

**Current and proposed monitoring activities in relation
to The Living Murray Lower Lakes, Coorong and
Murray Mouth Icon Site Environmental Management
Plan**



Kelly Marsland and Jason Nicol

**21 December 2006
SARDI Publication Number F2006/000081 P01**

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Executive Summary

Currently there are numerous monitoring and survey activities being conducted in the Lower Lakes, Coorong and Murray Mouth (LLCMM) region. The majority of projects have been undertaken by DEH (Freshwater soaks, bird and pest monitoring), Adelaide University (Earthwatch surveys), Flinders University (macrobenthos study), SA Water (water quality), DWLBC (water quality), SARDI (fish monitoring) and the Goolwa to Wellington Local Action Planning (LAP) Group (rehabilitation works, grazing trials). The recent formation of the CLLAMMecology Research Cluster has facilitated further research activities to be planned in the LLCMM region over the years 2006 to 2008.

The research activities that will be undertaken by the CLLAMMecology Research Cluster will yield excellent baseline information that in many instances can be used to assess the targets. However, it is emphasised that the Cluster will conclude their research by 2008 and their activities will not be ongoing in the region.

None of the biological monitoring programs are being undertaken to coincide with barrage outflow events (except the Barrage Fishways Evaluation Project). Therefore, intervention monitoring programs will need to be established to assess the biological responses to changes in flow. This will be of particular importance to key species such as *Ruppia* spp., benthic invertebrates and fish.

The monitoring timelines and project summaries included in this report are correct at the time of publication. At the time of writing the CLLAMMecology cluster were in the process of finalising individual projects. Therefore it is likely that the extent of projects may change.

It is recommended that individual consultations be made with the relevant researchers or institutions to ensure the Icon Site EMP identified targets are adequately being assessed, that this information is readily accessible and the monitoring activities reproducible. Additionally, a follow-up review may be required toward the end of 2008 to assess the work of CLLAMMecology and other monitoring activities to determine other future monitoring programs against Icon Site EMP identified targets.

Introduction

To streamline monitoring activities and assess where funding for monitoring needs to be directed; SARDI Aquatic Sciences were engaged by DWLBC to undertake a review of the monitoring and research activities currently being undertaken in the Lower Lakes, Coorong and Murray Mouth Living Murray Icon Site. The main aim of the review was to determine whether any current research or monitoring activities could be used to assess the attainment of any of the 22 Living Murray targets (listed below). In addition this review will identify targets, which are not being adequately monitored and outline a timetable for the monitoring activities (Table 1). The final aim of this review is to determine whether there were any research or monitoring projects that would partially assess a target, identify those projects and what additional information needed to be collected or tasks undertaken to assess the target (Table 2).

Target 1. Enhance *Ruppia megacarpa* colonisation and reproduction (North Lagoon).

Target 2. Enhance and maintain estuarine-lagoonal invertebrate population (North Lagoon).

Target 3. Maximise mud flat exposure during summer (North Lagoon).

Target 4. Maintain sediment size range in mud flats (North Lagoon).

Target 5. Establish and maintain organic content of mud flats (North Lagoon).

Target 6. Monitor and maintain the 1% waterbird flyway population level for waterbird indicator species: sharp-tailed sandpiper, curlew sandpiper, red-necked stint, sanderling, common greenshank and banded stilt (North Lagoon and Estuary).

Target 7. Enhance *Ruppia tuberosa* colonisation and reproduction (South Lagoon).

Target 8. Establish viable invertebrate populations in the South Lagoon.

Target 9. Maximise mud flat exposure during summer (South Lagoon).

Target 10. Establish and maintain organic content of mud flats (South Lagoon).

Target 11. Monitor and maintain the 1% waterbird flyway population level for waterbird indicator species: sharp-tailed sandpiper, curlew sandpiper, red-necked stint, sanderling, common greenshank and banded stilt (South Lagoon).

Target 12. Establish and maintain variable salinity regime with >30% of area below seawater concentrations.

Target 13. Maintain aquatic and floodplain vegetation (Lower Lakes).

Target 14. Maintain and enhance habitat for native fish (Lower Lakes).

Target 15. Expose mud flats during summer around the lake edge (Lower Lakes).

Target 16. The Murray Mouth open 100% of the time through freshwater outflows with adequate tidal variations to meet the needs of the Coorong ecosystem.

Target 17. Successful spawning and recruitment of black bream and greenback flounder (Coorong and Lower Lakes).

Target 18. Improved connectivity between the Lower Lakes and Coorong to facilitate required fish passage between freshwater and estuarine habitats that provides for the improved spawning and recruitment success of diadromous fish species such as congolli (*Pseudaphritis urvilli*) and common galaxias (*Galaxias maculatus*).

Target 19. Improved connectivity between Coorong and the sea to facilitate required fish passage between habitats for juvenile and adult life-history stages of diadromous fish species such as lampreys and eels or estuarine dependent species such as mulloway.

Target 20. Management of flows to the South Lagoon to provide conditions for growth and spawning of small-mouthed hardyhead (*Atherinosoma microstoma*).

Target 21. Improved spawning and recruitment success in the Lower Lakes for endangered fish species, including Murray hardyheads and pygmy perch.

Target 22. Management of flows to the Southern Ocean to provide diatoms for off-shore cockle communities.

Work Plan

Proposed Monitoring Timeline

	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Target 1*												
Target 2*												
Target 3												
Target 4												
Target 5												
Target 6												
Target 7*												
Target 8*												
Target 9												
Target 10												
Target 11												
Target 12												
Target 13												
Target 14												
Target 15												
Target 16												
Target 17**												
Target 18**												
Target 19*												
Target 20**												
Target 21*												
Target 22*												

Table 1: The proposed timeline for monitoring activities in the Lower Lakes, Coorong and Murray Mouth Region. Shaded cells indicate the approximate time of year when monitoring should occur to assess the target. * Indicate that additional monitoring following barrage releases will need to be undertaken in order to assess the target. ** Indicate additional intervention monitoring is currently being done and will need to continue.

Current Monitoring Activities

	2006			2007								
	Oct	Nov	Dec	Jan	Feb	Mar	April	May	June	July	Aug	Sept
Target 1	++			++		++						
Target 2	++			++		++						
Target 3	++++	+++										
Target 4	++++	+++										
Target 5	++++	+++										
Target 6	* * * *	* * * *	* * * *	* * * *	* * * *	* * * *	* * * *	* * * *	* * *	* * *	* * * *	* * * *
	+ +		+ +	+++++	+ +				+ +			
Target 7	+ +++		+ +		+ +				+ +			
Target 8	+ +		+ +		+ +							
Target 9	++++	+++										
Target 10	++++	+++										
Target 11	* * * *	* * * *	* * * *	* * * *	* * * *	* * * *	* * * *	* * * *	* * *	* * *	* * * *	* * * *
	+ +		+ +	+++++	+ +				+ +			
Target 12	■	■	■	■	■	■	■	■	■	■	■	■
Target 13	□ □											
Target 14												
Target 15	++++	+++										
Target 16	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■	■■■■
Target 17	+ +		+ +		+ +		+ +		+ +		+ +	
Target 18	● ●	● ●	● ●	● ●	● ●	● ●	● ●	● ●	● ●	● ●	● ●	● ●
Target 19	+ +		+ +		+ +							
Target 20	+ +		+ +		+ +							
Target 21	●				●				●			
Target 22												

Table 2: Current Monitoring in the Lower Lakes, Coorong and Murray Mouth Region. Shaded cells indicate that current monitoring will not assess the target. Each symbol represents one week of sampling.
 (+ CLLAMMecology Research Cluster/Earthwatch; □ Goolwa to Wellington LAP; * DEH Monitoring; ■ SA Water (AWQC); ● SARDI).

