

CURRENT RESEARCH PROJECTS

– AQUATIC ECOSYSTEMS –

(Last updated 19 January 2012)

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Research Project Description

Project title:

Hume Highway Duplication – Threatened Species Monitoring
(Con2008/178)

Principal Investigator:

Mr Martin Asmus

Funding Sources:

NSW Department of Primary Industries and the NSW Roads & Traffic Authority

Objectives:

Assess the distribution and abundance of populations of the threatened southern pygmy perch and other fish species during upgrading of the Hume Highway between the Sturt Highway junction south to Albury in southern NSW.

Summary:

The Roads and Traffic Authority of NSW (RTA) is upgrading five sections of the Hume Highway from single carriageway to a four-lane dual carriageway in the area from the Sturt Highway junction south to Albury (the Hume Highway Duplication project) in southern NSW. The southern pygmy perch was recorded at three localities during pre-construction surveys of the waterways in the vicinity of the Duplication project. This species is of conservation significance and is listed as 'vulnerable' to extinction under the NSW state legislation.

NSW DPI is undertaking surveys for the southern pygmy perch and other fish species in the vicinity of the Hume Highway Duplication project during the construction phase. The information from these surveys will be compared with existing information collected prior to the commencement of highway construction works to evaluate any changes in the distribution and abundance of these populations which may have resulted from the works. This information can guide future mitigation actions, offsetting priorities and future monitoring programs to assist in the protection and conservation of the aquatic biodiversity in the area.

Research Project Description

Project title:

Development of methods to determine the effectiveness of fishery management strategies on the Hawkesbury River estuary
(Con2008/159)

Principal Investigator:

Ms Karen Astles

Funding Sources:

NSW Department of Primary Industries, the Australian Centre for International Agricultural Research (ACIAR) and the Commonwealth Scientific & Industrial Research Organisation (CSIRO)

Note: This project supports 2 existing projects that are funded by the CSIRO – Marine & Atmospheric Research the ACIAR (projects FSC2004/147 and Con2005/107 respectively)

Objectives:

1. Develop methods to test for the effectiveness of the implementation of the fishery management strategies for two estuarine fisheries on ecosystem functions.
2. Develop methods to detect changes in ecological indicators between regimes of fishing.

Summary:

Fishery management strategies for Estuary General and Estuary Prawn Trawl fisheries in NSW have been in operation since 2003. Vital to any strategy is determining how effective it is in achieving its objectives. For fisheries management strategies, it is important to know how an ecosystem, not just the harvested species of fish, responds to the changes to the management of the fishery. A significant aspect of the NSW fishery management strategies was the development of ecological indicators – aspects of the environment that tell us how the ecosystem is functioning compared to some reference point. However, field based methods to determine suitable indicators have not been developed so far. Furthermore, the relationship between different types of indicators and changes to fishing activity and other non-fishing influences are yet to be understood. In the scientific literature a number of different types of ecological indicators to monitor the effects of fishing on an ecosystem have been proposed, but these have not been tested in the field.

This project will develop methods to test a range of ecological indicators and their relationship to changes in fishing activity in the Hawkesbury estuary compared to estuaries where commercial fishing has ceased (Port Jackson, Botany Bay and Port Hacking). Because assemblages of estuarine plants and animals vary naturally in abundance and location, the project will investigate how much sampling should be done and how often it should be repeated to detect differences, if present, between areas commercially fished and those not commercially fished. The outcomes of the project will be an assessment of which ecological indicators and what methods are most cost effective and informative for evaluating fishery management strategies for the 2 commercial fisheries in the Hawkesbury estuary. These methodologies can then be incorporated into any coastal planning process in conjunction with other approaches such as ecosystem modelling.

Research Project Description

Project Title:

Vulnerability assessment of the effects of climate change on estuarine habitats in the Lower Hawkesbury Estuary
(Con2010/203)

Principal Investigator:

Ms Karen Astles

Funding Sources:

NSW Department of Primary Industries and Hornsby Shire Council.

Objectives:

1. Assess the vulnerability of estuarine habitats in the Lower Hawkesbury Estuary to the effects of climate change under a range of scenarios.
2. Map the projected vulnerabilities of each habitat in terms of loss, shift or gain.
3. Assess the level of risk of these vulnerabilities from climate change compared to other human activities within the Lower Hawkesbury Estuary.
4. Recommend appropriate adaptive management action to enhance the ecological resilience of vulnerable habitats.
5. Recommend appropriate monitoring programmes to evaluate management actions.

Summary:

Climate change will potentially have a number of effects in our estuaries as they occupy a transition zone between terrestrial and marine environments. Sea level rise, changes in water and air temperature and freshwater input in particular could have a significant impact on estuarine habitats such as mangroves, seagrass, saltmarsh and wetland forests. However, our understanding of how these habitats might adapt to climate change effects and their capacity to do so is inadequate at the level of individual estuaries. Regional management agencies, such as local councils, need specific information about the vulnerability of habitats within their jurisdictions so that they are better able to make specific plans to protect them.

Hornsby Shire Council has developed a Lower Hawkesbury Estuary Management Plan (LHEMP). One of the key risks identified to estuarine habitats was climate change. To address this risk they are seeking to improve their understanding of local impacts which may arise from climate change and the management responses to such impacts. This project will undertake a vulnerability assessment of estuarine habitats in the lower Hawkesbury estuary. This will involve determining the exposure and sensitivity of habitats to the effects of changes in sea level rise and air and water temperature. It will then assess the capacity of habitats to adapt to cope with these effects to determine their vulnerability. Assessment of the adaptive capacity of habitats to cope with climate change effects will be based on the ecology of each habitat type and the physical characteristics of each habitat location. Another factor that will be assessed are any potential stressors from human activities, such as some foreshore developments, that may decrease the ability of a habitat to adapt to climate change impacts. The project will produce maps indicating where estuarine habitats will be potentially lost, or shift in location or increase in area. These maps can then be used by Hornsby Shire Council in implementing their management plan for the lower Hawkesbury estuary. It is also anticipated that the methods developed for this estuary can be used for other estuaries in assessing the vulnerability of habitats to climate change.

Research Project Description

Project Title:

Qualitative ecological risk assessment of human disturbances on marine biodiversity in NSW
(Con2011/227)

Principal Investigator:

Karen Astles

Funding Sources:

NSW Department of Primary Industries.

Objectives:

1. Identify all threats from human disturbances to marine biodiversity in coastal NSW.
2. Assess the level of risk to marine biodiversity from the identified human disturbances.
3. Identify and prioritise the issues that need to be addressed to reduce the level of risk to marine biodiversity.
4. Assess the effectiveness of current marine park zoning and other natural resource management regimes in NSW in addressing these issues.
5. Recommend appropriate management action and scientific research to enhance the ecological resilience of coastal marine ecosystems to human disturbances to maintain and /or improve the protection of marine biodiversity in NSW.

Summary:

Australia is committed to international and national conventions concerning the conservation of marine biodiversity. Marine biodiversity includes iconic species such as grey nurse sharks, and habitats such as seagrass, rocky reefs, soft sediment, and processes that keep these species and habitats functional, such as feeding, migration and breeding. A large variety of human activities, such as commercial and recreational fishing, aquatic recreation, human development, occur within and in close proximity to coastal areas in NSW. These activities can potentially affect marine biodiversity because they can interact across a complex array of marine and estuarine habitats and iconic marine species. These effects may result in marine habitats becoming degraded such that they are unable to support marine biodiversity and in iconic species not be able to maintain their populations. Because marine biodiversity is so vast we do not yet know enough about the biology and ecology of every marine species in order to protect them. Instead, scientists use substitutes that act as an umbrella for marine biodiversity. These are sometime called surrogates. These substitutes can encapsulate other aspects of diversity, such as genes, many small species and biological functions, that are difficult to protect individually. Marine habitats and iconic species have been considered as appropriate substitutes for marine biodiversity. Therefore, protecting marine habitats and iconic species from human disturbances contributes to the protection of marine biodiversity.

The diversity and distribution of marine habitats along coastal NSW has recently been mapped, primarily in marine parks but also in other areas of significance such as around the Sydney region. Very little is known about the size, where and how often different human activities occur in NSW in relationship to marine habitats and iconic species. Furthermore, there has been little systematic scientific assessment of the potential effects of a range of human activities on marine habitats and iconic species. To effectively protect marine biodiversity all human activities and their effects on marine biodiversity will need to be identified, assessed, prioritized and issues clearly elucidated. Only then can there be a systematic assessment of how current management regimes, such as marine park zoning plans and coastal catchment management plans, address the issues to reduce the identified levels of risk.

This project will assess the level of risk to each marine habitat type and some iconic species has to becoming degraded from the large range of human activities that interact with them. It will be able to identify the issues that contribute to marine habitats and iconic species to becoming degrading and what

management action needs to be taken in order to reduce the risk to each type. It will be done for each marine park and will assess the effectiveness of marine parks in addressing these issues. It will also assess the effectiveness of other management plans in protecting marine biodiversity in NSW.

Research Project Description

Project Title:

Murray River Fishway Assessments
(Con2002/047)

Principal Investigator:

Mr Lee Baumgartner

Funding Sources:

NSW Department of Primary Industries and the Murray Darling Basin Authority.

Objectives:

The project aims to assess the efficiency of up to 11 newly constructed fishways on the Murray River and answer the following questions for each fishway:

- Is the fishway allowing passage of a full range of size classes and species of fish?
- Is the fishway reducing accumulations of fish downstream of the barrier?
- Is the fishway contributing to positive changes in the abundance and diversity of native fish in the river?
- Are the location, design and operation of the fishways optimised?

Summary:

The Murray River is a highly regulated inland stream that incorporates two main storages (Lake Mulwala, 118GL and Lake Hume, 3038 GL) and 13 locks required for navigation. The presence of these instream barriers has adversely affected the migratory potential for native fish species. At Euston Weir (Lock 15) numbers of Golden Perch (*Macquaria ambigua*), Silver Perch (*Bidyanus bidyanus*) and Murray Cod (*Maccullochella peelii*) recorded from fish traps since 1950 have reduced by 51%, 94% and 96% respectively.

The Murray River Fishway Assessment project represents a tri-state approach to assess the new fishways on the Murray River over the next four years. Scientists from NSW Department of Primary Industries, Department of Natural Resources and Environment and South Australian Research and Development Institute have undertaken pilot studies to determine optimal sampling regimes required to determine any environmental benefits arising from fishway construction.

A subsequent sampling program will determine whether constructed fishways are allowing passage of a full range of size classes and species of fish, reducing accumulations of fish downstream of the barrier and contributing to positive changes in the abundance and diversity of native fish in the river. Fish are collected using boat electrofishing and large individuals of key species such as cod, golden perch and carp are tagged and then released after being identified and measured.

Samples of fish communities are being taken both before and after fishway construction and will be combined with a micro-chipping project to determine whether fish are successfully negotiating any fishways that are constructed. Fishway optimisation tests will also be performed that will determine whether modifications can be made to future fishway installations to make them more efficient.

Research Project Description

Project Title:

Downstream mortality of native fish
(Con2006/131)

Principal Investigator:

Dr Lee Baumgartner

Funding Sources:

NSW Department of Primary Industries and the Murray-Darling Basin Authority (project no. MD744).

Objectives:

1. Understand the effects of undershot and overshot weirs on species of Murray-Darling Basin fish.
2. Document the survival of different species and size classes as they pass through different weir configurations.
3. Investigate the survival of fish species as they pass over dam spillways.
4. Develop techniques to improve the survival of these fish as they pass through the structures.
5. Identify current management practices used to ameliorate an potential impacts of dams and weirs.
6. Create a prioritisation list for structures requiring mitigation
7. Provide concrete management recommendations for future construction and operation of dams and weirs, especially for structures to be constructed under the living Murray.

Summary:

The proliferation of dams and weirs has had a profound affect on both the abundance and diversity of Australia's inland fish communities. Such obstructions create physical barriers that can prevent important spawning and recolonisation migrations but in the extreme, can result in the extinction of some species upstream of the structure. At Euston Weir on the Murray River, important recreational angling species such as Murray Cod, Golden Perch and Silver perch have declined in abundance by 96%, 51% and 94% respectively since weir construction.

Previously, all migration of freshwater fish species was thought to be in an upstream direction and related directly to spawning. Fishways were subsequently constructed to provide upstream passage. However, more recently, it has been determined that significant numbers of adult inland fish, in addition to eggs and larvae undertake large-scale downstream movements. It essential that fish are able to negotiate any barriers to downstream migrations, without delay or injury but unfortunately there are no prior studies that have attempted to quantify this.

Many weirs that were constructed in the early 1900's are currently being upgraded to more structures to comply with OH&S requirements and to minimise maintenance. Two major weir designs, undershot and overshot, are constructed on Australian waterways. Undershot weirs are usually operated via steel gates and water is released underneath the weir whilst overshot weirs are usually of concrete or wood constructed and water cascades over the weir crest. Research into optimising fish passage through these weirs will significantly enhance the management of inland species and promote their long-term sustainability.

NSW DPI recently undertook some small scale experiments, using Murray cod and golden perch larvae, on a low-level weir in an experimental channel and determined that undershot weirs caused the death of 95% (Golden perch) and 52% (Murray cod) larvae that passed under the weir. In contrast, mortality due to overshot weirs was only 1.5%. These results demonstrate potentially catastrophic effects of undershot weirs on native fish populations. This project subsequently aims to undertake further research in this area to determine if such mortalities are similar across different species and size classes of native fish.

Research Project Description

Project Title:

Establishment of a fish monitoring program for the Edward / Wakool / Niemur system
(Con2010/202)

Principal Investigator:

Dr Lee Baumgartner and Mr Ian Wooden

Funding Sources:

NSW Department of Primary Industries and the Murray Catchment Management Authority.

Objectives:

1. Establish a set of baseline monitoring sites to determine fish distributions across a range of macro-habitat types (main channel, anabranch/wetland, creeks/lakes).
2. Identify and monitor populations of threatened species and exotics.
3. Determine meso-habitat requirements of LBF after replenishment flows.
4. Determine movement corridors through the system for large-bodied species (golden perch and Murray cod, silver perch and carp).
5. Commence the establishment of a long-term monitoring system for LBF using acoustic technology.

Summary:

The Edward River, located in the South West Riverina region of NSW, is a large anabranch of the Murray River main channel. The river begins at Picnic Point, upstream of the Barmah choke, and travels northwest through a series of river red gum forests before discharging into the Wakool River downstream of Deniliquin. The system contains a large and varied system of creeks and channels including Yallakool Creek, Colligen Creek, Coobool Creek, Merran Creek and the Niemur River. These systems have abundant areas of fish habitat, and historically had diverse fish communities which supported both commercial and recreational fisheries.

Like many areas of the Murray-Darling Basin, the Edward anabranch system has greatly suffered from the effects of river regulation, migration barriers and degradation of water quality, exacerbated by the recent drought. These problems culminated in a large fish kill event in early 2008 which resulted in a loss of many hundreds of native fish, including large individuals of the iconic Murray cod. This event required the delivery of environmental water to help reduce stress on the system, which had moderate success.

The current project builds on an earlier project (<http://www.dpi.nsw.gov.au/research/areas/systems-research/aquatic-ecosystems/outputs/2009/1198>) to provide further data on the status of fish communities through the system. Specifically, there is a pressing need to gather information on:

- Species distribution throughout the system
- Areas of key fish habitat assets
- Fish migration corridors
- Important drought refuge habitat
- Important habitat during flow events
- Spawning habitat
- Larval settling and rearing habitat
- Juvenile rearing habitats

Improved understanding of these critical factors will allow the implementation of management strategies to both preserve fish during dry periods and to maximise the benefits of environmental watering events. This will help to ensure fish within the system do not experience further declines and to help provide the best opportunities for a system-wide recovery.

Research Project Description

Project title:

Effectiveness of stocking – Snowy River Bass
(Con2008/164)

Principal Investigator:

Dr Lee Baumgartner and Mr Leo Cameron

Funding Sources:

NSW Department of Primary Industries, the NSW Recreational Freshwater Fishing Trust Fund and the Southern Rivers Catchment Management Authority.

Objectives:

1. Determine the success of an Australian Bass re-introduction into the Snowy River.
2. Develop techniques for differentiating wild from stocked fish.
3. Assess how the stocked population interacts with wild fish communities.
4. Determine the rate at which Australian Bass disperse and migrate through the river system.

Summary:

The Snowy River is one of the great Australian natural icons. The river itself has featured in books and movies; and the Snowy Mountains Scheme (SMS) is one of the greatest engineering achievements that the country has ever undertaken. The SMS involved the construction of weirs and aqueducts in the upper Snowy catchment between 1955 and 1967. Since completion, the scheme has diverted a large proportion of flow from the Snowy River. The diversion of flows has led to dramatic changes to riverine habitats, flooding and the complete loss of seasonal flow variability. These changes have substantially affected the distribution and abundance of native fish in the system.

Australian Bass were once abundant in the Snowy River but have declined in recent years. It has been estimated that no successful spawning has occurred since 1988, although the declining population was helped with small stocking event in the late 1990's. Australian Bass are an important recreational species and it is planned to commence a stocking program to re-introduce the species into upland reaches of the Snowy River. The Southern Rivers Catchment Management Authority have arranged the production of 65,000 fish to be stocked into the Snowy River in November 2007 near Dalgety.

This re-stocking will be the first to occur into a reach where wild bass are not already present. It therefore represents an excellent opportunity to assess the success of a re-stocking program and gather data to guide future stocking events. NSW DPI will undertake a two year research study to assess the success of the stocking program. Staff will deploy electrofishing to determine the growth rate, survival and diets of the stocked fish.

Research Project Description

Project title:

Evaluating freshwater fish stocking and other freshwater recreational fishing activities in NSW
(Con2008/170)

Principal Investigator:

Dr Lee Baumgartner

Funding Sources:

NSW Department of Primary Industries and the NSW Recreational Freshwater Fishing Trust Fund.

[Note: this research includes a PhD project at the University of NSW]

Objectives:

This project team will conduct a series of experiments, field and survey work that will attempt to meet the following objectives:

1. Determine the need for re-stocking in certain areas.
2. Optimise stocking practices (i.e., optimal stocking sizes and methods).
3. Determine standing stock and recreational take in the Murrumbidgee River
4. Determine the effectiveness of size limits as a tool to manage Murray cod populations
5. Assess the relative impacts of different gear types on fish (i.e., line vs set-line vs lure fishing vs fly fishing etc.).
6. Help determine the population structure or key recreational species to ensure size and bag limits provide fish with a maximum chance to spawn before reaching a harvestable size

Summary:

Recreational fishing is a major industry in NSW and the sport is enjoyed by millions of people annually. NSW is home to many fisheries, some which are supported by wild recruitment and some which have been stocked for recreational purposes. These fisheries are strictly regulated by legislation that imposes restrictions to ensure species are harvested in a sustainable manner. Management interventions can include re-stocking programs, imposition of size and bag limits, restrictions on gear types, seasonal fishing closures and, in some instances, the closure of specific waterbodies.

Stocks of many commonly sought freshwater fish species in NSW were greatly reduced in the latter part of last century, and some previously angled species such as Macquarie perch and Trout cod are now listed as endangered. Efforts to rebuild numbers of these threatened species, and others such as Murray cod, bass and golden perch, have included seasonal closures, size & bag limits and stocking. It is important to understand what effects these measures have had so as to constantly improve the management of these valuable fish resources.

This project is a long-term attempt to address some key issues concerning the optimization of stocking practices, the quantification of recreational catch in some key locations and quantify the effectiveness of management controls, such as imposition of size limits. This project will perform targeted research in specific impoundments and rivers throughout NSW to determine the status of recreational fisheries. Tag-recapture studies and angler surveys will be used to assess recreational angler take on Murray cod in the Murrumbidgee River. Chemical marking will be used to assess the contribution of stocking to several fisheries in the Murray-Darling Basin. Researchers will also assess the Murray cod population in the Murrumbidgee and Murray River, before and after changes in size limits, to determine if fish sizes are increasing.

The proposed project seeks to establish and implement a long-term framework for performing specific research that will provide benefit to both recreational fishers and managers. The framework will involve a

combination of consultation and on-ground research to provide data to augment and support the development of suitable management strategies that will protect freshwater fisheries. It may also be used to test and potentially eliminate existing strategies that are inefficient at sustaining recreational fisheries.

Research Project Description

Project Title:

Development of fish passage technology to increase fisheries production on floodplains in the lower Mekong and Murray-Darling River basins system
(Con2010/208)

Principal Investigator:

Dr Lee Baumgartner

[Note: This is a collaborative project with the Living Aquatic Resources Research Centre in Laos]

Funding Sources:

NSW Department of Primary Industries, the Australian Centre Australian Centre for International Agricultural Research (project no. FIS/2009/041), the Living Aquatic Resources Research Centre (Laos), the National University of Laos, the World Wide Fund for Nature, the Wetlands Alliance and the Queensland Department of Employment, Economic Development & Innovation.

Objectives:

1. Analyse and prioritise water infrastructure barriers to lateral fish migrations between the Mekong River and floodplain habitat.
2. Research the effectiveness of low-cost fishways at floodplain barriers in the lower Mekong basin and Australia.
3. Quantify the ecological and socio-economic benefits of floodplain rehabilitation using fish passage technology.

Summary:

The Murray-Darling Basin and the Mekong are two of the world's major catchment systems. They drain similar catchment areas, are both over 4,000kms in total length and over 60 million people. Both systems contain unique endemic fish communities which provide importance sources of biodiversity, food security and recreational opportunities. The Murray-Darling Basin has an active recreational fishery estimated at between \$AUD750 – 1000 Million annually. More than 80% of rural households in the Mekong basin in Thailand, Lao and Cambodia are involved in a capture fishery which has a first-sale value of between US\$2,000 – 4,000 million per year. The lower Mekong basin provides an average 48% (Lao PDR) and 79% (Cambodia) of the total animal protein intake and the current annual production from the capture fishery in the lower Mekong basin is about two million tonnes, which is approximately 2% of the total world marine and freshwater catch.

Irrigation development in Australia and Laos has led to construction of numerous water regulation devices (over 10,000 in both countries) which limit migratory fish movement. Consequently, the fish cannot move between rivers and floodplains, and this has led to severe declines in fish production in many areas. Previous research in Australia and Laos has demonstrated that fish passage technology has the potential to enable movement of migratory fish past these low-level (less than 6 m) barriers. Consequently, fisheries agencies in both countries are interested in increasing capacity to design manage and operate fish passage facilities on new and existing low-level water control structures in order to ensure the long-term sustainability of fish resources in each country.

