem processes and the environmental consequences of change driven by socio-economics, models at the landscape scale can help identify key thresholds in the environment, critical points in regional economic development and the social conditions that communities aspire to. Planners and policy-makers can use this knowledge to influence change towards desirable outcomes across the triple bottom line. Such outcomes complement protected areas and help ensure that protected areas convey the biodiversity they contain into the future.

Addressing the Terms of Reference

The values and objectives of Australia's national parks, other conservation reserves and marine protected areas

Australia's protected areas have two distinct and overlapping objectives. One is to provide recreational opportunities and inspirational values to the people of Australia. This is particularly so of our major iconic protected areas (e.g. The Great Barrier Reef, the Wet Tropics World Heritage Area, Kosciuszko, Kakadu, South-west Tasmania). The other role is to conserve biodiversity by promoting the protection of ecosystems, natural habitats and viable populations of species (Natural Resource Management Ministerial Council 2005). This submission focuses on the biodiversity protection role of protected areas.

Biodiversity is the variety of life (Appendix 2). From the micro-organisms that fix nitrogen in soils to the tree kangaroos and coral reefs that draw tourists and their dollars, biodiversity provides many services it would be hard to do without. We need biodiversity for its direct contribution to human welfare. Biodiversity is the biological component of the natural resource base that we all depend on. In addition, by protecting biodiversity we also satisfy important cultural, spiritual, aesthetic and recreational needs.

Australia is a signatory to the Convention on Biological Diversity (CBD). A primary CBD target is to achieve a significant reduction in the current rate of loss of biodiversity by 2010 (Conference of the Parties [COP] 6, 2002). A main mechanism for reaching this target is the establishment of protected areas.

At the national level, a comprehensive adequate and representative (CAR) protected area system has been endorsed by the Commonwealth, State and Territory governments (Commonwealth of Australia 1996).

CAR protected area systems require substantial resources to develop, manage effectively and maintain. It is therefore necessary to deploy those resources in the most cost-effective way. Protected area networks in Australia, and all over the world, generally contain a biased sample of biodiversity from ecosystems and habitats that were selected because they are remote and inaccessible, or they were unfit for alternative uses such as agriculture or urban development. While on the face of it there should be far greater opportunity for representative conservation in the marine environment, in practice MPA boundaries are limited to areas not identified by the oil and gas companies. This has led to a very biased selection of habitats for the recent MPAs, with most in the abyssal depths that have no obvious threats.

When establishing new protected areas for a CAR system it is important to take a systematic approach rather than repeating the patterns of the past. It may be more cost effective to invest in more expensive or contested pieces of land than to repeat the representation of biodiversity already covered in existing protected areas. A key approach to protecting biodiversity is understanding what human activities are compatible with it. Protecting an area's biodiversity does not have to mean that all other uses are excluded.

For example, CAR marine protected area systems have been designed primarily to protect the seabed flora and fauna. As the seabed in many reserves will be a 1000m or more below the water surface, fishing methods (pots, traps and long-lines) that do not damage seabed fauna may be compatible with many objectives of the CAR system and should not necessarily be excluded from protected area networks.

Substantial areas of the seabed have been set aside for oil and gas exploration and proposed protected areas essentially omit areas set aside for oil and gas exploration, leaving little opportunity for a CAR system. Yet there is no *a priori* reason why oil and gas exploration would not be compatible with biodiversity conservation. Most exploration involves non-destructive equipment, and even if an area is determined to have economic quantities of oil and gas, extraction methods such as mobile oil rigs are compatible with conservation of the broader area. Indeed, while there is a real but relatively low risk of oil blowout, the presence of oil rigs and pipes create navigation hazards, monitored by the oil and gas companies to ensure that no equipment that could impact the seabed comes close to it.

Legislating marine protected areas is a long and expensive process. If the CAR objectives are to be met in the marine environment, areas already set aside for oil and gas exploration must be included for consideration.

Legislating larger areas for Marine Protected Areas (MPAs) and subsequently managing those areas to achieve multiple use objectives will ultimately do more to protect marine biodiversity and ecosystem functioning, than protecting the much smaller areas left over from existing and proposed commercial use. Legislating larger areas as MPAs provides the basis for future informed management without requiring a further legislative effort.

An excellent example of this is the Representative Areas Program in the Great Barrier Reef Marine Park. Based on scientific principles, in July 2004 the park was divided into seven different zones, each allowing a different spectrum of activities from Preservation Zones (no human activity allowed except scientific research under permit) to General Use Zones (a range of activities allowed, including limited fishing and aquaculture under permit).