Target 1. Enhance *Ruppia megacarpa* colonisation and reproduction (North Lagoon)

Current Monitoring

CLLAMMecology Key Species Research (Geddes 2006)

David Paton (Adelaide University)

Aims:

To document the responses of aquatic vegetation (including *R. megacarpa*) in the Coorong to changes in water regimes.

Timing:

At this stage, three surveys are planned every two months from October 2006 to March 2007. Follow-up surveys later in 2007 are expected but details are not known at the time of writing.

Project outline:

The project will document changes in abundance, distribution, growth, reproduction, recruitment and biomass of aquatic vegetation (including *R. megacarpa*) in response to changes in water regime.

Applicability to Target:

This project may provide baseline information that can be used to assess the attainment of Target 1. However, the monitoring is not applicable to intervention monitoring, as its timing is independent of barrage outflow. Therefore further surveys will be needed if the timing of barrage outflows does not correspond to the current monitoring schedule. Additional monitoring will also be needed in order to evaluate the target in the long-term. Sites will need to be concentrated around the barrages and mouth because these are the areas where *R. megacarpa* is likely to colonise under low flow conditions. The salinities at the southern end of the North Lagoon are unlikely to be below the threshold for germination and recruitment unless there are barrage outflows similar to those experienced in the mid 1980s (Geddes 1987).

Target 2. Enhance and maintain estuarine-lagoonal invertebrate population (North Lagoon)

Current Monitoring

DEH funded mudflat study (Dittman 2006)

Sabine Dittman (Flinders University)

Sabine Dittman undertook a comprehensive study of the benthic macroinvertebrates in the LLCMM region in 2004, assessing the spatial distribution of food availability in the LLCMM for migratory shorebirds (Dittman 2006). The study determined macrobenthos diversity, abundances, biomass and community structure as well as sediment and water quality parameters (Dittman 2006). The proposed monitoring for Target 2 has been based on the methods used in this study. Therefore it will provide excellent baseline information that can be used to assess Target 2.

CLLAMMecology Key Species Research (Geddes 2006)

Sabine Dittman (Flinders University)

Aims:

The project will be examining benthic invertebrate populations in the LLCMM region in response to changes in water regimes. This will include parameters such as changes in abundance, distribution, growth, reproduction, recruitment, behaviour and community structure.

Timing:

Currently three surveys are planned from October 2006 to March 2007. Follow-up surveys later in 2007 are expected but details are not known at the time of writing.

Project outline:

The project will document changes in abundance, distribution, growth, reproduction, recruitment, community structure and biomass of benthic invertebrates in response to changes in water regime. Specifically, 20 core samples will be collected at each of 10- 12 sites across the LLCMM region and invertebrates identified, counted and collected for further analysis. Laboratory analysis will provide information on the size frequency distribution of invertebrates at a range of depths and sediment type.

Applicability to Target:

This project will provide excellent baseline information that can be used to assess the attainment of Target 2. However, as the sites are spread across the LLCMM region, additional sites may be required in the North Lagoon to adequately assess Target 2.

If the survey continues to be undertaken regularly, this may act as the intervention monitoring for Target 2; conversely, if the surveys do not follow barrage releases additional monitoring will be required. In any event, additional monitoring will be needed in order to evaluate the target in the long-term.

Target 3. Maximise mud flat exposure during summer (North Lagoon)

Current Monitoring

DEH funded mudflat study (Dittman 2006)

Sabine Dittman (Flinders University)

Sabine Dittman undertook a comprehensive study of the benthic macroinvertebrates in the LLCMM region in 2004, assessing the spatial distribution of food availability in the LLCMM for migratory shorebirds (Dittman 2006). The study determined macrobenthos diversity, abundances, biomass and community structure as well as sedimentary, water quality and depth (Dittman 2006). The proposed monitoring for Target 3 has been based on the methods used in this study. Therefore it will provide excellent baseline information that can be used to assess Target 3.

DWLBC (HYDSYS Database)/ SA Water (AWQC) (Seaman 2005)

Aims:

To monitor water quality, water levels, salinity (EC) and flow in the LLCMM region.

Timing:

Varies from constant (every minute) to daily and randomly.

Project Outline:

Water quality parameters are measured via Automatic data loggers (water level, temperature, salinity) and meteorological stations (wind direction) at various sites throughout the LLCMM region.

As of October 2006, an additional 10 real-time surface water monitoring (SWM) conductivity, temperature and depth sensors (CTD) have been commissioned by the DWLBC and will be installed from Goolwa barrage to the South Lagoon (SWMP Meeting 11.10.06). Surface water monitoring infrastructure will measure water level, salinity and temperature in the LLCMM region in real time and can be accessed via the DWLBC website.

Applicability to Target:

This infrastructure, if used in conjunction with aerial photography and ground-truthing, can be used to assess water levels and mudflat exposure in the North Lagoon that can be used to assess the attainment of Target 3.

CLLAMMecology Habitat Project (Geddes 2006)

Jason Tanner (SARDI) Simon Benger (Flinders University), Russell Seaman (DEH)

Aims:

This project aims to produce a GIS habitat model that predicts physical habitat distribution as a function of water regime and a dynamic GIS-based model to predict habitat availability for key species, and system-wide productivity, under defined flow-scenarios.

Timing:

Three surveys are planned from September to December 2006. Plans of follow-up surveys are not known at the time of writing.

Project outline:

This project will produce a habitat model based on a thorough analysis of the physical habitat parameters of the LLCMM region. The sub-tidal, intertidal and mudflat habitats will be mapped and parameters such as substrate type and key physical features (macrophytes and sessile invertebrates) will be determined. In addition, a digital elevation model will be constructed using existing bathymetry and topography data. Aerial photographs will also be used to map exposed mudflats.

Applicability to Target:

This project aims to produce a habitat model based on a thorough analysis of the physical habitat parameters within the Coorong. This project will not cover the monitoring objectives needed for assessing Target 3 because it is not ongoing and it does not evaluate the target in response to barrage outflow. However, it may serve as a predictive tool, indicating the extent of mudflat exposure that corresponds with specific water levels in the LLCMM region if extensive ground-truthing is undertaken. Additionally, the project will document mudflat exposure in the North Lagoon during summer 2006-07 that may be used in conjunction with additional monitoring activities to assess this target.

Target 4. Maintain sediment size range in mud flats (North Lagoon)

Current monitoring

DEH funded mudflat (Dittman 2006)

Sabine Dittman (Flinders University)

Sabine Dittman undertook a comprehensive study of the benthic macroinvertebrates in the LLCMM region in 2004, assessing the spatial distribution of food availability in the LLCMM for migratory shorebirds (Dittman 2006). The study determined macrobenthos diversity, abundances, biomass and community structure as well as sediment and water quality parameters (Dittman 2006). The proposed monitoring for Target 4 has been based on the methods used in this study. Therefore it will provide excellent baseline information that can be used to assess Target 4.

