Conservation Action Planning

Derwent Estuary Conservation Action Plan

Second Iteration Conservation Action Plan
for the Derwent Estuary, Tasmania,
October 2012.

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Abbreviations

CAP	Conservation Action Planning
DEP	Derwent Estuary Program
GA	Greening Australia
TAFI	Tasmanian Aquaculture and Fisheries Institute
CSIRO	Commonwealth Scientific and Industrial Research Organisation
NRM	Natural Resources Management Board
DIPWE	Department for Primary Industries, Parks, Water and Environment

1. Background

1.1. Conservation Action Planning (CAP)

Estuaries are inherently complex systems, where a myriad of anthropogenic impacts often disrupt physical and ecological processes, and contribute to reduced ecological integrity of species, and habitats. One of the most challenging processes in the management of coastal and marine ecosystems is identifying where to direct limited resources for maximum conservation gain. Various planning tools can assist this decision making process. The Derwent Estuary Program applied the Conservation Action Planning (CAP) framework developed by the US-based conservation group The Nature Conservancy www.nature.org to develop a Conservation Action Plan. This framework is widely used in the development of international conservation projects and is becoming more widely adopted in Australia for planning large scale conservation projects with multiple stakeholders. The basic concepts of this conservation approach follow an adaptive management framework of setting goals and priorities, developing strategies, taking action and measuring results. This process involved a fresh look at the current state of natural values and sources of major threat in the system to identify high conservation priorities. One of the underpinning goals of CAP planning is to move conservation projects from the site scale (10's or 100's of hectares) to the conservation and preservation of **Functional Landscapes** (100,000's hectares) which are able to sustain and support biodiversity at an ecoregional scale (Low 2003).

The CAP process typically involves a series of conservation planning workshops with 5-10 participants from multiple organisations. The process is facilitated by a trained CAP coach and uses a standard step-by-step methodology (refer Low 2003) and an Excel-based software program to guide participants through the development of a landscape conservation plan. The components of the process include: clearly defining the 'conservation targets' or most critical values; clearly identifying and rating threats to these targets; using monitoring data and other information to assign current conservation status (poor, medium, good or very good) to conservation targets; and applying the findings to adaptive management. The Derwent Estuary CAP process commenced in February 2010 and the planning team (refer Table 1) met six times over several months to develop a 1st iteration CAP for the region, released in July 2010. The1st iteration CAP was adopted by the DEP and has influenced works programs since. The CAP reinforced the value of DEP's core business in areas of water quality and pollution management, and the support of single species conservation programs (e.g., spotted handfish and little penguins). The CAP also raised the profile of some natural values, ecological attributes, and threatening processes that have been largely overlooked in the Derwent estuary. In response, some of these areas were targeted in 2010 and 2011 (e.g., saltmarsh condition and futures).

The Derwent CAP was revisited in 2012 in a 2nd iteration to focus on the tail end of the planning process, being strategy development, prioritisation, and action planning. This document captures the outcomes of this process as at September 2012. Strategies have been restructured around 5 major conservation strategies and refined to better identify the key action steps required to meet challenging yet necessary objectives. The result is a collection of high priority major projects and a potential road map for their implementation designed to help conserve key targets within the Derwent estuary. It is intended that land managers, Industry, research orgnisations, and community use this CAP to justify existing works, refine current practices, and identify new priority works.

The geographical scope of the Derwent estuary CAP captures the entuire estuary from New Norfolk (maximum extent of salt water) to the mouth, which lies between Tinderbox and the Iron Pot Lighthouse. As some threats enter the Derwent estuary from the greater catchment or from marine sources (e.g., contaminents and nutrients) a braoder scope is applied to their management.

1.2. Methodology

There are a range of tools available to conservation practitioners to help design and prioritise conservation programs. These include a number of broad conservation planning frameworks, a large range of technical resources (e.g. databases, vegetation / habitat mapping, threatened species records) and ecological modelling software products (refer Wintle 2008 for a review of the available tools). This document outlines one approach for developing a landscape conservation plan for the Derwent Estuary. For more information on the CAP process refer to Low (2003) or http://conserveonline.org/workspaces/cbdgateway/cap/resources/index_html

Whilst built on solid scientific principles, the approach recognises that there are often large gaps in ecological knowledge and data sets and hence a strong on-going adaptive management ethic is implied throughout the process. It also recognises that a large amount of knowledge already exists with local conservation practitioners and therefore incorporates intuitive and locally-based reasoning into the planning process. Further input from local knowledge and additional research to address data gaps is envisaged to refine this plan in the future.

The major steps in the process, as outlined in this document, are:

- the identification of conservation assets and nested assets (i.e. ecosystems, communities and species);
- an analysis of the viability (i.e. health) of the conservation assets and the key threats;
- the development of measurable objectives to achieve the long-term conservation of the assets;
- the development of conservation strategies and action steps to achieve the conservation objectives;
- the identification of practical monitoring indicators to support a robust monitoring, evaluation and adaptive management framework.

Table 1: Invited Participants of the Conservation Action Planning Process (CAP) for the Derwent Estuary

Member	*Organisation*		
Christine Coughanowr	DEP	Sasha Migus	Aquenal
Jason Whitehead	DEP	Vishnu Prahalad	Uni of Tasmania
Ursula Taylor	DEP	Dr Richard Mount	Uni of Tasmania
Neville Barrett	TAFI	Dr Eric Woehler	Birds Tasmania
Sean Tracey	TAFI	Peter McGlone	Tas Conservation Trust
Catriona MacLeod	TAFI	Dr Ruth Eriksen	Aquatic Science
Amelia Fowles	TAFI	Sebastian Burgess	GA
Vanessa Lucieer	TAFI	Alexandra Spink	GA
Dr Jeff Ross	TAFI	Mike Bidwell	Hydro Tas
Kerry Swadling	TAFI	Alison Howman	Hydro Tas
Beth Fulton	CSIRO	Kaylene Allen	NRM South
Karen Wild-Allen	CSIRO	Jill Pearson	NRM South
Tim Farrell	Inland Fisheries	Anthony Reid	DPIPWE
Lynne Sparrow	Parks & Wildlife	Stuart Blackhall	DPIPWE
Ali Coombe	Glenorchy City Council	Martin Reid	DPIPWE
Phil Watson	Clarence City Council	Louise Gilfedder	DPIPWE
Nikki de Exeter	Kingborough Council	Michael Askey-Doran	DPIPWE
Jill Hickie	Hobart City Council	Oliver Strutt	SCAT/Understorey Network
Jon Doole	Kingsborough Council	Andy Crawford	Southern Water
Stephen Joyce	Derwent Valley Council	Kristy Blackburn	EPA Division / SCAT
Jenny Skerrat	CSIRO		

2. Identification of Conservation Assets

2.1. Methodology for Identifying Assets

The first step in the conservation action planning process involves the identification of a small number of focal conservation assets (i.e. ecosystems, communities or species) that collectively represent the biodiversity of a region. The explicit assumption within this process is that by conserving representative examples of broad-scale communities and ecosystems, the majority of species will also be conserved. The list of focal conservation assets therefore need not be long and exhaustive; rather, it should be short and representative. In general, the CAP methodology recommends that no more than eight conservation assets are selected to be the focus of a landscape conservation program.