A fundamental between establishing protected area networks in the marine environment compared to the terrestrial environment is ownership. Land is subject to private ownership, while the marine environment has essentially open access to resources, subject only to legislative limitations. This perhaps provides greater opportunity for governments to legislate for CAR compliant marine protected areas. However, it means that many additional measures that may affect biodiversity conservation in the terrestrial realm, as detailed below, are not available in the marine realm.

The role of land outside of protected areas is critical. Identifying and securing protected areas is necessary but not alone sufficient to protect biodiversity. Protected area networks within regions should form the framework upon which other conservation actions build. These other actions could include compatible management practices in areas adjacent to protected areas, threat abatement and the restoration of degraded areas. CSIRO and international collaborators have developed an approach called Management Strategy Evaluation to determine management strategies that are most robust to conflicting management goals in an uncertain environment.

Cost effective mechanisms to assist such actions include market-based instruments, policy instruments and incentives. Community engagement is also needed for effective management of the landscape or seascape matrix Protected areas are increasingly being complemented by conservation on private lands, for example Land Trusts (heritage, private or statutory conservation trusts), Bush Tenders and Biodiversity Corridors.

Complementary management of private lands for conservation goals also delivers benefits by way of ecosystem services. For example, the value of pollination services to Australian agriculture has been estimated to be worth hundreds of millions of dollars (Gill 1989). A famous example of the value of ecosystem services is that of the New York city water catchment where, to maintain drinking water standards, the city faced a choice of investing in a new chemical filtration plant at a cost of over $8billion plus ongoing maintenance or restoring catchments and managing them for water quality at a cost of $2 billion (Chichilnisky & Heal 1998).

The protection of biodiversity has been one of the most intractable problems for conservation policy makers, planners and managers. This is at least partly because biodiversity management programs have focused on defining species specific management plans and habitat quality standards primarily in ecological terms. Yet there is still no widely accepted ecological approach for determining optimal management actions to meet those standards. For biodiversity conservation to succeed it is also necessary to identify threatening processes and their impacts, understand the role of institutions, policy mechanisms and governance arrangements, quantify the cost and efficacy of management alternatives, and create flexible and adaptive implementation programs. Better strategies (and there will be no generally optimal strategy, just better or worse ones) will depend on the impacts of land uses, the range of existing and potential management practices, and their cost effectiveness across landscapes and seascapes. A flexible approach to biodiversity management is essential. Approaches must be based on the best available knowledge of a particular managed area and not on a simplistic formula that assumes the same management approach is appropriate in all instances. Effective biodiversity conservation must be spatially explicit and will require that natural resource ownership and property rights issues are fully acknowledged and taken into account, that costs are acceptable to a wide range of stakeholders and that institutional arrangements support implementation.

Whether governments are providing sufficient resources to meet those objectives and their management requirements

Establishing and managing protected areas is expensive. It is imperative that ongoing knowledge and management needs are recognised and funded to avoid protected areas becoming "paper parks" that do not meet conservation objectives and therefore waste money, and to avoid creating havens for feral animals and weeds and sources of fire.

The identification of protected areas should be based on a sound knowledge of biological patterns and processes. There is still much we don't understand about the ecological & evolutionary processes that ensure the persistence of biodiversity and this knowledge would help us make effective management decisions about the protected area system.

It has been estimated (Frazee *et al.* 2003) that a representative protected area network in the Cape Floristic Region of South Africa would cost $US45.6 million per year over 20 years to establish, with annual maintenance costs of $US24.4 million. These figures should be set against both the potential benefits of biodiversity and the economic losses that occur when ecosystem services provided by native landscapes and seascapes are lost. They should also be considered in the context of the costs to repair degraded landscapes (and seascapes), where protected areas are one element of sustainable management for both production and protection.

Currently, there are insufficient resources to establish and maintain a network of protected areas that is CAR compliant at the national level. Although the National Representative system of Marine Protected Areas is designed to achieve this in the marine environment, marine protected areas still encompass a biased selection of habitats. Recent new protected areas have been established in the abyssal depths where there are no obvious exploitable resources.

To improve this situation, Governments can directly increase the allocation of resources and this is a very effective way of supporting protected areas. But there are other options as well.

Governments can pursue, and this is already occurring, joint management arrangements with traditional land owners. Lease-back arrangements can be made for protected areas that come under native title claims. Joint management arrangements with traditional owners can also increase the effective area of the protected area network.