CLLAMMecology Habitat Project (Geddes 2006)

Jason Tanner (SARDI) Simon Benger (Flinders University), Russell Seaman (DEH)

Aims:

This project aims to produce a GIS habitat model that predicts physical habitat distribution as a function of water regime and a dynamic GIS-based model to predict habitat availability for key species, and system-wide productivity, under defined flow-scenarios.

Project outline:

This project will produce a habitat model based on a thorough analysis of the physical habitat parameters of the LLCMM region. The sub-tidal, intertidal and mudflat habitats will be mapped and parameters such as substrate type and key physical features (macrophytes and sessile invertebrates) will be determined. In addition, a digital elevation model will be constructed using existing bathymetry and topography data. Aerial photographs will also be used to map exposed mudflats.

Applicability to Target:

This project will not cover the monitoring objectives needed for assessing Target 4 because it is not ongoing and it does not evaluate sediment size in response to barrage outflow. However, it may serve as a predictive tool, indicating sediment size expected under specific water levels and

flow regimes if extensive ground-truthing is undertaken. Additionally, the project will document sediment parameters in the South Lagoon during summer 2006-07 that may be used in conjunction with additional monitoring activities to assess this target.

Target 5. Establish and maintain organic content of mudflats (North Lagoon)

Current Monitoring

DEH funded mudflat (Dittman 2006)

Sabine Dittman (Flinders University)

Sabine Dittman undertook a comprehensive study of the benthic macroinvertebrates in the LLCMM region in 2004, assessing the spatial distribution of food availability in the LLCMM for migratory shorebirds (Dittman 2006). The study determined macrobenthos diversity, abundances, biomass and community structure as well as sediment and water quality parameters (Dittman 2006). The proposed monitoring for Target 5 has been based on the methods used in this study. Therefore it will provide excellent baseline information that can be used to assess Target 5.

CLLAMMecology Habitat Project (Geddes 2006)

Jason Tanner (SARDI) Simon Benger (Flinders University), Russell Seaman (DEH)

Aims:

This project aims to produce a GIS habitat model that predicts physical habitat distribution as a function of water regime and a dynamic GIS-based model to predict habitat availability for key species, and system-wide productivity, under defined flow-scenarios.

Timing:

Three surveys are planned from September to December 2006. Plans of follow-up surveys are not known at the time of writing.

Project outline:

This project will produce a habitat model based on a thorough analysis of the physical habitat parameters of the LLCMM region. The sub-tidal, intertidal and mudflat habitats will be mapped and parameters such as substrate type and key physical features (macrophytes and sessile invertebrates) will be determined. In addition, a digital elevation model will be constructed using existing bathymetry and topography data. Aerial photographs will also be used to map exposed mudflats.

Applicability to Target:

This project will not cover the monitoring objectives needed for assessing Target 5 because it is not ongoing and it does not evaluate the sediment organic matter content in response to barrage outflow. However, it may serve as a predictive tool, indicating the organic content of mudflats expected under specific water levels and flow regimes if extensive ground-truthing is undertaken. Additionally, the project will document sediment parameters in the North Lagoon during summer 2006-07 that may be used in conjunction with additional monitoring activities to assess this target.

CLLAMMecology Productivity and Trophodynamics (Geddes 2006)

Justin Brookes (Adelaide University), Sebastien Lamontagne (CSIRO), Kane Aldridge (Adelaide University)

Aims:

This project aims to understand, describe and produce a quantitative model of nutrient dynamics in the Coorong and Lower Lakes region under varying salinities and flow regimes.

Timing:

Two surveys are planned each year commencing late 2006 until mid 2008. Specific timing of surveys is not known at the time of writing.

Project outline:

The project will quantify the concentrations of key nutrients (carbon, nitrogen and phosphorous) at the various trophic levels; from initial nutrient sources such as substrate and water, to biota higher in the trophic chain, such as piscivorous fish. Sampling will occur in six sites across the Coorong (3 replicates).

Applicability to Target:

A part of this project will be to quantify the nutrient content of mudflats. Using this information for assessing Target 5 is limited because organic content is not measured as a response to barrage outflow (although it is to salinity) and there are only a small number of sites in the North Lagoon. However, it will provide baseline information about organic content of mudflats in the North Lagoon that may be used in conjunction with additional monitoring to assess this target.

Target 6. Monitor and maintain the 1% waterbird flyway population level for waterbird indicator species: sharp-tailed sandpiper, curlew sandpiper, red-necked stint, sanderling, common greenshank and banded stilt (North Lagoon and Estuary)

Current Monitoring

Adelaide University/Earthwatch surveys: Coorong Health Monitoring (D. Rogers pers. Comm., Seaman 2005)

David Paton, Daniel Rogers (Adelaide University)

Aims:

To monitor the status of water bird populations in the Coorong over time as a function of changes in water regimes.

Timing:

Biannually (January and July)

Project Outline:

The program determines the distribution and abundance of water bird populations throughout the Coorong. Birds are counted along 116 transects by teams on each side of the Coorong and in the water. Additionally, bird behaviours are monitored and a proportion of birds are caught, sexed and aged.

Applicability to Target:

The proposed monitoring guidelines for this target have been set based on this program. This monitoring has been undertaken for seven years therefore will provide excellent baseline and continuing information that can be used to assess the attainment of Target 6. The monitoring will need to continue biannually in order to evaluate the target in the long-term.

CLLAMMecology Key Species Research (Geddes 2006)

David Paton, Dan Rogers (Adelaide University)

Aim:

To document the response of key bird populations to changes in water regimes.

Timing:

At this stage, three surveys are planned every two months from October 2006 to March 2007. Follow-up surveys later in 2007 are expected but details are not known at the time of writing.

Project Outline:

The project will be examining key wader (red-necked stint, sharp-tailed sandpiper, red-capped plover, banded stilt, red-necked avocet, pied oystercatcher, greenshank) piscivore (Australian pelican, fairy tern, Caspian tern, whiskered tern, hoary-headed grebe, cormorants) and grazer (Australasian shelduck, grey teal, chestnut teal, black swan) bird populations in the Coorong. This will include parameters such as changes in abundance, distribution, reproduction, behaviour and community structure. Specifically birds will be surveyed at 10 – 12 sites across the Coorong. Within these sites birds will be counted and foraging behaviours scored.

Relevance to Target:

Ultimately, the Adelaide University/Earthwatch surveys will adequately address the Target. However, the CLLAMMecology survey will provide more detailed information about the target species that can be used to better understand the dynamics between bird populations and changing water regimes. For migratory shorebirds, measuring foraging behaviour and food availability is critical because declines in abundance in the Coorong might be linked to effects elsewhere in the migratory pathway. Hence, the information gained should be used in conjunction with the Earthwatch monitoring to more clearly assess the attainment of Target 6.

DEH Bird Monitoring Surveys (Seaman 2005)

The Department for Environment and Heritage also carries out regular bird surveys as part of an ongoing monitoring program. The details of this monitoring program are outlined in Table 3.