The asset selection process begins by identifying the coarse-scale ecosystems and communities for conservation. The issue of whether to lump individual ecosystems and communities together or split into individual conservation assets is often a difficult one. In general, ecosystems and communities are lumped together if they:

- co-occur across the landscape;
- share similar ecological processes;
- share similar threats.

The next step is to screen for species and communities occurring at smaller scales that are not well "nested" within the broader set of ecosystems or communities; that is, those species and communities whose conservation requirements are not met through the conservation of the coarse-scale assets (as suggested by Noss et al. 1999; Margules and Pressey 2000; MacNally et al. 2002). This approach is known as the coarse filter – fine filter approach (Groves 2003). Examples of species often not captured by coarse-scale assets include:

- rare, threatened and endemic species;
- species with highly disjunct (spatially separate) populations or restricted distributions;
- keystone or highly interactive species (those that have a disproportionate influence on the structure and ecological function of the community);
- wide-ranging species.

Species and communities that fall into the above categories may be captured by threatened species recovery programs or may need to be considered as separate conservation assets.

Source: Adapted from Low (2003)

2.2. Conservation Assets of the Derwent Estuary

Eleven focal conservation assets were identified for the Derwent Estuary. Each conservation asset was also associated with numerous nested assets (i.e. plant communities, species assemblages, individual species and threatened species) which will be an important focus of conservation efforts and help further define the asset. The eleven focal conservation assets and associated nested assets are presented below.

Table 2: Conservation Assets and Nested Assets of the Derwent Estuary

1. Upper Derwent Wetlands & Macrophyte Beds	
Important Areas	Goulds Lagoon, Old Beach, Gagebrook, Risdonbrook (nationally significant wetlands)
Plant Communities	Freshwater aquatic sedgeland / rushland dominated by *Phragmites* and *Typha* spp.
Plant Communities	Saline aquatic sedgelands (e.g. *Juncus spp.*)
Plant Communities	Ruppia (& some seagrasses) Macrophyte Beds i.e. floating or submerged vegetation occasionally exposed on low tides
Plant Communities	Tea-tree (*Leptospermum sp.*) Shrublands, Swamp Gum (*Eucalyptus ovata*) Woodlands
Fauna	Water birds - Bitterns, Black Swans, Ducks, Egrets, Crakes, Rails, Swamp Hens, Pelicans, Cormorants, Gulls
Fauna	Sea Eagles, Marsh Harriers
Fauna	Fish - Bream, Whitebait, Galaxaids, Eels
Fauna	Platypus
Fauna	Water Rats
Fauna	Macro-invertebrates
Fauna	Snakes
Ecological Function	Fish spawning, nursery and migration area (e.g. Whitebait)
Ecological Function	Feeding, resting & breeding ground for water birds
2. Saltmarshes	
Important Areas	Ralphs Bay saltmarshes including Lauderdale (nationally significant / most diverse in SE Tasmania), South Arm and Clarence Bay
Plant Communities	Saline Aquatic Sedgelands (e.g. *Gahnia filum, Juncus krausii*)
Plant Communities	Saline herblands (e.g. samphire)
Fauna	Waterbirds - Swans, Ducks, Egrets, Crakes, Rails, Swamp Hens, Pelicans, Cormorants, Gulls
Fauna	Salt Marsh Moth (endemic / state vulnerable species, critical habitat in Lauderdale saltmarshes)
Fauna	Water Rats
Fauna	Macro-invertebrates
3. Ralphs Bay Tidal Flats	
Structural Composition	Inter-tidal sand flats
Fauna	Shorebirds
Fauna	Large number of invertebrates
Fauna	Fish including juveniles
Flora	Benthic micro-algae communities
Ecological Function	Important site within larger Ramsar network of SE Tasmania (Shorebird feeding area)
Ecological Function	High tide feeding area & nursery for fish
4. Intertidal Zone	
Structural Composition	Muddy foreshores, sandy beaches, rocky foreshores, rock pools, sandstone platforms
Fauna	Shorebirds and seabirds (nesting and roosting areas)
Fauna	Native macroinvertebrates - Crabs, Mussels, Gastropods, Shells, Seastar
Fauna	Fish
Flora	Benthic microscopic algae
Ecological Function	Transit area for Little Penguins
5. Terrestrial Foreshore Vegetation	
Important Areas	Bedlam Walls, Rosnie Bluff, Cornelian/Shag Bay, Tinderbox, Allum Cliff, Sth Arm, Ft Direction, Droughty Pt, Gage Brook
Structural Composition	Coastal cliffs, coastal dunes, foreshore
Plant Communities	Eucalypt Forests and Woodlands (e.g. threatened Swamp Gum Woodlands)
Plant Communities	Non-Eucalypt forests & woodlands (e.g. Drooping Sheoak Woodlands)
Plant Communities	Scrub heathlands
Plant Communities	Native Grasslands (e.g. Themeda Grasslands)
Fauna	Threatened Birds - Swift Parrot, Tawny Frogmouth, Masked Owl, Spotted Pardalote
Fauna	Little Penguin Colonies, Mutton Bird Colonies (Fort Direction), Sea Eagles, Silver Gull Colonies
Flora	Threatened Flora Species (e.g. native grasses & daisies)
6. Rocky Reefs (& Kelp Forests)	
Plant Communities	Kelp Forests (western shoreline), and red, green, brown seaweed / macroalgae
Fauna	Reef fish - Shaw's Cowfish, Draughtboard Shark, Red Cod, Wrasse, Leatherjackets, Seahorses, Weedy Seadragon, Bastard Trumpeter, Banded Morwong
Fauna	Pipehorses
Fauna	Rock lobsters
Fauna	Mussels, Abalone, Sponges, Octopus, Squid
7. Subtidal Soft Sediments (& Seagrasses)	
Structural Composition	Sandy and silty subtidal areas
Plant Communities	Microphytobenthos and small areas of seagrasses
Fauna	Fish - Skates, Sand Flathead, School Whiting, Sea Mullet, Smooth Toadfish, Elephant Fish, Flounder
Fauna	Spotted Handfish (critically endangered / endemic species)
Fauna	Native molluscs
Fauna	Spider Crabs
Fauna	Historic Native Oyster beds – no longer occur, previously occurred in Ralph's Bay
Fauna	Historic native scallop beds – no longer occur, previously in middle estuary

Table 2: Conservation Assets and Nested Assets of the Derwent Estuary (continued)

8. Pelagic System (Water Column)	
Important Areas	Dennes Point – Cape Direction (Shark Refuge area), Tinderbox (Marine Nature Reserve)
Fauna	Pelagic Fish - Eastern Australian Salmon, Silver Trevally, Barracouta, Barracouta, Jack Mackerel, Silver Dory, School Shark, Gummy Shark, White Spotted Dogfish
Fauna	Migratory Fish, Subtidal Soft Sediment Fish, Rocky Reef Fish (Refer Individual Assets)
Fauna	Marine Mammals - Whales, Dolphins, Seals
Fauna	Penguins
Fauna	Seabirds
Flora	Plankton & Algae
9. Migratory Fish (& Associated Tributaries	
Fauna	Migratory Fish - Sea Run trout (* introduced), Tasmanian Whitebait, Common Jollytail, Tasmanian Mudfish, Spotted Galaxias, Black Bream, Yellow Eyed Mullet, Short finned Eel, Pouched Lamprey, Short-headed Lamprey, Australian Grayling (*Threatened / endangered), Tasmanian Smelt, Congolli
Major Tributaries	Derwent River, Browns River (Bream breeding location), Jordan River, Lachlan River
10. Spotted Handfish (Critically Endangered)	
Fauna	Spotted Handfish (critically endangered / endemic species)
	8 populations remaining
11. Little Penguin	
Fauna	Little Penguins

3. Viability of Conservation Assets

3.1. Methodology for Assessing Viability

The second step in the conservation action planning process is an assessment of the viability (or overall health) of the conservation assets. This is a four step process.