Governments can use policy instruments, e.g. tax concessions and/or covenants on land tenures, or sustainable fishing practices, to supplement protected area networks. Care must be taken to ensure monitoring and compliance for these to be cost effective. These efforts should be coordinated with government initiatives for new protected areas and among stakeholders. Without coordination and monitoring it is impossible to evaluate what is being conserved and how effectively. Perhaps more importantly, areas need to be prioritised on the basis of their potential contribution to a biodiversity goal, given appropriate management, in order to determine exactly where these instruments should be applied. This is the type of problem that CSIRO has addressed through its conservation planning methods (Appendix 1).

Governments can also integrate their own actions on protected areas with the efforts of non-Government organisations (NGOs). Without coordination there is a risk of duplicating the biodiversity protected in government and non-government protected areas. While it may be desirable to protect replicate samples of biodiversity, it may also be an inefficient use of scarce conservation resources, especially if the current protected area network does not yet represent biodiversity adequately. If government and non-government actions are complementary they can be more cost effective.

Governments can promote, through resource allocation and policy and planning instruments, other types of conservation management in the landscape matrix that protected areas are embedded in. Many current incentives seem to be fairly short-term. The National Market-based Instruments Pilots Program (NMBIPP) launched in 2003 with $5M is now complete and an evaluation has prompted stage 2, which has a further $5M available to build on the successes and fill knowledge gaps from round 1. A continuing market-based instruments (MBI) program would be a valuable tool to ensure that ongoing support was available for actions in the broader landscape to complement the role of protected areas. The Environmental Protection and Biodiversity Conservation Act (EPBC) has been used to promote sustainable marine fisheries (and the system that sustains them). It seems certain that this will entail spatial management of fishing effort, and possibly reduction of excess effort. Effective coordination of the different management actions will be needed to achieve the greatest benefits.

When production lands are managed to ameliorate environmental problems like salinity, soil erosion, etc., there are spin-off benefits for biodiversity in the wider landscape, and for protected areas because threats are reduced. A holistic systems view of landscapes and seascapes as functioning multiple use entities, with variable levels of production and protection within them and with various levels of government and private (including NGO) resources allocated to different geographical parts of the landscape has provided the context for CSIRO and others to build planning tools from models of socio-economic change and associated environmental consequences (Appendix 3). Such tools address the dynamic processes leading to change in landscapes (and seascapes) and identify the control points available to policy makers and regional planners for steering the direction of change, and balancing desirable socio-economic goals with the protection of biodiversity, including the establishment and maintenance of protected areas. Employment of tools which provide decision support based on evidence can improve effectiveness

The Great Barrier Reef Region is a good example of a region in which there are major iconic protected areas, the rainforest and the reef, which are embedded in landscapes and seascapes that provide livelihoods in the form of agricultural production, fishing and tourism as well as opportunities for increased urban development. It is well recognised that this matrix must be managed sympathetically if the rainforests and reef are to maintain the biodiversity they currently protect.

Thus, there is a range of conservation management options that can be used to supplement protected area networks and bring them closer to the goal of being comprehensive, adequate and representative.

Any threats to the objectives and management of our national parks, other conservation reserves and marine protected areas

Threats, which often interact, include

- climate change;
- increasing population – encroachment, "loving to death" of reserves, and difficulty in controlling access to remote areas including offshore;
- weeds and pest animals including marine invasive species;
- altered fire regimes and grazing patterns;
- pollution; and
- broader land degradation issues such as salinity and soil acidification.

In addition, there are threats, especially to the achievement of the objectives of protected areas from:

- poorly specified (or missing) goals and objectives for protected areas and networks;
- lack of scientific understanding of the best size and distribution for protected areas;
- lack of knowledge on biological patterns and the processes which generate them.
- insufficient resources to establish and maintain a CAR protected area network;
- insufficient scientific, socioeconomic and stakeholder information being used in determining placement and management zoning in protected areas;
- insufficient emphasis on indirect economic conservation benefits when balanced against the direct economic benefits from resource extraction and production industries. Failing to look for mutually supportive management arrangements;
- Imperative of economic development – oil and gas, shipping (invasive species), coastal development (tourism and sea change);
- insufficient coordination of government efforts at federal, state and local levels and between government and non-government agencies; and
- a lack of monitoring to determine whether or not the protected area network is performing its role over time.

The responsibilities of governments with regard to the creation and management of national parks, other conservation reserves and marine protected areas, with particular reference to long term plans

If governments accept the responsibility of providing a CAR network of protected areas, then this can be pursued through a variety of complementary means; the direct allocation of resources, the development and implementation of policy instruments, the development and support of planning protocols and market based instruments; and the integration of activities at all levels of government, as well as government/NGO initiatives.

