The NSW Office of Water is a separate office within the Department of Environment, Climate Change and Water. The NSW Office of Water manages the policy and regulatory frameworks for the State’s surface water and groundwater resources to provide a secure and sustainable water supply for all users. The NSW Office of Water also supports water utilities in the provision of water and sewerage services throughout New South Wales.

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Introduction

WHAT IS THE PURPOSE OF THIS REPORT?
This report provides an update on the monitoring and evaluation activities undertaken in 2008–09 to assess the ecological and socio-economic performances of the water sharing plans adopted in the NSW Border Rivers. It provides an interim assessment of outcomes of the investigations and identifies priority needs for future monitoring and evaluation activities in the NSW Border Rivers.

WHY DO WE NEED TO MONITOR PLANS?
Water sharing plans provide water to meet environmental and socio-economic needs, and spell out the rules governing access to water. The NSW Border Rivers region contains a number of important environmental assets and supports a valuable irrigation industry. Important environmental assets have been identified in the background document for the water sharing plan for the NSW Border Rivers Regulated River Water Source. See water sharing plans at www.water.nsw.gov.au. An endangered fish species, the purple spotted gudgeon (Mogurnda adspersa; Figure 1) has been identified as an important ecological feature of the Tenterfield Creek Water Source.

It is important to know whether the water sharing plans are meeting their environmental objectives, so that their effectiveness can be reviewed at the end of their 10-year period of operation. This information will be used to make informed decisions on how the plans might be improved when they are renewed. To achieve this, the NSW Office of Water undertakes ecological monitoring and evaluation activities focused on specific clauses and performance indicators within the water sharing plans.

FIGURE 1
The endangered purple spotted gudgeon (Mogurnda adspersa), found in the Tenterfield Creek Water Source.

WHAT WATER SHARING PLANS ARE CURRENTLY IN PLACE?
Three water sharing plans in the NSW Border Rivers valley are currently gazetted (Figure 2):

- Water Sharing Plan for the NSW Border Rivers Regulated River Water Source 2009
- Water Sharing Plan for the Tenterfield Creek Water Source 2003 (Unregulated River)

More details of these plans can be found on the NSW Office of Water’s website www.water.nsw.gov.au under ‘Water sharing plans’.
FIGURE 2
Location of the current water sharing plans in the NSW Border Rivers valley.

LEGEND
- NSW Border Rivers Regulated River Water Source
- NSW Great Artesian Basin Groundwater Sources
- Tenterfield Creek Water Source
WHAT HAS INFLUENCED THE WATER SHARING PLAN'S OPERATION IN 2008–09?

Regulated rivers—water availability
Owing to lack of sufficient rain and inflows, available water determinations for general security access licences for the NSW Border Rivers Regulated River Water Source were zero per cent at the start of the 2008–09 water year and reached only 10 per cent by June 2009. Figure 3 shows the water availability for general security access licences in the NSW Border Rivers Regulated River Water Source for the period October 2001 to June 2009. Note that continuous accounting occurs in this water source.

Unregulated rivers—water availability
Annual allocations to all categories of access licences for the Tenterfield Creek Water Source were 100 per cent, although given the low flows in most streams, this amount may not have been extractable.

Groundwater—water availability
The Surat and Eastern Recharge Groundwater Sources are the only two NSW Great Artesian Basin Groundwater Sources that underlie the NSW Border Rivers valley. In the Surat Groundwater Source, the share components of aquifer access licenses authorised to extract from this groundwater source received 1 megalitre per share unit. Local water utility and domestic and stock (conveyance) access licence holders received 100 per cent of their entitlements. In the Eastern Recharge Groundwater Source, the share components of aquifer access licenses authorised to extract from this groundwater source received 0.8 megalitres per share unit. Local water utility access license holders received 100 per cent of their entitlements.

FIGURE 3
Available water determinations for NSW Border Rivers Regulated River Water Source from 2001 to 2009 (indicative only).
WHAT ENVIRONMENTAL ISSUES ARE ADDRESSED BY THE WATER SHARING PLANS?