Step 1 Identification of a small number (3 - 5) of key ecological attributes for each conservation asset.

Key ecological attributes represent the critical factors required for the long term viability of the conservation assets. These factors relate to the size, condition and landscape context of the assets and include attributes such as hydrological regimes, fire regimes, water quality, species diversity, total remnant area and the size and configuration of patches (refer table 3).

Step 2 Identification of appropriate indicators for each key ecological attribute.

Indicators are easily measurable factors closely related to the status of the key ecological attributes. For example, the frequency, duration and timing of flood events may be an appropriate indicator for hydrological regimes. Similarly, the presence or absence of a particular habitat-sensitive species may be an appropriate indicator for species diversity or habitat condition (refer table 6).

Step 3 Development of criteria for rating the current status of each indicator.

The development of criteria for rating the status of each indicator is an iterative process that typically starts as a simplified qualitative assessment (e.g. lots, some, few) and is progressively developed into more refined, numeric value ranges (e.g. 1,000 megalitres of water for 3 months during late spring).

Step 4 Ranking the current status of each indicator to determine the overall viability of the conservation assets.

The final step in assessing the viability of the conservation assets is to rank the current status of each indicator based on the criteria for poor, fair, good and very good (described below). These individual ratings are rolled up in the Conservation Action Planning software to provide an assessment of the overall viability for each asset (refer table 4).

POOR - allowing the factor to remain in this condition for an extended period of time will make restoration or preventing extirpation practically impossible.

FAIR – the factor is outside its range of acceptable variation and requires human intervention. If unchecked, the target will be vulnerable to serious degradation.

GOOD – the factor is functioning within its range of acceptable variation; it may require some human intervention.

VERY GOOD – the factor is functioning at an ecologically desirable status, and requires little human intervention.

Source: adapted from Low (2003)

3.2. Viability of the Conservation Assets of the Derwent Estuary

The overall viability of the conservation assets of the Derwent Estuary, as assessed by participants in the CAP workshops, is displayed in Table 4. This was determined by identifying and rating the current status (i.e. poor to very good) of the key ecological attributes of each asset, based on considerations of size, condition and landscape context – refer Table 3.

Most conservation assets were assessed to be of Fair overall viability with the exception of Ralphs Bay Tidal Flats and Rocky Reefs which were assessed to be of Good viability and Saltmarshes and the Spotted Handfish which were assessed to be of Poor viability. Overall the viability of the Derwent Estuary as a whole was assessed to be Fair.

Table 3: Key Ecological Attributes of the Conservation Assets. Status of Key Ecological Attributes - Poor, Fair, Good.

Conservation Asset	Landscape Context Key Ecological Attributes	Condition Key Ecological Attributes	Size Key Ecological Attributes
1. Upper Derwent Wetlands & Macrophyte Beds	• adjacent buffer / retreat areas • freshwater regime • marine tidal influence	• fauna species diversity • primary productivity • flora species diversity • water quality	• total area remaining and patch size
2. Saltmarshes	• adjacent buffer / retreat areas • freshwater regime • marine tidal influence • connectivity to adjacent vegetation communities	• fauna species diversity • flora species diversity • water quality	• total area remaining and patch size
3. Ralphs Bay Tidal Flats	• marine tidal influence • adjacent buffer / retreat areas • nutrient cycling • integrity of shorebird network	• fauna species diversity • flora species diversity • sediment quality • water quality	• total area remaining (size)
4. Inter-tidal Zone	•buffered by terrestrial vegetation • adjacent retreat areas • marine tidal influence • mosaic / proportion of different habitat types (sand, rock, mud)	• fauna species diversity • flora species diversity • functionality of food chain • water quality • sediment quality	• total area remaining (size)
5. Terrestrial Foreshore Vegetation	• fire regime • connectivity to adjacent vegetation communities	• fauna species diversity • flora species diversity	• total area remaining and patch size
6. Rocky Reefs (& Kelp Forests)	• connectivity (degree of fragmentation) of reef systems	• fauna species diversity • flora species diversity • water quality & circulation	• total area remaining and patch size
7. Subtidal Soft Sediments (& Seagrasses)	• mosaic / proportion of different habitat types (sand to silt)	• fauna species diversity • flora species diversity • seagrass condition / cover • water quality & circulation • sediment quality • sediment processes	• total area remaining (size)
8. Pelagic System (Water Column)	• hydrological regime	• fauna species diversity • functioning plankton system • water quality	• total area remaining (size)
9. Migratory Fish (& Associated Tributaries)	• fish passage / connectivity between freshwater and marine habitat	• migratory species diversity • habitat condition • recruitment success	• total number of migratory fish
10. Spotted Handfish	• dispersal ability between populations & suitable habitats	• habitat condition • population structure (age class) & recruitment success	• total number / populations of Spotted Handfish
11. Little Penguin	• dispersal ability between suitable habitats	• habitat condition • population structure (age class) & recruitment success	• total number / populations of Little Penguins

Table 4: Viability Ratings of the Conservation Assets

	Conservation Asset	Landscape Context	Condition	Size	Overall Viability
1	Upper Derwent Wetlands & Macrophyte Beds	Poor	Fair	Good	**Fair**
2	Saltmarshes	Poor	Fair	Poor	**Poor**
3	Ralphs Bay Tidal Flats	Fair	Good	Good	**Good**
4	Inter-tidal Zone	Poor	Poor	Good	**Fair**
5	Terrestrial Foreshore Vegetation	Fair	Fair	Fair	**Fair**
6	Rocky Reefs (& Kelp Forests)	Good	Fair	Good	**Good**
7	Subtidal Soft Sediments (& Seagrasses)	Fair	Poor	Good	**Fair**
8	Pelagic System (Water Column)	Fair	Fair	Good	**Fair**
9	Migratory Fish	Poor	Fair	Fair	**Fair**
10	Spotted Handfish	Poor	Poor	Poor	**Poor**
11	Little Penguins	Fair	Fair	Fair	**Fair**
Overall Landscape Viability					**Fair**

4. Threats to Conservation Assets

4.1. Methodology for Assessing Threats

The third step in the conservation action planning process involves the identification of high priority threats to the conservation assets. This is a two step process.