The overall aim of this project is to maintain food security, biodiversity and recreational opportunities for communities in the Lower Mekong and Murray-Darling Basin by rehabilitating fish communities through the construction of fishways. The team will specifically:

- Identify and prioritise water infrastructure that creates migration barriers to lateral fish migrations between the Mekong River and floodplain habitat;

- Research the effectiveness of low-cost fishways for widespread application at floodplain barriers in the lower Mekong basin;
- Quantify the biological, ecological and socio-economic benefits of floodplain rehabilitation using fish passage technology to increase awareness and uptake of low-cost mitigation measures.

Australia will benefit directly from this work as a project component aims to undertake a series of fishway trials within the Murray-Darling Basin (Year 3). These trials seek to develop a low-cost design that can be applied to sites of key conservation significance to help rehabilitate fish communities on a large scale. The project will be undertaken over five years and involve the establishment of collaborative links between research and management staff in Australia and Laos.

Research Project Description

Project Title:

Integrated monitoring of environmental flows (fish component)
(Con2000/022)

Principal Investigator:

Dr Craig Boys (with ongoing collaboration from Dr Ivor Grouns, NSW Office for Water)

Funding Sources:

NSW Department of Primary Industries and the NSW Office for Water

Objectives:

The broad objectives of the NSW Government's IMEF program are to:

1. Measure changes in the hydrology, habitats, biota and ecological processes relevant to fish communities, in the major regulated river systems (and the Barwon-Darling River) following the application of environmental flow rules.
2. As far as practical, to infer relationships between these changes and environmental flows, through statistical analysis and an understanding of ecosystem processes.
3. Provide scientific information needed for the River Flow Objectives review process.

The more specific objectives of the current years sampling (2011) are to compare post flood assemblages to drought assemblages in the Namoi and Gwydir Rivers to those collected from regulated river flows during drought years.

Summary:

The relationships between fish communities and river flows have not been clearly established, but river regulation has been implicated in the decline of many freshwater fish species in NSW. The Integrated Monitoring of Environmental Flows Project (IMEF) was established in 1999 to investigate the responses of fish communities (both larval and adult) to flow regimes in New South Wales rivers. To date researchers have found little improvement in native fish numbers in the regulated streams from environmental releases, even though there were significant benefits to in-stream habitat and overall riverine health. Researchers are now investigating whether the recent drought-breaking rains and subsequent natural inflows have spawned larger numbers of native fish in the Gwydir and Namoi River systems. This will involve comparing post-flood fish assemblages with those collected during the previous eight years of drought where environmental flows delivered from dams on these river systems were the only flow events to promote fish spawning and improve native habitat.

Research Project Description

Project Title:

Fish and crustacean communities in rehabilitated wetlands of the Hexham Swamp
(Con2004/081)

Principal Investigator:

Dr Craig Boys

Funding Sources:

NSW Department of Primary Industries and the Hunter Central Rivers Catchment Management Authority.

Objectives:

1. Quantitatively assess differences between fish and crustacean assemblages in Ironbark Creek and Hexham Swamp before and after the floodgates are opened within both short and long-term time frames.
2. Characterise the fish and crustacean communities and their spatial and temporal variability in the primary habitats within Hexham Swamp.

Summary:

Coastal floodplains and their associated wetlands are vital for the maintenance of estuarine and inshore fish populations. Many of the commercially and recreationally important species use a wide range of coastal wetland habitats during different stages in their lives. Protection and restoration of the widest possible range of wetland habitats is recognised as a very important fisheries management practice.

A primary threat to coastal floodplain wetland habitats and their associated fisheries in northern New South Wales and southern Queensland has been the proliferation of poorly designed and managed floodgate systems since the early 20th century. Floodgate structures have been designed for flood control purposes, primarily to allow effective drainage of flood waters from private properties into main river channels while preventing tidal river waters from regularly inundating agricultural land. Most of these structures only open during floods and have been generally left closed at all other times. Recent studies by NSW Fisheries have shown that unmanaged floodgates act as barriers to fish and prawns, particularly juveniles.

Hexham Swamp is located approximately 15km west of Newcastle CBD. The wetlands are a floodplain feature of the Hunter River. Ironbark Creek flows through the wetlands and is the major hydrological influence in the wetlands at present. Floodgates were installed at the mouth of Ironbark Creek in 1970/71 to protect the suburbs of Wallsend/Plattsburg from floods originating in the Hunter River. The installation of these floodgates has also allowed agricultural activities to be pursued in the wetland.

The floodgates have remained virtually closed since their construction thus allowing only limited tidal inflows, which has resulted in reduced salinities and the degradation of estuarine wetland communities. The large areas of mangrove and saltmarsh that existed in the wetland prior to floodgate installation have been lost, although small patches of degraded saltmarsh and mangroves occur in places. The dominant vegetation of the swamp is the common reed, *Phragmites australis*, which has formed large stands throughout the wetland.

The Hexham Project aims to restore tidal flushing to approximately 2000 hectares of the wetland, primarily to rehabilitate the mangrove and saltmarsh communities after 30 years of predominantly freshwater conditions. A range of agencies have commissioned to monitor vegetation, fauna, benthic macroinvertebrates, mosquitoes and water quality responses. NSW DPI is conducting a study to allow differences between fish and crustacean assemblages, before and after floodgate opening, to be discerned. A secondary objective is to develop a list of species of fish and crustaceans present in the Swamp. The study will include an assessment of pest species abundance, in addition to providing information on the recruitment of commercial and recreational species.

Research Project Description

Project title:

Bourke to Brewarrina fish monitoring
(Con2005/112)

Principal Investigator:

Dr Craig Boys

Funding Sources:

NSW Department of Primary Industries, the Western Catchment Management Authority and the Murray Darling Basin Authority.

Objectives:

1. Implement a study which monitors meso-scale distributional changes in the fish assemblage before and after resnagging.
2. Assess the effectiveness of a partial-width rock ramp fishway at Brewarrina for passing native fish of various species and size classes.

Summary:

Restoring freshwater habitats to a standard that enhances native fish populations and other riverine ecosystem functions is a major part of fisheries management within NSW. 'Demonstration reaches' are being established throughout the State to showcase to the community the cumulative benefits of applying a number of rehabilitation interventions simultaneously, such as the provision for fish passage, re-snagging and management of alien species.

Following an earlier assessment of habitat condition and fish populations in the Darling River (http://www.fisheries.nsw.gov.au/science/scientific_outputs/aquatic-ecosystems/boys_-_fish_habitat_605), NSW DPI is currently rehabilitating river habitats in the Darling River within the scope of a demonstration reach between Bourke and Brewarrina. The works involve re-snagging large sections of river, fencing off and protecting riparian zones, managing carp numbers and constructing a fishway on Brewarrina Weir. It is envisaged that these works will increase opportunities for fish migration, improve water quality and provide structural habitat for native fish.

River rehabilitation is a relatively new science and this restricts our ability to accurately predict ecological responses to rehabilitation works. Detailed monitoring and assessment is therefore desirable to ensure that the works have achieved their anticipated outcomes. To that end, NSW DPI is undertaking a 3-4 year study to monitor the responses of fish to the re-introduction of in-channel snags within the demonstration reach and to the construction of a fishway on Brewarrina Weir. The monitoring program will incorporate 'before' and 'after' sampling at 'treatment' sites (degraded places where habitat restoration will be done), 'control' sites (similar to treatment sites but with no rehabilitation) and 'reference' sites (existing places which already have good quality habitat) to measure any changes in the fish assemblage in response to these works.

Research Project Description

Coastal River Rehabilitation Monitoring and Evaluation
(Con2007/146)

Principal Investigator:

Dr Craig Boys

Funding Sources:

NSW Department of Primary Industries, the Southern Rivers Catchment Management Authority and the University of Queensland.

[Note: The second component of this project is being done in collaboration with the NSW Department of Primary Industries' Conservation Assessment Unit and the University of Queensland]

Objectives:

3. Document the passage of fish (upstream and downstream) through a full-width rock ramp fishway and a double box culvert.
4. Document potential operational problems with these structures and suggest improvements to future designs.
5. Document the change in the wetland fish assemblage associated with the managed opening and eventual removal of floodgates at Yarrahapinni Broadwater.
6. Document the change in wetland water quality parameters associated with the managed opening and eventual removal of floodgates at Yarrahapinni Broadwater.
7. Determine the effect of body size and water temperature on the maximal sustainable swimming performances of focal NSW coastal fish species.

Summary:

Restoring freshwater habitats to levels that enhance native fish populations and the riverine ecosystems which they are part of is a major part of fisheries management within NSW. River rehabilitation is a relatively new science, however, and this restricts our ability to predict ecological responses to rehabilitation works. It is therefore vital that the opportunity is taken to rigorously monitor and assess any environmental works program to ensure that the works have achieved their anticipated outcomes. NSW DPI is currently undertaking a significant number of rehabilitation activities in coastal rivers to address key threats to native fish stocks brought about by human activities in coastal floodplain rivers, such as the construction of instream structures such as weirs, road crossings and floodgates.

This research project has two components. The first component, completed in 2010, evaluated the operational success of three common types of coastal river rehabilitation works and made recommendations on potential design improvements. The three types of rehabilitation works evaluated were:

1. The construction of a full-width rock ramp fishway on Stroud weir;
2. The construction of a double box culvert on the Buckenbowra River; and
3. The removal of floodgates at Yarrahapinni Broadwater.

The report on this component – 'Case studies in restoring connectivity of coastal aquatic habitats: floodgates, box culvert and rock-ramp fishway' by Craig Boys *et al.* (2011) – is available at: <http://www.dpi.nsw.gov.au/research/areas/aquatic-ecosystems/outputs/2011>

The second component involves an examination of the effect of body size and water temperature on the maximal sustainable swimming performances of seven NSW coastal fish species (Empire gudgeon, Striped gudgeon, Freshwater mullet, Duboulay's rainbowfish, Firetail gudgeon, Southern blue-eye and Western carp gudgeon). It will be done as an Honours project at the University of Queensland under the supervision of Dr Craig Franklin. The effect of acute and seasonal (acclimatisation) changes in temperature will be examined, as well as assessing the impact of elevated water temperatures as predicted by climate change models for river systems in NSW. The assessment of the maximum sustainable swimming performance of

fish will be used to infer and model the capabilities of fish to swim against currents and navigate through passage-ways.

Research Project Description

Project title:

Development and assessment of remedial measures to decrease loss of fish to irrigation offtakes
(Con2008/163)

Principal Investigator:

Dr Craig Boys

Funding Sources:

NSW Department of Primary Industries, the Murray-Darling Basin Authority and the Cotton Cooperative Research Centre.

Objectives:

1. Complete an updated national and international literature review of approaches to mitigating the loss of fish through irrigation systems.
2. Document the range of existing technologies available internationally for reducing the loss of fish through irrigation pumps and assess their potential for adaptation to Australian conditions.
3. Refine a list of (up to three) potential pump modifications suitable for use in the Murray-Darling Basin in conjunction with irrigation industry stakeholders and landholders from within the study reach.
4. Construct/purchase and install these selected modified pump options at selected sites within the Barwon-Darling and Namoi Rivers.
5. Assess the effectiveness of different pump modifications (treatments) at reducing the loss of native fish over two irrigation seasons.
6. Complete a draft and final report summarising the findings of the study and providing recommendations for the future development of irrigation pump modifications.

Summary:

The Murray-Darling Basin is Australia's largest catchment covering over one million square kilometres and draining water from five separate states and territories. Despite receiving little water, the Murray-Darling Basin supports at least 40% of Australia's agricultural production, a population of over 2 million people and is one of Australia's most important natural resources. Such a degree of development has led irrigation to be the largest user of water in the Murray-Darling Basin.

In northern reaches of the Murray-Darling Basin direct pumping from main river channels is known to extract up to 200 fish per day from main river systems. Fish extracted into pump systems were either killed or injured during passage and any fish which survived received few opportunities to return to the source river because most irrigation systems are terminal. A study recently completed by NSW DPI identified several management actions could help to reduce these impacts on fish which include:

- Altering the operations of irrigation systems during periods of expected fish entrainment.
- Constructing screening mechanisms to prevent or reduce the potential for extraction.
- Providing engineering solutions to enable extracted fish to be returned to main river systems.

NSW DPI is commencing a project to advance the development of screening technology to improve the intakes of pump systems for fish. The MDBA are currently funding a three year study where scientists will design, construct and install a series of screens at pump sites at selected pumps on the Barwon-Darling and Namoi Rivers. Researchers will perform a study to determine if the number of fish entrained is actually reduced by the presence of the screening mechanisms. If successful, the project will have wide application to pump systems throughout the Northern reaches of the Murray-Darling Basin.

Research Project Description

Project title:

Monitoring and evaluation of NSW demonstration reaches
(Con2008/177)

Principal Investigator:

Dr Craig Boys

Funding Sources:

NSW Department of Primary Industries, the Murray Darling Basin Commission, the Western Catchment Management Authority and the Natural Heritage Trust (NHT2) via the Namoi Catchment Management Authority

[Note: This is a collaborative project with the NSW Department of Primary Industries' Conservation Assessment Unit]

Objectives:

Monitor fish responses to rehabilitation activities within demonstration reaches.

Summary:

Restoring freshwater habitats to a standard that enhances native fish populations and other riverine ecosystem functions is a major part of fisheries management within NSW. 'Demonstration reaches' are being established throughout the State to showcase river rehabilitation to the community, involving actions such as the provision for fish passage, re-snagging and management of alien species.

An integral part of effective rehabilitation at demonstration reaches is being able to monitor and evaluate ecological outcomes. Unfortunately, such monitoring has been inconsistently applied in the past. Because of this, NSW DPI in conjunction with other State partners within the Murray-Darling Basin, have recently devised a scientifically-robust and cost-effective framework for monitoring at demonstration reaches (the report is free for download in full from the MDBC website: <http://publication.mdbc.gov.au/>).

This new research project will apply this monitoring and evaluation plan to NSW Demonstration reaches, picking up the monitoring currently being applied in the Bourke to Brewarrina demonstration reach and scoping the potential for a monitoring program associated with the Namoi River demonstration reach. If these programs are deemed to be successful, demonstration reaches and associated monitoring programs may be extended to other catchments throughout NSW.

Research Project Description

Project Title:

Lower Cockburn River Catfish Survey
(Con2010/214)

Principal Investigator:

Dr Craig Boys
[Note: This is a collaborative project with the NSW Office of Water]

Funding Sources:

NSW Department of Primary Industries, the Namoi Catchment Management Authority and the NSW Office of Water.

Objectives:

1. Investigate the age-class structure of local populations within refuge pools of the lower Cockburn and compare condition to that obtained from State-wide surveys.
2. Associate any between-pool differences in age-class structure with habitat quality and quantity and water extraction pressure.

Summary:

The Murray-Darling Basin population of freshwater catfish (or eel tailed) catfish (*Tandanus tandanus*) was gazetted as an endangered population within NSW waters in July 2009. Records show that the eel tailed catfish were once widespread in the western rivers of NSW, being one of the most abundant species in western waters. However, there has been a significant and rapid decline within the Murray-Darling Basin. One cause of this decline is believed to be reduced spawning and recruitment success due to alterations to flow patterns and flooding regimes.

Breeding pairs of catfish form a nest during the summer months and the males remain with the nest to tend to the eggs. These nests are often in shallow water (less than 1m depth) and as such, alterations in water level can affect nest establishment and subsequent breeding success. In particular, sudden short term drops in water level can expose nests, which are subsequently abandoned, and frequent fluctuations of water levels can result in no spawning events taking place.

Concerns have been expressed by some members of the recreational angling community within Tamworth that catfish may be abandoning their nests within the Lower Cockburn River as a result of water extraction from nearby groundwater sources during Summer. The groundwater aquifers on the floodplain are highly connected to the surface water pools within the Cockburn River. Although these reports remain anecdotal, they suggest that any proposed changes to the Water Sharing Plan for the Peel River Valley and nearby groundwater may have the potential to exacerbate localised impacts on catfish populations.

NSW DPI are currently undertaking fish and habitat surveys on behalf of the Namoi Catchment Management Authority to determine whether freshwater catfish have been successfully recruiting to populations in the lower Cockburn River in recent years. The results will be of direct benefit to threatened species researchers and managers within NSW, contributing to our knowledge of the abundance, distribution and habitat use of catfish.

Research Project Description

Project Title:

Defining criteria for fish friendly mini-hydro: Phase 1 capacity building
(Con2011/221)

Principal Investigator:

Dr Craig Boys

Funding Sources:

NSW Department of Primary Industries and Waratah Power Pty Ltd.

Objectives:

This project is the critical first step in developing the expertise, methodologies and facilities necessary to assess the performance of the SLH in relation to existing instream weir structures and to clarify the consent requirements to progress the development of mini-hydro technologies in accordance with Fisheries Management and NSW. Specific outputs arising from this project will be:

1. An expert panel workshop to develop project methodology, facilities and reach consensus of the process and data required to develop bio-design criteria for mini-hydro in NSW and to inform the consent process.
2. Construction and supply of specific engineering-designed items required to determine tolerances to fish. These include barotrauma facilities and shear manipulation flumes.
3. Modelled Computational Fluid Dynamics (CFD) estimates of shear and pressure through the SLH200 (sufficient size for Hay Weir).
4. Modelled CFD estimates of shear and pressure through Hay Weir.
5. Data on shear and pressure profiles through Hay Weir as measured with Sensorfish.
6. Experimental design developed for laboratory barotrauma and sheer experiments (Phase 2) for determining critical thresholds of injury and mortality of multiple species of native fish at different life history stages (eggs, larvae and young of year).
7. A discussion paper specifying practical ways of estimating significance of blade strike for a fisheries management approvals perspective;
8. A report summarising all the previous results and outlining a fully costed research plan for proceeding to Phase 2 and Phase 3 (*in situ* testing of a SLH unit at Hay Weir).

Summary:

In response to State and Federal Renewable Energy Targets, significant water reform and the subsequent restructuring of industries in regional centres, a mini-hydro market is emerging and private companies and irrigation agencies throughout south-eastern Australia are prioritising investment into new technologies and exploring how existing irrigation supply networks can be used to support new economies beyond water delivery for agricultural purposes.

Although a large amount of work has been done recently on quantifying the survival of downstream migrating fish through hydro-power plants, all of this research involves foreign fish species, including juvenile salmon moving through high-head turbine facilities. No data currently exists for Australian species which may have different physiology and migratory needs, and furthermore newer low-head turbine technologies have not been assessed. There has been some work done by NSW DPI&F scientists to understand the impacts of existing weir structures on Australian fish species, which forms the existing body of evidence suggesting potential adverse effects of weirs on Australian fish species. But there is no information of the mechanisms responsible injury and mortality, such as pressure change, turbulence, physical strike, or a combination of all of these. Until these knowledge gaps regarding potential 'baseline' environmental impacts at existing structures and the performance of innovative technologies are resolved, the informed management of an emerging mini-hydro industry in NSW (and Australia) that ensures aquatic ecosystems are protected cannot occur.

This project is the critical first step in developing the expertise, methodologies and facilities necessary to assess the performance of min-hydro technologies in relation to existing instream weir structures and to clarify the consent requirements to progress the development of mini-hydro technologies in accordance with Fisheries Management in NSW.

Research Project Description

Project Title:

Habitat utilisation, movement and distribution information required for a plan to control banded grunter, a noxious pest fish, in the Clarence River
(Con2006/128)

Principal Investigator:

Dr Gavin Butler

Funding Sources:

NSW Department of Primary Industries and the NSW Recreational Fishing Trust.

Objectives:

1. Determine whether banded grunter from throughout their range in the Clarence River aggregate to spawn at specific sites during the spring and summer, making them more susceptible to capture and control.
2. Determine details of habitat use during the spawning season, allowing the development of more efficient capture and control techniques.
3. Determine the extent of their seasonal movement patterns and distribution in the upper Clarence River to further assess the potential environmental damage caused by this noxious species.
4. Develop a plan for controlling the banded grunter population in the Clarence River, based on resulting biological and demographic information.

Summary:

The Clarence River, on the far north coast of NSW, is the largest coastal river system in the state. The river supports large recreational fisheries for species such as Australian bass, catfish, bream and garfish. It also supports unique fish communities, with endangered fish species such as eastern freshwater cod and Oxleyan pygmy perch. Unfortunately a number of exotic species including goldfish, silver perch, golden perch, gambusia and banded grunter have been introduced into the river system. Often the effect of introducing exotic species can be devastating for local fish stocks through the impacts of predation; aggressive competition for food, shelter and spawning grounds; habitat degradation or the introduction of disease. These introduced species have the potential to reduce populations of endemic species and degrade recreational fisheries and commercial fisheries in the Clarence River. In particular, the recently introduced banded grunter (*Amniataba percooides*) is a major threat to the recreational fish and their food sources in the Clarence River system. The banded grunter is a hardy and aggressive perch-like fish that reproduces and disperses rapidly over large distances to a wide range of habitats. It has little value as either a sport or food fish and has been declared a noxious pest species outside of its natural range of northern Australia.

Preliminary studies have revealed that banded grunter have invaded an extensive area of the Clarence River system between Grafton and the Gorge, a very popular hook and release fishing area for Australian bass. These studies also indicate that the species has been successfully reproducing in the Clarence River for at least five consecutive years by aggregating in an area near Copmanhurst during the summer before dispersing to a much wider geographic distribution during the rest of the year. The aim of the current study is to tag large, adult fish at the spawning grounds with acoustic transmitter tags during the summer, then track them during the following year in order to determine the extent of their distribution in the river system and how they utilise different habitats during different seasons. This information will help to formulate a management plan to control the banded grunter population before it impacts significantly on recreational and commercial fisheries or populations of threatened fish species in the Clarence River.

Research Project Description

Project Title:

An assessment of Murray cod, fish communities and the effects of stocking in the Border Rivers region of the Murray-Darling River System
(Con2009/188)

Principal Investigator:

Dr Gavin Butler

Funding Sources:

NSW Department of Primary Industries, the NSW Recreational Freshwater Fishing Trust Fund and the Border Rivers Catchment Management Authority.

Objectives:

1. Describe the fish communities in the Dumaresq, Gwydir and Macintyre rivers.
2. Determine the age and growth, reproduction, dietary habits and population structure of Murray cod in the Dumaresq, Gwydir, and Macintyre rivers.
3. Determine the movement patterns of large-bodied fish species (Murray cod, golden perch, eel-tailed catfish, silver perch) in the Dumaresq River, and associated rivers.
4. Determine the survival of golden perch fingerlings stocked in the Dumaresq River.