A long-term view, with an associated long-term commitment of resources for ongoing monitoring and management is imperative if protected areas are to achieve their objectives. Planning for and creating protected areas must be scheduled over a period of many years. As knowledge accumulates, social and economic conditions change, and institutions evolve, conservation priorities will likely change so the whole process from planning through to acquisition and management into the future must be flexible and iterative in order to take change into account.

A long term view is also needed to develop appropriate responses to some of the threats listed in the threats section above. Climate change is an example. We should be locating new protected areas where they will be most likely to ameliorate the impacts of climate change. This means ensuring that the protected area network samples the entire range of environmental variation in regions. It also emphasises the need to manage the surrounding landscape or seascape sympathetically. For many species to survive in the face of climate change it is likely that they will have to migrate so connectivity between protected areas may be necessary. Connectivity may involve the retention of wildlife corridors, but it may also include management for production that is not wholly inimical to species dispersal processes.

The record of governments with regard to the creation and management of national parks, other conservation reserves and marine protected areas

Comments on the record of governments, which is essentially the record of the creation of protected areas until the very recent advent of private acquisitions, have largely been covered . Essentially, reservation has been *ad hoc*, occurring in areas that were not suitable for alternative productive uses. At times, opportunities have been missed by presenting conservation and alternative uses as mutually exclusive. There has also been an assumption that once an area was designated as protected it was secure.

Governments now recognise that protected area networks are not CAR compliant so new protected areas should complement existing ones and that a landscape or seascape level management strategy is required to ensure that protected areas fulfil their stated objectives and convey the biodiversity they contain into the future.

Conclusions

Historically, with some exceptions, protected areas have been heavily biased towards areas that were considered to be unfit for alternative productive uses, and were therefore cheap or it was uncontroversial to declare them. This has led to a bias in the biodiversity that protected areas encompass. Many recent initiatives have helped or have the potential to ameliorate this situation including the National Reserve System, Regional Forest Agreements, the National Representative System of Marine Protected Areas and recent contributions from the NGO sector. However, it is still the case that many species and other biodiversity features such as habitat types are either not represented or are only poorly represented in protected areas. Many of these are characteristic of fertile soils, productive marine habitats or other areas that are readily converted to production so that even where they are represented in protected areas, those areas tend to be small, isolated remnants among alien habitat, e.g. cropland, so the species in them are vulnerable to extinction.

There are two ways of addressing this situation and both are relevant and applicable. The first is to ensure that future protected areas are created to complement existing protected areas. That is, they are established in areas that contain biodiversity features (species, habitat types, etc.) that either are not represented, or are only poorly represented, in existing protected areas. CSIRO and collaborators have developed planning tools to help achieve this goal (Appendix 1).

The second is to take a holistic view of landscapes and seascapes and ensure that they are managed both for production and to support the role of protected areas in conserving biodiversity. Existing zoning provisions for oil and gas leases severely restrict options for marine protected areas, for example, when ideally the two uses could be managed in a complementary way as IUCN Category VI zones. Improved coordination and collaboration between government departments, and between governments and the private sector is required. Policy instruments and planning tools can assist this process.

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Appendix 1

Systematic conservation planning

(Summarised from Margules & Sarkar 2006)

Systematic conservation planning is a structured step-wise approach to mapping conservation priority area networks, with feedback, revision and reiteration, where needed, at any stage. Priority areas include national parks, other conservation reserves and marine protected areas, but can also include other parts of the landscape or seascape that should have priority for the allocation of scarce conservation management resources. Though prioritising new areas for conservation action is central to systematic conservation planning, this process does not ignore or throw away existing protected areas or networks. In almost all regions there is a heritage of protected areas, which more than likely have been accumulated opportunistically and are therefore unrepresentative of regional biodiversity. Systematic planning normally accepts these imperfect networks and maps onto, or builds on, what already exists, with the objective of transforming them into better networks. In addition, analyses of the extent to which existing protected areas contribute to regional biodiversity goals might provide options for future rationalization. For example, it may be possible to trade existing protected areas making low contributions for new areas that would make higher contributions.

Appendix table 1.1 (see page 15), modified from Margules and Pressey (2000) and Sarkar (2004), describes systematic conservation planning in eleven stages. The first stage is stakeholder engagement. Stakeholders will often be local residents, farmers or pastoralists, but can also include government agencies responsible for managing natural resources such as water and forests, non-government organizations (NGOs), including conservation NGOs, both local and global, and industries, e.g. mining and agri-businesses. Stakeholders include all those people who have decision-making powers over a region, all those who will be affected by the conservation plans that are formulated, those with scientific or other expertise about the region, and those who may commit resources for conservation planning and implementation. For a conservation plan to be successful, the involvement of stakeholders should be transparent. Identifying and involving stakeholders can be a difficult and laborious process but, if it is done properly, it can help mitigate threats to potential priority areas and improve the chances that conservation plans will be implemented (Wilson et al. 2005).

