5 Monitoring – Pillar 4

Demonstration reach projects are designed to "demonstrate" the benefits to local communities that a coordinated program of river rehabilitation activities over a reach of river has on native fish, river health and stakeholder engagement. As such, monitoring and evaluation has to be a key component of all demonstration reaches.

When gauging the success of a demonstration reach project, there are three important questions that need to be asked:

- Have the rehabilitation interventions resulted in ecological improvement (in particular in relation to restoring native fish populations)?
- Has the project engaged all stakeholders, particularly the local community, and are they satisfied with the outcomes?
- Has the project been undertaken using "best practice" principles and does it represent value for money?

These questions can only be answered if the project embraces an adaptive management approach from the start and has developed and implemented monitoring and evaluation programs, to gauge both ecological and stakeholder engagement success.

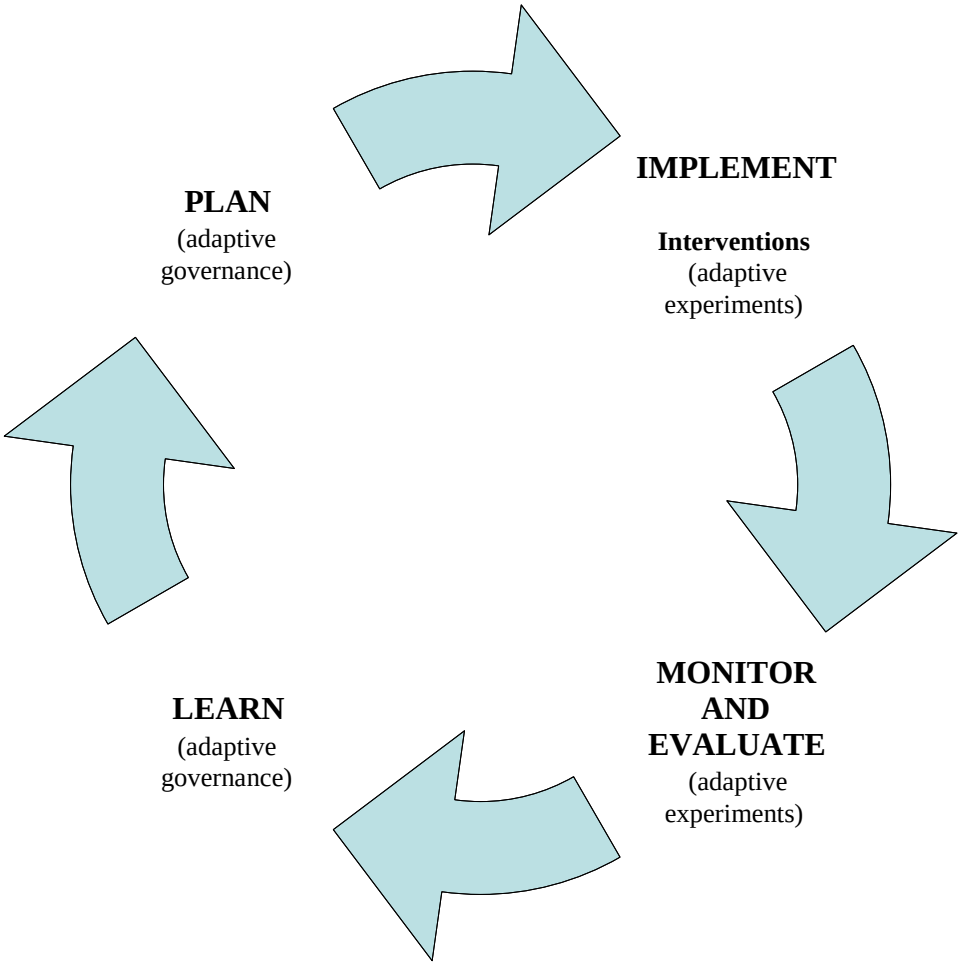
5.1 Adaptive management

- An adaptive management approach is essential if rehabilitation actions in demonstration reaches are to comply with "best management" principles.
- Adaptive management requires rigorous monitoring to enable the success or otherwise of restoration and engagement activities to be tested.
- Management interventions must be designed to test hypotheses and be closely linked to the monitoring program.
- The planning and governance framework must be flexible enough to respond in a timely manner to outcomes of monitoring and evaluation (adaptive experiments) and modify management actions accordingly (adaptive governance).
- Rigorous monitoring to demonstrate the impacts of interventions coupled with adaptive management is a core component of all **Demonstration Reaches**. In comparison, **Rehabilitation Reaches** where management interventions are undertaken without rigorous monitoring are high risk ventures as the impacts of the management activities will remain largely unknown..