Summary:

Restocking of freshwater fish is a major conservation and enhancement tool used by Fisheries agencies throughout Australia. Within NSW, large numbers of native fish have been stocked into rivers and impounded waters over the last 30 years. However, there have been few studies of the impacts that these stockings on local fish communities. Like most areas, large numbers of fish have been stocked in many of the rivers throughout the Border Rivers region of the Murray-Darling River System in north-western NSW. These rivers include the Dumaresq, Gwydir and Macintyre. In most cases the majority of these stockings have been successful, but there is growing concern that overstocking of some species, especially Murray cod may be having a detrimental effect on the overall fish communities in some areas. These effects include apparent slow growth and stunting of some Murray cod, and the lack of other native species such as golden perch, bony herring and silver perch. The aim of this project is to examine and quantify some of these potential impacts, ultimately leading to improved management of Murray cod and fish stocking practices throughout NSW.

Research Project Description

Project Title:

Survey and control of new pest fish
(Con2002/055)

Principal Investigator:

Dr Bob Creese

Funding Sources:

NSW Department of Primary Industries.

Objectives:

1. Survey newly reported pest fish species in order to describe their abundance and distribution and assess their potential environmental threat to NSW aquatic and marine environments.
2. Develop and evaluate suitable control procedures for new pest fish species in order to limit or remove the environmental threats posed by them, and improve the health and diversity of NSW aquatic and marine environments.

Summary:

The Survey and Control of New Pest Fish project aims to limit the increasing environmental threat posed by invasive pest fish species in NSW waters.

Pest fish species with established populations, such as carp (*Cyprinus carpio*), are known to severely damage native fish populations through processes such as competition and predation. Large and specific research projects, often with external funding, have (or will be) developed for these established pests.

This project targets newly reported pest species, that are likely to have very limited spatial distributions. For example, in March, 2002 the speckled mosquitofish (*Phalloceros caudimaculatus*) was recorded for the first time in NSW. In response to the environmental threat posed by this new pest species, an action plan was developed to survey and control the species.

In June, 2002 fish surveys revealed that the species was restricted to a series of ponds at Long Reef Golf Course in Sydney's northern suburb of Collaroy. However, at this site it was very abundant and appeared to have displaced the well-known pest species, *Gambusia holbrooki*. Given the restricted distribution of the speckled mosquitofish, an attempt to eradicate the species from NSW was made in August, 2002 using the fish poison Rotenone.

This trial will be monitored on a regular basis to check if there has been a substantial reduction in the abundance of speckled mosquitofish at Collaroy, and further eradication trials conducted if necessary. Surveys of other waterways in the vicinity will also be done in the future to check for the possible spread of this species from the current location.

Another situation arose in 2004 when several thousand Jack Dempsey cichlids, another common aquarium species which is renowned as a voracious predator, were found in a disused quarry at Angourie on the NSW north coast. A trial eradication in September 2004 using explosives successfully reduced their numbers dramatically. Again, follow-up surveys will be done and additional action taken to ensure that this potentially harmful species does not get established in NSW.

Reports of other such small, 'aquarium' fish becoming established in natural waterways will be rapidly investigated using the protocols established for the speckled mosquitofish and Jack Dempsey situations.

Research Project Description

Project Title:

Trophic associations between invertebrates and fish in coastal saltmarshes
(Con2004/101)

Principal Investigator:

Dr Bob Creese

[Note: this project is being undertaken as a PhD at the University of Newcastle with co-supervisors from NSW Department of Primary Industries and the Department of Environment, Climate Change & Water]

Funding Sources:

NSW Department of Primary Industries, the Australian Research Council (Linkage Project No. LP0561754), the University of Newcastle, the Department of Environment, Climate Change & Water, the Australian Nuclear Science & Technology Organisation (ANSTO) and the Australian Catholic University.

Objectives:

1. Characterise additional saltmarsh communities in terms of fish habitat, macrobenthic fauna and benthic and zooplankton production.
2. Use stable (& radioactive) isotope analyses to determine the trophic associations between saltmarsh and macrobenthic invertebrates and their larvae.
3. Use gut content analysis to determine the trophic associations between saltmarsh and itinerant fish.
4. Determine associations between the presence of saltmarsh and fish utilisation of adjacent mangrove.

Summary:

In collaboration with Newcastle University and the Australian Nuclear and Science and Technology Organisation, NSW Department of Primary Industries will undertake research to assist in the conservation of saltmarsh vegetation in NSW. The project will build on previous collaboration between the Australian Catholic University and NSW Department of Primary Industries in which various methods were used to assess the estuarine fish and invertebrates living in and associated with saltmarsh. As saltmarsh is listed as an Endangered Ecological Community under the *Threatened Species Act*, it is particularly important to provide a scientific basis for possible actions under the recovery plan, such as the removal of exotic weeds like *Juncus acutis* and limiting access to vehicles.

The current study will extend the scope of previous investigations to encompass more of the NSW coast to examine the generality of the ecological processes and interactions identified previously. It will also differentiate between saltmarsh communities existing as isolated vegetation and those occurring in association with mangroves. Traditional studies of fish diets rely on visual identification of items in their guts, but this is often difficult if most material is wholly or completely digested. This new study will use additional novel approaches involving stable isotopes and radioactive markers to determine the food web interactions between fish and other members of the saltmarsh fauna (e.g., crab larvae) and flora (e.g., plant detritus). The project will provide coastal resource managers with quantifiable indicators of the relative significance of different saltmarsh communities to estuarine fisheries.

Research Project Description

Project title:

Macquarie perch distribution and recovery research
(Con2006/134)

Principal Investigators:

Dr Bob Creese

Funding Sources:

NSW Department of Primary Industries, the Hawkesbury-Nepean Catchment Management Authority, and the NSW Department of Environment, Climate Change & Water.

Objectives:

1. Document the distribution of extant populations of Macquarie perch and, if possible, Adams Emerald dragonflies.
2. Quantify the habitat, water quality and sediment characteristics at sites where remnant populations are found.
3. Characterise the habitat requirements of Macquarie perch (and the dragonfly if possible) and hence assist the recovery plan for these threatened species.
4. Prioritise sites and/or actions so government agencies can better target their investment in habitat protection and/or rehabilitation.
5. Monitor the success of Macquarie perch habitat rehabilitation works.
6. Investigate methods for controlling the impacts of redfin perch on Macquarie perch.

Summary:

Macquarie perch is a small to moderate sized, freshwater fish native to the cooler middle-upper reaches of the Murray-Darling basin and several eastern coastal streams including the Hawkesbury-Nepean and Shoalhaven River systems. The species is listed as 'endangered' under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*, the ACT *Nature Conservation Act 1980*, and by the Australian Society for Fish Biology. It is also listed as 'data deficient' by the World Conservation Union (IUCN), as 'threatened' under the Victorian *Flora and Fauna Guarantee Act 1988* and as 'vulnerable' under the *NSW Fisheries Management Act 1994*. The NSW Fisheries Scientific Committee recently made a proposal to upgrade the status of Macquarie perch under the NSW act to 'endangered'. Processes threatening Macquarie perch populations include habitat degradation (erosion leading to siltation of spawning sites, removal of snags, alteration of river flows, barriers to fish migration, water extraction), reduced water quality and altered water temperatures, overfishing, interactions with introduced species, and disease.

This project, supported by funding from the Hawkesbury-Nepean Catchment Management Authority, involves backpack electrofishing surveys of all subcatchments of the Hawkesbury-Nepean and Georges river systems that are likely to support remnant populations of Macquarie perch. Many of the sites are very remote within the Blue Mountains National Park, so sampling crews will have to be winched from helicopters into some of the more inaccessible locations. The major water storage dams in these systems (Warragamba, Avon, Nepean, Cataract, Cordeaux and Woronora) will also be sampled using boat electrofishing. In addition to distribution & abundance data, information on habitat requirements, the availability of suitable habitat and the threats posed by things such as pest fish (e.g., redfin) and sediment influx following land-clearing or bushfires will also be collected. Some of the areas where Macquarie perch may occur in these systems are considered suitable habitat for another threatened species (the Adams Emerald Dragonfly). Very little is known about this species, so field opportunities will be used to collect larval dragonflies for identification by Museum and other specialist insect taxonomists.

The information collected will be used to assist the Hawkesbury-Nepean Catchment Management Authority in prioritising areas for future on-ground, habitat improvement work. It will also assist NSW DPI in finalising a recovery plan for this iconic but threatened fish species.

The project also undertakes broader surveys for remnant populations of Macquarie perch in coastal catchments based on new or historical sightings of the species. Macquarie perch have recently been recorded from the Georges River, south of Sydney in 2006 and from Little Wheeny Creek, north-west of Sydney in 2007. Surveys are required to determine the distribution, abundance and conservation status of Macquarie perch within these areas. Surveys are also needed to ascertain if Macquarie perch still exist in the Shoalhaven River and may also be required elsewhere in the event that additional new sightings for the species are reported in the future.

To assist in the conservation and recovery of Macquarie perch, degraded sections of streams inhabited by this species will be identified during the surveys and investigated to determine the feasibility of undertaking habitat remediation works to encourage re-establishment of populations. Rehabilitation works will be undertaken in the degraded streams in collaboration with local community groups. Fish surveys will be undertaken to monitor the success of any Macquarie perch habitat rehabilitation works undertaken (e.g., by Catchment Management Authorities). As there is a paucity of such information available, the knowledge gained through monitoring the affect of the rehabilitation works on the Macquarie perch population will help guide future rehabilitation projects of this species and other threatened aquatic fauna.

To further assist recovery efforts, methods for controlling the impacts of alien (i.e., introduced from overseas) redfin perch on Macquarie perch will be investigated. The Hawkesbury-Nepean Catchment Management Authority has funded a study aimed at determining the feasibility of installing an exclusion device (e.g., an instream barrier such as a weir) to prevent redfin invading Macquarie perch habitat within the feeder tributaries of Warragamba Dam. The study involves a review of the exclusion devices available for preventing the upstream dispersal of redfin; an 'on-ground' assessment of the relative suitability of drainage systems supporting Macquarie perch for the installation of an exclusion device; and an analysis of the potential impacts of an exclusion device on the local fish populations. Approvals required to construct and install an exclusion device in the most appropriate location will also be determined.

Research Project Description

Project Title:

Fish assemblage response to new fishways on the Parramatta River
(Con2010/218)

Principal Investigator:

Dr Bob Creese & Mr Andrew Bruce

Funding Sources:

NSW Department of Primary Industries and Cardno Ecology Lab (for Parramatta City Council).

Objectives:

1. Conduct electrofishing surveys before and after installation of fishways.
2. Provide data to Cardno Ecology Lab.

Summary:

Connectivity between riverine and estuarine is vitally important to the ecological functioning of coastal floodplain streams and estuaries. Many fish species inhabit a broad range of freshwater and estuarine habitats throughout their life and need to be able to migrate freely between these habitats. These migrations, whether for spawning, dispersal of juveniles from nursery grounds or movement of fish between habitats, maintain gene-flow and support ecological processes essential in maintaining the integrity and resilience of native fish assemblages.

Restoring freshwater habitats to levels that enhance native fish populations and the riverine ecosystems which they are part of is a major part of fisheries management in NSW. River rehabilitation is a relatively new science, however, and this limits the ability to predict ecological responses to any remediation works. Wherever possible, the opportunity should be taken to monitor and assess any environmental works project to investigate whether it has achieved its anticipated outcomes. The NSW government, Catchment Management Authorities and Local Councils are currently undertaking a significant number of rehabilitation activities to address key threats to native fish stocks in coastal floodplain rivers, such as the presence as weirs, road crossings and floodgates. Where weirs can't be removed, connectivity can often be restored by constructing fishways.

This 2 year project will evaluate the operational success of new fishways installed on 4 weirs on the upper Parramatta River in 2009-2010. Regular sampling of the fish assemblage at sites upstream and downstream of these former barriers will enable an assessment of whether the new fishways have improved the opportunities for migrating fish to move freely up and down this section of the Parramatta River.

Research Project Description

Project Title:

Developing estuarine indicators for Natural Resource Monitoring in NSW
(Con2007/149)

Principal Investigator:

Dr Bob Creese

Funding Sources:

NSW Department of Primary Industries and the Joint Steering Committee for the Natural Heritage Trust Strategic Reserve Fund.

[Note: This project is part of the government's Monitoring, Evaluation & Reporting (MER) Strategy]

Objectives:

1. Development and application of appropriate remote sensing technology to allow a state-wide assessment of the extent of major aquatic habitats in estuaries.
2. Development of an 'estuarine condition index' based on a combination of general (fish, vegetation condition) and targeted (chlorophyll a and macroalgae) indicators derived from preliminary data collection from up to 20 estuaries, representing a gradient of potential human impact.

Summary:

In 2005, the NSW Government endorsed 13 state-wide targets for Natural Resource Management (NRM) in NSW. Catchment Management Authorities (CMAs) are also required to incorporate consistent catchment targets into their Catchment Action Plans. CMAs are the primary avenue for delivering funding from the NSW and Commonwealth Governments to help managers improve and restore the natural resources of the state. The NRM targets seek to implement cost-effective management initiatives that are focused on government priorities (as articulated in the State Plan, <http://www.nsw.gov.au/stateplan/>). By monitoring progress towards these targets, CMAs and other government agencies can adjust their management to ensure that the targets are achieved.

The Monitoring, Evaluation and Reporting (MER) system that supports this approach relies on comprehensive monitoring programs to determine trends in the condition of the state's natural resources. Resource condition monitoring relies on measuring a natural resource 'indicator' through time using a rigorous and consistent sampling methodology. This monitoring shows whether the overall health of the resource is changing, and hence whether NRM targets are being met. Separate studies can then be done to explain what caused any observed changes.

'Estuaries and Coastal Lakes' is one of the 13 NRM themes that form MER. Monitoring for this theme will use at least 5 indicators, 2 of which will be measured and reported on by NSW DPI: 'Extent of mangroves, saltmarsh and seagrass' and 'Status of estuarine fish assemblages'. This 14-month project will develop the methodology to be used in monitoring these two indicators on a regular basis from 2008 onwards. For estuarine macrophytes, this will involve trialling remote sensing techniques (such as satellite images) to examine their reliability compared to current, labour-intensive methodology (visual interpretation and digitization of aerial photographs followed by detailed checking in the field). For fish, it will involve testing different combinations of sampling gears (beam trawls, gill nets and seine nets) and associated analytical techniques to determine the most efficient way of characterizing fish assemblages in estuaries and hence of being able to detect changes into the future.

Research Project Description

Project Title:

Baseline aquatic condition for the Hawkesbury-Nepean River
(Con2007/155)

Principal Investigator:

Dr Bob Creese

Funding Sources:

NSW Department of Primary Industries, the Department of Environment & Climate Change and the Hawkesbury-Nepean Catchment Management Authority.

Objectives:

1. Document the spatial extent of freshwater plant species.
2. Compare the present extent of these species to any historical data.
3. Document the composition of the freshwater fish community.
4. Compare the present composition to any historical data.
5. Provide input into the design of a long-term monitoring program incorporating freshwater plants and fish as 2 key indicators.

Summary:

The *2006 Metropolitan Water Plan* proposes a range of initiatives designed to improve both water supply and river health in the Hawkesbury-Nepean system. The Plan committed the NSW Government to developing an integrated monitoring program for the Hawkesbury-Nepean River that would provide information on river health, the outcomes of environmental flows and recycling initiatives. This program will build on previous monitoring work and provide an information base for adaptive management as the Metropolitan Water Plan is carried out. The Hawkesbury Nepean River Environmental Monitoring Program is being coordinated by the NSW Department of Environment & Climate Change. It will provide broad surveillance monitoring of the condition of the river system downstream of the major water storages. It will monitor the cumulative effects of management action and changes in the catchment over time. In the first instance, specific targeted studies have been devised to give more definitive information on cause/effect relationships of specific initiatives including environmental flows and the replacement flows project.

The composition of freshwater fish assemblages and the extent and type of in-stream aquatic plants were selected as the two key biological indicators for the Hawkesbury Nepean River Environmental Monitoring Program. In order to provide a baseline condition for these two indicators and to design an ongoing monitoring framework, new data will be collected by NSW DPI for the stretch of the Hawkesbury River between Wisemans Ferry and Warragamba Dam, for South and Eastern Creeks, and for the upper Nepean River up to the junction with the Cataract River. Aquatic plants will be mapped by visual inspection along both banks supplemented where necessary by video footage. Fish assemblages will be determined by sampling using electrofishing and bait traps at 15 pre-determined sites. Comparisons of these data with previously collected information on these two indicators will assist in the monitoring framework.

Research Project Description

Project Title:

Paralytic shellfish poisoning – A molecular genetic probe for fast, accurate detection
(Aqu2006/0747)

Principal Investigator:

Dr Wayne O'Connor and **Dr Bob Creese**

[Note: This is a collaborative project which is being led by Prof. Brett Neilan at the University of New South Wales

Funding Sources:

NSW Department of Primary Industries, the University of New South Wales, the University of Tasmania, the Primary Industries and Resources South Australia, the NSW Food Authority and the Tasmanian Department of Health & Human Services.

Objectives:

1. Characterise and sequence the genes that code for enzymes involved in the synthesis of saxitoxin (STX) in paralytic shellfish poisoning-producing eukaryotes.
2. Develop DNA probes for rapid, sensitive quantification of major Australian STX-producing organisms and STX gene expression in phytoplankton samples and shellfish tissues.

Summary:

Paralytic Shellfish Poisoning is one of several syndromes associated with the accumulation of toxins from phytoplankton (algae) in marine and freshwaters. Saxitoxin, the causative agent of paralytic shellfish poisoning, is an environmental toxin with significant economic, environmental and human health impacts. PSP has led to human paralysis and death, and to the deaths of livestock, fish and other marine organisms, following particular algal blooms. Phytoplankton monitoring for PSP is currently conducted in most states as part of the newly implemented Australian Marine Biotoxin Management Plan.

Saxitoxin is produced by a range of algal species, some of which are very similar in appearance. In NSW coastal waters, species of *Alexandrium* are the main saxitoxin producers, but some species have never been reported as toxic. The challenge is to produce a test that does not require the algal species to be identified.

A recent breakthrough in the laboratory is the discovery of genes with a role in saxitoxin biosynthesis in cyanobacterial species. The synthesis of saxitoxin is a highly complex and unusual pathway, and it is likely to be relatively similar in all organisms. It is highly likely that the identification of one gene in a dinoflagellate will lead to the successful identification of further genes. The identification of the genes for the toxin, rather than a particular organism, will allow for the simultaneous identification of all toxic PSP species in one assay.

This type of molecular probe based identification will remove confusion over species that are similar in appearance and will detect new species not previously known to produce PSP. Further, the test can be conducted in a matter of hours, rather than days. In New Zealand, where molecular probe methods have been used in monitoring since 1998, their introduction into monitoring programs has led to a decrease in closures of harvesting areas.

Research Project Description

Project Title:

Monitoring fish communities in Penrith Lakes
(Con2006/116)

Principal Investigator:

Dr Leanne Faulks

Funding Sources:

NSW Department of Primary Industries, the Penrith Lakes Development Corporation and the Recreational Fishing Trust.

Objectives:

1. Annually assess the structure and status of fish communities during the progressive development of the Penrith Lakes system.
2. Monitor the survival and growth of stocked Australian bass.
3. Provide advice on pest species management.

Summary:

The Penrith Lakes system is a series of lakes adjacent to the Hawkesbury River that have been formed as a result of progressive rehabilitation works at the pre-existing sand and gravel quarry. The Penrith Lakes Development Corporation (PLDC) is responsible for managing the system and some of the completed lakes have been used as venues for aquatic sports during the Sydney 2000 Olympics. Native fish communities in the lakes play a key role in the succession of ecosystems in the developing lake environments, as well as providing recreational fishing opportunities. Therefore, management and monitoring of fish communities in the lakes has been recognized as an important component of the adaptive management plan for the Penrith Lakes system. Australian bass have been stocked in the lakes as part of this adaptive management plan. The objectives of this project are to annually assess the structure and status of fish communities during the progressive development of the Penrith Lakes system and monitor the survival and growth of stocked Australian bass.

Research Project Description

Project title:

Phylogeography, conservation genetics and stocking management of perch and bass (*Macquaria* spp.) in New South Wales
(Con2005/106)

Principal Investigator:

Dr Leanne Faulks & Dr Dean Gilligan

[Note: This is a collaborative project with Macquarie University and is led by Dr Luciano Beheregaray]

Funding Sources:

NSW Department of Primary Industries, Macquarie University, the Australian Research Council and the NSW Recreational Fishing Trust.

Objectives:

1. Elucidate historical and current patterns of population genetic structure in the four species of the fish genus *Macquaria*: golden perch, Macquarie perch, estuary perch, and Australian bass.
2. Identify conservation and management units (i.e., genetically differentiated populations) in the four species.
3. Assess the geographic extent of hybridization between Australian bass and estuary perch.
4. Where possible, identify pre-stocking population structure using DNA extracted from scale and otolith samples collected during the pre-stocking era.
5. Assess potential impacts (historical and contemporaneous) of fish stocking on genetic diversity
6. Provide recommendations regarding zonation or regions for broodstock collection and fingerling release.

Summary:

Stocking fish in freshwaters is considered an important component of the management of freshwater recreational fisheries in NSW. As identified in the *NSW Fisheries – Fish Stocking Environmental Impact Statement* (FS EIS), the way stocking activities are managed may pose environmental, social and economic risks, particularly regarding impacts on threatened species by non-native fish, changes to the genetic integrity of natural fish populations and the potential introduction of pests and diseases into natural waterways. Other issues involve adequate operating standards in hatcheries, information management for stocking events, scientific information gaps and indigenous expectations. The FS EIS stated “these risks must be addressed for the activity to proceed in a sustainable way and for the necessary approvals to be granted”. In response, NSW DPI has developed a Hatchery and Broodstock Quality Assurance Program (HBQAP) to define policies and outline an accreditation scheme for stocking programs in NSW. The HBQAP explicitly specifies the need for the definition of *population level management units* for all stocked species in NSW. Once identified, the HBQAP will ensure the implementation of these management units by identifying them as ‘stocking zones’ within which all fingerlings released in that zone are to be bred from local broodfish.

This project seeks to define population level management units and assess the risk of changes to the genetic integrity of natural populations of four species of perch and bass. Golden perch and Australian bass sustain significant recreational fisheries in inland and coastal NSW, respectively. Freshwater fish stocking of golden perch has been conducted in NSW since 1960, but was not regular, widespread or significant until after 1973. Australian bass stocking began in 1980. In contrast, Macquarie perch is a nationally listed threatened species which has declined significantly throughout its range since the 1950’ s. Macquarie perch have only been stocked on a small number of occasions., Estuary perch is a relatively uncommon species co-existing with the closely related Australian bass in the lower reaches of coastal river systems and have never been stocked. Despite the ~30 year history of large-scale stocking activity for golden perch and Australian bass, a combination of the long-life span, accurate recording of stocking history for native species, NSW DPI’s policy on limited river stockings, and variable survival of stocked fingerlings, substantial potential

exists to infer the natural population genetics structure in many catchments. Further, the patterns observed in the two un-stocked (or minimally stocked species) can be used to help infer natural patterns expected for the two heavily stocked species.