The second stage is data collection. This involves collating existing data, collecting new data if required, and any treatment of data that might be needed for subsequent use in conservation planning. The care and attention given this stage has a major bearing on the quality of the outcome. It can be time-consuming, labour intensive and scientifically and technically challenging. However, the collection and treatment of the biological and environmental data are crucial components of systematic conservation planning. They can place severe constraints on the planning process if not done properly. The cost data collection and management activities and the urgency to act tend to foster the use of existing data held, for example, in museums and herbariums or data that can be derived remotely, for example environmental data such as climate surfaces and other maps. All possible use should be made of such data. However, much greater attention than what has been paid in the past should be devoted to the design of surveys to collect new biological records from the field (Margules & Austin 1994; Haila & Margules 1996). Environmental stratification combined with recording the absences as well as the presences of species will deliver data sets that are comprehensive and consistent in detail across entire planning regions. At this stage it is also desirable to compile as much social and economic data as possible which may then be used in a trade-off analysis in Stage 6, or alternatively in a multi-criteria analysis at Stage 9 below. Socio-economic data include the expected monetary value of the natural resources in candidate conservation areas, or alternative measures such as timber volume or agricultural potential. They can also include human population density and information on land ownership and tenure, as well as infrastructure.

The third stage is to choose biodiversity surrogates. This means selecting those features that are going to be used to represent biodiversity in the planning process. Taxa sub-sets, species assemblages and environmental variables and classes, or combinations of two or more of these three, have all been used in conservation planning. Species or other features at risk, and rare or endemic species are obvious candidate surrogates. Charismatic or iconic species and species with commercial value have often been used as biodiversity surrogates. The choice of surrogates will always be constrained to a certain extent by what data are available, or realistically obtainable in an acceptable time-frame. Therefore, this choice is never independent of the results of the previous stage.

At the fourth stage, explicit targets for the representation of surrogates within a protected area network for the region of interest must be set. Without these targets it is impossible to determine the success or failure of a plan. Typical targets might be populations of a certain size, or number of populations of species, or the spatial extent (percentage of coverage) of assemblages or environmental classes. Again, the actual numbers used here are often not determined, sometimes not even strongly suggested, by biological criteria such as models or empirical data. Viable population sizes are known for only a handful of species in a few habitats. Actual targets most often represent conventions arrived at by biological intuition, or a limited budget. Many have argued that the achievement of such targets could provide an unwarranted sense of security, suggesting that biodiversity was being protected when in fact the targets have little or no biological meaning. This is undoubtedly true but, as noted above, protected areas are not supposed to provide a complete solution of the problem of protecting biodiversity. Identifying protected areas is only one stage in the challenging but necessary task of learning to manage whole regions so that ecosystem processes and the biodiversity they give rise to can be sustained alongside production.

At this stage it is also appropriate to introduce design criteria. Though not usually included in setting targets, these are ecological characteristics of the actual protected areas – size, shape, dispersion, connectivity, alignment, and replication, for example. In meeting conservation goals there seems no doubt that big is better than small, but ecology does not say how big is big enough. In addition, the roles of shape, dispersion, connectivity, alignment, and replication in conservation area networks remain controversial (Margules *et al*. 1982; Margules & Pressey 2000). Biogeographical theory, successional pathways, space requirements (especially for wide-ranging species), source-sink population structures, and habitat modification all impact conservation area design.

The fifth stage is a review of any existing protected areas within the planning region. The purpose is to determine the extent to which conservation targets have already been met and therefore to identify gaps that need to be filled by new protected areas. Usually, existing protected areas have been established on land that has (or had at the time of establishment) little economic value. Gaps in existing protected area networks therefore are often in productive areas or close to population centres where competition for natural resources is highest. This emphasizes the need for flexibility in planning and signals the importance of cost trade-offs. A careful assessment of the performance of existing protected areas is critical because, in practice, conservation plans will typically consist of augmenting an existing network rather than creating one from scratch.