Demonstration reaches are about implementing a range of on-ground actions designed to achieve strategic goals that primarily focus on aspects of rehabilitating native fish populations. An adaptive management approach is taken by implementing a rigorous monitoring and evaluation program to test that these actions are "best practice" and modifying them as necessary Similarly, a number of communication and engagement activities are implemented to involve all stakeholders in the project. These activities will

be wide ranging from field days to dissemination of posters, information pamphlets, and school visits for example. The success of these communication and engagement activities must be evaluated and modified as necessary to maximise their impacts.

It is important to recognise that there are two components to adaptive management; *adaptive governance* and *adaptive experimentation* (see figure below).



Conceptual Model of Adaptive Management (modified from Allan *et al.* 2007).

Management activities are designed to test hypotheses through on-ground ecological experiments. The design and implementation of river restoration management interventions (e.g. re- snagging, riparian restoration etc.) must be undertaken to test specific hypotheses and be designed in conjunction with the monitoring and evaluation plan, not separately. For example, it is not simply a matter of "piggy backing" on an existing resnagging program and then trying to design a monitoring and evaluation program around it. The snagging program has to be designed to test a particular hypothesis and the snags placed in the river in a way that allows the hypothesis to be tested.

The planning processes for a demonstration reach (see *Planning Pillar*) and the monitoring evaluation program must be properly coordinated and integrated. They must be flexible enough to respond to the outcomes of the monitoring and evaluation (*adaptive*

experiments) by modifying management actions accordingly (*adaptive governance*). Similarly, communication and engagement activities can be viewed as on-ground experiments (*adaptive experiments*) that need to be tested and the planning process must be flexible enough to respond to the results (*adaptive governance*).

A reach of river where a coordinated program of rehabilitation is undertaken **without the monitoring and evaluation program** is referred to as a *Rehabilitation Reach*. This toolbox can be used as a guide to setting up a Rehabilitation Reach; however potential proponents should be aware of the limitations of such an approach from the start and all stakeholders must be willing to accept the risks. Assumptions will have to be made on the likely impact of particular interventions on fish populations and reporting to stakeholders will largely be based on inputs (number of riparian trees planted, number of snags placed in the river etc.) rather that outcomes (increase in fish recruitment, adult fish numbers etc.). There will be no opportunity to take an adaptive management approach and to demonstrate best practice.

In effect, demonstration reaches and rehabilitation reaches represent two extremes i.e. rigorous monitoring and no monitoring. In the real world there will be intermediaries between these two. The amount of monitoring and evaluation that can be undertaken will depend on funding and resource availability, the hypotheses to be tested and the rigor in which they can be tested will be set within this context. What is important is to recognise what level of information a particular monitoring program can deliver right from the start. In this way there will be no unrealistic expectations amongst stakeholders and the risks (i.e. expected lack of knowledge of outcomes in some areas) can be acknowledged and deemed acceptable or otherwise by investors etc.

Whatever funds are available, the following guidelines can be applied to the development of a monitoring and evaluation program. The steps in developing such a program are outlined below:

5.2 Ecological monitoring

Current knowledge of the responses of native fishes to a particular river restoration activity or a combination of activities remains limited; consequently learning must be a big component of such activities. Despite this, many if not most, rehabilitation projects are undertaken without any substantial monitoring taking place. Where monitoring does occur, surrogates such as physical condition, increase in woody debris, water quality etc. may be used to infer improved conditions for biota. Even within existing demonstration reaches, it has proved difficult to extrapolate results between reaches. Quite different results may be obtained depending on different geomorphology, climate, hydrology and fish faunas, and when interventions have been undertaken in slightly different ways according to local circumstances. Given our current state of knowledge of fish biology it is not possible to make direct correlations between changes in physicochemical conditions and biological values for fish. Direct measurements of fish population parameters are required.