The first step involves an assessment of the severity of the key stresses to the conservation assets. Stresses are inversely related to the key ecological attributes (refer section 3) and may include altered fire regimes, altered hydrological regimes, altered species diversity, reduced water quality, habitat fragmentation, etc. Stresses are ranked from very high to low based on:

● **severity of damage where it occurs** i.e. what level of damage can reasonably be expected within 10 years under current circumstances (Very High - destroys or eliminates the conservation asset, High - seriously degrades, Medium - moderately degrades, Low - slightly impairs);
● **scope of the damage** i.e. what is the geographic scope of impact on the conservation asset that can be reasonably expected within 10 years under current circumstances (Very High - very widespread, High - widespread, Medium - localised, Low - very localised).

The second step in the process involves the identification and ranking of the source of stresses (i.e. the direct threats). For example, the source of stress for reduced species diversity may be total grazing pressure (i.e. over fishing) and the source of stress for altered hydrological regimes may be excessive river extraction. Sources of stress are ranked from very high to low based on:

● **contribution of the source to the stresss** i.e. expected contribution of the source, acting alone, to the full expression of the stress under current circumstances (i.e. Very High - very large contributor, High - large contributor, Medium - moderate contributor, Low - small contributor).
● **irreversibility of the stress caused by the source** (Very High - not reversible, High - reversible, but not practically affordable, Medium - reversible with reasonable commitment of resources, Low - easily reversible at low cost).

Once the stresses and sources are ranked according to the above criteria, a summary rating for each threat is generated by the Conservation Action Planning (CAP) software. This results in the threats summary table (refer table 5) that allocates a ranking for each threat from very high to low, both in terms of the threat to the individual conservation assets and to the collective impact of the threat across the landscape.

Source: adapted from (Low 2003)

4.2. Threats to the Conservation Assets of the Derwent Estuary

The key threats to the conservation assets of the Derwent Estuary, as assessed by participants in the CAP workshops, are displayed in Table 5. This shows that all assets are considered to be subject to a high level of threat and that the impacts of sea level rise (i.e. due to the absence of available retreat areas), poor water / sediment quality (from urban run off, catchment run-off, sewage treatment plants, industry discharges, aquaculture), introduced estuarine fauna, Derwent River water extraction / management, and land reclamation and development are the most serious threats to the health of the system.

Table 5: High Ranked Threats to the Conservation Assets

Threats Across Targets	Upper Derwent Wetlands & Macrophytes	Salt-marshes	Ralphs Bay Tidal Flats	Inter-tidal Zone	Terrestrial Foreshore Vegetation	Rocky Reefs & Kelp Forests	Subtidal Soft Sediments & Seagrass	Pelagic System	Migratory Fish	Spotted Hand-fish	Little Penguins	Overall Threat Rank
Absence of Adequate Retreat / Buffer Areas (with sea level rise)	High	Very High	High	High							High	Very High
Urban Stormwater & Upper Catchment Run Off	Low	Medium		High		High	Medium	Medium	Low	High	Low	High
Introduced Estuarine Fauna			High	High		Medium	Medium	Low		High		High
Reclamation	High	High	High	Low								High
Sewage Treatment Plants & Industry Discharges	Medium			High		Medium	Medium	High	Low	Medium	Low	High
Extraction from Derwent River, Tributaries, Hydro Power Generation	Medium					Medium	Medium	High	High			High
Construction and Upgrade of Roads, Railways, Pipelines & Infrastructure	High	High			Medium	-			Medium			High
External Nutrients (e.g. Aquaculture, Ocean currents)				High		Medium	Medium	High				High
Bio-availability of Heavy Metals	Medium	Medium	Medium	Medium		Medium	High	Medium				High
Aquatic / Wetland Weeds	High	Low				Medium		Low	Low			Medium
Drought					Medium				High			Medium
Subdivisions, Infill Housing and other Developments (land clearing)					High						Low	Medium
Asset protection, view enhancement (land clearing)					High							Medium
In-stream Dams, Weirs, Fords, Pipes									High			Medium
Terrestrial Weeds					High							Medium
Land-based Recreational Activities		Low		Medium	Medium						Medium	Medium
Recreational Fishing, Boating & Diving	Low		Low			Medium	Low	Low	Low	Medium	Low	Medium
Threat Status for Targets and Project	High	High	High	High	High	High	High	High	High	High	Medium	Very High

5. Setting Conservation Objectives

5.1. Methodology for Setting Conservation Objectives

The fourth step in the conservation action planning process involves setting measurable objectives that, if achieved, would ensure the long term conservation of the assets. In particular, objectives are developed in line with the S.M.A.R.T principles (i.e specific, measurable, actionable, realistic and time-bound) and are aimed at addressing high priority threats (threat abatement) or achieving improvements in size, condition and landscape context attributes. Some useful considerations for setting conservation objectives relating to size, condition and landscape context are described below:

Size: Species-area curves provide useful guidelines for setting goals relating to the amount of habitat required for conservation. A variety of studies indicate that, as a general rule, retaining 30-40 percent of pre-European extent will conserve 80-90 percent of species associated with a particular habitat type (Dobson 1996, Nachlinger et al. 2001). As a general rule, a minimum 30-40 percent area target may be applied for conservation assets that have not been subject to broad scale clearance. For highly depleted or restricted conservation assets this may be raised to 50 percent.

Condition: Condition attributes such as flora and fauna diversity / composition and water quality are often poorly recorded at the landscape scale but are integral to the concept of functional landscapes. Maintaining ecological integrity over long time periods requires condition attributes functioning within their natural range of variation over specified geographical areas and time periods. Historical condition benchmarks (i.e. pre-European), when available, provide a useful reference point for goal setting; however, caution should be applied due to the likely influence of climate change (Harris et al. 2006) and historical degradation (e.g. salinity). In some regions, benchmark conditions may be referenced to regional condition monitoring manuals (e.g. Tasmanian Rivers Index)

Landscape Context: The spatial distribution of habitat “patches” and key disturbance events such as fire and hydrological regimes are critical to conservation at the landscape scale. Much of the theory relating to the spatial distribution of habitat is underpinned by metapopulation theory in which independent species populations may eventually go extinct due to the incremental impacts of wildfire, weeds, predation and population dynamics. The protection and management of existing populations, habitats and refugia, together with the restoration of terrestrial and aquatic processes is therefore critical to landscape conservation. Factors for goal setting relating to the spatial distribution of patches include the size, shape, number and distance between patches. Goals for fire and hydrological regimes should consider the timing, frequency, duration and extent.

5.2. Conservation Objectives for the Derwent Estuary

Twelve conservation objectives have been developed based on an assessment of the medium to high ranked threats of the Derwent Estuary (refer Table 5), and restoration of the key ecological attributes of degraded assets.

Objective 1. By 2015, no reclamation or clearance within high value areas of saltmarsh, wetland, terrestrial foreshore vegetation, and inter-tidal areas, with approvals outside of these areas designed to minimise impacts on existing vegetation

Objective 2. By 2020, maximise the hydrological pathways of wetlands, saltmarshes and the inter-tidal zone, and begin establishing buffers around high priority sites to improve connectivity with adjacent habitat (support life-history cycles), and to provide retreat zones with sea level rise.

Objective 3. By 2020, measurable improvement (to ‘Good’ levels, TBA) of high value foreshore habitats significantly impacted by recreational activities through the provision of appropriate infrastructure, education and signage, and on-ground restoration works.