The sixth stage involves prioritizing new areas for conservation action to satisfy the targets and goals set in the fourth stage. This stage corresponds to what can be thought of as reserve network selection. This stage is at the heart of systematic conservation planning. It implements complementarity as a measure of conservation value. In other words, one site has greater complementarity than another if it has more biodiversity features (species, assemblages, habitat types, etc) that have not already met their representation target in the protected area network. Some methods also implement cost trade-offs (Faith & Walker 2002; Faith *et al*. 2001). This takes advantage of the fact that there are usually many spatial arrangements of areas that can be selected in planning regions that each achieves the conservation goals. A set of protected areas can be sought that optimizes opportunity costs such as agriculture, logging, recreation, industrial development and urbanization, but nevertheless achieves the conservation goal. Stage 9 below represents an alternative approach to taking costs and competing uses of biodiversity into account. In many practical applications, area selection will be limited to those areas that are not obviously irrelevant to conservation because of extensive habitat degradation, for instance, completely built-up areas. Thus, Stage 6 may include a preliminary exclusion of such areas.

The seventh stage assesses the risks to the persistence of biodiversity in selected areas. Threats can come from outside or within. Size, shape, dispersal, connectivity, alignment, and replication are ecological criteria for risk assessment. Suitability for competing uses such as agriculture or urban development increase the probability that a site will be lost to these land uses (Pressey & Taffs 2001). Risk assessment is a difficult task and more remains uncertain than what is known. Nevertheless, vulnerability and threat must be taken into account in conservation planning. Once risks to persistence have been assessed, it is likely that some areas with a poor prognosis will be dropped and prioritisation repeated without those areas as candidates. It may be that there are no substitutes for an area with a poor prognosis and in that case a decision has to be made whether to spend scarce management resources on intensive management actions to improve the prognosis or relinquish the biodiversity features of that site to their fate and divert management resources to areas and features with a greater likelihood of long term persistence. The eighth stage then, is the reiteration of the prioritization process in Stage 6.

The ninth stage attempts to take account of competing uses of land other than biodiversity conservation such as agriculture, recreation, etc. Typically, a number of sets of selected potential protected areas (or "solutions" from an area prioritisation algorithm) are first produced with each satisfying the biodiversity representation targets. Stakeholders decide the relative importance of different potential uses of land, and these preferences are used to order each of the alternative solutions by all the criteria other than biodiversity. Biological criteria other than representation of surrogates, such as size, shape, dispersal, connectivity, alignment, and replication, can also be incorporated in this way through multi-criteria analysis. The best solutions become candidates for implementation and the others are discarded. There are a variety of techniques for carrying out such a multi-criteria analysis, mainly developed by economists and the decision theory community and only lately being explicitly incorporated into conservation planning (Moffett & Sarkar 2005). If the alternative of incorporating trade-offs in the area selection process (Stage 6) is preferred, and all relevant criteria have been incorporated into the trade-off analysis, then this stage is redundant.

The tenth stage is implementation of the conservation plan. This requires decisions on the most appropriate form of legal protection for each selected area and the most appropriate management actions for each selected area. An important consideration here is the scheduling of implementation. Resources are not normally available to act on all selected areas simultaneously. More vulnerable areas might receive priority, especially if the biodiversity surrogates they contain are absent or scarce in other areas (Pressey & Taffs 2001; Wilson *et al*. 2005). If it proves impossible to implement the plan because, for example, some areas are seriously degraded, budgets have changed or the forgone opportunity costs associated with parts of the plan are unacceptable to society, then it is necessary to return to Stage 6 and try again. Because of this inevitable scheduling problem we must accept that planning is a dynamic iterative process. Planners and policy-makers should return to earlier stages repeatedly because social and economic conditions change, social and political attitudes change, and knowledge accumulates. The plan that was right given the knowledge base and the social, economic and political climate last year will not necessarily be the best plan this year.

The eleventh and final stage is to monitor the effectiveness of management actions in sustaining the biodiversity that areas were selected for. Monitoring also requires that thresholds are defined, which if passed, warn that unacceptable changes might be under way. The status of biological entities changes over time, as do social and economic conditions. Management actions that seemed appropriate at one point in time might be less effective at another point in time. Changes to management prescriptions are one response. As suggested above, another response might be to repeat the entire conservation planning process periodically. The most desirable situation is that conservation planners have the facility to repeat the process as and when needed in order to take account of societal change and the gaining of new knowledge. Such iterative dynamic managerial response with feedback is called "adaptive management".