Research on population structure, migration and genetic variation in fish species from NSW are non-existent, limited or based on allozyme methods that lack the power to discriminate relationships among populations. On the other hand, DNA data provide a powerful tool for elucidating patterns of individual movements and infer historical and current patterns of population structure. This project will use a comprehensive sampling regime and modern population genetic approaches to identify populations. Once historical and contemporary patterns of population structure have been inferred, informed decisions can be made regarding the management of these fish populations within NSW. This management will address NSW DPI policies regarding translocations, the NSW biodiversity strategy, stocking, broodstock and hatchery management, hatchery accreditation and recovery planning for threatened species.

Research Project Description

Project Title:

Preliminary investigation of an Achilles' Heel for Redfin perch in NSW
(Con2010/206)

Principal Investigator:

Dr Leanne Faulks and Dr Dr Gilligan

Funding Sources:

NSW Department of Primary Industries, the Murray Darling Basin Authority and the NSW Recreational Freshwater Fishing Trust Fund.

Objectives:

1. Prepare a detailed species synopsis and identification of traits of Redfin perch that could be exploited by different control techniques.
2. Identify potential control techniques and prioritise based on cost, benefit and effectiveness.
3. Undertake preliminary field trials of some priority physical control techniques and complementary approaches to test their effectiveness to reduce redfin abundances.
4. Prevent further spread of redfin by conducting a comprehensive survey of the waterways in the upper Cox's River.
5. Investigate the movement/dispersal behaviour of redfin.

Summary:

Controlling alien fish species is one of the six driving actions of the Native Fish Strategy for the Murray-Darling Basin 2003-2013, a plan that aims to rehabilitate and protect the fish communities of the Murray-Darling Basin. Recently, redfin perch has been identified as a species that requires further investigation, including the development of possible control measures. Redfin perch is an alien fish species introduced into Australia from Europe. The species is considered a significant problem in rivers in Queensland and NSW (see <http://www.dpi.nsw.gov.au/fisheries/pests-diseases/freshwater-pests/species/redfin-perch>) (under state legislation) and in the Murray-Darling Basin (MDB). It has been implicated in the decline of several native fish populations because it is a predator of native fish and invertebrates, can destroy recreational fisheries in enclosed waters by building up large numbers of stunted fish and eliminating other species, and may devastate native fish populations by being the carrier of a lethal virus. Redfin are a significant pest in the context of recovery of threatened native fish populations, particularly the endangered Macquarie perch and southern pygmy perch. Recent work by NSW DPI (Knight 2010) investigated various methods of excluding redfin from Macquarie perch habitat (http://www.dpi.nsw.gov.au/_data/assets/pdf_file/0008/347552/AE_2010_Output-1678_Knight_Redfin-Final-Report-No-121_REPORT.pdf).

The current project extends the work of Knight (2010) by exploring techniques for physically reducing the size of redfin populations. There are a wide range of techniques, including mechanical, biological and chemical control, which can be used to control alien fish and to manage their impacts. Based on a review of the scientific literature on the biology and methods for sampling and controlling the behaviour of redfin and related percids, NSW DPI proposes to undertake preliminary trials to test the effectiveness of a range of physical removal methods and complementary approaches to reduce redfin abundances. NSW DPI researchers are also continuing monitoring of at risk areas, especially in the upper reaches of vulnerable coastal catchments such as the Hawkesbury-Nepean, to help prevent the further spread of redfin populations.

Research Project Description

Project title:

Targeted survey of Darling River hardyhead and purple spotted gudgeon
(Con2010/215)

Principal Investigator:

Dr Leanne Faulks

Funding Sources:

Hunter Central Rivers Catchment Management Authority

Objectives:

1. Survey specific sites in the upper Hunter to determine the distribution and abundance of both Darling River hardyhead and southern purple spotted gudgeon.
2. Collect tissue samples to contribute to future genetic studies to determine the origin of these populations.
3. Contribute to future management of these species in the upper Hunter catchment.

Summary:

The Darling River hardyhead (*Craterocephalus amniculus*) and the southern purple spotted gudgeon (*Mogurnda adspersa*) are both rare and restricted in distribution within New South Wales (NSW). Both species are naturally distributed in the northern Murray-Darling Basin in the upper tributaries of the Darling River near the NSW – Queensland border, but are also found in the upper Hunter catchment on the NSW central coast. There is a degree of uncertainty regarding the presence and origin of these species in the Hunter due to a lack of specimens and the isolation of this catchment from the natural populations of each species. Assessing the distribution and abundance of these species in the upper Hunter and collecting tissue samples for genetic analysis will help determine whether these populations are extensions of the natural range for each species or the result of translocation activities. This study will provide information to guide the conservation of each of the species and the riverine habitat of the upper Hunter.

Research Project Description

Project Title:

Sustainable regional development and strategic options for management of marine uses and industries in NSW – ecologically healthy and economically productive regional ecosystems
(FSC2004/147)

Principal Investigator:

Dr Philip Gibbs

[Note: This is a collaborative project with CSIRO, Marine Research]

Funding Sources:

NSW Department of Primary Industries and CSIRO Marine Research.

Objectives:

1. Identify management issues, potential management strategies, likely development scenarios, and modelling frameworks for a study of multiple-use management of NSW coastal environments (which include ocean waters under the jurisdiction of NSW, estuaries, the coastline and coastal attachments).
2. Develop and apply models of the ecosystem and human activities for NSW coastal environments within a multiple-use MSW framework.
3. Design and evaluate potential monitoring programs for these systems to underpin ecosystem-based management.

Summary:

The coming decades will see NSW experience extensive changes to its marine and coastal environment. Large-scale changes in population are expected, regional development in primary, secondary and service industries will continue and impacts from climate change are forecast to occur. Simultaneously and, in some respects in conflict with these changes, community demands for healthy and robust ecosystems will continue to grow.

This project will undertake strategic research that will provide the tools and ideas to assist planners, decision-makers and the community to understand how we can sustainably develop our regional coastal and marine ecosystems so that they are ecologically healthy as well as economically productive. This challenge will require an integration of our understanding of the climate, ocean and estuaries, the complex biology and ecology of natural and man-made systems, economic and social development, and systems of human governance.

CSIRO Marine Research has already developed a suite of tools involving complex computer modeling that can be applied to this challenging but crucial task. These tools predict the consequences of a range of natural resource management decisions on the bio-economic systems in North West Australia. Rather than simply making simplistic calculations about future situations, these tools involve methods to identify and discover strategies that generate good biological, economic and social outcomes – regardless of the myriad of uncertainties that exist. If such outcomes are not possible, then the necessary trade-offs are apparent to both decision-makers and the community.

This project will apply and extend the development of CSIRO's existing tools to the coastal regions of NSW. The time-span to be considered will be 1950 to 2020, which captures the historical period of rapid development and environmental change, as well as a manageable projection period of immediate interest to policy matters. High priority issues will be identified and used as case studies to focus the methods and outcomes. For example, strategies for effective multiple-use management of ecologically and economically important estuarine systems will be investigated. The initial phase of the project will focus on the northern bio-economic region of NSW (Northern Coast), particularly the Clarence and Richmond River systems. In the

final phase of the project, decision-making processes that incorporate standards and targets will be evaluated so that future regional and aquatic plans can include well-considered performance measures.

This ambitious, 5 year project will provide practical tools to support the ecosystem-based development of coastal NSW. Complex and inter-relating biophysical, economic and social systems demand new research to understand and improve long-term regional and aquatic planning. This project combines world-class expertise from CSIRO Marine Research with the commitment of NSW Department of Primary Industries to implement ecosystem-based management. Such combinations of scientific excellence and policy allegiance are rare and necessary for the sustainable development of coastal NSW.

Research Project Description

Project Title:

Integrated Fisheries Resource Management (Rinconada Lakes, Philippines and NSW, Australia)
(Con2005/107)

Principal Investigator:

Dr Philip Gibbs

Funding Sources:

NSW Department of Primary Industries, the Australian Centre for International Agricultural Research (ACIAR Project FIS/2003/033), the Bureau of Fisheries and Aquatic Resources (Philippines) and Econcern Pty Ltd.

Objectives:

1. Facilitate adoption by key stakeholders of management actions to improve management of the Rinconada Lakes in the Philippines and of selected fisheries resources in NSW, Australia.
2. Facilitate improved fish cage management to increase economic return and reduce impacts on water quality in Lakes Buhi and Bato, Philippines. To effectively manage water hyacinth infestations in Lakes Buhi, Bato and Baao, Philippines, by physical removal.
3. Document and package the ecosystem based management findings and outcomes of this project for adoption.

Summary:

This project will assist the integration and implementation phase of ecosystem based sustainable management plans in both the Philippines and Australia. Management plans are in various stages of development, for the Rinconada System (Lakes Buhi, Bato & Baao-Bula) in the Bicol region of the Philippines. Wider testing of the applicability of the risk based assessment framework fishery management plans already implemented in NSW Australia is required.

World Bank economic studies of the Bicol River basin identify the Rinconada System as ranking second in terms of the incidence of poverty in the Philippines. The project aims to improve the livelihoods of the communities surrounding the lakes especially the marginal fishers. In Australia the on-going success of the fishery management plans will depend on how well they meet the expectations of key participants, expressed during original consultations and drafting phases.

The project will provide a framework for the Philippine lakes implementation plan to be developed and enacted locally, with ownership by the affected stakeholders. The framework will be modelled on the risk assessment derived, ecosystem based management approach implemented for the wild capture and stocking fisheries in NSW, Australia.

The strategy for the Australian component involves assessing the effectiveness of Fisheries Resource Management Plans implemented over the last two years. In particular, scientists, managers and stakeholders will be consulted to assess how well the Plans have met, the expectations generated during the consultation/preparation phase.

NSW Department of Primary Industries, Agriculture and Fisheries Division and the Bureau of Fisheries and Aquatic Resources, National Inland Fisheries Technology Centre will undertake the project in Australia and the Philippines respectively.

The overall objective of this proposal is to improve sustainable fish production, through both capture fishing and aquaculture. The specific objectives are:

- To facilitate adoption by key stakeholders of management actions to improve management of the Rinconada Lakes in the Philippines and of selected fisheries resources in NSW, Australia.
- To facilitate improved fish cage management to increase economic return and reduce impacts on water quality in Lakes Buhi and Bato, Philippines.
- To effectively manage water hyacinth infestations in Lakes Buhi, Bato and Baao, Philippines, by physical removal.
- To document and package the ecosystem based management findings and outcomes of this project for adoption.

The community impacts of the project flow to the fishery sector in the Bicol region, which contributes to the livelihood of nearly 6,000 families. This project should return fishery production to previous levels and the management plans will help ensure sustainability and improved amenity for the marginal fishers, fish farmers and the community. The indirect impacts of the project to Australia are the wider validation, acceptance and use of the existing resource assessment framework.

The end users of the information from the project in the Philippines are the marginal fishers, fish farmers and communities in the barangays around the Lakes. The communication strategy is through empowering the Fisheries and Aquatic Resources Management Council (FARMC) groups associated with each Lake, which include representatives of the end users above. In Australia the end users are fisheries managers and fishermen who are implementing the finalised management plans.

The methodology requires the transfer of the risk based resource management framework and consultation process developed in Australia to the Philippines. This is combined with on ground field trials in the Philippines of water hyacinth composting and control, water quality monitoring for Lake turnover and fish farm stocking and feeding rates to maximise growth and minimise pollution. In the third year of the project a "How to Guide" will be produced to include a comparative section on the differences in use of the framework and process in Australia for sustainable harvest Fishery Management Plans and the Philippines for sustainable Lake Management. This comparison will evaluate how the framework accommodates the science – management and the stakeholder – management interfaces under the different political structures and how the scientists, managers and stakeholders define the resource problems, interpret the information collected and communicate the outputs.

Research Project Description

Project Title:

Risk assessment of impacts of climate change for key species in south eastern Australia
(Con2010/204)

Principal Investigator:

Dr Philip Gibbs

[Note: This is a component of a larger project funded by the Fisheries Research & Development Corporation and led by Dr Gretta Pecl at the University of Tasmania and Dr Tim Ward at the South Australian Research & Development Institute]

Funding Sources:

NSW Department of Primary Industries, the Fisheries Research & Development Corporation (Project no. FRDC 2009/070), the University of Tasmania and the South Australian Research & Development Institute.

Objectives:

1. Identify the life history stages, habitats and aquaculture systems of key species that may be impacted by climate change.
2. Identify the physical and chemical parameters that may determine the potential impacts of climate change on key species.
3. Conduct a preliminary risk assessment of each key species to the potential impacts of climate change.
4. Highlight what additional information on the tolerances and sensitivities will be needed to develop bioclimatic envelope models for key species.

Summary:

Climate change is expected to alter physical and chemical oceanographic conditions and processes around Australia, yet the influence this could have on the distributions of various marine species is still relatively unknown. The marine waters of South Eastern Australia are expected to be significantly affected by climate change, experiencing the greatest climate-driven changes in the southern hemisphere over the next century. The impacts and opportunities that will result from these changes will depend, in part, on how well the fisheries and aquaculture sectors and their managers respond to these challenges.

This vulnerability particularly relates to changes in the East Australian Current, which has strengthened by 20% in the last 50 years. As a result, water temperatures in the south-eastern region have risen and continue to rise more rapidly than elsewhere in Australia and, according to some model projections, than the rest of the world. This region is also predicted to experience the greatest increases in sea levels, which will have implications for critical inshore habitats that are important recruitment sites for many species, and these inshore habitats will also be affected by further increases in salinity levels within estuaries due to increasing evaporation driven by predicted increases in land air temperatures and reduced rainfall. These changes are expected to have significant implications in the region and the sustainability of the fisheries and aquaculture resources in the region will obviously be affected.

Each of the States contributing to this project will assess the tolerances and sensitivities of approximately five-seven key species throughout South Eastern Australia. Identifying the life history stages, habitats and aquaculture systems of the key species that may be impacted by climate change, and identify the physical and chemical parameters that may determine the potential impacts of climate change on key species. This information is the basis for a preliminary risk assessment of each key species to the potential impacts of climate change to inform future fisheries management decisions on sustainable harvest strategies.

Research Project Description

Project Title:

Refinement and application of Cage Aquaculture Decision Support Tool (CADS Tool) for freshwater systems in the Philippines
(Con2010/205)

Principal Investigator:

Dr Philip Gibbs

[Note: This is a collaborative project with the University of New South Wales and the Southeast Asian Fisheries Development Centre (SEAFDEC)]

Funding Sources:

NSW Department of Primary Industries, the Australian Centre for International Agricultural Research (ACIAR Project FIS/2009/054), the University of New South Wales and the Southeast Asian Fisheries Development Centre.

Objectives:

1. Refine, validate and disseminate CADS_Tool for freshwater application in the Philippines and use in Australia.
2. Scope and then establish a permanent home for CADS_Tool either in Indonesia, the Philippines and/or Australia.

Summary:

A cage aquaculture decision support tool (CADS Tool) which enables managers to classify fish aquaculture sites (poor, medium and good), select sites, determine holding / carrying capacity and make an initial economic appraisal of a site has been developed for marine systems as an output of previous ACIAR funded projects in Indonesia.

Initial trials of the tool for freshwater lake aquaculture of tilapia in the Philippines indicate some adaption of the algorithm in the model is necessary to accommodate seasonal stratification of the lakes followed by turnover of oxygen depleted water.

Adaption of the existing tool to freshwater will involve an assessment of the models robustness and sensitivity to the available field data and modification of the algorithms and software coding.

The freshwater module of the CADS Tool will be integrated into existing aquaculture training programs in Australia, Philippines and Indonesia for wider reaching extension and adoption. The project will also coordinate workshops with partner agencies with a goal of building sufficient expertise in the technical and scientific support services of the various fisheries institutes.

Research Project Description

Project Title:

Assessment of environmental flows in the Snowy River (fish component)
(Con2000/023)

Principal Investigator:

Dr Dean Gilligan

Funding Sources:

NSW Department of Primary Industries and the NSW Office of Water.

Objectives:

1. Establish the condition of the structure and composition of fish communities in the Snowy River before the implementation of environmental flows.
2. Determine whether increased flow results in greater abundance of native fish, and strengthened population structure through the addition of age classes.
3. Measure habitat diversity and availability for trout species, especially upstream of Snowy Falls, potentially resulting in an increased trout population due to increased flows.
4. Determine levels of interaction between trout and native species with respect to increased flows.
5. Determine whether increased flow will result in a reduction in populations of goldfish and redfin perch.

Summary:

Since construction of the Snowy Mountains Hydro-electric scheme in 1968, flows in the Snowy River downstream of Jindabyne Dam had been reduced to only 1% of natural flows. This has had substantial impacts on riverine habitats and the abundance and distribution of fish throughout the catchment. In line with interstate agreements on water reform for the Snowy system, it has been proposed that flows in the river should be increased to as much as 28% of the natural flow volume. This is predicted to result in significant improvements in fish communities in the Snowy catchment.

As part of the environmental flows program, the NSW government initiated a long-term, before-after sampling program to gauge the response of fish populations (amongst other aquatic ecosystem components) to the provision of environmental flows. Fish assemblages are sampled at 6 treatment sites in the Snowy River and 8 reference sites in tributary streams. Fish samples are collected using electrofishing. In the first three years (2000 – 2002) the sampling described the fish communities present in the catchment before any environmental flows were released. In the subsequent years the response of fish assemblages to the incremental increases in environmental flows will be monitored. The abundance, diversity and size-structure of native fish species, the abundance of trout, the abundance of introduced 'pest' species, and the quality of fish habitat will be compared before and after implementation of the new flow regime. To date (2009), no significant response has been detected for any of these variables. This was not unexpected given the very modest increase in flow rates. Most of the measured variables should, however, respond to environmental flows once at least 21% of natural flows have been provided over the next few years.

Research Project Description

Project Title:

Sustainable Rivers Audit
(Con2002/040)

Principal Investigator:

Dr Dean Gilligan

Funding Sources:

NSW Department of Primary Industries, the Murray-Darling Basin Authority and the NSW Office of Water.

Objectives:

The Sustainable Rivers Audit aims to:

1. Determine the ecological condition and health of river valleys in the Murray-Darling Basin.
2. Provide a better insight into the variability of river health indicators across the Basin and over time.
3. Detect trends in river health over time.
4. Trigger changes to natural resource management by providing a more comprehensive picture of river health than is currently available.

Summary:

The Murray-Darling Basin is a network of streams and rivers stretching from the Condamine in south east Queensland to the mouth of the Murray River in South Australia. The Sustainable Rivers Audit is a program designed to measure the health of the rivers at this large Basin scale. The SRA is an initiative of the Murray-Darling Basin Authority involving partner agencies in each state and territory within the Basin. It provides a standard monitoring framework, allowing comparisons between rivers and over time.

The Audit uses several scientific indicators of river health to determine the current status of the Basin's rivers and any potential trends. Groups of indicators or "themes" for assessment are fish, macroinvertebrates, hydrology, physical form and floodplain vegetation. Methods for the first three themes were developed and refined during the Pilot Audit undertaken in 2002. Themes for vegetation and physical form were added in 2008. NSW DPI is responsible for sampling for the fish theme in NSW. The methods used to sample fish assemblages were developed by the SRA Fish Theme Technical Reference Group. An annual sampling protocol manual is prepared by this group and distributed by the MDBA.

Each valley within the Murray-Darling Basin is sub-divided into altitude zones (Lowlands <200m, Slopes 201-400m, Uplands 401-700m and Highlands >701m). Within each valley, seven sites are sampled within each altitude zone. The location of each site is chosen randomly by the MDBA, using a GIS system. NSW DPI's objective is to sample within 500m of this randomly selected point. Random site selection is necessary in order to ensure that the sites sampled are representative of that zone, valley and the basin. Fish sampling involves a combination of boat and backpack electrofishing as well as bait traps. The species caught are identified, the number of each species captured is counted and a sub-sample of the catch is measured and examined for external parasites and disease symptoms etc. before being released. NSW DPI provide the raw data to the MDBC, who then analyse the data and report on the results. The first SRA report covering the first complete round of SRA sampling is available at <http://www.mdba.gov.au/programs/sustainable-rivers-audit>. The second SRA report covering the second complete round of sampling is currently under preparation by the MDBA.

The Audit reports provide river managers and users with the first comprehensive understanding of the health of the many rivers and streams that run across the Basin. The information gained through the Audit will help the MDBA and its partner governments to set targets and develop strategies to improve the management of Murray-Darling Basin rivers. It will also identify those areas of the Basin needing particular attention and protection. The ongoing Audit is essential for knowing whether collective management and recovery actions

aimed at improving or protecting river health in inland NSW are working. Together with a companion project in coastal river systems, the Audit contributes to a statewide assessment of the condition of all NSW rivers under the NSW Government’s Monitoring Evaluation & Reporting (MER) program. This will lead to a better understanding of the magnitude of management investment that may be required in the future to meet the State Plan target for Riverine Ecosystems.