Regulated rivers water sharing plans

The water sharing plan for the NSW Border Rivers Regulated River Water Source provides:

- a continuous low flow of 10 megalitres per day to provide riparian flow and connectivity of pools and riffles
- a translucency rule to pass a portion of inflows into the dam on to the river downstream in order to provide a reflection of natural flows in the river and to provide for the best outcome for ecological features in the river
- a stimulus flow rule to stimulate natural ecological processes, intended to:
  1. provide a flow in the river that mirrors a naturally occurring hydrograph
  2. add benefit to any translucency-related environmental health releases
  3. provide targeted pre-season cues for fish breeding
  4. regularly wet and inundate the interconnected riparian areas primarily in the river downstream of Pindari Dam to the confluence with Frazers Creek
  5. provide an opportunity for more extensive stimulus flows in the system which will extend aquatic benefits further downstream into the known sites of significance as far as Holdfast (west of Yetman).

More details can be found on the water sharing plan for the NSW Border Rivers Regulated River Water Source by visiting the NSW Office of Water’s website www.water.nsw.gov.au
Unregulated rivers water sharing plans

The water sharing plan for the Tenterfield Creek Water Source sets cease-to-pump rules for very low flows. These rules protect low flows and pools within the five management zones established by the plan.

The plan also establishes daily flow sharing rules to protect a proportion of flows for the environment. Within the plan, access to very low flows and pools varies between the individual management zones in order to limit the environmental impacts of reduced habitat.

Groundwater water sharing plans

The water sharing plan for NSW Great Artesian Basin Groundwater Sources requires that water be allocated for the fundamental health of the water source and its dependent ecosystems as a first priority. The plan identified 37 geothermal springs as high-priority groundwater-dependent ecosystems which need a high level of protection. The plan also recognises that the upward leakage and rejected recharge contribute base flows to water courses. To protect the geothermal springs and water courses, the plan sets distance rules for granting work approvals.

In the Eastern Recharge Groundwater Source, the plan reserves the long-term average storage component and 30 per cent of the long-term average annual net recharge for the environment. In the Surat Groundwater Source, the volume set aside for the environment is that required to maintain 1990 pressure levels, minus increased extraction from 1990 until end of June 2008, plus water savings made under the Cap and Pipe the Bores program between 1990 and 1999, plus 70 per cent of savings made under that program since 1999. For more information on the water sharing plans visit www.water.nsw.gov.au
ecological monitoring

WHAT ECOLOGICAL MONITORING IS OCCURRING?

Regulated rivers water sharing plans
The Integrated Monitoring of Environmental Flows scientific program was established in 1997 to assess the ecological benefits of environmental flow rules in the State’s regulated rivers and the Barwon–Darling River. The program has since been revised to monitor and evaluate the ecological performance of the water sharing plans for the regulated rivers.

Three projects are currently under way in the NSW Border Rivers Regulated River Water Source:

Pindari fish monitoring project
In August 2006, the NSW Office of Water initiated a 2-year field program to examine relationships between flows and fish spawning activity in the Severn, Macintyre and Mole Rivers. The study was undertaken by the University of New England. The monitoring sites are shown in Figure 4.

The primary objectives were to determine the species composition of recruitment across these river systems, and to analyse temporal links between flow variability and spawning activity in a suite of species common to these rivers, in the lead-up to trialling possible changes to stimulus flow releases from Pindari Dam, on the Severn River. The release occurred in late 2008, and the fish response report is due in 2011.

Pindari benthic algae monitoring project
In February 2006, the NSW Office of Water initiated and funded a PhD research project through the University of Technology Sydney to examine the influence of the Pindari Dam stimulus flows on benthic algae (algae attached to rocks) and grazing macroinvertebrates. The monitoring sites are shown in Figure 4.

The primary objective was to determine the species composition and biomass of periphyton and macroinvertebrates before and after flow events in order to determine whether the stimulus flows had a positive environmental benefit. The study has found that although the stimulus flows did alter the periphyton community, flows of a higher magnitude are more effective at changing the algae to a better food source for macroinvertebrates. The results will be published in mid 2011.