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Appendix Table 1.1

Systematic Conservation Planning

1. Identify stakeholders for the planning region: ▪ Stakeholders include: (a) those who have decision-making powers; (b) those who will be affected by conservation plans for region; (c) those with expertise about the region and (d) those who may commit resources for conservation plans; ▪ Include both local and global stakeholders; ▪ Ensure transparency in the involvement of all stakeholders from the beginning.
2. Compile and assess biodiversity and socio-economic data for the region: ▪ Compile available geographical distribution data on as many biotic and environmental parameters as possible at every level of organisation; ▪ Compile available socio-economic data, including values for alternate uses, resource ownership and infrastructure; ▪ Collect relevant new data to the extent feasible within available time; remote sensing data should be easily accessible; systematic surveys at the level of species (or lower levels) will usually be impossible; ▪ Assess conservation status for biotic entities, for instance, their rarity, endemism, and endangerment; ▪ Assess the reliability of the data, formally and informally; in particular, critically analyse the process of data selection.
3. Identify biodiversity surrogates for the region: ▪ Choose surrogate sets for biodiversity. Be explicit about criteria used for this choice; ▪ Prioritise sites using biodiversity surrogate sets; prioritise sites using as many combinations of surrogate sets as feasible, and compare them; ▪ Use other methods of surrogacy analysis to assess surrogate sets, including measures of spatial congruence between plans formulated using different surrogate sets; ▪ Assess which surrogate set is best on the basis of (i) economy and (ii) representation.
4. Establish conservation targets and goals: ▪ Set quantitative targets for surrogate coverage; ▪ Set quantitative targets for total network area; ▪ Set quantitative targets for minimum size for population, unit area, etc.; ▪ Set design criteria such as shape, size, dispersion, connectivity, alignment, and replication; ▪ Set precise goals for criteria other than biodiversity, including socio-political criteria.

5. Review the existing protected area network: ▪ Estimate the extent to which conservation targets and goals are met by the existing set of protected areas; ▪ Determine the prognosis for the existing protected area network; ▪ Refine the first estimate.
6. Prioritize new areas for potential conservation action: ▪ Using principles such as complementarity, rarity, and endemism, prioritise areas for their biodiversity content to create a set of potential protected area networks; ▪ Starting with the existing protected area network, repeat the process of prioritisation to compare results; ▪ Incorporate socio-political criteria, such as various costs, if desired, using a trade-off analysis; ▪ Incorporate design criteria such as shape, size, dispersion, connectivity, alignment, and replication, if desired, using a trade-off analysis.
7. Assess prognosis for biodiversity within each newly selected area: ▪ Assess the likelihood of persistence of all biodiversity surrogates in all selected areas. This may include population viability analysis for as many species using as many models as feasible; ▪ Perform the best feasible habitat-based viability analysis to obtain a general assessment of the prognosis for all species in a potential conservation area; ▪ Assess vulnerability of a potential protected area from external threats, using techniques such as risk analysis.
8. Refine networks of areas selected for conservation action: ▪ Delete the presence of surrogates from potential conservation areas if the viability of that surrogate is not sufficiently high; ▪ Run the prioritisation protocol again to prioritise potential conservation areas by biodiversity value; ▪ Incorporate design criteria such as shape, size, dispersion, connectivity, alignment, and replication.
9. Examine feasibility using multi-criteria analysis: ▪ Order each set of potential protected areas by each of the criteria other than those used in Stage 6; ▪ Find all best solutions; discard all other solutions; ▪ Select one of the best solutions.

10. Implement a conservation plan: ▪ Decide on the most appropriate legal mode of protection for each targeted place; ▪ Decide on the most appropriate mode of management for persistence of each targeted surrogate; ▪ If implementation is impossible return to Stage 5; ▪ Decide on a time frame for implementation, depending on available resources.
11. Periodically reassess the network: ▪ Set management goals in an appropriate time-frame for each protected area; ▪ Decide on indicators that will show whether goals are met; ▪ Periodically measure these indicators; ▪ Return to Stage 1.

Appendix 2

What do we mean by biodiversity

(Summarised from Margules & Sarkar 2006)

Biodiversity is the variety of life bequeathed to us by evolutionary processes over millennia. It is what we have to conserve if we do not want to squander this inheritance. The biological realm is characterized by variability and complexity at every level of structural, taxonomic, and functional organization. The term "biodiversity" was introduced in the mid-1980s as a contraction of "biological diversity" to refer to the totality of this variability (Takacs 1996). From a biological perspective, all such diversity is important because it provides the raw material for evolution.