Survey	Aim	Timing	Project outline
Australian Waterbird Study Group: Summer wader counts	To monitor the status of migratory and resident wader population in concurrence with barrage outflow and USE drainage releases	Monthly, ongoing	Birds are counted in teams across 12 sites in the North and South Lagoons, as well as sites in the Lower Lakes and Estuary
Water bird and wader counts	To monitor the status of water bird and wader population in CNP	Monthly, ongoing	Birds are counted in 500 m radii across 10 sites in the CNP
Coorong and Lakes Bird Surveys	To monitor fluctuations in bird numbers and habitat use.	Fortnightly except winter (monthly), ongoing	Shoreline to shoreline count across 57 sites in the Coorong and Lakes.

Table 3: Bird monitoring activities undertaken by DEH in the LLCMM area.

Relevance to Target:

The monitoring programs are ongoing and will indicate whether the targets are being achieved or not. The combination of these surveys will allow a thorough analysis of the attainment of Target 6. As the surveys are conducted frequently, they may be used as intervention monitoring.

Target 7. Enhance *Ruppia tuberosa* colonisation and reproduction (South Lagoon)

Current Monitoring

Adelaide University/Earthwatch surveys: Coorong Health Monitoring (D. Rogers pers. Comm., Seaman 2005)

David Paton, Daniel Rogers (Adelaide University)

Aims:

The monitoring program aims to monitor the status of *Ruppia tuberosa* in the South and one site in the North Lagoon.

Timing:

Biannually (January and July)

Project Outline:

The proposed monitoring guidelines for this target have been set based on this monitoring program. This monitoring has been undertaken for seven years and will thus provide excellent baseline information. The program assesses the abundance and reproductive status of *R. tuberosa* by taking core samples at intervals across the South Lagoon and determining turion and seed abundances, as well as the abundance of live aboveground plants.

Applicability to Target:

This project will provide excellent baseline information that can be used to assess the attainment of Target 7. The monitoring will need to continue biannually in order to evaluate the target in the long-term.

Reproduction in *R. tuberosa* is highly dependent on seasonal variations of water depth (Nicol 2005). Salinity does affect the success of *R. tuberosa* although it is tolerant to high salinities (Nicol 2005). Therefore, this program primarily assesses the response of *R. tuberosa* to this variable.

The Earthwatch monitoring is not applicable to intervention monitoring, as it is independent of barrage outflow. Therefore additional surveys will be needed if the timing of barrage (or Upper South East Drainage) outflows do not correspond to the current monitoring schedule.

CLLAMMecology Key Species Research**David Paton, Daniel Rogers (Adelaide University)****Aims:**

To document the responses of aquatic vegetation (including *R. tuberosa*) in the Coorong in response to changes in water regimes.

Timing:

Reconnaissance survey: November-December 2006. Follow-up surveys may be planned in 2007.

Aquatic Vegetation survey: At this stage, three surveys are planned every two months from Oct 2006 to March 2007. Follow-up surveys later in 2007 are expected but details are not known at the time of writing.

Project outline:

Reconnaissance survey: The project will examine parameters such as changes in abundance, distribution, growth, reproduction, recruitment and biomass in response to changes in water regimes. Specifically, a systematic survey of the South and southern part of the North Lagoon will be undertaken to locate, map and estimate the distribution of *R. tuberosa*. Furthermore, the research group will survey reproductive structures of *R. tuberosa* across the sample sites (including the number of flower-heads in 1 m² quadrats and seed/turion estimates from core samples).

Aquatic Vegetation survey: Detailed surveys of aquatic vegetation across 10-12 sites throughout the Coorong are planned. This will document the distribution and abundance of *R. tuberosa* through vegetation surveys and core sampling (as described above).

Applicability to Target:

Reconnaissance survey: This will provide definitive information on the current status of *R. tuberosa* in the Coorong that may be used to assess changes over time with follow-up surveys. However, the survey and follow-ups are unlikely to be aligned with barrage releases. Logistically they cannot be used for intervention monitoring due to the extensiveness of the surveys. In summary, information from this survey will provide essential information for condition monitoring of target 7 if follow-up surveys are undertaken.

Aquatic Vegetation survey: This project will provide excellent baseline information that can be used to assess the attainment of Target 7. If the survey continues to be undertaken regularly, this may act as the intervention monitoring for Target 7. Conversely, if the surveys do not follow

barrage releases additional monitoring may be required to assess the target. However, additional monitoring will be needed in order to evaluate the target in the long-term.

DEH Status of Coorong Freshwater Soaks

Aims:

To map the location of freshwater soaks in the South Lagoon and monitor the health of associated vegetation.

Project Outline:

This program monitors salinity, composition and health of vegetation in the Southern Lagoon in response to freshwater soaks from drainage releases. Baseline information has been collected since 2000.

Timing:

The monitoring will be undertaken until 2010 at variable intervals (coinciding with drainage releases).

Applicability to Target

As the project collects baseline information on the status of vegetation in relation to drainage releases, the use of this information for assessing Target 7 is limited. However, it will present information on the status of vegetation (including *R. tuberosa*) in the South Lagoon at varying temporal intervals. Also, the project will offer an additional variable (freshwater drainage releases) that should be considered when assessing this target.

Target 8. Establish viable invertebrate populations in the South Lagoon

Current Monitoring

DEH funded mudflat study (Dittman 2006)

Sabine Dittman (Flinders University)

Sabine Dittman undertook a comprehensive study of the benthic macroinvertebrates in mudflats in the LLCMM region (2004). This study assessed the spatial distribution of food availability in the LLCMM for migratory shorebirds (Dittman 2006). The study determined macrobenthos diversity, abundances, biomass and community structure as well as sediment and water quality parameters (Dittman 2006). The proposed monitoring for Target 8 has been based on the methods used in this study. Therefore it will provide excellent baseline information that can be used to assess Target 8.

CLLAMMecology Key Species Research (Geddes 2006)

Sabine Dittman (Flinders University)

Aims:

The project will be examining the benthic invertebrate populations in the South Lagoon in response to changes in water regimes. This will include parameters such as changes in abundance, distribution, growth, reproduction, recruitment, behaviour and community structure.

Timing:

At this stage, three surveys are planned every two months from October 2006 to March 2007. Follow-up surveys later in 2007 are expected but details are not known at the time of writing.

Project outline:

The project will document changes in abundance, distribution, growth, reproduction, recruitment, community structure and biomass of benthic invertebrates in response to changes in water regime. Specifically, 20 core samples will be collected at each of 10- 12 sites and invertebrates identified, counted and collected for further analysis. Laboratory analysis will provide information on the size frequency distribution of invertebrates at a range of depths and sediment type.

Applicability to Target:

This project will provide excellent baseline information that can be used to assess the attainment of Target 8. If the survey continues to be undertaken regularly, this may act as the intervention monitoring for Target 8. Conversely, if the surveys do not follow barrage releases additional monitoring may be required to assess the target. However, additional monitoring will be needed in order to evaluate the target in the long-term.

Target 9. Maximise mud flat exposure during summer (South Lagoon)

Current Monitoring

DEH funded mudflat study (Dittman 2006)

Sabine Dittman (Flinders University)

Sabine Dittman undertook a comprehensive study of the benthic macroinvertebrates in the LLCMM region in 2004, assessing the spatial distribution of food availability in the LLCMM for migratory shorebirds (Dittman 2006). The study determined macrobenthos diversity, abundances, biomass and community structure as well as sediment and water quality parameters (Dittman 2006). The proposed monitoring for Target 9 has been based on the methods used in this study. Therefore it will provide excellent baseline information that can be used to assess Target 9.