Border Rivers algal suppression study
The manipulation of flow is one of the few ways in which phytoplankton growth can be controlled in a river. In rivers where blooms are related to flow and stratification, increased flow targets can be used to prevent bloom development. The impact of supplementary access flow rules on toxic algal blooms in the Border Rivers at Boggabilla, Goondiwindi and Mungindi is being tested. If blooms of toxic algae in the Border Rivers are related to flow and stratification, this study will quantify the effects of environmental flows at reducing blooms. The final report is due in 2012.
**FIGURE 4**
Monitoring sites of current fish and periphyton studies in the Border Rivers.

**LEGEND**
- Rivers
- Larval Fish Sites
- Periphyton (Benthic Algae) Study Sites

NSW Office of Water - www.water.nsw.gov.au
Unregulated rivers water sharing plans

The NSW Office of Water has established a program to assess the ecological outcomes of the 20 water sharing plans for unregulated water sources that were gazetted in 2004. The first aim of ecological monitoring in unregulated rivers is to determine whether the environmental objectives of the water sharing plans are being achieved. A monitoring program has been established in the unregulated river sections covered by the water sharing plan for the Tenterfield Creek Water Source. The monitoring sites are shown in Figures 5, 6 and 7. The aim is to determine whether:

- the access regime within the plan impacts on the environment and the ecology of the water source
- the access regime directly impact on habitat availability for and the viability of the endangered purple spotted gudgeon in the water source
- the pool draw-down results in changes in water quality, specifically in relation to temperature and dissolved oxygen, following extensive periods of pool stratification.

This project is also complemented by experimental work being undertaken by the Murray–Darling Basin Freshwater Research Centre (MDFRC) in conjunction with the NSW Office of Water on the resilience of the endangered purple spotted gudgeon. The aim of this work is to understand how sensitive the purple spotted gudgeon is to changes in dissolved oxygen during drought or low flow conditions, and how the impacts can be managed by the rules within the water sharing plan.

Additional to this work is a synthesis being drafted by MDFRC on the resistance and resilience of riverine fish communities to drought. This will focus on the purple spotted gudgeon, and the findings will be incorporated into the evaluation of the low flow and pool access rules required under the water sharing plan and the suitability of refuges within the Tenterfield Creek Water Source.

In addition, photo-point monitoring being undertaken within the Tenterfield Creek Water Source will enable field verification of river heights and conditions at specific low flows for a range of sites.
Groundwater water sharing plans

Over 500 flowing bores in the NSW Great Artesian Basin Groundwater Sources have been monitored for pressure, flow, temperature and groundwater quality since the early 1990s. Monitoring was discontinued in many bores as they were plugged, became sub-artesian or became unsuitable owing to the poor condition of the bore head. At present, 65 bores are being monitored at least once every 2 years. Currently, 14 bores are being monitored in NSW Great Artesian Basin Groundwater Sources underlying the NSW Border Rivers valley (Figure 8). Nine of these bores are being fitted with telemetered data loggers for real-time monitoring.
FIGURE 8
Approximate locations of monitoring bores in the NSW Great Artesian Basin Groundwater Sources.

LEGEND

- Monitoring bores
- Border Rivers catchment

NSW GREAT ARTESIAN BASIN GROUNDWATER SOURCES

- Eastern Recharge Groundwater Source
- Southern Recharge Groundwater Source
- Surat Groundwater Source
Groundwater-dependent ecosystems
The listing of high-priority groundwater-dependent ecosystems has been completed for each of the NSW Great Artesian Basin Groundwater Sources. This process involves a desktop exercise of assembling all known records of groundwater-dependent ecosystems, and includes examining known databases, GIS records and other studies followed by identifying the high-priority groundwater-dependent ecosystems. Forty-six high-priority geothermal or mound springs have been identified within the NSW Great Artesian Basin Groundwater Sources.

The next stage of the process is the assessment of the current condition of groundwater-dependent ecosystems and possible additional groundwater-dependent ecosystems. This stage involves a comprehensive field-based assessment of the groundwater dependency and ecological value of currently listed groundwater-dependent ecosystems identified in the first stage and a more comprehensive search for additional groundwater-dependent ecosystems.

Although other springs are known to exist, a more comprehensive survey will be required to ensure that all mound springs are included.

Plumed Whistling Ducks occur in large flocks
plan provisions being monitored

WHICH PLAN PROVISIONS ARE WE MONITORING?