Objective 4. By 2015, identify water quality targets (WQTs) and objectives (WQOs) for the Derwent estuary, by 2020 ensure WQTs are met for high value estuarine habitats through management of sewage treatment plants, industry, urban runoff, agriculture, aquaculture and other sources, and see improvements in condition of degraded estuary aquatic habitats to “good" levels (TBA).

Objective 5. By 2020, heavy metals in the Derwent estuary are managed to meet identified standards, minimise sediment toxicity and uptake in estuarine plants and animals (crustaceans, fish and birds), by 2040 see improvements in condition of degraded estuary aquatic habitats to at least "fair" levels (TBA).

Objective 6. By 2020, negligible environmental impacts from recreational fishing, boating, diving, and development (dredging, pylons, pontoons) on native species and habitats of the Derwent estuary.

Objective 7. By 2020, achieve and maintain adequate river conditions of lower Derwent and estuary tributaries to improve water quality / circulation, support migratory fish passage, wetland/saltmarsh health, and sediment processes.

Objective 8. Remove or reduce barriers to fish passage in the Derwent estuary and tributaries by 2020 to allow for the completion of species life cycles, and keep priority areas barrier free.

Objective 9. By 2020, achieve viable populations (i.e. number of individuals, number of colonies, and age classes) of Spotted Handfish in the Derwent estuary through water quality improvements, and improved spawning habitat (artificial and natural substrate).

Objective 10. By 2020, occupied little penguin breeding colonies have improved habitat quality, and are at or near carrying capacity, and new colonies are forming, and/or old ones re-occupied.

Objective 11. Prevent new infestations of priority invasive marine/aquatic fauna species and control those already established to minimise impacts on native species.

Objective 12. By 2020, contain the distribution and abundance of high priority invasive estuarine and foreshore weed species, restrict new introductions, and eradicate outlying occurrences of WONS so that the impacts on native species are minimised.

6 Conservation Strategies and Actions

6.1. Methodology for Developing Conservation Strategies and Action Plans

The fifth step in the conservation action planning process involves the identification of effective strategies and action steps to achieve the conservation objectives developed in Section 5. This is a three step process.

Step 1 Conduct a thorough situation analysis of the key factors related to the conservation objectives.

This includes consideration of the causal factors underlying particular threats and potential hurdles for enhancing the condition of conservation assets (e.g. social, cultural, economic and individual motivations). This can help pinpoint opportunities for intervention and guide decisions about which regional delivery mechanisms are best employed to achieve the conservation objectives (e.g. direct targeting of landholders, competitive market based instruments, education programs, legislative or policy changes).

Step 2 Brainstorm conservation strategies and action steps

Conservation strategies and action steps are the broad courses of action required to achieve the conservation objectives. There are essentially three "pathways" for strategy development that should be considered for threat abatement objectives. These include:

- direct protection or management of land or water;
- influencing a key decision maker;
- addressing a key underlying factor.

Once the major conservation strategies are identified, they may be broken down into smaller, more detailed action steps.

Step 3 Prioritise conservation strategies and action steps according to a cost-benefit and feasibility analysis.

Useful considerations for prioritising strategies and action steps include the relative conservation value of the asset (e.g. nationally threatened habitat type), its level of threat, the contribution of the strategy to meeting the conservation objectives, the duration of the benefit achieved and the potential leverage of the action (e.g. high profile site that provides a catalyst for further action). Feasibility of implementation should also be considered including the total cost and time required to implement the strategy, the ease of land access and the degree to which a lead individual / institution exists to implement the strategy. It may be useful to initially prioritise a small number of conservation strategies that provide a mix of high benefit and high feasibility (i.e. low hanging fruit) actions. In particular the high feasibility actions ensures that the project can get some early 'runs on the board' to leverage investment into the more complex and costly strategies.

Use of Conceptual Models

Conceptual models are increasingly being used for strategy development in conservation planning. A conceptual model is a visual method (diagram) of representing a set of causal relationships between factors that are believed to impact on one or more of the conservation assets. A good model should explicitly link the conservation assets to the direct threats impacting them, the factors (i.e. indirect threats) influencing the direct threats, and the strategic activities proposed to mitigate those factors (WWF 2005).

The Miradi software program (www.miradi.org) can be used to develop conceptual models and fully supports the Conservation Action Planning (CAP) process. The software was developed by the Conservation Measures Partnership, a consortium of international NGO's (with major contributors including The Nature Conservancy and World Wide Fund for Nature) seeking to develop a common language and approach to the design, management and monitoring of conservation programs. It is recommended that conservation projects that have applied the CAP process investigate the use of the Miradi software program and conceptual models during the strategy development process.

6.2. Conservation Strategies for the Derwent Estuary

The following section presents the recommended strategic actions and action steps required to achieve the 12 objectives identified in Section 5. Often multiple strategic actions are available under a single objective. This occurs when there are alternative or complementary 'pathways' available that can singly or collectively abate critical threats and meet ojectives. Different pathways generally involve 1) Direct protection or management; 2) Influencing a 'pressure point; and 3) Addressing some key underlying factor. It is important to note that this is not a difinative list of action steps, and that some steps may have been overlooked or alternative opportunities may be available. Furthermore, it is anticipated that over time new pathways and the most effective set of action steps may change, or be refined, as new knowledge arises. For example, the feasibility of implementing action steps may change as new partnerships or funding sources are identified. This highlights that the development of conservation strategies and action steps is an ongoing, iterative

process. CAPs need to be revisited on a regular basis to update action steps adn make the most of available opportunities when required.

Key strategic actions for the Derwent estuary fall under five broad conservation strategies. Each strategy relates directly to the protection and enhancement of at least one objective, but more commonly includes numerous objectives. These conservation strategies identify broad areas where works are required toeither address major threats, or enhance a set of key conservation assets.

1- **Foreshore Protection and Restoration -** Protection and restoration of high value saltmarsh, wetland, tidal flats, inter-tidal zone, and foreshore vegetation, and future proofing landscape linkages.

2- **Aquatic Environment Protection and Restoration** - Restoration of the marine environment in general through improved water quality, reduced heavy metal loads, and managed physical impacts (diving, boating, dredging), to see increased condition of degraded aquatic habitats, and maintenance of existing high value habitats.

3- **Restoration of Aquatic Connectivity** - Restoration and maintenance of flows and connectivity between aquatic estuarine habitats for habitat and species conservation.

4- **Improved Condition of Key Species** - Increased abundance of key native species

5- **Pests and Weeds** - Contain high priority pests and weeds and restrict new introductions

Clear strategic actions or 'pathways' towards achieving these major conservation strategies and their relevant objectives are presented below.

Conservation Strategy 1 – Foreshore Protection and Restoration

<u>Objective 1.</u> By 2015, no reclamation or clearance within high value areas of saltmarsh, wetland, terrestrial foreshore vegetation, and inter-tidal areas, with approvals outside of these areas designed to minimise impacts on existing vegetation

Strategic Action 1: Amend clearance and reclamation policy to protect saltmarsh, wetlands and inter-tidal zones (e.g., State coastal policy, Local Planning Commission approvals process, NVA listing of saltmarsh).

Strategic Action 2: Covenants, land acquisition, and improved property management of private lands to protect and improve existing wetland, saltmarsh, inter-tidal areas, and high priority buffers.