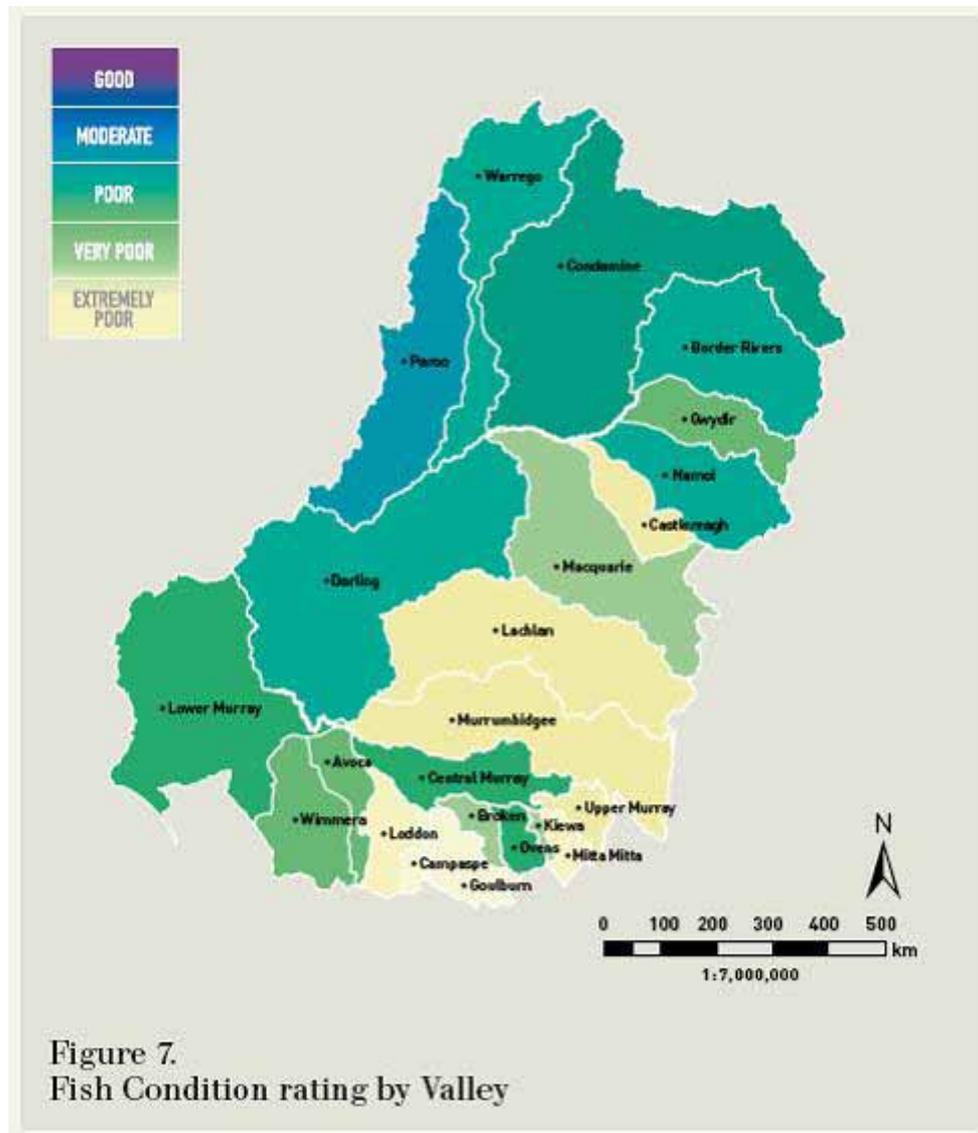


Figure 7.
Fish Condition rating by Valley

Summary of SRA fish results presented in the first SRA Interim report – MDBC (2008). Murray-Darling Basin Rivers; Ecosystem health check, 2004 – 2007. A summary report based on the Independent Sustainable Rivers Audit Group’s SRA report 1: A report on the ecological health of rivers in the Murray-Darling Basin, 2004-2007 (submitted to the Murray-Darling Basin Ministerial Council in May 2008).

Research Project Description

Project title:

Rescue and protection of Macquarie perch from upper Lachlan river system and investigations into captive breeding techniques
(Con2007/145)

Principal Investigators:

Mr John Pursey and **Dr Dean Gilligan**

[Note: This is a collaborative project between NSW DPI's Science & Research Division and the Fisheries, Compliance & Regional Relations division]

Funding Sources:

NSW Department of Primary Industries and the NSW Recreational Freshwater Fishing Trust Fund.

Objectives:

1. Ensure the preservation of Macquarie perch from the Lachlan river catchment by removing a representative portion of the population to secure refuge.
2. Investigate captive breeding techniques for Macquarie perch.
3. Reintroduce the captive individuals to the wild following establishment of one or more of the following:
 - Information that redfin are not causing the extinction of the Lachlan population of Macquarie perch (the wild population increases in range and abundance despite the presence of redfin perch).
 - Redfin are eliminated from the upper Lachlan catchment.
 - A suitable refuge area (isolated dam or impoundment) is established within the Lachlan catchment.

Summary:

Macquarie perch (*Macquaria australasica*) are listed as 'vulnerable' under the *Fisheries Management Act 1994* (NSW) and are recognised as threatened under various other jurisdictions at state, national and international levels. Although the distribution and abundance of Macquarie perch have declined significantly, the upper Lachlan river system (upstream of Wyangala dam and including the Lachlan and Abercrombie rivers and their major tributaries) still supports a viable population of Macquarie perch. This is the northernmost population of Macquarie perch in the Murray Darling Basin.

The introduced species redfin perch (*Perca fluviatilis*) was first discovered in 2 locations within the upper Lachlan system in November 2005. Redfin had not been recorded in the upper Lachlan before this. Follow up surveys during 2006 have confirmed the presence of redfin at a number of sites in the upper Lachlan, and their distribution seems to be expanding. Redfin perch are known to impact on Macquarie perch by direct predation (especially of eggs and larvae) and as carriers of Epizootic Haematopoietic Necrosis (EHN) virus. EHN virus has been shown to be lethal to Macquarie perch. There is no feasible way to effectively control the spread of redfin throughout the upper Lachlan system. The threat from redfin, combined with reduced habitat quality and extent due to current drought conditions, places the Macquarie perch population in the upper Lachlan system at significant risk of major decline within the next few years.

This project aims to relocate and protect a large number of Macquarie perch from the upper Lachlan River system by removing a representative portion of the population to a secure refuge at the Narrandera Fisheries Centre. A range of techniques such as fyke nets, drum nets and electrofishing will be employed to capture sufficient number of Macquarie perch. Whilst in captivity, attempts will be made to breed Macquarie perch. If techniques to produce Macquarie perch on a large scale prove to be feasible, future breeding and stocking programs could be considered to expedite species recovery.

The captive individuals will be reintroduced to the wild once a suitable refuge area (isolated dam or impoundment) is established within the Lachlan catchment and/or redfin are either eliminated from the upper Lachlan catchment or are found not to have caused any significant decrease in numbers of Macquarie perch (i.e., the wild population increases in range and abundance despite the presence of redfin perch). To assist in making decisions regarding reintroduction of the captive population or of captive-bred fingerlings, a number of sites in the upper Lachlan catchment will be sampled on an annual basis in order to monitor the impacts of redfin and the status of the wild Macquarie perch population. A sampling strategy based on standardised electrofishing techniques will be used and will be the same as that typically used by NSW DPI (Fisheries) to undertake fish community monitoring programs.

Research Project Description

Project Title:

NSW Integrated Fish Monitoring Program
(Con2004/077)

Principal Investigator:

Dr Dean Gilligan

Funding Sources:

NSW Department of Primary Industries and the Natural Heritage Trust (via the Catchment Management Authorities).

Objectives:

1. Provide a standardised and powerful fish community assessment tool that is consistent with previous NSW Fisheries projects and the upcoming Sustainable Rivers Audit.
2. Provide information on freshwater fish communities required by Catchment Management Authorities.
3. Compare data collected during this program with the original NSW Rivers Survey to assess changes in fish communities over the last decade.
4. Publish a detailed book on the freshwater fish of NSW.
5. Enter data onto the NSW Fisheries freshwater sampling database and Fishfiles.

Summary:

Natural resource management within NSW has been changed so that Catchment Management Authorities (CMAs) now have responsibility for implementing management actions within each of their jurisdictions. As a result, expenditure of federal funding is being coordinated by each CMA for actions undertaken within the respective catchments. To date, the process of prioritisation has involved each CMA developing catchment targets. As all CMAs have catchment targets associated with riverine ecosystem health, protection of threatened species, or control of aquatic pests, each CMA will require sampling of sufficient intensity to detect changes or trends in fish and aquatic communities through time.

In the process of developing an aquatic monitoring program for the Murray-Darling Basin (known as the *Sustainable Rivers Audit* or SRA), the Murray-Darling Basin Authority (with the involvement of NSW Department of Primary Industries and other state agencies) has developed and tested sampling strategies and analysis techniques for monitoring changes in fish communities throughout the Murray-Darling Basin. The sampling protocol used for riverine sites in the pilot SRA was consistent with that used for a large fish sampling project in the mid 1990s (the NSW Rivers Survey), with the addition of bait trap sampling at each site. Based on analyses of SRA pilot data, and consideration of cost-efficiency, a monitoring program using this protocol will provide a powerful assessment tool to assess changes in fish community variables such as native/alien fish ratios, observed/expected number of taxa, species richness, diversity indices and % of carp caught.

Sampling for the full SRA, however, is restricted to inland rivers and current plans are that catchments will only be sampled every 3 years. Further, the site selection process does not allow assessment of specific issues relevant to the CMAs, such as threatened species monitoring and assessment of habitat rehabilitation programs such as demonstration reaches. The Integrated Fish Monitoring project will complement the full SRA by:

- extending standardised fish sampling to catchments outside the Murray Darling Basin,
- addressing the particular needs of individual CMAs and the requirements of other NSW Department of Primary Industries programs in their catchments,
- increasing the frequency of sampling at key sites to provide better long-term data.

Integrated Fish Monitoring was done in the Hunter region and in the South-West region of NSW (the Lower Murray-Darling and the Murrumbidgee) in 2004/05 as interim projects. Fish monitoring in South Creek, part of the Hawkesbury river system, will be done in 2005/06. Additional funding will be sought as the opportunity arises to extend the IFM across NSW. It is anticipated that the eventual implementation of IFM throughout all CMA areas will result in the availability of standardised fish monitoring data across all catchments in the state. The value of these data will be enhanced, in many cases, by direct comparison to data collected for previous NSW Department of Primary Industries projects.

Research Project Description

Project Title:

River Blackfish (*Gadopsis marmoratus* – Southern form) in the Snowy River catchment
(Con2006/120)

Principal Investigator:

Dr Dean Gilligan

Funding Sources:

NSW Department of Primary Industries and the Premier's Department.

Objectives:

1. Determine range, population size and size structure of river blackfish populations in the Snowy River catchment.
2. Identify a potential source population for potential future translocation program.
3. Determine preferred habitat attributes and rehabilitation requirements for river blackfish.
4. Determine feasibility of captive-breeding as an alternative to translocation of wild fish. If successful, this will be an innovative fish conservation development.
5. Monitor the effectiveness of a reintroduction program (both translocation and captive-breeding & reintroduction) for river blackfish in the Snowy catchment.
6. Determine whether the introduction of artificial spawning-tubes in remnant River Blackfish populations enhances recruitment and results in increases in population size and distribution.
7. Clarify the taxonomic relationships between *Gadopsis marmoratus* (southern form), *Gadopsis marmoratus* (northern form) and *Gadopsis bispinosus*.

Summary:

With most of the Snowy Rivers flow diverted through the Snowy Mountains Scheme for a period of ~40 years, native fish populations of the Snowy catchment have been greatly reduced. As part of the Snowy River rehabilitation program being undertaken by the NSW government (in parallel with environmental flows from Jindabyne Dam), NSW DPI is developing a strategy for native fish recovery in the Snowy River. The strategy outlines a number of actions that can be carried out to improve fish populations, including increased knowledge through fish population surveys, improvement of fish habitat, improvement of fish passage past barriers, and direct enhancement of ailing fish populations. Several fish species have been identified as important signatures for the recovery of the Snowy River, including the river blackfish. River blackfish was once an important food fish for Aboriginal people and became a local dietary mainstay for Snowy River pioneers. Historical accounts recall the ease with which pioneers could catch a string of blackfish. Blackfish have declined throughout much of the Snowy catchment, and in NSW are thought to only remain in the upper reaches of the Delegate River sub-catchment. Factors contributing to the decline include changes to instream habitat; with lower flows, sedimentation, increased water temperature, a lack of hollow logs (essential spawning habitat), and the impacts of alien species. Biologically, the Snowy river blackfish population is important for biodiversity conservation in New South Wales as it is the sole population of the coastal (southern) form of this species in the state.

To aid in the recovery of the Snowy river blackfish population, the following projects have been developed as part of the Snowy's Native Fish Strategy:

1. Survey the Snowy River Catchment in order to determine the current abundance, distribution and size structure of the river blackfish population.
2. Determine preferred habitat attributes and rehabilitation requirements.
3. Assess the feasibility of a captive breeding program for river blackfish.
4. Comparisons of the effectiveness of a reintroduction program using captive bred versus translocated individuals at rehabilitated habitats in the Snowy River.

5. Determine whether the introduction of artificial spawning-tubes into remnant River blackfish populations enhances recruitment and results in increases in population size and distribution.

Research Project Description

Project Title:

Identification of 'hot-spots' of carp reproduction in the Murray-Darling Basin
(Con2006/119)

Principal Investigator:

Dr Dean Gilligan

Funding Sources:

NSW Department of Primary Industries, the Invasive Animals Cooperative Research Centre (Project No. 4.F.5), the Queensland Department of Primary Industries & Fisheries, Primary Industries Research Victoria and the South Australian Research & Development Institute.

Objectives:

1. Provide complete spatial coverage for identification of carp spawning hotspots within the Murray-Darling Basin.
2. Provide data on temporal variability in carp spawning success at hotspots.
3. Assess the relationship between spawning hotspots and recruitment hotspots.
4. Validate larval sampling as a method of detecting recruitment hotspots.

Summary:

The current NSW DPI project 'Assessment of wild carp populations required for successful implementation and monitoring of daughterless carp gene technology' funded by the Pest Animal Control CRC (PAC CRC) consisted of four tiers of field sampling designed to provide information on spatial variability of carp population dynamics parameters across NSW and benchmark the sex ratio of carp as a means of monitoring the effectiveness of 'daughterless carp' genetic technology. One component of this project, larval drift sampling, has proven effective in demonstrating that carp reproductive activity is not widespread throughout NSW, with specific areas being identified as the origin of huge numbers of carp larvae. Larval sampling over the past 2 breeding seasons has identified the Gwydir wetlands, Namoi wetlands, Lower Boomi River, Barmah-Millewa Forest and large impoundments (where valley floors are flooded) as 'hot-spots' of carp reproduction in NSW.

However due to the prevailing drought, not all river systems were sampled under the current PAC CRC project. Secondly, the Daughterless Carp Reference Group (CRG –the scientific body advising the PAC CRC) recommended that field sampling and data collection be extended throughout the entire Murray-Darling Basin. Given the important consequences of the knowledge of each 'hot-spot' for implementation of effective carp control strategies, the Invasive Animal CRC (IA CRC) will fund continued larval sampling in NSW and extend the NSW sampling strategy to other states within the Murray-Darling Basin for the next three years. Continuation of the sampling program will enable complete coverage of all river systems and the replication of sampling in a selection of river systems will provide scientific validity to the results, which are at present only based on a single replicate sample. However, the sampling of larval carp is strictly only a demonstration of carp spawning activity and does not necessarily translate into recruitment of those larvae into the adult population. By assessing recruitment success at hotspots, this project will validate the results of larval drift sampling as a technique to identify carp recruitment hotspots.

Importantly the identification of recruitment hotspots would suggest that instead of carp control being required over 10s of 1000s of kilometers of river, targeted control within a finite number of 50km reaches could achieve effective carp control. The identification of carp recruitment 'hot-spots' will enable:

- Control of adult carp migrating towards spawning areas.
- Targeted control of spawning aggregations.
- Exclusion of spawning adults from preferred spawning areas.
- Control of dispersing juveniles from spawning areas.

- Control (elimination) of sink populations through limiting immigration from source populations.
- Identification of priority control sites.

Research Project Description

Project Title:

Monitoring the status of fish populations in the Lower Murray-Darling CMA area
(Con2006/122)

Principal Investigator:

Dr Dean Gilligan

Funding Sources:

NSW Department of Primary Industries and the Lower Murray Catchment Management Authority.

Objectives:

1. Provide a standardised and powerful fish community assessment capable of assessing progress towards the Lower Murray-Darling CMAs riverine health catchment targets:
 - 55% improvement in the native/alien species ratio.
 - 25% improvement in the native/alien abundance ratio.
 - 25% improvement in the native/alien biomass ratio.
2. Annually report on progress towards catchment targets.
3. Enter data onto the NSW Fisheries freshwater sampling database and Fishfiles.

Summary:

The riverine health target “An identifiable nett improvement in riverine health across the Lower Murray Darling Catchment by 2012” was established under the Catchment Action Plan (CAP) for the Lower Murray-Darling CMA. The CAP states that this will be determined by:

- an improvement in the native to introduced fish ratio (55% improvement in species ratio, 25% improvement in abundance ratio, 25% improvement in biomass ratio);
- a 20% reduction in the number of days subject to blue green algal alerts; and
- the reinstatement of more natural flow patterns as modelled in each of five river management zones”.

As part of a monitoring strategy to assess progress towards these targets, the Lower Murray-Darling CMA requires fish community sampling of sufficient intensity to detect changes of this magnitude. An initial benchmarking assessment of the status of fish communities in the Lower Murray-Darling CMA area was undertaken in 2003/04. In order to assess progress towards the CMAs riverine health targets, the Lower Murray-Darling CMA has funded annual fish community sampling for the years 2006/0, 2008/09, 2009/10 and 2010/11.

This assessment strategy includes sampling of riverine and wetland fish communities at up to 37 locations throughout the catchment area. Fish are sampled using the same standardised protocol developed for the Murray-Darling Basin Authority’s Sustainable Rivers Audit which was also used for the benchmarking assessment. The protocol involves boat electrofishing, backpack electrofishing and bait traps. Captured fish are counted, measured and weighed and the data used to calculate the 3 metrics concerning the ratios of native to introduced fish. Following completion of sampling each year, an annual report is prepared that assesses progress towards the CMA’s riverine health catchment targets. The benchmarking report and 2005/06, 2006/07 and 2008/09 annual progress reports can be downloaded from:

Benchmarking report: <http://www.dpi.nsw.gov.au/research/areas/systems-research/aquatic-ecosystems/outputs/2005/output-664>

2005/06 Annual report: <http://www.dpi.nsw.gov.au/research/areas/systems-research/aquatic-ecosystems/outputs/2007/967>

2006/07 Annual report: <http://www.dpi.nsw.gov.au/research/areas/systems-research/aquatic-ecosystems/outputs/2008/1117>

2008/09 Annual report <http://www.dpi.nsw.gov.au/research/areas/aquatic-ecosystems/outputs/2009/1597>



The Murray River at The Boiler.

Research Project Description

Project title:

Susceptibility of previously untested fish species in the Murray-Darling Basin to EHN Virus, and the epidemiology of EHN Virus in the wild
(Con2006/135)

Principal Investigator:

Dr Dean Gilligan

[Note: This is a collaborative project with the University of Sydney]

Funding Sources:

NSW Department of Primary Industries, the University of Sydney and the Murray Darling Basin Authority.

Objectives:

1. Validate earlier findings of susceptibility of native fish to EHN virus.
2. Determine the susceptibility to infection by EHN virus of a range of previously untested fish species in the Murray-Darling Basin.
3. Investigate the epidemiology of EHN virus in wild populations of priority fish species.
4. Develop a test to determine exposure of wild populations of priority fish species to EHN virus.
5. Identify the extent to which EHN virus is a risk to native fish in the Murray-Darling Basin.

Summary:

The diseases impacting on wild freshwater fishes in Australia are poorly understood. We know very little about what diseases exist in natural systems, their distributions and their impacts on wild fish populations. At least one disease, Epizootic Haematopoietic Necrosis Virus (EHN) is known to be a serious threat to a number of native fish species. This virus, unique to Australia, was first identified in 1985 in introduced redfin perch. EHN is characterised by sudden high mortalities of fish, and affected fish have abnormalities of vital body organs such as the kidneys, liver, spleen and pancreas.

Eleven species of Australian fish have been tested for sensitivity to EHN, a number of which were found to be susceptible, including 2 threatened species – Macquarie perch and Silver perch. Macquarie perch were particularly affected, with all 10 fish in 2 separate laboratory trials dying within 6 – 11 days after exposure to the virus. It is suspected that the sudden and severe depletion of the Macquarie perch population in Lake Eildon, Victoria, may have been partly due to EHN. However, there are populations of Macquarie perch and Silver perch still remaining in catchments that have experienced outbreaks of EHN, suggesting that the behaviour of this virus in the wild may be different to that recorded under laboratory conditions.

The virus has been recorded from Victoria, New South Wales and the ACT. EHN can remain infective after being stored dry for up to 113 days. Therefore, its spread may have been aided by transport on nets, fishing lines, boats and other equipment. Further, introduced redfin perch and trout species are known vectors for EHN. The spread of these species throughout the Murray-Darling Basin may have provided a means for the introduction of EHN into formerly disease free waterways. Once EHN has entered a water body, it is considered impossible to eradicate.

This project will test earlier findings of the susceptibility of native fish to EHN and to extend these tests to a broader range of fish species. The project is also investigating the behaviour of EHN in wild populations of priority fish species and developing a test to determine the exposure of wild populations of priority fish species to EHN. The project will identify the extent to which EHN is a risk to native fish in inland NSW. This information will allow managers to ensure the conservation of the native fish fauna of NSW and, in particular, assist the recovery of listed threatened fish species.

Research Project Description

Project Title:

NSW Threatened Freshwater Fish Monitoring Program
(Con2006/140)

Principal Investigator:

Dr Dean Gilligan

Funding Sources:

NSW Department of Primary Industries and the Murray Catchment Management Authority.

Objectives:

1. Document the location and status of remnant populations of threatened freshwater fish.
2. Provide a routine monitoring framework for each threatened taxon which will enable assessment of trends.
3. Provide rigorous scientific evaluations of recovery plan actions.

Summary:

Of the 60 native freshwater fish species in NSW, twelve are listed as threatened under the *NSW Fisheries Management Act 1994* (see http://www.fisheries.nsw.gov.au/threatened_species/threatened_species) and an additional three are listed nationally under the *EPBC Act 1999*. These numbers equate to 36% of inland freshwater fish species and 10% of coastal freshwater species being threatened. Further, the entire ecological communities of the lower Murray catchment, the lowlands of the Darling catchment and the lower Lachlan catchment have been listed as endangered ecological communities.

There is a need for ongoing assessment of the status of each of these threatened species and ecological communities. Overall assessment should include monitoring trends in population numbers, identifying new threatening processes, evaluating the effectiveness of recovery plan actions and doing basic research into the biology of these generally poorly understood species. Remnant populations of most threatened species are small and fragmented and sites where they occur are under-represented in existing state-wide biodiversity monitoring programs which rely on randomly chosen sites. Therefore, targeted sampling of threatened fish is required.

A standard freshwater fish community survey technique, based on electrofishing and bait traps is used at sites and within catchments where threatened species occur. Detailed descriptions of habitat characteristics and water quality are also made, and a fin clip is collected from each threatened fish sampled. Fin clips are catalogued and stored in the *NSW DPI Freshwater Fish DNA Collection* for subsequent genetic analyses. Finally, a PIT tag is inserted into individuals > 150 mm in length so that subsequent surveys can collect data on the growth rate and movement of tagged individuals.

In 2009, the Murray CMA provided funding to undertake surveys of the endangered population of Macquarie perch within Mannus Creek in the Upper Murray catchment.

Research Project Description

Project title:

Conservation of the Murray crayfish *Euastacus armatus*: addressing knowledge gaps of juvenile biology and burrow use
(Con2007/141)

Principal Investigator:

Dr Dean Gilligan

[Note: This is a collaborative project with Macquarie University]

Funding Sources:

NSW Department of Primary Industries and Macquarie University.