Regulated rivers water sharing plans

Water Sharing Plan for the NSW Border Rivers Regulated River Water Source

Clause 10: Performance indicators

The performance of the plan is assessed against changes in:

(a) the ecological condition of the water source and dependent ecosystems
(b) the low flow regime
(c) the moderate to high flow regime
(d) the water quality in the water source
(e) the economic benefits derived from water extraction and use.

Clause 12: Planned environmental water

The plan establishes the following environmental water rules for the water source:

(a) the long-term extraction limit may not be exceeded by water being taken or used for any purpose. By limiting long-term average annual extractions to an estimated 194,500 megalitres per year, the plan aims to preserve about 60 per cent of the long-term average annual flow at Mungindi, estimated to be 565,560 megalitres a year, so as to maintain basic ecosystem health

(b) water availability must be managed to ensure that the long-term extraction limit will not be exceeded

(c) at least 10 megalitres will be released from Pindari Dam every day. More can be released to meet basic landholder rights and access licence quantities. This continuous low flow aims to provide connectivity for downstream pools and riffles and to curtail problems associated with extended flow recession

(d) from September to May, up to 50 megalitres will be released from Pindari Dam every day. More will be released where necessary to meet basic landholder rights and access licence quantities

(e) from June to August, up to 200 megalitres will be released from Pindari Dam every day. More will be released where necessary to meet basic landholder rights and access licence quantities

(f) at the start of each water year, 4,000 megalitres will be reserved in Pindari Dam for a stimulus flow. The stimulus flow will be released if more than 1,200 megalitres per day has flowed into the dam on any day between 1 April and 31 August, and will be released between 1 August and 1 December. The aim is to provide a flow that mirrors a naturally occurring hydrographic recording, that targets pre-season cues to fish breeding, and that regularly wets and inundates interconnected riparian areas

(g) the Department of Environment, Climate Change and Water will determine the timing, rate, volume and duration of the stimulus flow after consideration of conditions, irrigation demand, flows and its ability to monitor environmental outcomes

(h) any water set aside for a stimulus flow but not released may be carried over to the next water year, to a maximum of 8,000 megalitres to be released as a stimulus flow
(i) releases from Pindari Dam as described above may not be extracted from downstream of Pindari Dam to the confluence of the Severn River and Frazers Creek from 1 September to 31 March, holders of access licences may not take uncontrolled stream flows from this water source if the flow in the Barwon River at Mungindi would be less than 100 megalitres per day.

**Unregulated rivers water sharing plans**

**Water Sharing Plan for the Tenterfield Creek Water Source**

**Clause 13: Performance indicators**

The performance of the plan is assessed against changes in:

(a) low flows
(b) moderate to high flows
(c) the ecological condition of this water source and dependent ecosystems
(d) the economic benefits derived from water extraction and use.

**Clause 17: Flow classes**

The sharing of daily flows is based on flow classes established by the plan.

**Clause 45: Total daily extraction limits**

The plan sets a total daily extraction limit for each flow class established in clause 17.

**Clause 73: Amendment of very low flow provisions**

The Minister may vary the very low flow levels established in clause 17 within a small range following field verification that pools and natural low flows would be protected.

**Clause 75: Environmental review of provisions allowing access to very low flows and pools**

The Minister may delete clause 62A and Schedule 6, following a review of the environmental effects of pumping on the health of the water source, including pools.

**Groundwater water sharing plans**

**Water Sharing Plan for the NSW Great Artesian Basin Groundwater Sources**

**Clause 11: Performance indicators**

The performance of the plan is assessed against:

(a) change in groundwater extraction volume relative to the extraction limit
(b) change in groundwater levels and pressures
(c) change in groundwater levels and pressures adjacent to identified groundwater-dependent ecosystems
(d) change in groundwater quality
(e) change in economic benefits derived from groundwater extraction and use
(f) the total length of bore drains replaced by efficient water distribution methods.

**Clause 12: Basis for water sharing**

The basis for water sharing in the Eastern Recharge Groundwater Source is the long-term average annual net recharge, which is estimated to be 19,000 megalitres per year. The Minister may vary this estimate after year 5 of the plan, following further acceptable recharge studies.