Strategic Action 3: Develop and implement a communications strategy to increase awareness and education of land clearing policy, laws and best practice, targeting relevant industry and private sector groups, private landowners, and the community more broadly.

<u>Objective 2.</u> By 2020, maximise the hydrological pathways of wetlands, saltmarshes and the inter-tidal zone, and begin establishing buffers around high priority sites to improve connectivity with adjacent habitat (support life-history cycles), and to provide retreat zones with sea level rise.

Strategic Action 4: Implement a targeted education program to encourage and facilitate on-ground works to protect, maintain, and restore hydrological pathways, habitat linkages, and buffer areas (for landward transgression of high value habitat with SLR)at high priority sites in existing wetlands, saltmarsh and inter-tidal zone.

Strategic Action 5: Pursue legal protection and land acquisition to protect, maintain, and restore hydrological pathways, habitat linkages, and buffer areas of high priority wetland, saltmarsh and the inter-tidal zone.

<u>Objective 3.</u> By 2020, measurable improvement (to 'Good' levels, TBA) of high value foreshore habitats significantly impacted by recreational activities through the provision of appropriate infrastructure, education and signage, and on-ground restoration works.

Strategic Action 6: Identify priority sites of key habitat impacted by recreational use, engage key land managers/owners to implement on-ground works, monitor recovery, and review/update coastal foreshore recreational use strategies where appropriate.

Conservation Strategy 2 – Aquatic Environment Protection and Restoration

Objective 4. By 2015, identify water quality targets (WQTs) and objectives (WQOs) for the Derwent estuary, by 2020 ensure WQTs are met for high value estuarine habitats through management of sewage treatment plants, industry, urban runoff, agriculture, aquaculture and other sources, and see improvements in condition of degraded estuary aquatic habitats to "good" levels (TBA).

Strategic Action 7: Identify WQ required for improved condition (e.g., flora and fauna species diversity) and extent (e.g., macrophyte and seagrass beds) of degraded aquatic habitats of the Derwent Estuary, set WQ targets and objectives, implement major projects at major pollutant hotspots or near sensitive habitats/areas, and monitor recovery.

Strategic Action 8: Build awareness within the public and industry more broadly through education and training to promote the uptake of existing strategies, guidelines and recommendations, and see improved WQ management to reduce discharge of pollutants (nutrient, sediment and organic matter) through on-ground actions and infrastructure improvements.

Objective 5. By 2020, heavy metals in the Derwent estuary are managed to meet identified standards, minimise sediment toxicity and uptake in estuarine plants and animals (crustaceans, fish and birds), by 2040 see improvements in condition of degraded estuary aquatic habitats to at least "fair" levels (TBA).

Strategic Action 9: Limit uptake of heavy metals in estuarine plants and animals by implementing the DEP Water Quality Improvement Plan (2010) to further reduce inputs and minimise disturbance of contaminated sediments, promote research on ecosystem health, toxicity pathways and nutrient effects, and prioritise sites and biota (e.g., seafood safety) for monitoring.

Strategic Action 10: Investigate the most cost-effective means of managing habitats, to limit and reduce metal bioavailability.

Objective 6. By 2020, negligible environmental impacts from recreational fishing, boating, diving, and development (dredging, pylons, pontoons) on native species and habitats of the Derwent estuary.

Strategic Action 11: Reduce physical impacts and increased protection and restoration (evident through monitoring) of sub-tidal soft sediments, seagrasses, and rocky reefs through an education and awareness program targeted at recreational activities of concern (divers, fisherman, boaters).

Strategic Action 12: Reduce physical impacts and increase protection of sub-tidal soft sediments, seagrasses, and rocky reefs by seeking amendments to state or local estuarine management policies and regulations (State coastal policy, Local Planning Commission approvals process) to pick up high impact development activities, and recreational activities of concern (divers, fisherman, boaters).

Conservation Strategy 3 – Restoration of Aquatic Connectivity

Objective 7. By 2020, achieve and maintain adequate river conditions of lower Derwent and estuary tributaries to improve water quality / circulation, support migratory fish passage, wetland/saltmarsh health, and sediment processes.

Strategic Action 13: Identify and define river conditions required to support healthy habitat and native species populations (e.g., volume and timing of freshwater flow requirements), set flow targets, and develop and implement a Rehabilitation Plan.

Objective 8. Remove or reduce barriers to fish passage in the Derwent estuary and tributaries by 2020 to allow for the completion of species life cycles, and keep priority areas barrier free.

Strategic Action 14: Design and implement a targeted barrier upgrade and removal program to improve connectivity and fish passage, and influence land managers and planning to keep priority areas barrier free.

Conservation Strategy 4 – Improved Condition of Key Species

<u>Objective 9.</u> By 2020, achieve viable populations (i.e. number of individuals, number of colonies, and age classes) of Spotted Handfish in the Derwent estuary through water quality improvements, and improved spawning habitat (artificial and natural substrate).

Strategic Action 15: Build capacity, stewardship, and resourcing of the SHF recovery working group to continue and expand surveys and on-ground works, and monitor effectiveness of these actions.

<u>Objective 10.</u> By 2020, occupied little penguin breeding colonies have improved habitat quality, and are at or near carrying capacity, and new colonies are forming, and/or old ones re-occupied.

Strategic Action 16: Maintain partnerships with Local councils and community groups to ensure continued on-ground works, maintenance, and public education at breeding sites to improve breeding success and population size.

Conservation Strategy 5 – Pests and Weeds

<u>Objective 11.</u> Prevent new infestations of priority invasive marine/aquatic fauna species and control those already established to minimise impacts on native species.

Strategic Action 17: Restrict new arrivals of invasive marine/aquatic fauna through education and training, and build capacity to respond to new arrivals.

Strategic Action 18: Contain existing high priority species by promoting hygiene and best practice (e.g., boat transport) and control invasive species at sites of high conservation value.

<u>Objective 12.</u> By 2020, contain the distribution and abundance of high priority invasive estuarine and foreshore weed species, restrict new introductions, and eradicate outlying occurrences of WONS so that the impacts on native species are minimised.

Strategic Action 19: Contain or eradicate high priority estuarine and foreshore weeds by co-ordinating existing on-ground works, and promoting new works at high priority sites through education and training.

Strategic Action 20: Implement weed prevention program via education and training to restrict the translocation of invasive estuarine and foreshore weeds, and detect new arrivals in the Derwent estuary.

6.3 Action Plan for the Derwent Estuary

The Derwent Estuary Program have drafted a set of action steps and associated tasks for each of the strategic actions outlined in this CAP, but these steps require further consideration before they can be presented as an action plan. Workshops targeting some of the conservsation strategies identified in this CAP will be held through late 2012 and early 2013 to finalise an action plan that will meet the stated objectives. Key stakeholders will be invited to these workshops to assist in identifying major actions, resource availability, and constraints regarding their implementation. Following these meetings an updated list of action steps will be added to the CAP. Action plans typically specify a series of steps which are presented in a logical order, first addressing how to overcome any resource or knowledge gaps, and barriers to implementation, then on-ground works, and monitoring. The aim of the action plan is to provide some direction to industry, environmental managers, and community as to how they can contribute tohigh priority conservation outcomes in the Derwent estuary.