Any such definition is necessarily partly conventional. However, that does not mean that it must be arbitrary. Such a definition is conventional because we know that it does not include all of what we mean by diversity. For instance, the definition of biodiversity as diversity of alleles, species, and ecosystems excludes interspecific hybrids. More importantly, it excludes biological phenomena such as the migrations, which may be essential for the continued existence of some species. Nevertheless, this definition is not arbitrary because focusing conservation efforts on genes, species, and ecosystems will protect much of the diversity within species, taxonomic diversity at levels higher than species and many ecological communities. The concept of biodiversity must be operationalized through the use of "surrogates," features of the landscape such as the presence of species or other taxa, habitat types, *etc*., that can *in principle* be quantified and assessed in the field. Candidate surrogates are species, species assemblages (habitat types, etc.), environmental domains and various combinations of all of these.

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Appendix 3

Community capacity to manage regions as social, economic and biophysical systems

New approaches and tools to assist communities make decisions about resource use planning and management.

The issues

As communities face change – from rapid increases in population to declines in local industry – planners, policy makers and local groups in the community must address a range of complex issues that affect their local region and how it manages change into the future.

To make decisions that are sustainable for both people and the natural environment, people need to have relevant information, fair processes and ways to evaluate progress towards clearly articulated and shared goals.

Our research approach and tools helps planners, policymakers and other natural resource managers to make informed decisions to manage the natural environment in line with community aspirations. Our scientists have a range of backgrounds in social, biophysical, economic and political science and draw on participatory action research to bring together theory and practice.

We work in partnership with rural and regional communities and together we learn together how people perceive, use and benefit from natural resources. We support people and communities to make informed decisions that improve their own well-being and ensure well-planned growth, sustainable local industries, equitable access to resources, and viable populations of native plants and animals.

Current or recent projects

The **Regional Development Futures (RDF) Framework** helps communities, including local government, to identify and understand the issues and drivers associated with future planning and development, and to identify and evaluate strategies to achieve a shared vision for the future. Both a toolbox and an approach to thinking about the future, the RDF is designed to roll out in four distinct phases over two years but can be modified to work within or build on other initiatives

The **Regional Development Futures Framework has been** trialled in several parts of Australia from 2003 - 2005:

- The Shire and community of Augusta-Margaret River in Western Australia worked with CSIRO to develop a better system for making decisions that affect how the region develops into the future. The aim is to ensure Augusta-Margaret River remains a vibrant region with a great quality of life for all.
- The Catalyst project based on New South Wales Central Coast was able to provide local decision makers with the ability to predict the consequences of development and will ensure the Central Coast develops in a manner that will provide responsible growth but protect the region's unique cultural and environmental identity.
- Based in the Campbelltown–Camden region of Sydney, TwinCam Futures helped to build regional capacity to explore the opportunities and risks of a range of possible future development pathways. A team of researchers from CSIRO is working with key regional decision makers to assist them chart this transition into the future by building the capacity and tools required for testing future options. The project will build on existing regional planning work and enhance the ability of the Campbelltown-Camden Region for integrated, evidence based planning.

Sustainable Futures for the Agriculture in the Douglas Shire, North Queensland - In the Douglas Shire region of Queensland, a special place bounded by two World Heritage areas, the local Douglas Shire Council wanted to build sustainability into the heart of its practice. This need led to a partnership with CSIRO, the Douglas Shire Joint Venture Partnership. An important outcome of this partnership has been improved access to information needed for planning via the Douglas Shire Sustainability Information System: a strategic planning device that helps local people to access and update a broad range of information relevant to the region's sustainability. Another outcome was the successful bid by the Douglas Shire Council for

Australian Government funding of $2.5 million for a Water Quality Improvement Program.

Outback Atlas - A database of issues in outback communities is being developed to help people identify ways in which to make their towns more viable. The "Outback Atlas" is an initiative of the Tropical Savannahs and Desert Knowledge Co-operative Research Centres to give a deeper level of understanding of remote towns. The Outback Atlas should help both regional planners and communities make informed decisions on their town's future.

The Ecosystem Services Project studied a cross section of ecosystem services that underpin key traditional agricultural industries within Australia such as dairy, horticulture, beef, wool, and cropping. Also examined were ecosystem services that support the growing "quality of life" industries such as recreation, rural sub-division and tourism.

The project considered possible changes to these services under various land management scenarios were considered in partnership with a range of stakeholders. We also considered what these changes might mean to Australians in economic, social and ecological terms. Coupled with the scenarios, biophysical models were developed to determine the ability of ecosystems to continue to provide services under various land use pressures. Our findings were released in 2003 in the report Natural Values: Exploring options for enhancing ecosystem services in the Goulburn Broken catchment. This work also led to further study of markets for ecosystems services which seeks to identify and build the regional capacities needed to initiate markets for ecosystem services.