The basis for water sharing in the Surat Groundwater Source is the volume of water required to maintain pressures experienced under the level of water extraction associated with the water entitlements, infrastructure and management rules in place at 1990 ('sustainable pressure estimate equivalent'), which is estimated to be 75,000 megalitres per year. This estimate may be varied through the granting of aquifer access licences and dealings to not less than 67,500 megalitres per year, provided that the combined total of the volumes of the Surat, the Warrego and the...
Central Groundwater Sources is not more than 105,300 megalitres per year. The Minister may vary the sustainable pressure estimate equivalent after year 5 of the plan, following further acceptable pressure studies.

Clause 15: Planned environmental water

Planned environmental water in the Eastern Recharge Groundwater Source comprises:

(a) the long-term average storage component of the groundwater source
(b) plus 30 per cent of the long-term average annual net recharge.

Planned environmental water in the Surat Groundwater Source comprises:

(a) the sustainable pressure estimate equivalent
(b) minus the increased extraction from 1990 until the start of this plan
(c) plus the water savings made through the capping and piping of any bores from 1990 to 30 June 1999
(d) plus 70 per cent of the water savings made through the capping and piping of any bores from 1 July 1999.

The Minister may vary the proportion of long-term average annual net recharge and/or the percentage of water savings made available through the capping and piping of any water bores that is reserved as planned environmental water after year 5 of this plan on the basis of further acceptable studies of groundwater ecosystem dependency, after considering the needs of the environment and the socio-economic impacts of the proposed variation.
WHAT HAS THE ECOLOGICAL MONITORING TOLD US SO FAR?

Regulated rivers water sharing plans

Monitoring activities
The flow rules have been monitored and evaluated since 2006. The data from those programs are still being processed and will be available for the review of the water sharing plan in 2014.

1. Pindari fish monitoring project
Preliminary analyses of the fish monitoring project downstream of Pindari Dam suggest that flow management can have significant implications for fish spawning. For example, spawning in September to November could be enhanced through the delivery of base and then stimulus flows. Options for managing backwater recruitment of undesirable mosquito fish through disrupting flows are being explored. During the field assessment, 55,000 fish were sampled. This work and the results of sampling during a stimulus flow trial revealed that fish recruitment is enhanced by larger summer flows, especially for carp gudgeon (*Hypseleotris spp.*) in the Mole River. Overall, there were differences in species composition among rivers sampled, with fewer species than expected in the Severn and Macintyre Rivers. The reasons for this reduction are being explored.

2. Pindari benthic algae monitoring project
Flows from Pindari Dam provided by stimulus rules are unlikely to alter periphyton (algae attached to rocks) communities greatly at below 1,000 megalitres per day. However, if stimulus flows are increased (to above 2,000 megalitres per day) or are piggy-backed onto unregulated tributary flows, there is likely to be a positive change in periphyton communities towards early-successional-stage species. The impact of different drying times on periphyton was assessed to determine whether drying of the river may be a suitable technique for periphyton resetting. The final report is due in mid 2011.

3. Border Rivers algal suppression study
The impact of supplementary access flow rules on toxic algal blooms at Boggabilla, Goondiwindi and Mungindi is still being assessed. The final report is due in 2011.

Links to other projects
- environmental flow management on those streams that are shared between the States
- formalising water sharing between the States and the environment
- formalising water access agreements
- provision of adequate flows to the Darling River downstream of Mungindi
- interstate trading of water.

The States are required to establish and document parameters to be monitored or measured in the form of an integrated environmental monitoring program, and to resource the collection, recording and management of data.

The Border Rivers Standing Committee has been established to oversee the requirements of the IGA. The development of the monitoring program will begin in 2010–11.

This project will address major knowledge gaps in the dynamics and resilience of key vegetation communities of floodplains within the Border Rivers catchment and will provide crucial information for improving decision making regarding water resource management and conservation.
Unregulated rivers water sharing plans

Monitoring activities
Monitoring and evaluation of the flow rules within the Tenterfield Creek Water Source have focused on the sampling of fish assemblages. A detailed survey was undertaken during 2010 to determine the status of the endangered purple spotted gudgeon. The purple spotted gudgeon has suffered a long-term reduction in distribution and abundance within the Murray–Darling Basin, with populations contracting northwards. The first step was a geomorphological assessment of the biophysical characteristics and behaviour of Tenterfield Creek to verify whether or not the selected pools were permanent and provided drought refuge potential.