7 Monitoring, Evaluation and Adaptive Management

7.1. Methodology for Developing a Monitoring Program

The final step in the conservation action planning process is an ongoing one which involves the development and implementation of a rigorous monitoring, evaluation and adaptive management program. This serves a number of important functions including:

- determining whether the conservation strategies and actions are achieving the desired goals;
- showing trends in the condition of conservation assets and the levels of threat;
- demonstrating the effectiveness and efficiency of investment into the conservation program;
- linking local conservation outcomes with other programs to describe the local-global biodiversity outlook
- securing future funding

In particular two types of monitoring and evaluation are identified in the Conservation Action Planning framework. This includes monitoring and evaluation for 1) strategy effectiveness and 2) resource condition (i.e. asset condition and / or level of threat). The latter is analogous to a medical "check-up", where the doctor measures indicators such as blood pressure to provide early warning signs of systemic problems. Ideally, a monitoring and evaluation program should include both components.

Appropriate Level of Resourcing for Monitoring and Evaluation

Many researchers and conservation practitioners agree that a monitoring effort of 10-20% of the total program budget is an appropriate level of resourcing. However the level of resources allocated to monitoring should vary in proportion to the level of uncertainty surrounding our assumption that action A will lead to the conservation goal B. Higher levels of uncertainty may necessitate greater scientific rigour (i.e. replicated experiments and trials) to test a particular conservation theory.

Use of Results chains

Results chains are a relatively recent tool to assist conservation planners test assumptions that an action will achieve a desired goal. Results chains are broadly based on principles of logical framework analysis (developed in the 1960's) and are supported by Miradi software (www.miradi.org). By identifying interim results or milestones along a trajectory towards the delivery of an outcome, results chains make implicit assumptions about the expected results of activities explicit. This process typically results in more rigorous strategy development by the project team. Once a sequence of outputs and outcomes are represented as a results chain diagram, it is relatively easy to visualise and identify monitoring indicators and milestones along the way to a conservation goal.

The Miradi program has not been applied in the Derwent Estuary Program at present, but future strategy development and monitoring may make use of this software.

7.2. Monitoring and Evaluation Indicators for the Derwent Estuary

An effective monitoring and evaluation program for the Derwent Estuary should aim to achieve two major outcomes:

1) RESOURCE CONDITION MONITORING
- provide quantative data to confirm or revise the current status of the key ecological attributes and overall viability of the conservation assets and/or the current status of the key threats.
- establish baseline data to monitor future changes in the status of the key ecological attributes and overall viability of the conservation assets and/or status of the key threats.

2) STRATEGY EFFECTIVENESS MONITORING
- provide quantative data to assess the effectiveness of the conservation strategies and action steps and identify areas for refinement.

Monitoring indicators should be closely associated to the current status of the key ecological attributes and address landscape context, condition and size attributes of the conservation assets (refer Table 6). A monitoring and evaluation program should also make use of any existing data and monitoring activities in the region so as to ensure resources are used efficiently. This may involve creating links with other organisations such as large land managers and industry that may have complimentary aims or legislative requirements to undertake environmental monitoring.

Table 6 presents recommended monitoring indicators for the Derwent Estuary based on the key ecological attributes and monitoring indicators identified by participants in the CAP workshops.

Table 6: Monitoring Indicators for Key Ecological Attributes (KEA) of the Conservation Assets

	Conservation Asset	Upper Derwent Wetlands & Macrophyte Beds	Saltmarshes	Ralphs Bay and Tidal Flats	Inter-tidal Zone	Terrestrial Foreshore Vegetation
LANDSCAPE CONTEXT	Connectivity with adjacent buffer/ retreat areas, or adjacent communities/ habitats	% of wetlands buffered by adequate terrestrial conservation areas (50-100m wide)	% of saltmarsh buffered by adequate terrestrial conservation areas (50-100m wide)	1. % of tidal flats buffered by adequate terrestrial conservation areas (50-100m wide). 2. Integrity of shorebitrd network - Abundance & diversity of shorebirds within the network	1. % of sensitive intertidal zone habitat (muds, sands) with suitable retreat areas. 2. % of sensitve intertidal zone buffered by significant areas of native vegetation	% connected to significant areas of inland vegetation
	Hydrological Regime	1. Timing, frequency and duration of Derwent River base flows and flood events. 2. Marine Tidal Influence - Barriers to Tidal flows	1. Timing, frequency and duration of Derwent River base flows and flood events. 2. Marine Tidal Influence - Barriers to Tidal flows	Marine Tidal Influence - Barriers to Tidal flow (Luaderdale / Race course Flats)	Number of Barriers / Sea Walls impacting tidal influence	
	Mosaics				Relative % of different intertidal zone habitats (sand, mud, rock, etc)	
CONDITION	Nutrient cycling			1. Process measurements (e.g. respiration, denitrification). 2. Presence/absence of mats of macroalgal		
	Fauna Species	1. Number and diversity of water birds and fish species. 2. Primary productivity - Biomass (Ruppia per hectare)	Number and diversity of water birds	Number and diversity of water birds and fish species	Shorebird and native / introduced macro-invertbrate / crabs diversity	Woodland & shorebird bird diversity / Habitat Potential Mapping
	Flora species	Extent of Weed Species (Karamu, Blackberry, Willows)	species composition, age classes and habitat structural components	benthic microalgae	1. Inter-tidal agal species composition and diversity. 2. Functional food chain - Abundance and diversity of top order food chain fauna (fish and shorebirds)	Vegetation Condition Assessment (species diversity, age classes, weed presence, structural components)
	Water Quality (salinity, nutrients, temperature, clarity)	Health of Macrophyte beds / occurence of algal blooms	Nutrients & salinity	Nutrients & salinity	Abundance of Sea Lettuce and Algae	
	Sediment quality (redox profile, contaminants) and processes			Macro-invertebrate diversity & abundance or level of contaminants (heavy metals)	Levels of organic, heavy metals, nutrients, sediment loading (soft sediments)	
SIZE	Total area, total number	Square kilometers of wetlands and macrophyte beds	square kilometres of saltmarsh	square kilometres of tidal flat	square kilometres of unimpounded inter-tidal zone	total area (hectares) and width to length ratio of foreshore vegetation / linear extent