DWLBC (HYDSYS Database)/ SA Water (AWQC) (Seaman 2005)

Aims:

To monitor water quality, water levels, salinity (EC) and flow in the LLCMM region.

Timing:

Varies from constant (every minute) to daily and randomly

Project Outline:

Water parameters are measured via Automatic data loggers (water levels, temperature, salinity) and meteorological stations (wind direction) at various sites throughout the LLCMM region.

As of October 2006, an additional 10 real-time surface water monitoring (SWM) conductivity, temperature and depth sensors (CTD) have been commissioned by the DWLBC and will be installed from Goolwa barrage to the South Lagoon (SWMP Meeting 11.10.06). Surface water monitoring infrastructure will measure, salinity, temperature and depth in the LLCMM region in real time and can be accessed via the DWLBC website.

Applicability to Target:

This infrastructure, if used in conjunction with aerial photography and on-ground works, can be used to assess water levels and mudflat exposure in the South Lagoon that can be used to assess the attainment of Target 9.

CLLAMMecology Habitat Project (Geddes 2006)

Jason Tanner (SARDI) Simon Benger (Flinders), Russell Seaman (DEH)

Aims:

This project aims to produce a GIS habitat model that predicts physical habitat distribution as a function of water regime and a dynamic GIS-based model to predict habitat availability for key species, and system-wide productivity, under defined flow-scenarios.

Timing:

Three surveys are planned from September to December 2006. Plans of follow-up surveys are not known at the time of writing.

Project outline:

This project will produce a habitat model based on a thorough analysis of the physical habitat parameters of the LLCMM region. The sub-tidal, intertidal and mudflat habitats will be mapped and parameters such as substrate type and key physical features (macrophytes and sessile invertebrates) will be determined. In addition, a digital elevation model will be constructed using existing bathymetry and topography data. Aerial photographs will also be used to map exposed mudflats.

Applicability to Target:

This project will not cover the monitoring objectives needed for assessing Target 9 because it is not ongoing and it does not evaluate the target in response to barrage outflow. However, it may serve as a predictive tool, indicating the extent of mudflat exposure that corresponds with specific water levels in the LLCMM region if extensive ground-truthing is undertaken. Additionally, the project will document mudflats exposure in the South Lagoon during summer 2006-07 that may be used in conjunction with additional monitoring activities to assess this target.

Target 10. Establish and maintain organic content of mudflats (South Lagoon)

Current Monitoring

DEH funded mudflat (Dittman 2006)

Sabine Dittman (Flinders University)

Sabine Dittman undertook a comprehensive study of the benthic macroinvertebrates in mudflats in the LLCMM region (2004). The study determined macrobenthos diversity, abundances, biomass and community structure as well as sedimentary and water quality parameters (Dittman 2006). The proposed monitoring for Target 10 has been based on the methods used in this study. Therefore it will provide excellent baseline information that can be used to assess Target 10.

CLLAMMecology Habitat Project (Geddes 2006)

Jason Tanner (SARDI) Simon Benger (Flinders University), Russell Seaman (DEH)

Aims:

This project aims to produce a GIS habitat model that predicts physical habitat distribution as a function of water regime and a dynamic GIS-based model to predict habitat availability for key species, and system-wide productivity, under defined flow-scenarios.

Timing:

Three surveys are planned from September to December 2006. Plans of follow-up surveys are not known at the time of writing.

Project outline:

This project will produce a habitat model based on a thorough analysis of the physical habitat parameters of the LLCMM region. The sub-tidal, intertidal and mudflat habitats will be mapped and parameters such as substrate type and key physical features (macrophytes and sessile invertebrates) will be determined. In addition, a digital elevation model will be constructed using existing bathymetry and topography data. Aerial photographs will also be used to map exposed mudflats.

Applicability to Target:

This project will not cover the monitoring objectives needed for assessing Target 10 because it is not ongoing and it does not evaluate the target in response to barrage outflow. However, it may serve as a predictive tool, indicating the organic content of mudflats expected under specific water levels and flow regimes if extensive ground-truthing is undertaken. Additionally, the project will document sediment parameters in the South Lagoon during summer 2006-07 that may be used in conjunction with additional monitoring activities to assess this target.

CLLAMMecology Productivity and Trophodynamic (Geddes 2006)

Justin Brookes (Adelaide University), Sebastien Lamontagne (CSIRO), Kane Aldridge (Adelaide University)

Aims:

This project aims to understand, describe and produce a quantitative model of nutrient dynamics in the Coorong and Lower Lakes region under varying salinities and flow regimes.

Timing:

Two surveys are planned each year commencing late 2006 until mid 2008. Specific timing of surveys is not known at the time of writing.

Project outline:

The project will quantify the nutrient content at the various trophic levels; from initial nutrient sources such as substrate and water, to biota higher in the trophic chain, such as piscivorous fish. Sampling will occur in six sites across the Coorong (3 replicates).

Applicability to Target:

A part of this project will be to quantify the organic content of mudflats. Using this information for assessing Target 10 is limited because organic content is not measured as a response to barrage outflow (although it is to salinity) and there are only a small number of sites in the South Lagoon. However, it will provide baseline information about organic content of mudflats in the South Lagoon that may be used in conjunction with additional monitoring to assess this target.

Target 11. Monitor and maintain the 1% waterbird flyway population level for waterbird indicator species: sharp-tailed sandpiper, curlew sandpiper, red-necked stint, sanderling, common greenshank and banded stilt (South Lagoon)

Current Monitoring

Adelaide University/Earthwatch surveys: Coorong Health Monitoring (D. Rogers, Pers. Comm.)

David Paton (Adelaide University)

Aims:

To monitor the status of water bird populations in the Coorong over time as a function of changes in water regimes.

Timing:

Biannually (January and July)

Project Outline:

The program will determine the distribution and abundance of water bird populations throughout the Coorong. Birds are counted along 116 transects by teams on each side of the Coorong and in the water. Additionally, bird behaviours are monitored and a proportion of birds are caught, sexed and aged.

Applicability to Target:

The proposed monitoring guidelines for this target have been set based on this program. This monitoring has been undertaken for seven years therefore will provide excellent baseline and continuing information that can be used to assess the attainment of Target 11. The monitoring will need to continue biannually in order to evaluate the target in the long-term.

CLLAMMecology Key Species Research (Geddes 2006)

David Paton, Daniel Rogers (Adelaide University)

Aim:

To document the response of key bird populations to changes in water regimes.

Timing:

At this stage, three surveys are planned every two months from October 2006 to March 2007. Follow-up surveys later in 2007 are expected but details are not known at the time of writing.

Project Outline:

The project will be examining key wader (red-necked stint, sharp-tailed sandpiper, red-capped plover, banded stilt, red-necked avocet, pied oystercatcher, greenshank) piscivore (Australian pelican, fairy tern, Caspian tern, whiskered tern, hoary-headed grebe, cormorants) and grazer (Australasian shelduck, grey teal, chestnut teal, black swan) bird populations in the Coorong. This will include parameters such as changes in abundance, distribution, reproduction, behaviour and community structure. Specifically birds will be surveyed at 10 – 12 sites across the Coorong. Within these sites birds will be counted and foraging behaviours scored.