A well planned and resourced monitoring program has significant benefits for a demonstration reach project, including:

- Allowing an adaptive management approach to be taken. Proponents can learn from poor results (e.g. rehabilitation actions that have no beneficial impacts on fish

communities or are selective to some species only) so that these suboptimal actions are not perpetuated for the life of the project. (see examples in Appendix 5a).
- Allowing the benefits of the rehabilitation program to be clearly demonstrated to the community, greatly assisting ongoing support and engagement.
- The investors in the project (both financial and resources) can see the benefits from their investment and that best practice is being followed.
- Demonstrating outcomes will assist in applications to potential funding partners.
- The project will contribute to the overall knowledge of river rehabilitation techniques.

5.2.1 Developing and Implementing a Monitoring and Evaluation Plan (see also Planning Pillar)

- There is an existing framework developed by the MDBA to guide monitoring and evaluation plans in demonstration reaches (see Boys, *et al* 2008).
- Existing demonstration reaches have used jurisdictional natural resource management agencies (often fisheries departments) or consultants to develop and implement monitoring and evaluation plans.
- **Rehabilitation goals** are generally developed through the Whole of Life Plan and should be agreed to by all stakeholders.
- All existing demonstration reaches have undertaken both **condition** (responses of fish to all interventions at the reach scale) and **intervention** (responses of fishes to specific interventions) monitoring.
- The development of **conceptual models** is key to understanding how the ecosystem may operate in relation to particular stressors and to developing **hypotheses** related to the impact of the interventions on the targeted fish populations**;** identifying appropriate **indicators** and **sampling methods;** and developing the **experimental design**.
- Given the importance of the experimental design and the **statistical analysis** of the data, it is essential that the services of a competent biometrician are sought.
- **Implementation** varies between reaches depending on the length of the reach and the particular interventions. Sampling sites normally include a number on a control reach and sampling methods depend on the location and characteristics of the reach.
- Regular analysis and **reporting** of results to all stakeholders is vital. It is important to release all findings whether they represent successes or failures.
- Given the long-term nature of fish population responses to interventions it may be necessary to use surrogates (e.g. length of river re-snagged) to "celebrate" achievements with the community in the short-term.
- Documenting the experimental design is important to ensure integrity of the program over a long period of time (10 years or more) and to ensure consistency of methodologies.

In order to ensure a consistent approach to monitoring and evaluation across demonstration reaches, the MDBA commissioned the development of a "framework for developing and implementing ecological monitoring and evaluation of aquatic rehabilitation in demonstration reaches" (Boys *et al.* 2008). The reader is referred to this document for more details, but the key steps are summarised below, using experiences from existing demonstration reaches as a guide where possible.

The framework was compiled to ensure that a minimum standard of monitoring was undertaken at demonstration reaches but is flexible enough to allow the different challenges and circumstances at each demonstration reach to be taken into account.

In the development of a monitoring plan and its implementation it is important to have persons with the appropriate technical skills (e.g. qualified scientists). If these skills do not reside within the organisation leading the project it may be necessary to recruit personnel either through other agencies or via consultants.

5.2.1.1 Establishing rehabilitation goals

Before planning a monitoring and evaluation program it is necessary to clearly define the rehabilitation goals for the demonstration reach. These should be articulated in the *Whole of Life Plan* and developed at the concept stage for the project. It is here that all stakeholders must agree on the type of restoration intervention improvements that will be sought. These improvements should be realistic, degraded rivers cannot be returned to pristine states and there will be social-economic constraints as well.

(See examples of rehabilitation goals for existing demo reach whole of life plans in Appendix 5b.)

5.2.1.2 Choosing the types of monitoring

There are two types of monitoring that have been undertaken in existing demonstration reaches, together they allow for a good understanding on both the combined impacts of monitoring interventions and the contributions of individual actions.

Condition monitoring

Trend or condition monitoring is used to report on broad scale patterns of river health through time. In demonstration reaches it focuses on the whole demonstration reach and how the condition of the fish community has changed over time. It will identify general trends in the reaches response to the interventions undertaken but gives no indication of the underlying mechanisms and contributions of the different interventions.

Intervention monitoring

Intervention monitoring focuses on the outcomes of particular on-ground actions, and their contribution to fish responses in the reach. The level of monitoring needed depends on the scale of the intervention being undertaken.

(see table of intervention monitoring undertaken in existing demonstration reaches in Appendix 5c)

5.2.1.3 Conceptual models and hypotheses

The development of monitoring and evaluation activities will be governed by the rehabilitation goals outlined in the *Whole of Life Plan*, and the interventions planned. To test these goals and interventions it is important to develop stressor/response **conceptual models** and **hypotheses**. These will bring together existing information on how the ecosystem may be expected to function and where the gaps in knowledge might be. Conceptual models can be quite simple diagrams. They are starting points gathering and developing knowledge about how the ecosystem in question may respond to the interventions and are qualitative in nature. However, they allow both the development of hypotheses to be tested and suitable **indicators** to be measured.