Objectives:

1. Develop effective sampling strategies for juvenile Murray crayfish.
2. Document the habitat requirements of juvenile Murray crayfish.
3. Investigate the morphology of Murray crayfish burrows.
4. Report on the impacts of river regulation on burrow use.

Summary:

NSW DPI, along with collaborators from Macquarie University and Environment ACT are in the final stages of completing a detailed review, funded by the Murray-Darling Basin Authority, of all current knowledge of the Murray crayfish. This review identified that knowledge of the habitats and biology of juvenile crayfish and the impact of river regulation on access to burrows and burrowing substrates are two of the most important knowledge gaps for the species.

Knowledge of the habitats and biology of juvenile crayfish is limited as only two of the numerous previous studies of Murray crayfish biology actually sampled any Murray crayfish less than about two years of age. Hypotheses used to explain the general absence of zero to two-year old crayfish from samples are: (i) sampling gears used in previous studies were ineffective at collecting juveniles; (ii) juveniles remain within burrows for the first two years of life; or (iii) that population level migrations result in adult and juvenile crayfishes utilising totally different habitat types, with juvenile habitats not sampled by a majority of the previous studies. This project aims to develop effective sampling tools for juvenile Murray crayfish and to test the above hypotheses. Juvenile crayfish will be sampled using habitat traps, bait traps, drop nets and electrofishing, as well as by screening the stomach contents of predatory fish. All field work will be undertaken in the Murrumbidgee River near Narrandera, an area known to support a large population of adult Murray crayfish. Laboratory experiments in aquaria will also be used to assess parental behaviour and cannibalism in order to test hypothesis 2.

Murray crayfish excavate and utilise submerged burrows in clay banks within river channels. Access to burrows and burrowing substrates is thought to be particularly important during May (the moulting season) and September/October (the hatching season). River regulation across the range of Murray crayfish has generally resulted in seasonal flow reversal, where summer flows are now higher than natural and winter river levels are generally lower than natural. As a result of reduced river levels during the important May – October period, a portion of burrows and burrowing substrates will be exposed, and consequently may become unavailable to Murray crayfish when they are needed most. Therefore, it is possible that river regulation may have a significant impact on Murray crayfish populations. However, insufficient information is available on the distribution of Murray crayfish burrows, the distribution of burrowing substrates and the importance of burrows within the Murray crayfish life-cycle. Data on the distribution and depth of crayfish burrows in clay banks will be recorded and the impacts of river regulation on burrow access will be modelled.

The development of effective sampling tools for juvenile crayfish will enable assessment of the abundance and distribution, important prerequisites for any subsequent assessments of the general biology and recruitment ecology of juvenile crayfish. The development of a 'burrow access' model may lead to appropriate allocations of environmental flows for the benefit of crayfish populations. Together, this information may result in the needs of Murray crayfish being better served by habitat protection and rehabilitation activities, leading to the maintenance or enhancement of the important recreational fishery for Murray crayfish.

Research Project Description

Project title:

River Revival – Lachlan River Carp Cleanup
(Con2007/151)

Principal Investigators:

Dr Dean Gilligan

[Note: this is a large collaborative project involving additional partners from the South Australian Research & Development Institute, the NSW State Water Corporation, the Victorian Department of Sustainability & Energy, the Victorian Department of Primary Industries, K&C Fisheries and Kingfisher Research]

Funding Sources:

NSW Department of Primary Industries, the Lachlan Catchment Management Authority and the Invasive Animals Co-operative Research Centre. This is a collaborative project involving additional partners from the South Australian Research & Development Institute, the NSW State Water Corporation, the Victorian Department of Sustainability & Energy, the Victorian Department of Primary Industries, K&C Fisheries and Kingfisher Research.

Objectives:

Phase 1 (Benchmarking phase 2007 – 2009)

1. Quantify the size of the carp population in the Lower Lachlan catchment before carp control initiatives commence.
2. Quantify the relative level of carp recruitment from each of the four potential carp recruitment hotspots in the Lower Lachlan catchment.
3. Benchmark water quality parameters in the Lower Lachlan catchment.
4. Benchmark aquatic vegetation cover in the Lower Lachlan catchment.
5. Benchmark bank stability in the Lower Lachlan catchment.
6. Benchmark macro-invertebrate community composition in the Lower Lachlan catchment
7. Benchmark native fish community composition in the Lower Lachlan Catchment.
8. Benchmark community attitudes to carp and their impacts.
9. Establish a series of replicated carp exclosures in the Lake Cargelligo system and monitor the response of aquatic vegetation, macroinvertebrates and native fish (small species) to carp exclusion.
10. Set ecosystem recovery targets for the catchment based on the 'impacts' results obtained from the exclosure experiments.
11. Develop, test and refine screening and trapping technologies for immediate implementation in year three of the project.
12. Tag a large number (~4,000) of carp within the lower Lachlan catchment for subsequent removal assessments.
13. Establish and maintain community education/involvement networks for carp control activities in the Lower Lachlan.
14. Undertake a study into the importance of the Great Cumbung Swamp to carp recruitment in the Lachlan catchment and the biology of juvenile dispersal.
15. Implement a carp eradication program in the Lake Cowal/Bland Creek system (only feasible if the drought continues).

Phase 2 (Implementation phase 2009 – 2011)

16. Install and manage wetland style Carp Separation Cage designs developed through IA CRC project 4.F.12 to reduce carp recruitment within the Lake Cargelligo carp recruitment hotspot.
17. Install and manage new WCSCs at Buggan Weir, Booligal Weir and Cargelligo Weir, and continue to manage the existing WCSC at Island Creek Weir.
18. Investigate strategies for limiting carp recruitment in the Great Cumbung Swamp hotspot.*

19. Reduce the abundance of carp in Lake Cargelligo hotspot using pheromone traps (developed through IA CRC project 4.F.4), the Judas carp approach, commercial fishing methods and chemical attractants (developed through IA CRC project 4.F.13).
20. Trial and compare the use of pheromone traps in spawning habitats versus riverine locations.
21. Capitalise on current zero flows within the lower Lachlan River by targeting carp removal within isolated drought refugia.
22. Model the long-term outcomes of the proposed carp control plan using CARPSIM.
23. Undertake a basic financial analysis assessing the cost-efficiency of the range of removal strategies implemented.
24. Use otolith microchemical analysis to gauge changes in the contribution of recruits from the Lake Cargelligo hotspot to the broader lower Lachlan system following management actions, and identify additional hotspots within the demonstration site.
25. Monitor changes in the carp population and those ecosystem variables quantified during the benchmarking phase.
26. Conclude the exclusion plot assessment of carp impacts.
27. Monitor changes in community attitudes to carp, their impacts and the project.
28. Implement the projects Community Engagement Strategy.
29. Dependant on flows inundating the Great Cumbung Swamp within the project period.

Summary:

During an initial benchmarking phase undertaken between January 2007 and February 2009, a multi-partner collaborative team under the auspices of the Invasive Animal Co-operative Research Centre (IA CRC) established a 'demonstration site' in the lower Lachlan catchment. Its purpose was to trial and show-case carp control technologies developed through the IA CRC's Freshwater Products & Strategies program (http://www.invasiveanimals.com/research/freshwater_products_and_strategies/index.html). During this initial phase, the status of the local carp population and other important aquatic ecosystem variables were documented across the lower Lachlan catchment and in neighbouring waterways (controls). A social dimension was also incorporated into the benchmark assessment by undertaking a survey of the Lachlan Valley community's attitudes towards carp, their impacts and the health of the Lachlan River. Concurrently, a number of auxiliary assessments and pilot exercises were undertaken and plans were developed for the infrastructure that would facilitate rapid implementation and adoption of a carp control plan during the subsequent implementation phase.

The intention for the second phase of this project is to lower carp biomass to a point where reduced impacts of carp on the aquatic environment can be demonstrated by measurable recovery of aquatic ecosystem indicators. Priority activities under the carp control plan include limiting or preventing migration of large carp into known recruitment hotspots within the catchment using 4 approaches: specially designed traps; William's Carp Separation Cages on fishways to harvest carp migrating within the river channel; pheromone traps to attract carp to specific control points; the Judas carp approach to maximise the commercial harvest and removal of carp from Lake Cargelligo. There will also be several auxiliary investigations done, including a comparison of the efficiency of pheromone traps in lake versus flowing water environments and investigating options for targeted carp control in the Great Cumbung Swamp. Success of the project will be evaluated using results from the monitoring program established during the benchmarking phase. Further, otolith microchemical analysis will be used to gauge changes in the contribution of recruits from the Lake Cargelligo carp breeding hotspot to the broader lower Lachlan system following management actions. The cost-effectiveness of each carp removal strategy will be determined and compared using a basic cost-benefit analysis. Community education and engagement will be facilitated by following the project's community engagement strategy.

Research Project Description

Project title:

Drought emergency response for endangered southern Pygmy Perch in Coppabella Creek
(Con2009/184)

Principal Investigator:

Dr Dean Gilligan

Funding Sources:

NSW Department of Primary Industries, the Murray Darling Basin Authority and the Murray Catchment Management Authority.

[Note: This is a collaborative project with the NSW Department of Primary Industries' Fisheries Conservation & Aquaculture Branch]

Objectives:

1. Map the distribution of remnant water within Coppabella Creek and assess the risk to each remnant pool.
2. Document the presence/absence of Southern Pygmy Perch within remnant pools.
3. Quantify the status of the remnant population in 6-8 locations throughout the creek.
4. Rescue Southern Pygmy Perch from those pools at high risk of drying and maintain them in ponds at the Narrandera Fisheries Centre.
5. Once drought conditions ease, release the rescued fish at their collection locations as well as additional sites with viable habitat in order to minimize future drought risk to the population.

Summary:

Southern Pygmy Perch are one of the 15 threatened freshwater fishes of NSW. They were formerly abundant throughout the southern rivers of the Murray-Darling Basin but suffered a severe decline since the 1970s. Only five isolated remnant populations have been found in NSW since 2000 and two of these may have already been lost, leaving just three known remnant populations. One of these occurs in Coppabella Creek (Murray River catchment), a small tributary (38 km long) of the upper Murray near Jingellic. Coppabella Creek was heavily drought-affected in 2006 and 2007, and as an emergency drought response, over a hundred fish were removed from shallow remnant pools and held in a pond at the Narrandera Fisheries Centre until flows in the creek returned, at which point these fish were returned to Coppabella Creek. However, persistent low rainfall throughout 2008 and 2009 has resulted in even drier conditions in Coppabella Creek and remnant pools are drying rapidly, with several small pools known to support thousands of pygmy perch drying totally between February and March 2009.

In February 2009, around 1000 fish were rescued from drying pools, with 800m being held at Narrandera and the remainder at a facility at Tumut. These fish are being held until a suitable release location can be found. Further, rescue efforts are required in numerous other drying pools in Coppabella Creek, and suitable reintroduction sites need to be identified. Funding has been obtained from the Murray Darling Basin Authority and the Murray CMA to facilitate this.

This exercise will involve mapping the location and depth of remnant pools within Coppabella Creek, rapid assessment fish surveys in remnant pools to establish whether pygmy perch are present or absent and standard fish community surveys of several remnant pools will be undertaken to assess the status of the populations present. If populations are found to be present in pools with a high risk of drying, these fish will be removed and held in ponds at the Narrandera Fisheries Centre. These will be maintained until flows once again return to Coppabella Creek and they can be released. Habitat quality in neighbouring creeks will also be assessed for potential as additional release locations to minimise the risk of future drought impacts or catastrophes in Coppabella Creek.

The mapping of the remnant pools and determining the extent of the population will allow for a greater understanding of the risk and security of this population. It will allow for more informed planning on how to best manage this population in these dry times.



Pool containing many hundreds of Southern Pygmy Perch on the 17/2/09



The same pool completely dry 5/3/09

Research Project Description

Project title:

Scoping study to determine methodologies and data availability for identifying native fish hotspots in the Murray-Darling Basin
(Con2009/185)

Principal Investigator:

Dr Dean Gilligan

Funding Sources:

NSW Department of Primary Industries, the Murray Darling Basin Authority and the Murray Catchment Management Authority.

[Note: This is a collaborative project led by Alison King of DSE Victoria with involvement from a number of research partners from across a wide range of MDB jurisdictions.]

Objectives:

1. Define the 'hotspots' concept for use within the Murray-Darling Basin (MDB).
2. Establish the types of datasets, and where possible identify specific datasets, that would be applicable in determining 'hotspots' throughout the MDB,
3. Explore the management applicability and use of defined native fish 'hotspots' throughout the MDB.
4. Identify custodians of important fisheries related datasets that may help to establish 'hotspots' in the MDB.
5. Explore the literature and review the utility of the 'hotspots' concept with the known biology and ecology of several target species.
6. Assist with literature review of appropriate methodologies and experimental designs for determining 'hotspots' for native fish in the MDB.

Summary:

The native fish 'hotspots' project is a collaborative partnership involving the NSW Department of Primary Industries (NSW DPI), the Arthur Rylah Institute (ARI) for Environmental Research (Victoria), and a number of other research partners from throughout the various Murray-Darling Basin (MDB) jurisdictions. The 'hotspots' concept is typically used to describe 'biodiversity hotspots', where key regions or areas are identified that support largely intact natural ecosystems and the diversity of native and endemic species are considered to be extremely high. The MDB Commissions Native Fish Strategy identified the need for targeted management and protection of some areas, termed "Habitat Management Areas", that remain in relatively good condition and important for native fish. However, one of the primary constraints to the establishment of a system of representative Habitat Management Areas (or freshwater protected areas) throughout the MDB, is the clear identification and justification of suitable sites. This project will review the existing literature and available data from throughout the MDB, and undertake extensive consultation with a range of relevant experts to develop an appropriate experimental design and methodology which could be used in Stage II of the project to identify 'hotspots' across the MDB that are significant for native fish. Although the scoping study will principally focus on a number of key species (Murray cod, Silver perch, Golden perch and Eel-tailed catfish), it also proposed to consider whether the 'hotspots' concept is applicable to other common (e.g., Australian smelt, un-specked hardyhead) and threatened species (e.g., Macquarie perch, southern pygmy perch), and also determine how consistently the 'hotspots' identified for one species overlap with those of others.

Research Project Description

Project Title:

Do artificial substrates facilitate the invasion of NSW estuaries by exotic marine invertebrates?
(Con2003/075)

Principal Investigator:

Dr Tim Glasby

Funding Sources:

NSW Department of Primary Industries, the University of NSW and the Australian Research Council (ARC Linkage Project No. LP0562518).

Objectives:

1. Determine the relative abundance of exotic species on artificial structures vs natural rocky reefs in the major harbours around Sydney.
2. Investigate the ecological characteristics that might predispose introduced fouling organisms to dominate artificial structures.
3. Investigate the impacts that exotic species have on natural systems (rocky reefs).
4. Monitor the establishment of exotic species (including those listed officially as pests) and develop survey protocols for these species in major NSW ports and other estuaries.

Summary:

The introduction of exotic species is considered one of the greatest threats to biodiversity, second only to habitat destruction. There is presently very little information about the distribution and abundance of exotic marine species in NSW, or indeed Australia and few studies in the world have investigated the impacts of invasive marine species on native biota.

This Ph.D. project will investigate the distribution of various exotic species in estuaries (concentrating on the major ports and harbours in the greater Sydney metropolitan area) and determine whether artificial structures in harbours and estuaries (e.g., pontoons and pilings) enhance the spread of exotic marine invertebrates (e.g., barnacles, mussels, oysters, bryozoans, ascidians and sponges) and facilitate the invasion of nearby rocky reef habitats. The project will involve sampling fouling organisms on artificial structures in areas with different degrees of boating activity, namely commercial shipping ports, recreational marinas, private berths (associated with residential properties along the foreshore of the harbour) and non-mooring areas (rocky reefs) and so will also provide information about the possible roles of different types of boating in transporting exotic marine organisms. Techniques developed during the project will be useful for refining port survey protocols and the sampling done over the 3 year study will provide crucial monitoring data for the current status of pest species in waterways around Sydney.

Importantly, the project will investigate whether exotic species are having impacts on native organisms living on rocky reefs by experimentally manipulating the abundances of these species. Some fouling species (e.g., mussels) are well known to have major impacts overseas, while others (such as ascidians) have also recently been identified as serious marine pests (see attached additional information). With such information, we will be able to better understand the effects of artificial structures and determine what kinds of structures might have the fewest impacts on native biota in terms of spreading exotic species. A by product of the research will be a comprehensive inventory of the invertebrate biodiversity on hard substrata in the estuaries around Sydney.

Research Project Description

Project Title:

Interactions between the invasive alga, *Caulerpa taxifolia*, and native species and habitats
(Con2004/085)

Principal Investigator:

Dr Tim Glasby

Funding Sources:

NSW Department of Primary Industries, the University of Technology, Sydney and the University of Newcastle.

Objectives:

1. Determine whether beds of seagrass are being invaded by *Caulerpa taxifolia*.
2. Establish whether sparse beds of seagrass are more susceptible to invasion by *Caulerpa* than dense beds.
3. Examine the value of *Caulerpa* as a habitat for native fishes and invertebrates and the effects that *Caulerpa* may have on these native species.
4. Examine relationships between soft sediments and *Caulerpa* in an attempt to document and understand the fluctuations in the abundance of the seaweed.

Summary:

The noxious seaweed *Caulerpa taxifolia* was first discovered in NSW in 2000 and now occurs in 13 estuaries or coastal lagoons. Since its discovery, a great deal of effort has gone into trying to control the species. While partial control has been successful in some estuaries, in others the seaweed has continued to spread despite attempts to kill it using salt. Thus, it appears that *Caulerpa* cannot be eradicated completely using current methods and we need to investigate the effects that this invasive species is having on native biota. Such studies will assist us to understand better the consequences of *Caulerpa* invading our estuaries, and help us target control efforts towards the most vulnerable parts of estuarine ecosystems.

This project will consist of several targeted studies that will provide information about the effects that *Caulerpa* is having on native species and habitats. Detailed surveys of *Caulerpa* will be done in areas where native seagrasses (such as *Posidonia* and *Zostera*) are common and these will be followed by experiments to test whether *Caulerpa* is capable of outcompeting (and killing) seagrass. These experiments will also help determine whether some seagrass beds are more resistant to invasion by *Caulerpa* than others. Sampling of fishes and invertebrate communities in seagrass and in beds of *Caulerpa* will provide information about the role of *Caulerpa* as habitat for fishes and invertebrates. This information will enable us to understand better the effects that the spread of *Caulerpa* might have on biodiversity in NSW estuaries, and consequently the level of threat that it poses to commercial and recreational fisheries.

The final aspect of this project will be an investigation of the growth of *Caulerpa* on soft sediments. The seaweed has been observed to thrive and then suddenly disappear from some sites for no apparent reason. These patterns will be documented and experiments will be designed to determine their causes. Such information will assist greatly with refining the current NSW Department of Primary Industries *Caulerpa* control plan.

Research Project Description

Project Title:

Distribution and abundance of *Caulerpa taxifolia* in NSW
(Con2004/099)

Principal Investigator:

Dr Tim Glasby and Dr Bob Creese

Funding Sources

NSW Department of Primary Industries.

Objectives:

1. Map the distribution of *Caulerpa taxifolia* in NSW waterways. [note – this objective discontinued Dec'08]
2. Examine temporal changes in the distribution and abundance of *C. taxifolia*.

Summary:

Since being discovered in NSW in April 2000, *Caulerpa taxifolia* has spread widely and has now been recorded in 13 estuaries or coastal lagoons. Mapping is essential to document the distribution of this invasive species so that management and control measures can be made as effective as possible. Information on the distribution of invasive species is also needed by various other state and federal organisations and is often requested by the general public.

This project initially utilised a rapid survey mapping technique to document the distribution and abundance of *C. taxifolia* in NSW waterways during summer and winter over a number of years. Field surveys were done from a small boat equipped with a specially designed, habitat mapping system involving a global positioning system (GPS), laptop computer and underwater video. Detailed mapping of all *Caulerpa* beds is now too time consuming to do, and all previous maps have been augmented to produce cumulative distribution maps of all known infestations of *Caulerpa* which are available on the NSW DPI website. Now, rather than creating detailed maps of *Caulerpa*, we are estimating the abundance of *Caulerpa* along transects in each of the 13 estuaries or coastal lagoons. This method is much quicker than mapping, but still provides the same information about changes in abundance of *Caulerpa* over time.

Research Project Description

Project title:

Marine biodiversity in NSW estuaries – native and exotic species surveys
(Con2004/086)

Principal Investigator:

Dr Tim Glasby

Funding Sources:

NSW Department of Primary Industries.

Objectives:

1. Identify pest species that could become established in NSW and develop an ‘early warning’ system for detecting these species.
2. Gather data on the distribution and abundance of exotic marine species.
3. Monitor known pest incursions, e.g., the fan worm *Sabella spallanzanii*, the green crab *Carcinus maenas* and the New Zealand screwshell *Maoricolpus roseus*.
4. Design experiments to investigate the impacts that introduced species may have on native biota.
5. Investigate where and how introduced species become established.
6. Conduct targeted biodiversity surveys in selected NSW harbours and estuaries.

Summary:

Estuaries are popular sites for urbanization and recreational activities, they support commercial and recreational fisheries and are commonly cited as being important nursery areas for marine animals. Threats to estuaries from human activities are numerous and have been increasing steadily as urbanization of the coastal zone continues. Despite their ecological and commercial importance, there is a paucity of ecological knowledge about estuaries in Australia.

Habitat alteration and the introduction of non-native species are considered two of the greatest threats to native biodiversity. In estuaries, these two processes are often coincident. In order to meet the obligations of the UN Conventions on the Law of the Sea and Biological Diversity, we must understand the effects that exotic species can have on our native biota and how these species can spread. There is currently limited information about the distribution and abundance of native and exotic marine species in NSW, particularly those that live below the level of low tide. It is, however, known that various exotic species are present in Australian marine waters and that the majority of these are marine invertebrates that grow on hard surfaces.

This project is multi-faceted and includes reviews of literature and liaising with national and international experts to gather information about pest species that could be introduced into NSW. Second, an early warning system will be developed for marine invertebrate pests (species already present in NSW and those that could invade). One aspect of this will involve deploying small concrete panels, onto which invertebrates (such as mussels and oysters) can settle and grow, at different positions in estuaries throughout NSW and collecting these at various times to check for the presence of exotic (and native) species. Surveys for other pest and native species will involve using underwater video, baited traps and benthic trawls. In addition, information brochures on some of the most “unwanted” pest species in NSW will be distributed to various dive groups, researchers and consultants who regularly sample marine species. Finally, laboratory and field-based experiments will be designed to investigate the ways that exotic species establish and spread, and to determine their impacts on native biota.