Relevance to Target:

Ultimately, the Adelaide University/Earthwatch surveys will adequately address the Target. However, the CLLAMMecology survey will provide more detailed information about the target species that can be used to better understand the dynamics between bird populations and changing water regimes. Hence the information gained should be used in conjunction with the Earthwatch monitoring to more clearly assess the attainment of Target 11.

DEH Bird Monitoring Surveys (Seaman 2005)

The Department for Environment and Heritage also carries out regular bird surveys as part of an ongoing monitoring program. The details of this monitoring program are outlined in Table 4.

Survey	Aim	Timing	Project outline
Australian Waterbird Study Group: Summer wader counts	To monitor the status of migratory and resident wader population in concurrence with barrage outflow and USE drainage releases	Monthly, ongoing	Birds are counted in teams across 12 sites in the North and South Lagoons, as well as sites in the Lower Lakes and Estuary
Water bird and wader counts	To monitor the status of water bird and wader population in CNP	Monthly, ongoing	Birds are counted in 500 m radii across 10 sites in the CNP
Coorong and Lakes Bird Surveys	To monitor fluctuations in bird numbers and habitat use.	Fortnightly except winter (monthly), ongoing	Shoreline to shoreline count across 57 sites in the Coorong and Lakes.

Table 4: Bird monitoring activities undertaken by DEH in the LLCMM area.

Relevance to Target:

The monitoring programs are ongoing and will indicate whether the targets are being achieved.

The combination of these surveys will allow a thorough analysis of the attainment of Target 11.

As the surveys are conducted frequently, they may be used as intervention monitoring.

Target 12. Establish and maintain variable salinity regime with >30% of area below seawater concentrations

Current monitoring

DWLBC (HYDSYS Database)/ SA Water (AWQC) (Seaman 2005)

Aims:

To monitor water quality, water levels, salinity (EC) and flow in the LLCMM region.

Timing:

Varies from constant (every minute) to daily and randomly

Project Outline:

Water parameters are measured via Automatic data loggers (water levels, temperature, salinity) and meteorological stations (wind direction) at various sites throughout the LLCMM region.

As of October 2006, an additional 10 real-time surface water monitoring (SWM) conductivity, temperature and depth sensors (CTD) have been commissioned by the DWLBC and will be installed from Goolwa barrage to the South Lagoon (SWMP Meeting 11.10.06). Surface water monitoring infrastructure will measure salinity, temperature and depth in the LLCMM region in real time and can be accessed via the DWLBC website.

Applicability to Target:

This infrastructure can be collated and used to assess salinity levels in the Estuary, Murray Mouth and Coorong.

CLLAMMecology Research Cluster (Geddes 2006)

Within all the various research groups spot measurements of water quality, including salinity, will be determined throughout the Estuary, Mouth and Coorong. This data will be stored on a central database and may be used in conjunction with DWLBC water quality data to assess Target 12.

DEH Status of Coorong Freshwater Soaks (Seaman 2005)**Aims:**

To map the location of freshwater soaks in the South Lagoon and monitor the health of associated vegetation.

Project Outline:

This program monitors salinity, composition and health of vegetation in the Southern Lagoon in response to freshwater soaks from drainage releases. Baseline information has been collected since 2000.

Timing:

The monitoring will be undertaken until 2010 at variable intervals (coinciding with drainage releases).

Applicability to Target:

As the project collects information on salinity in the South Lagoon in relation to drainage releases, the use of this information for assessing Target 12 is limited. However, the project will offer an additional variable (freshwater drainage releases) that should be considered when assessing this target.

Target 13. Maintain aquatic and floodplain vegetation (Lower Lakes)

Current Monitoring

Goolwa to Wellington LAP Lower Lakes Grazing Trial (J. Tesoriero Pers. Comm.)

Jem Tesoriero (Goolwa to Wellington and Coorong Local Action Planning Committee)

Aims:

To examine changes in lakeshore stability as well as biodiversity, feed composition and quality of vegetation as a result of variations in the grazing regime.

Timing:

Annually (October-November). Expected to continue for 5-10 years.

Project outline:

The project will compare the effects of four variations of grazing regimes (no grazing, current grazing, predominantly summer grazing, and strategic grazing) on riparian vegetation along the Lower Lakes. Two permanent transects (20 and 100 m long) will be established at each of the eight sites across the Lower Lakes. Vegetation composition will be determined at 1 m (20 m transects) and 5 m (100 m transects) intervals using 50 x 50 cm quadrats. Bank stability and feed quality will also be determined at each site.

Applicability to target

The survey design is robust, but is designed to detect changes in vegetation under varying grazing regimes. Therefore, to adequately assess floodplain and aquatic vegetation additional, non-grazed sites would be required in both Lakes that incorporate other habitat types, e.g. wetlands. Additional sites, especially in Lake Albert, would also be needed to assess Target 13 with greater statistical certainty. Also, transects within sites will need to be extended into the water in order to survey aquatic vegetation. Biannual sampling is also required to meet the requirements of target 13.

Although the variables considered in this project are different to that of Target 13, both variables should be considered when looking at riparian and aquatic vegetation in the Lower Lakes. Both grazing and water regimes have significantly influenced the floodplain, riparian and aquatic vegetation of the Lower Lakes; hence both need to be considered.

**Target 14. Maintain and enhance habitat for native fish
(Lower Lakes)****Current Monitoring**

Currently there is no monitoring of fish habitats in the Lower Lakes. The monitoring sites for this target requires links with the fish surveys undertaken in the Lower Lakes (Target 18).

Target 15. Expose mud flats during summer around the lake edge (Lower Lakes)

Current Monitoring

DEH funded mudflat study (Dittman 2006)

Sabine Dittman (Flinders University)

Sabine Dittman undertook a comprehensive study of the benthic macroinvertebrates in the LLCMM region in 2004, assessing the spatial distribution of food availability in the LLCMM for migratory shorebirds (Dittman 2006). The study determined macrobenthos diversity, abundances, biomass and community structure as well as sedimentary and water quality parameters (Dittman 2006). The proposed monitoring for Target 15 has been based on the methods used in this study. Therefore it will provide excellent baseline information that can be used to assess Target 15.

DWLBC (HYDSYS Database)/ SA Water (AWQC) (Seaman 2005)

Aims:

To monitor water quality, water levels, salinity (EC) and flow in the LLCMM region.

Timing:

Varies from constant (every minute) to daily and randomly

Project Outline:

Water parameters are measured via Automatic data loggers (water level, temperature, salinity) and meteorological stations (wind direction) at various sites throughout the LLCMM region. A surface water monitoring program (SWMP) has been undertaken in the Lower Lakes (SWMP Meeting 11.10.06). Surface water monitoring infrastructure measures water levels, salinity and depth in the Lower Lakes in live time and can be accessed via the DWLBC website.

Applicability to Target:

This infrastructure allows monitoring of water levels in the Lower Lakes, and if this data is used in conjunction with aerial photographs and on-ground works, it can assess water levels and mudflat exposure in the Lower Lakes. Additional sensors in the Lower Lakes will be required to more accurately assess Target 15.