	Conservation Asset	Rocky Reefs & Kelp Forests	Subtidal Soft Sediments & Seagrasses	Pelagic (Water Column) System	Migratory Fish & Associated Tributaries	Spotted Handfish	Little Penguins
LANDSCAPE CONTEXT	Connectivity with adjacent buffer/ retreat areas, or adjacent communities/ habitats	Spatial Distribution and distance between reefs (species dependent)			Fish Passage / Connectivity (Marine to Freshwater Habitats)- Total area available for fish passage in freshwater tributaries (based on # and location of fish barriers on tributaries), Adequate river flows (tbd) of tributaries to allow fish passage	Connectivity between suitable habitat and populations (i.e., distance between populations and suitable habitats)	Dispersal ability / connectivity between suitable habitat
	Hydrological Regime			Derwent River (volume flow, duration, timing), Residency time of water, River colour, Presence of salt wedge / stratification, levels of dissolved oxygen			
	Mosaics		% of sandy to silty sediment habitat across the estuary				
CONDITION	Fauna Species	Presence of key indicator species (e.g. Brittle Star)	Community Diversity & Abundance, especially sensitive, or key Indicator Species (or suite of species)	Diversity & Abundance of Key Indicator Species (Sharks, Dolphins, fish), Excessive numbers of jellyfish	Diversity of Migratory Fish Species (Medowbank Dam, or Fishers Catch Effort in structured surveys), Abundance (e.g., Fishers Catch Effort surveys), and breeding success/ recruitment (population structure, age class surveys) using post-grad studies where available.	Population Structure & Recruitment. Presence of spawning structures, Introducesd speceis abundance and Seagrass Distribution and Abundance	Population Structure & Recruitment
	Flora species	Diversity of macroalgae & kelp forests (key indicator species)	Microphytobenthos abundance / biomass / distribution (measure of chlorophyll), and Seagrass abundance / distribution / condition	Functioning Plankton System- Seasonal blooms of palatable species OR Presence of unpalatable nuisance algal blooms (size & type of species - toxins, foaming, shell fish poisoning, monospecific Noctilua problem algae)			Habitat Conditon
	Water Quality (salinity, nutrients, temperature, clarity)	Salinity, Nutrients, Turbidity (Sedimentation, Circulation, suspended solids)	dissolved oxygen, salinity, nutrients, river flow, circulation	Exess nutrients, heavy metals / toxins, salinity, temp, dissolved oxygen, clarity / turbidity, foecal bacteria (pathogens), pharmaceuticals (anti-biotics)	Water Quality, sediment quality, riparian vegetation (Tasmania River Index)	Water Quality	
	Sediment quality (redox profile, contaminants) and processes		Dissolved oxygen, deposition & erosion, contaminants, and Redoxnitrogen process nutrient cycling, productivity, and absence of nusiance algal blooms			Sediment quality	

SIZE	Total area, total number	km square (mapping)	km square (mapping)	Total Area		Total Number, and number of populations	Total Number, and number of populations

References

Conservation Measures Partnership (2007). Open standards for the practice of conservation. Available online at: www.conserveonline.org .

Dobson, A.P. (1996). Conservation and Biodiversity. New York: Scientific American Library.

Foundations of Success. (2007). *Using Results Chains to Improve Strategy Effectiveness: An FOS How-To Guide.* http://fosonline.org/Site_Documents/Grouped/FOS_Results_Chain_Guide_2007-05.pdf

Groves, C.R. (2003). Drafting a Conservation Blueprint: A Practitioners Guide to Planning for Biodiversity. The Nature Conservancy. Island Press, Washington.

Hanski, I. (1991). Single species metapopulation dynamics: concepts, models and observations. In M.E. Gilpin and I. Hanski, eds., Metapopulation Dynamics: Empirical and Theoretical Investigations, pp 17-38 New York, NY: Academic Press.

Harris, J. A., Hobbs, R., Biggs, E. and Aronson, J. (2006). Ecological restoration and global climate change. Restoration Ecology 14(2): 170-176.

Landres, P.B., Morgan, P. and Swanson, F.J. (1999). Overview of the use of natural variability concepts in managing ecological systems. Ecological Applications 9: 1179-1188.

Low, (2003). Landscape-scale Conservation: A Practitioners Guide. The Nature Conservancy, 4th Edition

Mackey, B.G., Soulé, M.E., Nix, H.A., Recher, H.F., Lesslie, R.G., Williams, J.E., J Woinarski, C. Z.R., Hobbs, J. and Possingham, H.P. (2007) Applying landscape-ecological principles to regional conservation: the WildCountry Project in Australia *In:* Key Topics and Perspectives in Landscape Ecology**.** Cambridge University Press. Edited by Jianguo Wu and Richard J. Hobbs.

MacNally, R., Bennett, A.F., Brown, G.W., Lumsden, L.F., Yen, A., Hinkley, S., Lillywhite, P. and Ward, D. (2002). How well to ecosystem-based planning units represent different components of biodiversity? Ecological Applications 12: 900-912.

Margules, C.R. and Pressey, R.L. (2000). Systematic conservation planning. Nature 405: 243-253.

MERI (2008). Australian Government Natural Resource Management Monitoring, Evaluation, Reporting and Improvement Framework.

Moilanen, A., Franco, A. M. A., Early, R., Fox, R., Wintle, B., and C. D. Thomas. 2005. Prioritising multiple-use landscapes for conservation: methods for large multi-species planning problems. Proceedings of the Royal Society of London, Series B, Biological Sciences 272: 1885-1891.

Nachlinger, J., Sochi, K., Comer, P., Kittel, G.and Dorfman, D. (2001). Great Basin: An ecoregional based conservation blueprint. Arlington VA: The Nature Conservancy.

Noss, R. F.E., Dinerstein, B., Gilbert, M., Gilpin, B.J., Miller, B.J., Terbough, J. and Trmbulak, S. (1999). Core areas: where nature begins. In J. Terbough and M. Soule, eds., Continental Conservation: Scientific Foundations of Regional Reserve Networks, pp 99-128. Washington DC: Island Press.

Parkes, D., Newell, G. and Cheal, D. (2003). Assessing the quality of native vegetation: The 'habitat hectares' approach. Ecological Restoration and Management. 4: 29-38.

Poiani, K.A., Baumgartner, J.V., Buttrick, S.L., Green, S.C., Hopkins, E., Ivey, G.D., Sutton, K.P., and Sutter, R.D. (2000). Biodiversity conservation at multiple scales: functional sites, landscapes and networks. Bioscience 50: 133-146.

Possingham, H., Ball, I. and Andelman, S. (2000). Mathematical methods for identifying representative reserve networks. In: S. Ferson and M.A. Burgman, eds. Quantitative Methods in Conservation Biology, pp 291-306. New York, NY: Springer-Verlag.

Pressey, R.L. and Nichols, A.O. (1989). Application of a numerical algorithm to the selection of reserves in semi-arid New South Wales. Biological Conservation 50: 263-278.

Soulé, M.E., Mackey, B.G., Recher, H.F., Williams, J.E., Woinarski, J.C.Z., Driscoll, D. Dennison, W.C. and Jones, M.E. (2004). The role of connectivity in Australian conservation. Pacific Conservation Biology 10: 266-79, Surrey Beatty & Sons, Sydney.

Thomson, J. R. , Moilanen, A. J. , Vesk, P. A. , Bennett, A. F. , Mac Nally, R. (2009). Where and when to revegetate: a quantitative method for scheduling landscape reconstruction. Ecological Applications: Vol. 19, No. 4, pp. 817-828.

Wiens, J.A. (1996). Wildlife in patchy environments: metapopulations, mosaics and management. In: D.R. McCullough, ed., pp. 53-84. Washington DC: Island Press.

Wintle, B.A. (2008) A Review of Biodiversity Investment Prioritization Tools. A report to the Biodiversity Expert Working Group toward the development of the *Investment Framework for Evironmental Resources,* School of Botany, University of Melbourne

WWF. 2005. *Basic Guidance for Cross-Cutting Tools: Conceptual Models.* www.panda.org/standards or http://assets.panda.org/downloads/1_4_conceptual_model_11_08_05.pdf