Research Project Description

Project Title:

How to develop and build seawalls to enhance native marine biodiversity and deter exotic species
(Con2005/105)

Principal Investigator:

Dr Tim Glasby

[Note: This is a collaborative project with the University of Sydney]

Funding Sources:

NSW Department of Primary Industries, the Australian Research Council (Linkage Project No. LP0667593), the University of Sydney, NSW Maritime, Sydney Ports, NSW Department of Environment & Conservation and the Sydney Coastal Councils.

Objectives:

1. Determine which types of seawalls support the most diverse marine communities.
2. Investigate why seawalls create habitats different from natural rocky shores and whether this difference contributes to the successful establishment of exotic pest species.
3. Investigate ways in which seawalls can be modified to enhance native biodiversity and minimise colonization by exotic species.
4. Examine the effects that seawalls have on the biodiversity of the adjacent seafloor.

Summary:

Increasing urbanization of coastal zones has led to natural habitats being reclaimed and shorelines being “armoured” with structures such as seawalls and breakwalls. This trend will continue in the future with climatic change leading to a rise in sea level and increased frequency of storms. Many marine invertebrates and seaweeds live attached to hard surfaces. Replacing natural shores with artificial structures could have significant impacts on these species which are a very important component of the food chain in coastal harbours such as Port Jackson, Botany Bay, Port Kembla and Eden. Ultimately, many commercially and recreationally valuable estuarine fish species depend on these species.

Of particular concern is the fact that many native species that are normally found on natural rocky shores do not colonise artificial structures. Instead, these structures are often colonised by exotic species. Further, some native species on seawalls do not grow as big as they normally would which may reduce their potential to breed.

NSW DPI is responsible for the conservation of native aquatic biodiversity and habitats. The proposed research will provide a better understanding of the ways that humans impact on the marine environment. If seawalls replace areas of natural rocky shoreline, this may have flow on effects to fishes and other estuarine species. The project will investigate whether particular types of artificial structures support more natural and diverse communities of species and will determine any indirect effects that these structures have on the animals living in or on the adjacent sandy and muddy seafloor (e.g., due to altered patterns of water flow and accumulation of seaweeds).

Results of this work will help inform management decisions about the construction of seawalls and so help ameliorate any impacts of seawalls on marine biodiversity. The project is a major collaborative initiative involving researchers at the University of Sydney and NSW DPI with funding and logistical support from the Australian Research Council and several other agencies.

Research Project Description

Project Title:

The effectiveness of marine protected areas as a conservation tool for syngnathids
(Con2004/103)

Principal Investigators:

Mr David Harasti and Dr Tim Glasby

[Note: This is a collaborative project with Dr Bill Gladstone at the University of Newcastle and Dr Keith Martin-Smith at the University of Tasmania and is also Mr Harasti's PhD project]

Funding Sources:

NSW Department of Primary Industries, the University of Newcastle and the Sydney Aquarium Conservation Fund

Objectives:

1. Determine the distribution and abundance of syngnathids within Port Stephens.
2. Examine the effectiveness of marine protected areas as protection for syngnathids.
3. Examine the biology and ecology of *Hippocampus whitei* and *Filicampus tigris*.
4. Assess the importance of artificial structures and epibiota as habitat for seahorses.
5. Determine if captive bred seahorses survive when released into the wild.

Summary:

The Syngnathid family consists of seahorses, pipefishes, pipehorses and seadragons. There is international concern about declining seahorse populations as a result of over-harvesting, declining water quality and damage to their habitats. All syngnathids were protected in New South Wales in July 2004 and it is now illegal to take, buy, sell or possess any of the species in this family. Little work has been done on syngnathid populations in NSW waters. This project will enhance our knowledge about the biology and ecology of seahorses and determine the effectiveness of marine protected areas in providing protection for seahorses.

This project will focus primarily on White's Seahorse (*Hippocampus whitei*), a species found in sheltered waterways from Port Stephens to Sydney. Most work is being done in Port Stephens where we are comparing the distribution and abundance of White's Seahorse and Tiger Pipefish between the Fly Point aquatic reserve and similar habitats outside the reserve. We are also examining habitat preferences and depth ranges of White's Seahorse and other syngnathid species. The project involves mapping of the habitats used by the seahorses and tagging individuals to track their movements and to estimate population sizes.

As part of the study, we are investigating the potential for captively bred White's seahorses to be released back into the wild. Captively bred animals are being tagged in aquaria and released into the wild at various locations inside and outside the aquatic marine reserve. The released seahorses will be monitored to determine survival rates in the wild and whether their size/age influences survival.

The final component of the project assesses the importance of marine growth (fouling) on artificial structures (protective swimming enclosure nets) for seahorses. Within Port Jackson, populations of seahorses (pot-belly seahorse & White's Seahorse), can be found living on the protective swimming nets at various locations. Local councils clean and repair the nets on an adhoc basis. Observations have revealed that the cleaning/removal of nets can significantly reduce the numbers of seahorses in these areas. This project will assist Manly council with their future maintenance and cleaning of nets by determining the best methodologies for cleaning to minimise impacts on the local seahorse population. In addition, captively bred individuals (with unique identifying tags) will be released onto the artificial structures and monitored to determine if and when they use the structures as habitat.

Research Project Description

Project Title:

Marine pest surveys in the Southern Rivers catchment
(Con2006/137)

Principal Investigator:

Dr Tim Glasby

Funding Sources:

NSW Department of Primary Industries and the Southern Rivers Catchment Management Authority.

Objectives:

1. Determine presence and/or absence of targeted marine pest species in five south coast estuaries.
2. If targeted marine pest species are detected, determine the extent of their distribution.
3. Provide recommendations for eradication or control programs for new marine pest incursions.
4. Increase public awareness about marine pests by distributing pest identification cards.

Summary:

There are currently seven recognised marine pests in NSW, and four of the highest profile pest species are known to occur in some parts of the Southern Rivers catchment which extends from Port Hacking to Eden. Once a marine pest becomes established (i.e., a reproductive population is maintained in large numbers), it is generally impossible to eradicate and often becomes difficult to control. Thus it is imperative that any new pest incursions are detected early, before numbers have built up, so that eradication can be attempted, and control programs can stop further spread.

Surveys for marine pests will be done in estuaries that have rarely or never been surveyed, namely Port Kembla, Jervis Bay, Bateman's Bay, Shoalhaven River and Merimbula. The main target species will be the European fanworm *Sabella spallanzanii*, the European green crab *Carcinus maenas*, and the New Zealand screwshell *Maoricolpus roseus*. These species are known to occur in Twofold Bay, but it is not known whether these species might occur in estuaries to the north. The green crab has, however, been reported from some areas between Eden and Sydney (most recently from Port Kembla), but estimates of its abundance have not been made. Targeted surveys will be done on two occasions over a period of 18 months in each of the five estuaries within the Southern Rivers catchment. If the species of concern are detected, then recommendations for eradication or control programs will be provided.

Research Project Description

Project Title:

Associations between *Caulerpa taxifolia* and sediments
(Con2007/150)

Principal Investigator:

Dr Tim Glasby

[Note: This is a collaborative project with Dr Paul Gribben at the University of Technology, Sydney]

Funding Sources:

NSW Department of Primary Industries, the University of Technology, Sydney and Southern Cross University.

Objectives:

1. Test whether the growth of *Caulerpa* is correlated with levels of nutrients in sediments.
2. Examine the relationships between sediment nutrients and the health of seagrass and *Caulerpa*.
3. Develop a model that can help predict the distribution of *Caulerpa* in NSW estuaries.

Summary:

Since its discovery in NSW in 2000, control efforts by NSW Department of Primary Industries have helped slow the spread of the seaweed, but eradication is not possible. There is some evidence that the growth of *Caulerpa* is affected by nutrients in sediments and so the distribution of this species may be closely associated with levels of nutrients (such as nitrogen & phosphorous) in estuarine sediments. *Caulerpa* may also influence the nature of the sediments in which it grows, by for example, reducing oxygen levels. This project will aim to determine the extent to which sediment nutrients influence the growth of *Caulerpa*. Manipulative experiments will investigate the effects of *Caulerpa* on sediment chemistry and the possible flow on effects to seagrasses.

Research Project Description

Project Title:

Experimental cultivation and rehabilitation of seagrass
(Con2007/153)

Principal Investigator:

Dr Tim Glasby (NSW DPI – Systems Research) and Dr's Ross Worrall and Sophie Parks (NSW DPI – Production Research)

Funding Sources:

NSW Department of Primary Industries and the Environmental Trust.

Objectives:

1. Trial methods for growing and enhancing the growth of *Posidonia* seedlings.
2. Examine tissue culture techniques for propagating *Posidonia*.
3. Determine the best method for planting *Posidonia* seedlings and rhizomes in the wild.
4. Monitor the long-term success of seedlings and rhizomes in the wild.
5. Determine the optimal sediment characteristics for growth of *Posidonia*.
6. Examine methods for enhancing re-growth of damaged *Posidonia* beds.

Summary:

The seagrass *Posidonia australis* (also known as strapweed) is considered an important habitat-forming species for a variety of marine animals. The amount of *Posidonia* in NSW, and in fact the world, has been declining. *Posidonia* is a true grass and it reproduces primarily from seeds that are borne in fruits. Although numerous seeds can be produced, no seed bank is created in sediments and the survival of seedlings in the wild is relatively poor. This poor seedling survival, coupled with the fact that mature plants grow relatively slowly, means that beds of *Posidonia* that are damaged by human activities can take many years or decades to recover. This project aims to cultivate *Posidonia* in the laboratory and develop techniques for enhancing the growth and survival of the species in the wild. *Posidonia* will be grown from seeds and using the expertise of NSW DPI horticulture researchers, we will develop techniques for propagating plants from rhizomes based on methods developed for terrestrial plants. Methods for planting *Posidonia* will be investigated and data on the sediment requirements for *Posidonia* will be obtained. The results of this project should greatly enhance our knowledge about *Posidonia* in NSW and enable small-scale rehabilitation of damaged *Posidonia* beds.

Research Project Description

Project title:

Using rocky reef biota for monitoring the condition of the marine waters of NSW
(Con2008/176)

Principal Investigator:

Dr Tim Glasby and Dr Bob Creese

Funding Sources:

NSW Department of Primary Industries, the Natural Heritage Trust Fund (NHT2) and Catchment Action NSW.

Objectives:

1. Identify sensitive marine species that are likely to respond to direct and indirect human impacts (e.g., pollution, climate change).
2. Monitor changes in these sensitive marine species over time in selected locations throughout NSW (ranging from heavily impacted to mildly impacted).
3. Map estuarine and nearshore coastal rocky reefs, including the dominant habitat-forming species on these reefs.
4. Compile information summaries for regional marine environments in NSW.

Summary:

The Monitoring Evaluation & Reporting (MER) program for the marine waters of NSW, has 4 primary indicators. Three of these relate to water quality or Marine Parks and are managed by the Department of Environment, Climate Change & Water (DECCW). The fourth is titled 'rocky reef biota', and incorporates a range of possible sub-indicators. This integrated research project has been established to investigate which are the most useful sub-indicators and to develop methodologies and protocols to measure them at regular intervals across the state and hence contribute to the overall assessment of the health of marine waters in NSW. The research documents the geographical distribution patterns of various marine habitats and, within those, the occurrence and/or abundances of key marine species. The project focuses on shallow, near-shore coastal habitats and species, but also covers some estuarine rocky reefs and shorelines. These habitats are potentially some of the most impacted in the marine environment due to their close proximity to urbanisation, yet they are little understood. Human modification of shoreline habitats (e.g., land reclamation, breakwalls, retaining walls, etc.) are also documented to help identify and quantify the pressures imposed upon estuarine and coastal marine habitats. Human harvesting of key species within these habitats is assessed to provide a measure of both the condition of the resource and the pressure being placed on it.

The main aim of this project is to test for changes in rocky reef habitats and/or key indicator organisms over time and to determine, where possible, the extent to which these changes are caused by human impacts. The study is also designed to test hypotheses about effects of climate change (including sea level rise, increased storm activity) on rocky reef assemblages. For example, the abundance, spatial distribution and persistence of juvenile tropical fish on sheltered shallow reefs may indicate changes in water temperature and/or the strength of the East Australian Current. Reef habitats such as algal beds are sampled in numerous locations throughout the state using new techniques including low altitude digital photography using helicopters. This enables large-scale sampling not previously attempted for intertidal rock platforms, and also provides permanent records of these marine habitats. Maps showing locations of subtidal and intertidal rocky reefs will be produced. Concurrent investigations, in partnership with University collaborators, will investigate smaller scale ecological processes within these reef habitats to assist our understanding of how these complex systems function.

Research Project Description

Project title:

Monitoring and rehabilitation of seagrass
(Con2009/186)

Principal Investigator:

Dr Tim Glasby

Funding Sources:

NSW Department of Primary Industries and Energy Australia.

Objectives:

1. Develop methods for rehabilitating damaged beds of *Posidonia australis*.
2. Assess and monitor changes in seagrass beds due to human disturbances.
3. Develop new techniques for assessing natural short- and long-term changes in the size and density of seagrass beds.

Summary:

Seagrasses fill a number of important roles in estuaries and species such as *Posidonia australis* (strapweed) are particularly susceptible to human disturbances such as physical damage and pollution. *Posidonia* can be slow to recover after being damaged and natural recruitment of *Posidonia* seedlings is rare. The seagrasses in Botany Bay, in particular, are under considerable threat from human disturbances. For example, the expansion of Port Botany requires the removal of beds of *Posidonia* and the continual addition of rock gryones has indirect impacts due to changed patterns of water flow. To add to these pressures, Energy Australia has recently been granted permission to damage a bed of *Posidonia australis* at Kurnell. Six power cables and two fibre optic cables will be laid across Botany Bay from Kurnell to La Perouse to help secure future energy supplies for Sydney. To minimise damage to the entire seagrass bed, it is proposed that two defined trenches (600 m long x 0.6 – 0.8 m wide x 0.3 m deep) be cut through the bed before the cables are bundled and laid beneath the sediment.

Energy Australia has provided funding to contribute to research on seagrasses and, in particular, to ameliorate any effects this project may have on the seagrass bed. Experiments and sampling will be designed to (a) document changes in the area and shape of the seagrass bed at Kurnell (e.g., due to blow-outs from trench), (b) compare the effectiveness of various rehabilitation techniques and (c) examine natural recovery of the seagrass bed. This project will also provide an opportunity to begin development of new techniques for assessing large-scale changes to the size and density of seagrass meadows.

Research Project Description

Project title:

Management of coastal lakes to minimise invasion by marine pests
(Con2009/200)

Principal Investigator:

Dr Tim Glasby

[Note: this is a PhD project supervised primarily by Dr Melanie Bishop (Macquarie University) and co-supervised by Dr's Brendan Kelaher & Melinda Coleman (Batemans Marine Park) & Dr Tim Glasby (NSW DPI)]

Funding Sources:

NSW Department of Primary Industries; the Australian Research Council (ARC Linkage Grant LP0660568); Macquarie University; Batemans Marine Park; Southern Rivers Catchment Management Authority; and the Eden Discovery Centre.

Objectives:

1. Ascertain whether natural and artificial opening and closing regimes of intermittently closed coastal lakes influence the spatial distribution of established *C. maenas* populations.
2. Determine whether closed entrances serve as a physical barrier to larvae produced offshore and/or produce lake conditions that are unsuitable for successful reproduction.
3. Assess whether *C. maenas* are more susceptible to aggressive and competitive interactions with native crabs in closed than open lakes.
4. Provide critical information about invasive pest control to managers of estuarine systems to aid in long-term conservation of Australia's native marine biota.

Summary:

Some non-indigenous marine species that successfully establish in coastal habitats cause economic or environmental harm by reducing biodiversity, impacting sustainable harvesting and aquaculture or causing losses of important ecosystem functions. Minimisation of these impacts is dependent on a comprehensive understanding of factors that influence each stage of the invasion process. The European green crab, *Carcinus maenas*, was first introduced into Australia over 100 years ago. Despite predictions that its broad environmental tolerances and opportunistic life history would enable it to spread rapidly northward to Queensland, the crab has only ever been found as far north as Botany Bay where it was last observed over 20 years ago. Over the past 3 years, sampling by NSW DPI has found *C. maenas* in 14 estuaries or coastal lakes in southern NSW, ranging from Wonboyn River to Batemans Bay.

Although interactions with native species may partially explain why *C. maenas* has failed to establish in many NSW estuaries, the fact that many south coast estuaries can remain "closed" to the sea by sand bars might also influence the patterns of colonisation by the invasive crab. Water conditions in these Intermittently Closed Coastal Lagoons and Lakes (ICOLLs) range from near freshwater to hypersaline, depending on local rainfall, tidal and freshwater flows, surface area, catchment size and catchment characteristics including land use. This study will investigate whether populations of *C. maenas* in ICOLLs are transient and if so, determine why. We will ascertain how estuarine morphology, especially cycles of natural and managed opening and closing of sandbars, impacts on the dynamics of *Carcinus maenas* invasion and spread in NSW.

Research Project Description

Project title:

High resolution aquatic habitat mapping
(Con2010/217)

Principal Investigator:

Dr Tim Glasby and Mr Greg West

Funding Sources:

NSW Department of Primary Industries and various external consultancies (e.g., Department of Environment, Climate Change & Water, the NSW Marine Parks Authority and Catchment Management Authorities).

Objectives:

1. Create detailed maps of aquatic habitats (e.g., seagrass beds, mangroves, saltmarshes, rocky reefs) for monitoring changes over time.
2. Use detailed maps to test for environmental impacts at small spatial scales.

Summary:

Aquatic plants have been mapped in most NSW estuaries, but due to the work involved and the reliance on aerial photos typically obtained for other purposes, it is rare that any estuary has been mapped more than twice over the last 20 years. Consequently, we have limited understanding of the changes to aquatic plants over short time scales. Furthermore, the resolution of previous maps has meant that only large changes in the shapes of beds of aquatic plants can be detected. Advances in technology have meant that low altitude, high resolution digital images can be captured relatively easily. Such images can be used to generate extremely detailed maps which can discriminate species, identify patchiness within habitats and even estimate the density of cover of each habitat. This technology will be used to map various marine and estuarine habitats at small spatial scales, particularly in relation to testing for environmental impacts (e.g. due to boat moorings, powerstations, etc.). Areas can be re-mapped over time and compared to control locations to distinguish between human-induced changes to habitats from natural changes. Information about threats to habitats can also be overlaid on maps, thereby assisting threat prioritization and management actions.

Research Project Description

Project Title:

MPA's for the conservation of rocky intertidal communities
(Con2000/008)

Principal Investigator:

Dr Nick Otway

Funding Sources:

NSW Department of Primary Industries and Environment Australia (Marine Protected Areas Program).

Objectives:

1. Map the location of rocky intertidal shores in Manning Shelf Bioregion.
2. Document the habitats present on the rocky intertidal shores in Manning Shelf Bioregion.
3. Document the spatial variation in biota, and overall biodiversity for the rocky intertidal shores in Manning Shelf Bioregion.
4. Identify candidate sites for a system of MPAs assisting with the conservation of rocky intertidal communities in the Manning Shelf Bioregion.

Summary:

Rocky intertidal communities have, over the past decade, been subjected to ever-increasing, human-induced pressures via the collection of organisms for bait and food. In response to this, NSW Department of Primary Industries is currently involved in identifying candidate sites along the entire NSW coast for possible declaration as aquatic reserves to help protect the biodiversity of rocky intertidal communities.

This project is focusing on the Manning bioregion. It uses methodology developed in a previous project to: (1) map the location of rocky intertidal shores, (2) conduct a preliminary site assessment to document accessibility and, where accessible, the habitats present, (3) carry out detailed sampling of the rocky intertidal community in the habitats identified to document the spatial variation in biota, and overall biodiversity for the habitats sampled, (4) analyse data and identify those sites with the highest biodiversity, their spatial dispersion any obvious gaps within the bioregion, and (5) identify candidate sites for a system of MPAs for the conservation of rocky intertidal communities.

The project forms part of the NSW government's commitment to the Commonwealth Government's Strategic Plan of Action for the development of a National Reserve System of Marine Protected Areas (NRSMPA). Potential candidate sites identified from this assessment will be incorporated into the selection process for a marine park in the Manning Bioregion.

Research Project Description

Project title:

Artificial Propagation of Grey Nurse Sharks via “*In Vitro*” Development
(Con2004/096)

Principal Investigators:

Dr Nick Otway

Funding Sources:

NSW Department of Primary Industries, the NSW Catchment management Authority and the Environmental Trust.

Objectives:

1. Review and summarise the past and present scientific literature that has implications for this project.
2. Quantify the reproductive cycle of grey nurse sharks in the east coast population and determine the timing of key events.
3. Analyse histologically the reproductive tracts of grey nurse sharks.
4. Quantify the biochemical composition of blood, uterine fluids, eggs and other tissues of grey nurse sharks.
5. Document the microbiological flora of the various tissues and fluids of grey nurse sharks.
6. Construct a prototype of an “artificial uterus” (AU) and associated monitoring equipment.
7. Refine the artificial uterus and then develop the ability to carry out the *in vitro* development of a wobbegong or another non-threatened shark species.
8. Develop appropriate surgical and monitoring procedures to harvest developing embryos from grey nurse sharks.
9. Test and refine the *in vitro* development of grey nurse sharks.
10. Release the *in vitro* pups into the wild and monitor their growth and survival.

Summary:

Research on the endangered grey nurse shark along the east coast of Australia has shown that the species is in a very precarious position and facing extinction in 10 to 20 years. A major problem faced by the shark is brought about by its own bizarre reproductive biology. Initially, many eggs start developing in the mother’s 2 uteri. But when the developing embryos hatch, they begin to hunt and consume each other (a process referred to as intra-uterine cannibalism). Only two pups survive the intra-uterine cannibalism (one in each uterus). Having consumed their siblings, the two remaining embryos then consume unfertilized eggs ovulated by their mother. Following a gestation of approximately 9 - 12 months, the two pups are born about 1 m long and weighing 8 kg each.

This research project will focus on developing the knowledge and techniques to bypass the intra-uterine cannibalistic stage and enable the artificial propagation of grey nurse sharks via “*in vitro*” development.

The research will be done in 4 Phases over 10 years. Phase 1 will comprise: (1) population reproduction; (2) histological; (3) biochemical; (4) microbiological; and (5) bioengineering components and involve the collection of all the basic biological information needed and the construction of a prototype of an “artificial uterus” (akin to a “humidicrib” for sharks). Phase 2 will comprise: (1) population reproduction; (2) biochemical; (3) microbiological; and (4) bioengineering components and focus on developing artificial uterine fluids and eggs, and the testing of the artificial uterus. The artificial uterus will be tested using embryos of wobbegong and/or other non-threatened sharks to avoid risk to the grey nurse shark. Once successful, the research will progress to Phase 3. This phase will involve the development of surgical techniques to harvest the embryos of grey nurse sharks prior to the cannibalistic stage, and their subsequent *in vitro* development in the artificial uteri. Phase 4 will focus on the release of grey nurse shark pups into the wild following successful *in vitro* development.