Of 705 fish collected, 28 were purple spotted gudgeon, which were found in three out of the 21 pools sampled. Water quality data are also being collected in the selected pools. Monitoring will identify water quantity, quality and other habitat variables and reveal their relationship with flow and their suitability as a refuge. During low flow periods with high summer temperatures, any temperature stratification in the water column will be revealed. Under such conditions, the pool is likely to be severely restricted as a refuge. Further investigation will focus on assessing the ecological impact of water extraction on fish assemblages in the region, and in particular on the purple spotted gudgeon.

Links to other projects
The NSW Office of Water is enhancing linkages with the Queensland Department of Environment and Resource Management, the Cotton Catchment Communities Cooperative Research Centre and Griffith University through studies of ecosystem responses to flows, particularly in wetland and floodplain vegetation communities. Further information on monitoring of unregulated river water sharing plans can be found at [www.water.nsw.gov.au](http://www.water.nsw.gov.au).

Groundwater water sharing plans

Monitoring activities
Although none of the high-priority geothermal springs identified in the plan are located within the Border Rivers valley, six free-flowing bores in the valley have significant influence on the protected geothermal springs outside the valley. The pressure head in the Surat Groundwater Source rose by up to 3 metres in the last decade. Signs of pressure recovery in the aquifer are noticeable near where many free-flowing bores were plugged under the Cap and Pipe the Bores program.

During the 2009–10 irrigation season, the groundwater levels in the Eastern Recharge Groundwater Source fell by up to 15 metres near where groundwater is pumped for intensive irrigation. However, groundwater levels in monitoring bores show signs of recovery to acceptable levels since pumping ceased after the irrigation season ended.

Groundwater-dependent ecosystem monitoring
Two major information gaps have been identified in the identification of groundwater-dependent ecosystems. The first is that there are no current baseline data on the hydrological or ecosystem condition of each of the known groundwater-dependent ecosystems identified, including springs. The second is that there is no hydrological-ecological monitoring program to determine the ecological response of the springs to potential increases in pressure as a result of the Cap and Pipe the Bore program.

Links to other projects
The statewide groundwater monitoring network in the NSW Great Artesian Basin Groundwater Sources is linked to the federally
funded Great Artesian Basin monitoring network. Twenty-nine bores of the statewide monitoring network are being used for monitoring of the whole Great Artesian Basin.

The NSW Macro water sharing plan process is expected to have plans in place for all groundwater sources in the Border Rivers valley by the end of 2011. The plans for each groundwater source will impose long-term average annual extraction limits and rules that will allow only acceptable impacts on users and the environment. Groundwater sources that are highly connected to the rivers will include cease-to-pump criteria.

Groundwater-dependent ecosystems
A report was prepared for the Border Rivers - Gwydir Catchment Management Authority (CMA) to identify the range of currently recognised groundwater-dependent ecosystems (Figure 9) within its jurisdiction. The report, entitled ‘A Preliminary Identification of Groundwater Dependent Ecosystems within the Border Rivers – Gwydir River CMA Region’ (2009) presents a list of all known and potential groundwater-dependent ecosystems within the CMA’s boundaries based on an assessment of available knowledge (Table 1). The report includes a series of maps (Figure 10) displaying the locality and distribution of groundwater-dependent ecosystem types and subtypes. This new information about the location, ecological values and condition of the groundwater-dependent ecosystems will play a key role in the development of priorities for improved management.

A range of groundwater-dependent ecosystems and species occur within the Border Rivers - Gwydir CMA area.

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<tr>
<td>Base flow streams or reaches</td>
<td>576</td>
</tr>
</tbody>
</table>

**TABLE 1** Summary of groundwater-dependent ecosystems within the Border Rivers - Gwydir CMA area.
FIGURE 10
Distribution of identified groundwater-dependent ecosystems and aquifers within the Border Rivers - Gwydir CMA area.
Unregulated stream in the upper catchment of the Macintyre River
socio-economic monitoring

In 2005, the NSW Office of Water began a statewide project to monitor changes in the NSW irrigation industry following the introduction of water sharing plans. The project is designed to:

- monitor key social and economic changes at the farm and regional levels arising from water sharing plans
- provide data for the NSW Office of Water’s review and evaluation of water sharing plans
- provide data for the Natural Resources Commission’s review of water sharing plans
- provide a benchmark for other economic and social monitoring exercises in natural resource management.