CLLAMMecology Habitat Project (Geddes 2006)

Jason Tanner (SARDI) Simon Benger (Flinders University), Russell Seaman (DEH)

Aims:

This project aims to produce a map of sub-tidal habitats within the Coorong and Lower Lakes and from this information create a GIS habitat model that can predict changes to habitat distribution as a function of water management regimes.

Timing:

Three surveys are planned from September to December 2006. Plans of follow-up surveys are not known at the time of writing.

Project outline:

The sub-tidal habitat map will be constructed by investigating parameters such as substrate type and key physical features (macrophytes and sessile invertebrates). Within this project sediment samples will be collected from sub-tidal regions within the Coorong. Aerial photographs will also be used to map exposed mudflats. At the time of writing it was unclear whether or not the Habitat project would incorporate the Lower Lakes.

Applicability to Target:

The applicability of this project to Target 15 is dependent on the inclusion of the Lower Lakes to the model.

This project will not cover the monitoring objectives needed for assessing Target 15 because it is not ongoing and it does not evaluate the target in response to barrage outflow. However, it may serve as a predictive tool, indicating the extent of mudflat exposure that corresponds with specific water levels in the LLCMM region if extensive ground-truthing is undertaken. Additionally, the project will document mudflats exposure in the Lower Lakes during summer 2006-07 that may be used in conjunction with additional monitoring activities to assess this target.

Target 16. The Murray Mouth open 100% of the time through freshwater outflows with adequate tidal variations to meet the needs of the Coorong ecosystem

Current Monitoring

DWLBC (HYDSYS Database)/ SA Water (AWQC) (Seaman 2005)

Aims:

To monitor water quality, water levels, salinity (EC) and flow in the LLCMM region.

Timing:

Varies from constant (every minute) to daily and randomly.

Project Outline:

Water parameters are measured via Automatic data loggers (water levels, temperature, salinity) and meteorological stations (wind direction) at various sites throughout the LLCMM region.

As of October 2006, an additional 10 real-time surface water monitoring (SWM) conductivity, temperature and depth sensors (CTD) have been commissioned by the DWLBC and will be installed from Goolwa barrage to the South Lagoon (SWMP Meeting 11.10.06). Surface water monitoring infrastructure will measure water levels, salinity and depth in the LLCMM region in real time and can be accessed via the DWLBC website.

Applicability to Target:

This infrastructure allows monitoring of water levels and flow in the estuary, and if this data is used in conjunction with aerial photographs and on-ground works, it can assess the outflow of freshwater through the Murray Mouth.

CLLAMMecology Habitat Project (Geddes 2006)

Jason Tanner (SARDI) Simon Benger (Flinders University), Russell Seaman (DEH)

Aims:

One of the aims of this project is to produce a three-dimensional hydrodynamic model that can predict salinity, water level and sediment transport in the Murray Mouth in response to management actions and flow regimes.

Timing:

Three surveys are planned from September to December 2006. Plans of follow-up surveys are not known at the time of writing.

Project outline:

The model will be constructed by investigating parameters such as substrate type and key physical features (macrophytes and sessile invertebrates). Within this project sediment samples will be collected from sub-tidal regions within the Coorong. Aerial photographs will also be used to map exposed mudflats. At the time of writing it was unclear whether or not the Habitat project would incorporate the Lower Lakes.

Applicability to Target:

This project will not cover the monitoring objectives needed for assessing Target 16 because it is not ongoing and it does not evaluate the target in response to barrage outflow. However, it may serve as a predictive tool, indicating the outflow through the Murray Mouth under different flow and management regimes, if extensive ground truthing is undertaken.

Target 17. Successful spawning and recruitment of black bream and greenback flounder (Coorong and Lower Lakes)

Current Monitoring

SARDI Aquatic Sciences/CLLAMMecology (Q. Ye, pers. comm.)

Qifeng Ye (SARDI), Bronwyn Gillanders (Adelaide University)

Aims:

The project will be examining fish populations in the LLCMM region in response to changes in water regimes. This will include parameters such as changes in abundance, distribution, growth/survival, reproduction, recruitment, movement, migration, biomass and community structure.

Timing:

Sampling will occur over two years starting from October 2006. Surveys will initially be bimonthly, however there will be a 12 month period where sampling will be increased to monthly in order to undertake a more detailed analysis of reproductive biology.

Project outline:

The project will document changes in abundance, distribution, growth, reproduction, recruitment, community structure and biomass of key fish species (including *Acanthopagrus butcheri* and *Rhombosolea tapirina*) in response to changes in water regime. Specifically, 60 metre seine nets will be used to collect samples at 10-12 sites (3 replicates). Supplemental gill netting will be conducted using multi-panelled nets at selected sites. Fish caught will be identified, counted and a sub-sample of fish from each species will be collected and measured at each site. A further sub-sample of fish will be collected for laboratory analysis (reproductive biology studies) to determine the linkage between flow, salinity and reproduction. In addition, otolith microchemistry studies will also be conducted to investigate the movement/migration of key species and their dependence on estuarine conditions. Targeted sampling will also be conducted following barrage releases, to investigate flow related reproductive biology particularly for black bream and greenback flounder.

Applicability to Target:

The project is a detailed study of key fish species within the LLCMM region thus will provide sufficient detail to assess the reproductive success of both *A. butcheri* and *R. tapirina*. The

frequency of collection will enable the survey to act as both condition and intervention monitoring of this target. However, additional monitoring will be needed in order to evaluate the target in the long-term.

Target 18. Improved connectivity between the Lower Lakes and Coorong to facilitate required fish passage between freshwater and estuarine habitats that provides for the improved spawning and recruitment success of diadromous fish species such as congolli (*Pseudaphritis urvilli*) and common galaxias (*Galaxias maculatus*)

Current Monitoring

SARDI Aquatic Sciences

Brenton Zampatti (SARDI)

Aims:

To provide data on fish passage and ecology in the LLCMM region to improve the delivery of water to the Coorong, facilitate fish movement and enable targeted use of environmental water allocations.

Timing:

Sampling is conducted fortnightly, from August to March, for the next three years.

Project outline:

The project will examine the success of diadromous fish populations by sampling fish along the tops and bottoms of the three fishways. Spatial and temporal variations in fish movement will be investigated by a frequent sampling effort from August to March. In addition, the age of fish utilising the fishways will be determined and used as a measure of recruitment.

Applicability to Target:

This project has been designed to meet multiple objectives set by the Living Murray, therefore will effectively address Target 18. The design of the survey and frequency of collection will permit it to serve as both intervention and condition monitoring for Target 18. However, additional monitoring will be needed in order to evaluate the target in the long-term.

SARDI Aquatic Sciences/CLLAMMecology (Q. Ye, pers. comm.)

Qifeng Ye (SARDI), Bronwyn Gillanders (Adelaide University)

Aims:

The project will be examining fish populations in the LLCMM region in response to changes in water regimes. This will include parameters such as changes in abundance, distribution, growth/survival, reproduction, recruitment, movement, migration, biomass and community structure.

Timing:

Sampling will occur over two years starting from October 2006. Surveys will initially be bimonthly, however there will be a 12 month period where sampling will be increased to monthly in order to undertake a more detailed analysis of reproductive biology.