Research Project Description

Project Title:

Great White Shark Tagging Project
(Con2006/124)

Principal Investigator:

Dr Nick Otway

Funding Sources:

NSW Department of Primary Industries and the Northern Rivers Catchment Management Authority.

Objectives:

1. Document the migratory movements and the duration of occupation of sites by Great White sharks off NSW.
2. Quantify the interactions between Great White sharks and commercial and recreational fishers and encourage these groups to report these interactions (including their timing and location).
3. Document the localised movements of Great White sharks off Stockton Beach.
4. Identify sites that may prove to be critical to the survival of the species.
5. Use the movement data to better target the monitoring efforts of observer programs documenting the interactions between Great White sharks and commercial and recreational fishers.
6. Interpret the movement data and provide a preliminary estimate of the risk of attack (albeit extremely low) by Great White sharks at various locations along the NSW coast.
7. Educate commercial and recreational fishers, swimmers, surfers, other water users, conservation groups and the general public about Great White sharks, their identification, biology, important role in the ecosystem, reasons for listing as a threatened species, their current threats and status.

Summary:

This study will obtain information necessary for the NSW and National Recovery Plans for the Great White shark. In doing so, the project will quantify the interactions between Great White sharks and commercial and recreational fishers and encourage these groups to report these interactions. The migratory movements of Great White sharks will be documented by tagging individuals off Stockton Beach with pop-up archival satellite tags and acoustic tags. The pop-up archival satellite tags will record the position, water temperature and depth of the shark in the tag's memory. This information is then transmitted via satellite to NSW DPI scientists at the end of the tag's pre-programmed deployment. The acoustic tags will transmit their information to individual acoustic listening stations comprising the South East Australian Coastal Acoustic Monitoring System (SEACAMS). The localised movements of Great White sharks will be documented by using various acoustic tracking systems. The movements of these sharks will have important ramifications for managing their recovery and long-term conservation. For example, the movement data will be used to better target the monitoring efforts of observer programs documenting the interactions between Great White sharks and commercial and recreational fishers. The results will also be used to estimate the risk (albeit extremely low) to water users of possible attack by Great White sharks at various locations along the NSW coast. This project will also provide an opportunity to educate commercial and recreational fishers, swimmers, surfers, other water users, conservation groups and the general public about Great White sharks, their identification, biology, important role in the ecosystem, reasons for listing as a threatened species, their current threats and status.

Research Project Description

Project Title:

“Fishtrack”: Effects of flows and barriers on the distribution, abundance, movements and migration of freshwater fishes in the Clarence River System
(Con2006/129)

Principal Investigator:

Dr Stuart Rowland and Dr Gavin Butler

Funding Sources:

NSW Department of Primary Industries, the Northern Rivers Catchment Management Authority, the Recreational Freshwater Fishing Trust Fund, North Coast Water, Caring for Our Country Fund, Clarence Valley Council, Coffs harbour Council and Country Energy.

Objectives:

1. Implement years 3 and 5 of the project to monitor freshwater fishes in the upper Clarence River System.
2. Collect seasonal baseline data on the fish assemblages in the Clarence River System.
3. Assess fish assemblages and fish movements and migration in relation to environmental flows, fish barriers and stream bed stabilization in the upper Clarence River System.
4. Establish further links with collaborative funding bodies to develop an integrated tagging and tracking program to determine detailed movement and migration patterns of key fish species.
5. Tag freshwater catfish, Australian bass, bully mullet, freshwater mullet and eastern freshwater cod with radio or acoustic tags, and establish an array of listening stations to monitor movements and migration of these freshwater fishes in the Clarence River System.

Summary:

The Clarence is the largest coastal river system in NSW. It supports large commercial and recreational fisheries, as well as unique freshwater fish communities which include endangered species such as the eastern freshwater cod. The regional water supply for the rapidly growing human population in the Clarence Valley and Coffs Harbour area is sourced from the Nymboida and Orara rivers that are major tributaries of the Clarence River System. Large volumes of water are diverted from these tributaries, and the recently-constructed Shannon Creek Dam has become a key part of the water supply system. Besides Nymboida Weir, there are also natural barriers in the system, including the Clarence River Gorge. Barriers and altered flows due to water extraction potentially disrupt fish movements, migration and other aspects of fish biology and ecology. However, because little is known about the freshwater fish communities of the Clarence River System or the movement and migration of wholly freshwater and catadromous species, the actual effects of barriers and flows on fish in the system are not known. Fish are good indicators of aquatic ecosystem health, and there is a high public awareness of their commercial, recreational and ecological value. The key objectives of this project are to develop and implement a long-term fish monitoring program, and to use radio and acoustic tags and an extensive array of listening stations to increase our knowledge of fish movements and migration. The project will provide data and information about freshwater fish that is needed to understand the impacts of flows and barriers, and to enable adaptive management of water extraction and diversion, and fish passage in the Clarence River System, as well as other coastal catchments in NSW.

Research Project Description

Project title:

Recovering recreational fisheries for freshwater catfish (*Tandanus tandanus*) in the Murray-Darling Basin (Con2007/143)

Principal Investigator:

Dr Meaghan Rourke

Funding Sources:

NSW Department of Primary Industries the Recreational Freshwater Fishing Trust Fund and Fisheries Victoria.

Objectives:

1. Identify patterns of population structure in freshwater catfish and identify management units (i.e., genetically differentiated populations).
2. Provide recommendations regarding zonation or regions for broodstock collection and fingerling release.
3. Collect and present data describing the habitat requirements of freshwater catfish.
4. Identify suitable reintroduction sites within each Murray-Darling catchment based on current habitat conditions.
5. Compile all the necessary data required in order to have catfish approved for stocking under the NSW Freshwater Fish Stocking Fisheries Management Strategy.
6. Contribute to a report which is being prepared by the Department of Sustainability & Environment for Fisheries Victoria advising on the design of a genetically sound freshwater catfish breeding program in Victoria.

Summary:

Freshwater catfish (*Tandanus tandanus*) were formerly very abundant across most of the Murray-Darling Basin in inland New South Wales. Prior to the 1980s, they provided recreational fishing opportunities and are still considered one of the premier table fish by many rural people. However, catfish numbers have declined substantially in most inland catchments, virtually disappearing from the Murray, Murrumbidgee and Lachlan. Only those reaches upstream of dams or waterfalls that act as barriers to carp invasion still retain abundant catfish populations. Catfish are still relatively common in coastal catchments North of Newcastle. Catfish are now one of the rarest species of native fish in many waterways across their natural range. Their current poor status will inevitably lead to their listing as a threatened population unless actions are taken to restore them to a level of viability. Given that the recreational fishery will be closed if catfish are listed under threatened species legislation, it is in the interests of the recreational fishing community to take steps to prevent further decline and restore the viability of the population.

The invasion of carp, thermal pollution and river regulation are thought to be three of the primary causes of the decline in catfish populations. Given that carp populations have declined substantially over the last few years, the government has developed plans to remediate thermal pollution in several catchments, and environmental flows are now provided through the Water Sharing Plans, potential exists to restore viable catfish populations. However, natural recovery cannot be relied on in many waterways, given that catfish stocks are virtually non-existent over large areas. Therefore, a catfish stocking program would be a primary means of rapidly recovering the recreational fisheries for this species.

A catfish stocking program also provides opportunities to study stocking effectiveness. As opposed to programs for Murray cod, golden perch and silver perch, a catfish stocking assessment would be working from a virtually 'clean slate'. These opportunities can be used to scientifically assess the importance of habitat quality, stocking density and captive breeding v translocation of juvenile and adult fish in stocking programs. However, as a precursor to development and implementation of a catfish stocking program, data is required on the natural population genetic structure across their range, as specified in the NSW

Freshwater Fish Stocking Fisheries Management Strategy (FMS) and in the Murray-Darling Basin Authority's resource document on freshwater catfish. This project will supply that data.

Data on the habitat requirements of freshwater catfish will also be collected and analysed. Habitat data is useful for identifying and prioritising release locations. Further, habitat data can be used to guide development of habitat rehabilitation strategies at release locations and within existing populations to promote establishment and natural population growth. This project will then compile all the necessary data required in order to have catfish approved for stocking in Murray-Darling Basin waters under the NSW Freshwater Fish Stocking Fisheries Management Strategy.

An additional component to this project funded by Fisheries Victoria, and conducted by NSW I&I and the Department of Sustainability & Environment, seeks to synthesize available published and unpublished data regarding the historical distribution, translocation history and genetic structure of catfish in Victoria. It will provide a valuable resource to assist managers to identify the most suitable source populations of broodfish to establish or supplement existing catfish populations, including outlining how potential negative genetic impacts of translocation/stocking can be minimised. This will include recommendations on the minimum number of pairs of broodfish required to ensure the greatest level of genetic diversity of the newly established populations.



Research Project Description

Project title:

Barmah-Millewa Fish Condition Monitoring
(Con2007/147)

Principal Investigator:

Dr Meaghan Rourke

Funding Sources:

NSW Department of Primary Industries, the Murray Darling Basin Authority (via the Department of Natural Resources and the Department of Sustainability and Environment) and the Victorian Arthur Rylah Institute.

Objectives:

1. Monitor the health and status of the Barmah-Millewa fish community through annual sampling.
2. Assess long term changes in fish populations and correlate any observed changes with factors such as flow, climate and thermal regimes.
3. Provide information that can feedback into management plans and reporting on condition for the Asset.

Summary:

Condition monitoring of fish, waterbirds and vegetation has been identified as necessary work to provide ongoing information on the 'health' of icon sites in the Murray River. Fish are important indicators of ecological health and monitoring changes in their abundance and composition can often reveal how a system is performing as a whole. This project was established to ensure a robust monitoring program for fish is developed and implemented on a regular, ongoing basis. It was particularly important for this program to start in 2007 because the Murray-Darling Basin was experiencing one of its driest periods on record. Sampling during this period was important because few previous studies have been able to investigate the influence of drought on native fish populations.

Condition monitoring of Living Murray icon sites is important to help formulate long-term management strategies to prevent population declines. The Barmah-Millewa forest system is one of the premier iconic sites in the Living Murray program and it is strategically important as it straddles the NSW-Victorian border. Data generated by this project will be used to establish a watering plan that complements the life cycles of fish within the Barmah-Millewa system. The plan will be specifically developed to ensure that any management decisions to alter flow within the forest will have minimal impacts on key resident fish species such as Murray cod, Golden perch and Silver Perch.

To establish this important baseline information, fish will be collected annually from eighteen sites established within the Barmah-Millewa forest, six in each of three major zones; rivers, creeks and wetlands. The sites will be monitored using well-established electrofishing techniques, to observe any changes in fish assemblage structure which might suggest an increase or decrease in abundance. Work will be undertaken in collaboration with scientists from Arthur Rylah Institute in Victoria and results will be reported annually to the Murray-Darling Basin Authority.

Research Project Description

Project title:

Assessment of fish passage improvements in the Nepean River
(Con2008/179)

Principal Investigator:

Dr Meaghan Rourke and Dr Lee Baumgartner

Funding Sources:

NSW Department of Primary Industries, the Sydney Catchment Authority and SMEC Pty Ltd.

Objectives:

1. Compare fish passage in the Nepean River before and after construction of new fishways (electrofishing).
2. Determine if the new fishways are complying to design specification (fishway trapping).
3. Ascertain whether the environmental flows program enhances fish movement through the fishways (PIT tags).
4. Determine whether the fishway construction program has increased gene-flow in the river (genetic analysis).

Summary:

The Hawkesbury-Nepean system is the second-largest river system in New South Wales. Dams in the upper reaches of the major tributaries supply 97% of Sydney's drinking water, whilst much of the sewage from western Sydney and the Blue mountains is discharged into the middle and lower reaches of the system. The system has been showing increased signs of environmental stress, which is indicated by algal blooms and the presence of invasive species.

In recent times, the fish community of the system has also declined. Species such as common galaxias, bully mullet, freshwater mullet and freshwater herring are reduced in abundance, and grayling are now rarely recorded. It is thought that river regulation along the Nepean River has probably had a negative effect on fish within the system. There are currently 13 weirs between Penrith Weir and Maldon Weir, and three headwater storages upstream of Maldon Weir (Avon Dam, Nepean Dam and Cordeaux Dam) that are operated to regulate flow within the system. The presence of these barriers can disrupt fish passage, and also reduce genetic diversity, although the full extent is unknown at this stage.

Sydney Catchment Authority is currently preparing to restore fish passage along the entire length of the Nepean River from Penrith Weir to Maldon Weir by installing fishways at each of the 13 barriers. This will be the largest-scale fish passage rehabilitation program ever undertaken on a coastal Australian system. The current project will monitor the fish community both before and after fishway installation to ensure that they are acting to increase fish passage and whether increased environmental flows encourage fish movements.

This monitoring project will use a combination of fishway trapping, fish tagging, electrofishing and genetic sampling to determine improvements to the fish community of the Nepean River following fishway construction.

Research Project Description

Project Title:

Survey of freshwater fish in unregulated rivers
(Con2010/207)

Principal Investigator:

Dr Meaghan Rourke

Funding Sources:

NSW Department of Primary Industries and the NSW Office of Water.

Objectives:

1. Undertake fish surveys of two sites in each of 20 water sharing plan areas using Sustainable Rivers Audit (SRA) methods.
2. Provide the NSW Office of Water with a detailed quantitative description of the fish assemblages in each water sharing plan area.

Summary:

A water sharing plan is a legal document that establishes rules for providing water for both the environment and water users, such as irrigators and towns. Twenty of the 31 water sharing plans in NSW relate to unregulated rivers or streams. Water sharing plans must be evaluated against a series of performance indicators including environmental, social and economic indicators to compare the performance of each plan against its objectives. There is a need for ecological sampling to compare the fish community in each water sharing plan against a benchmark in order to evaluate the effect of water extraction on the fish community. NSW Department of Primary Industries has been engaged by the NSW Office of Water to conduct fish community assessment at two sites in each of the 20 different water sharing plan areas across the state. These data will then likely be provided directly to the NSW Office of Water in order for them to conduct predictive ecological modeling that will assess the ecological impact of water extraction on the fish community.

Research Project Description

Project title:

Koondrook-Perricoota Fish Condition Monitoring
(Con2010/220)

Principal Investigator:

Dr Meaghan Rourke

Funding Sources:

NSW Department of Primary Industries and the Murray-Darling Basin Authority.

Objectives:

1. Monitor the health and status of the Koondrook-Perricoota fish community through annual sampling.
2. Assess long term changes in fish populations and correlate any observed changes with factors such as flow, climate and thermal regimes.
3. Provide information to feedback into management plans and reporting on condition for the Asset.
4. Gain baseline data that can be used to report on fish benefits arising from flood enhancement works.

Summary:

The Koondrook-Perricoota Forest has been recognised as one of six Icon sites along the Murray River. These Icon sites are important to preserve given they support a wide range of flora and fauna species, many of which are threatened. Ongoing drought conditions have resulted in the Koondrook-Perricoota Forest being completely dry for over a decade. As a result, the flora community severely stressed, and the fauna community including fish, frogs and turtles is largely non-existent. The Living Murray program aims to substantially improve the condition of the Icon sites through a combination of environmental water allocations and environmental works programs to manage the distribution and retention water. At Koondrook-Perricoota, these works include the construction of an inlet channel leading from the Torrumbarry Weir pool to direct water into the forest, as well as a downstream levy and regulators on creeks to control the flow of the water out of the Forest. Regular flooding of the Forest will result in some parts of the Forest retaining water year-round, and is therefore likely to have some positive outcomes for fish. There have been no standardised fish surveys in the forest and very little baseline data exists upon which to assess condition of fish communities in the forest. It is necessary to gain access to such data through regular condition monitoring to help determine if the flood enhancement works meet their anticipated ecological objectives. Recent rainfall events have caused flooding throughout most of the forest and ephemeral wetlands, creeks and flood runners could now contain fish. This will allow fish condition monitoring to occur during autumn of 2011.

Fish will be collected annually from twenty sites throughout the Forest in creeks, lagoons and wetlands. The sites will be monitored using standard electrofishing techniques in order to determine how the fish community improves over time following the instigation of routine flooding of the Forest.

Research Project Description

Project title:

Tallowa Dam High Fishway Assessment
(Con2007/156)

Principal Investigator:

Mr Chris Walsh

Funding Sources:

NSW Department of Primary Industries, the Sydney Catchment Authority and Southern Bass.

Objectives:

1. Measure the effectiveness of the newly constructed fish-lift in providing upstream passage of fish in the Shoalhaven River;
2. Measure the effectiveness of spillway modifications to allow the downstream passage of fish in the Shoalhaven River;
3. Determine the survival rates of fish passing over the spillway fishway;
4. Use passive integrated transponder technology to quantify fish migrations in coastal systems;
5. Monitor changes in the fish community structure in the Shoalhaven river following fishway construction;
6. Disseminate results and methods widely and inform the national and international community of the effectiveness of fish lifts and spillway fishways for application at high dams throughout the world.

Summary:

The Sydney Catchment Authority and NSW Department of Primary Industries are conducting a study to investigate and minimise the impacts of Tallowa Dam in fish communities on the Shoalhaven River. Studies to date have shown that fish assemblages upstream and downstream of the dam differ significantly. Large numbers of migratory fish now accumulate immediately downstream of the dam, and ten species are believed to be locally extinct upstream of the dam.

An investigation of the broad options available to help restore these communities concluded that the construction of a high fishway is the most appropriate option available. To be effective in rehabilitating upstream fish communities, the fishway needs to accommodate all species attempting to migrate past the dam, ranging in size from 11 mm for juvenile gudgeons to over 1000 mm for large eels. For practical purposes, the fishway should operate in 95% of flows and be able to withstand flood events. The location and design of the fishway entrance are critical for fish to find and enter the fishway. Designs for a fishway were completed in 2006, and construction is due to commence in 2007. Once completed, this will be the first fishway constructed on a high dam in New South Wales.

The Sydney Catchment Authority has commissioned NSW DPI to determine the effectiveness of the fishway, and also to determine if fish are able to migrate downstream past the dam. The study will be undertaken in four stages:

- An initial tagging phase will be completed prior to fishway construction to enable migratory fish to be tracked through the fishway.
- Direct trapping of the fishway will be done to determine the total number of fish completing migrations.
- Automated tag reading systems will be installed to permit continuous monitoring of tagged fish.
- Monitoring upstream and downstream fish assemblages to determine any subsequent redistribution of fish following fishway construction.

NSW DPI will undertake the assessment over a four year period and prepare a project report detailing the effectiveness of the fishway at rehabilitating fish assemblages upstream of Tallowa Dam.

Research Project Description

Project Title:

Thermoshock Fish Mortality Investigation (Tallawarra Power Station)
(Con2011/230)

Principal Investigator:

Dr Chris Walsh

Funding Sources:

NSW Department of Primary Industries and TruEnergy Pty Ltd.

Objectives:

1. Determine species diversity, abundance and fate of fish passing through the cooling water screening system into the fish returning canal at Tallawarra Power Station.
2. Monitor fish populations and behaviour residing in the inlet channel (prior to the intake) as well as model the thermal plume (water quality) created by the 'thermoshock' process.
3. If necessary, provide recommendations for any possible future remediation works.

Summary:

Tallawarra Power Station, situated on the shores of Lake Illawarra (10 km south of Wollongong), is a 435 MW natural gas power station producing electricity for NSW during periods of high demand. During the power station's thermoshock cleaning process, water is heated to approximately 42°C, eliminating all bio fouling. During normal plant operations at Tallawarra, fish have been observed in the returning channel in healthy condition. However, during the thermoshock process, when fish and invertebrate populations are subject to higher than normal water temperatures, there have been reports of 'fish kills', in either the returning channel or in the outlet canal. A series of collection and holding experiments will be done to estimate the extent of fish mortality under a range of conditions. Therefore, during each sampling season (summer and winter) the cooling water screening system outlet during thermoshock will be monitored on 10 occasions, either in the day or at night. Species captured will be counted, measured, and any obvious signs of disease, injury, spawning condition or sex will be noted. Additionally, to determine any long term mortality and physical damage associated with the thermoshock process, a representative subsample of treated fish will also be held for up to 48hrs on at least one occasion each in summer and winter periods. As a result of these experiments we aim to better understand the effects of the thermoshock process on fish populations in Lake Illawarra, so that recommendations on possible ways of reducing or eliminating this mortality can be determined.

Research Project Description

Project Title:

Bass Habitat Mapping Project
(Con2002/046)

Principal Investigator:

Mr Greg West

Funding Sources:

NSW Department of Primary Industries and the Recreational Freshwater Fisheries Trust Fund.

Objectives:

1. Map habitats of three key bass rivers.
2. Initiate the basis for a long term monitoring project of those habitats.
3. Commission angler involvement in freshwater habitat assessments.

Summary:

Management of NSW coastal recreational fisheries, and particularly the freshwater fishery for the Australian bass (*Macquaria novemaculeata*), is in a large measure dependent on the successful management of fish habitat. Over the past 200 years, the clearing of catchments, construction of dams and the placement of barriers to fish passage have altered downstream flow and temperature characteristics and the ability of fishes to move freely within their home range. Streambanks have been eroded and alien species of plants and animals have successfully colonised. Unfortunately, relatively little is known about existing habitat characteristics in the coastal drainages or how these have changed over time.

The freshwater and brackish portions of the Macleay River from Georges Junction to the Belmore River, the Shoalhaven River from Tallowa Dam to Nowra, and the Hawkesbury River from Warragamba dam to Wisemans Ferry will be assessed via the analysis of aerial photographs and in-stream observations. Different habitat types will be identified and maps prepared. The character and length of foreshore (e.g., rock, beach, pasture, national park) will be determined. Native vegetation will be differentiated from alien communities. The location of features that add to habitat complexity will be ascertained, and the status of installations (dams, weirs, levees and roads) that impede fish passage will be noted. By doing this, a baseline of characteristics will be prepared against which to assess future change in habitat.

The analysis involves the acquisition and scanning of aerial photographs, the interrogation of images derived from the photos, and the calculation of lengths and areas of different habitat types. Global positioning system (GPS) will be used to identify locations of snags, riffles, rapids, structures and other features. GPS and echo sounding will establish depth. Data will be managed within a geographic information system.

Protocols to rank habitats will be jointly developed by anglers and staff of NSW Department of Primary Industries. Maintenance and/or enhancement of habitat at the respective rivers can be implemented and restoration targets identified.