The project was developed after extensive consultation with stakeholders, including the NSW Irrigators’ Council and the Primary Industries and Economic Development Standing Committee of the NSW Natural Resources Advisory Council.

The project reports on changes in a number of identified social and economic indicators. The data are collected primarily in a 20-minute telephone survey of irrigators who responded to an invitation to participate. A sample size of approximately 10 per cent of the eligible irrigators is targeted for each survey. Additional customised data from the Australian Bureau of Statistics’ Agricultural Census are also used.

The first of the surveys, in 2006, targeted irrigators in areas where the first 31 water sharing plans were implemented in July 2004. These plans included all major regulated rivers in NSW, and represented approximately 80 per cent of the extractive water use in NSW. The 2006 survey collected baseline data reflecting the socio-economic conditions of farms in these areas.

In 2009, the companion baseline survey targeted irrigators in the remaining areas of the State, where water sharing plans were implemented after 2004 or are about to be implemented. This survey covered irrigators whose water sources are predominantly unregulated rivers or major inland groundwater systems. The combined 2006 and 2009 survey data will provide a complete statewide baseline data set to be used in the socio-economic reporting of plan performance indicators.

For reporting purposes the results of the irrigator surveys are tabulated by catchment management authority (CMA) area. The Border Rivers data are reported for the combined Border Rivers – Gwydir and Namoi CMAs for 2006 and for the Border Rivers – Gwydir CMA for 2009.

The 2006 survey results included irrigators from the regulated Gwydir, Namoi and Border Rivers:

- The median irrigation farm size was 526 hectares with a 25th to 75th percentile range of 117 to 1,560 hectares. The statewide medium farm size was 158 hectares (range 26 to 620 hectares).

- Figure 11 shows the types of irrigation system used by respondents from the 2006 survey from Border Rivers-Gwydir and Namoi CMA areas and compares this to the Statewide results.
Irrigators derived an average 49 per cent of total farm income from irrigated crops and pastures. The statewide average was 51 per cent.

60 per cent of irrigators employ non-family members on farm, and the percentage increases as entitlements increase. The statewide average was 52 per cent.

Full-time employment, including family and non-family members (excluding casuals), per irrigation farm was 4.0 equivalent full-time (EFT) positions. The statewide average was 3.9 EFTs.

The ratio of water entitlement to EFT employees was 435 megalitres per EFT employee. The statewide ratio was 270 megalitres per EFT employee.

29 per cent of irrigators had used their water entitlement as security for a loan. The statewide average was 30 per cent.

Figure 12 shows the irrigators' responses to the statement: ‘The water sharing plan has made a lot of difference to water use in this catchment’.

The 2009 survey included irrigators in the remaining unregulated rivers and inland groundwater areas:

- The median irrigation farm size was 650 hectares, with a 25th to 75th percentile range of 167 to 2,020 hectares. The statewide medium was 81 hectares (range 28 to 81 hectares).
Figure 13 shows types of irrigation systems in the unregulated and groundwater areas in the Border Rivers-Gwydir CMA area and compares them with statewide results.

Irrigators derived an average 27 per cent of total farm income from irrigated crops and pastures. The statewide average was 30 per cent.

60 per cent of irrigators employ non-family members on farm, and the percentage increases as entitlements increase. The statewide average was 45 per cent.

Full-time employment of family and non-family members (excluding casuals) per irrigation farm was 3.1 EFT positions. The statewide average was 2.1 EFTs.

The ratio of water entitlement to EFT employees was 245 megalitres per EFT employee. The statewide ratio was 136 megalitres per EFT employee.

31 per cent of irrigators had used their water entitlement as security for a loan. The statewide average was 17 per cent.

Figure 13 shows the irrigators’ responses to the statement ‘The water sharing plan made or will make a lot of difference to water use in this catchment’.

monitoring plans for 2009-10

WHAT ECOLOGICAL MONITORING IS PLANNED FOR 2009–10?