Project outline:

The project will document changes in abundance, distribution, growth, reproduction, recruitment, community structure and biomass of key fish species (including *Acanthopagrus butcheri* and *Rhombosolea tapirina*) in response to changes in water regime. Specifically, 60 metre seine nets will be used to collect samples at 10-12 sites (3 replicates). Supplemental gill netting will be conducted using multi-panelled nets at selected sites. Fish caught will be identified, counted and a sub-sample of fish from each species will be collected and measured at each site. A further sub-sample of fish will be collected for laboratory analysis (reproductive biology studies) to determine the linkage between flow, salinity and reproduction. In addition, otolith microchemistry studies will be also conducted to investigate the movement/migration of key species and their dependence on estuarine conditions. Targeted sampling will also be conducted following barrage releases, to investigate flow related reproductive biology particularly for black bream and greenback flounder.

Applicability to Target:

The surveys will provide information on the reproductive status of key diadromous fish species in the LLCMM region. The data may be used in conjunction with that from Brenton Zampatti's project to gain greater information on these fish species in response to barrage releases, and the effectiveness of the fishways.

Target 19. Improved connectivity between Coorong and the sea to facilitate required fish passage between habitats for juvenile and adult life-history stages of diadromous fish species such as lampreys and eels or estuarine dependent species such as mulloway

Current Monitoring

FRDC/SARDI/DWLBC/CLLAMMecology Key Species Research (Geddes 2006)

Qifeng Ye (SARDI)

Aims:

The project will be examining fish populations in the LLCMM region in response to changes in water regimes. This will include parameters such as changes in abundance, distribution, growth/survival, reproduction, recruitment, movement, migration, biomass and community structure.

Timing:

Sampling will occur over two years starting from October 2006. Surveys will initially be bimonthly, however there will be a 12 month period where sampling will be increased to monthly in order to undertake a more detailed analysis of reproductive biology.

Project outline:

The project will document changes in abundance, distribution, growth, reproduction, recruitment, community structure and biomass of key fish species (including mulloway) in response to changes in water regime. Specifically, 60 metre seine nets will be used to collect samples at 10-12 sites (3 replicates). Supplemental gill netting will be conducted using multi-panelled nets at selected sites. Fish caught will be identified, counted and a sub-sample of fish from each species will be collected and measured at each site. A further sub-sample of fish will be collected for laboratory analysis (reproductive biology studies) to determine the linkage between flow, salinity and reproduction. In addition, otolith microchemistry studies will be also conducted to investigate the movement/migration of key species and their dependence on estuarine conditions. Targeted sampling will also be conducted following barrage releases, to investigate flow related reproductive biology particularly for black bream and greenback flounder.

Applicability to Target:

The project will assess the recruitment of mulloway, and surveys may provide opportunistic information on other estuarine dependent and diadromous fish. Therefore some information necessary to assess Target 19 will be provided by this project, but it will not address the target specifically.

Notably, there are no monitoring activities in the LLCMM that specifically addresses the movement of fish between the Coorong and the sea. Therefore a monitoring program is needed in order to assess Target 19.

Target 20. Management of flows to the South Lagoon to provide conditions for growth and spawning of small-mouthed hardyhead (*Atherinosoma microstoma*)

Current Monitoring

FRDC/SARDI/DWLBC/CLLAMMecology Key Species Research (Geddes 2006)

Qifeng Ye (SARDI)

Aims:

The project will be examining fish populations in the LLCMM region in response to changes in water regimes. This will include parameters such as changes in abundance, distribution, growth/survival, reproduction, recruitment, movement, migration, biomass and community structure.

Timing:

Sampling will occur over two years starting from October 2006. Surveys will initially be bimonthly, however there will be a 12 month period where sampling will be increased to monthly in order to undertake a more detailed analysis of reproductive biology.

Project outline:

The project will document changes in abundance, distribution, growth, reproduction, recruitment, community structure and biomass of key fish species (including *Acanthopagrus butcheri* and *Rhombosolea tapirina*) in response to changes in water regime. Specifically, 60 metre seine nets will be used to collect samples at 10- 12 sites (3 replicates). Supplemental gill netting will be conducted using multi-panelled nets at selected sites. Fish caught will be identified, counted and a sub-sample of fish from each species will be collected and measured at each site. A further sub-sample of fish will be collected for laboratory analysis (reproductive biology studies) to determine the linkage between flow, salinity and reproduction. In addition, otolith microchemistry studies will be also conducted to investigate the movement/migration of key species and their dependence on estuarine conditions. Targeted sampling will also be conducted following barrage releases, to investigate flow related reproductive biology particularly for black bream and greenback flounder.

Applicability to Target:

Atherinosoma microstoma is a secondary targeted species; therefore, the project will only provide information on the abundance, distribution and size structure of this species. Additional monitoring will be required to gain information on growth and spawning in relation to barrage outflows and assess the attainment Target 20. Furthermore, the implications of freshwater releases from the Upper SE drainage scheme need to be considered.

Target 21. Improved spawning and recruitment success in the Lower Lakes for endangered fish species, including Murray hardyheads and pygmy perch

Current Monitoring

SARDI Aquatic Sciences

Qifeng Ye/ Chris Bice (SARDI)

Aims:

This project aimed to monitor relative abundance, distribution, recruitment and growth of three threatened fish populations in the Lower Lakes: Yarra pygmy perch, Murray hardyhead and Southern pygmy perch.

Timing:

The project was conducted in the Lower Lakes during February, June/July and October 2005. The project is currently funded by DEH and SAMDBNRM. Sampling has been undertaken in February 2006 and is planned for February 2007.

Project outline:

The project assesses seasonal changes in abundance, distribution, growth and recruitment. Specifically, biannual samples are taken across 14 sites from either open water or drain habitats. Fish are caught by various sampling methods including fyke nets, box traps and seine nets. Spawning, recruitment and growth parameters are determined using length-frequency distribution analyses.

Applicability to Target:

The design of the survey will permit it to serve as seasonal monitoring for Target 21; however, additional surveys following barrage outflows will be needed for the intervention monitoring component. Information on refuge habitats during low lake levels is needed if barrage releases continue over summer to achieve Target 16.

It should be noted that the current funding of the project does allow gonad staging and otolith analysis. These techniques are necessary to effectively evaluate spawning and growth. In addition, the current monitoring is limited to sites on Hindmarsh and Mundoo Islands and additional sites around Lakes Alexandrina and Albert will need to be established to assess this

target. Habitat surveys also need to be undertaken at each site in order to address the central questions. Such surveys need be linked to the habitat surveys required for Target 14.

Target 22. Management of flows to the Southern Ocean to provide diatoms for off-shore cockle communities

Current Monitoring

SARDI Aquatic Sciences

Greg Ferguson (SARDI)

Aims:

To gain information on the population status of Goolwa cockles to better manage the commercial fishery.

Timing:

Stock assessments are carried out every three years. Assessments were carried out in 2003 (Murray-Jones and Johnson 2003) and 2006 (Ferguson and Mayfield 2006).

Project outline:

Catch and effort data collected by commercial fishers are used to evaluate population status.

Applicability to Target:

This project will not adequately assess target 22 because of the time between stock assessments and monitoring of spawning and recruitment in relation to barrage outflows is required. In addition, the relationship between barrage outflows and the diatom *Asterionella* (the primary food source of Goolwa cockles) is not well understood and needs to be investigated.

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