Regulated rivers water sharing plans

The Integrated Environmental Monitoring Program for the Border Rivers project will enable a greater understanding of key wetland and floodplain vegetation water requirements within the Border Rivers catchment and will provide information necessary to monitor and review the water sharing plan for the NSW Border Rivers Water Source and the Queensland Border Rivers Resource Operation Plan.

The overarching aims will be:

- to predict the outcome of hydrologic alterations forecast under various climate change and water management scenarios on floodplain vegetation patterns
- to describe spatial and temporal patterns in mechanisms of vegetation regeneration (e.g. asexual vs. sexual) among key floodplain plant communities
- to identify hydrological thresholds (e.g. duration of dry spells) for the maintenance of vegetation to regeneration processes in key floodplain plant communities and to predict potential regime shifts in the vegetation dynamics of inland floodplain landscapes under various climate change and water management scenarios (e.g. is there a potential for communities dominated by vegetative reproduction to shift to dominance by sexually reproducing plants, or vice versa, and under what conditions might this occur?)
- to determine whether systems are in danger of crossing ecological thresholds leading to loss of wet-phase ecosystem function.

Unregulated rivers water sharing plans

Six pools in the Tenterfield Creek Water Source, located in each zone of the plan, have been selected as potential refuges on the basis of their...
geomorphic properties and ability to remain intact, without leakage, during low or no flow conditions. During periods of high temperature combined with low flow, river pools are likely to undergo temperature stratification, whereby the lower, colder, denser layer does not mix with the upper, oxygenated layer, and it becomes depleted in oxygen (hypoxic) or, if it persists, anoxic. These conditions render the lower layer unsuitable for oxygen-dependent life such as fish, and severely compromise their available habitat. Survival in the surface layers has difficulties as well, such as high temperatures and lack of shelter from predators. Water quality monitoring has begun with temperature loggers in the water column. A detailed survey of pool morphology and habitat is scheduled for early 2011. The combination of these results will enable the development of a hydraulic model that links flow with habitat variables, supporting a determination of the impact of flow rules on refuges within the system. Additional modelling may allow the prediction of stratification from climatic factors, pool morphology and flow. These results will inform the evaluation of access rules and pumping thresholds when the plan comes up for review in 2013.

Groundwater water sharing plans
The NSW Office of Water will continue monitoring the usage, wastage, water savings, pressure, flow, temperature and water quality in the NSW Great Artesian Basin Groundwater Sources.

WHAT IS PLANNED FOR FUTURE WATER SHARING PLANS?
Four additional water sharing plans covering the NSW Border Rivers are currently being developed for:

- Border Rivers Unregulated and Alluvial Water Sources
- Murray–Darling Basin Fractured Rock Groundwater Sources
- Murray–Darling Basin Porous Rock Groundwater Sources
- NSW Great Artesian Basin Alluvium and Cap Rock Groundwater Sources.

WHAT SOCIO-ECONOMIC MONITORING IS PLANNED FOR 2009–10?
The NSW Office of Water commissioned the Australian Bureau of Statistics to customise the 2006 Agricultural Census data to the water sharing plans’ boundaries and related water sources. The data will be made available in 2010 and will be used to ground-truth components of the survey data set.

The Australian Bureau of Statistics will also provide additional secondary socio-economic data to be used to monitor the performance of water sharing plans against their stated objectives.

The third of the planned series of irrigator surveys was undertaken in 2010, targeting the irrigators surveyed in 2006. The results will be compared against the benchmark surveys, and will be used to report against the water sharing plans’ performance reporting requirements.

FUTURE PRIORITy NEEDS FOR ECOLOGICAL MONITORING AND EVALUATION ACTIVITIES IN THE BORDER RIVERS
In accordance with ‘Macro Water Sharing Plans—the approach for unregulated rivers. Report to assist community consultation, 2nd edition’, (DWE 2009; available at www.water.nsw.gov.au), potentially high-priority water sources are those identified as being at high risk to instream environmental values by water extraction. During the development of the water sharing plan for the Border Rivers Unregulated and Alluvial Water Sources, the Ottleys Creek Water Source was identified as a potentially high-priority water source.
Additional information on water sharing plans and socio-economic assessment is available on the NSW Office of Water’s website - www.water.nsw.gov.au