(See examples of conceptual models in Boys et al. 2008, Appendix 5, page 53 "Developing Conceptual Models").

5.2.1.4 Developing environmental indicators and sampling methods

To suitably test conceptual models and hypotheses it is important to have a clear indication of what environmental indicators will be used to measure the condition and response (physical, chemical or biological). Indicators should be developed according to **SMART** criteria (Specific, Measurable, Achievable, Realistic and Time- bound). They should be measurable using existing and accepted methods (e.g. electrofishing, trapping etc.), and non-destructive to the ecosystem. Sampling of these indicators will allow for the statistical testing of the hypotheses.

(see Appendix 5d - Examples of indicators and sampling methods used by existing demonstration reaches).

5.2.1.5 Experimental design and statistical analysis

The choice of experimental design is crucial to the success of the monitoring program. Regardless of the resources available, a poorly designed monitoring program will not provide useful information and can result in a waste of resources. The design has to be tailored to the specific project, but the Boys *et al.* (2008) document provides very good broad guidance. Decisions about statistical analysis methods should be made before data collection starts and both the sampling design and proposed analysis should be developed with the assistance of a competent biometrician.

The experimental design for demonstration reaches needs to incorporate monitoring over different space and time scales.

Spatial

Different spatial scales will be used to evaluate demonstration reach outcomes depending on the type of monitoring. *Condition Monitoring* will be carried out with the whole demonstration reach as the management unit. Within the demonstration reach, sites will have to be sub- sampled at the sub-reach scale to account for spatial variability. The number and location of these sub-samples will depend on the particular indicator, its patchiness and the statistical power required.

Intervention Monitoring will require a different spatial scale depending on whether the response is expected to occur at specific sites (e.g. placement of lunkers or large woody debris) or throughout the reach (e.g. cold water pollution or Carp management). It is important to remember, particularly in short demonstration reaches, that there can be

confounding effects of multiple interventions on the impact of single interventions if interventions are undertaken too close to each other.

Temporal

Monitoring and evaluation programs associated with demonstration reaches need to be implemented over a number of years if an ecological response to interventions is to be detected. It may take 5 to 15 years to detect changes related to some on-ground activities particularly when considering natural "background" variability associated with extreme events such as floods and droughts. Depending on the indicator in question, there may be some short-term responses to interventions. For example, the placement of large woody debris in a reach may result in a relatively rapid increase in numbers of some species. This may simply be due to the woody debris acting as attraction devices, and actual increases in sustainable population numbers may take considerably longer to detect.

Likely response times will impact on the sampling regime and this needs to be made apparent to stakeholders so that there are no unrealistic expectations.

Overall Design

Although the overall monitoring designs for different demonstration reaches will vary, it is important that they include a period of before or pre-intervention monitoring as well as a period of after or post-intervention monitoring. The pre-intervention monitoring should cover a number of years if possible, to account for natural variability. Post-intervention monitoring may require sampling for a long period of time (e.g. 10 years) depending on the expected time lag for a fish population response to be detected. There should also be a control reach for comparison to ensure that the responses are due to the interventions and not natural variability. Together this will form a **Before-After-Control-impact (BACI)** design. (see Boys et al. 2008).

5.2.1.6 Implementation

In most instances, monitoring programs have been undertaken by jurisdictional natural resource management agencies (usually Fisheries). These agencies have the necessary equipment (electrofishers, nets etc.), the permits and the expertise to use the equipment effectively.

The number of sampling sites varies from reach to reach. For example, the Ovens River Demonstration Reach (100km in length) has 10 sites within the reach (five treatment and five non-treatment sites) together with four control sites in the King River. Boat mounted electrofishers and baited traps are used to sample the fish community.

Hollands Creek Demonstration Reach (20km in length) has seven sampling sites within the reach and four control sites on Ryans Creek. Sampling is undertaken with backpack electrofishers (due to the shallow nature of the creek) and fyke nets. Sampling times vary from reach to reach but is usually undertaken annually in summer.

5.2.1.7 Reporting

It is important that regular monitoring reports are produced (e.g. annually) and that these are made available to the steering committee and summaries of the results to the wider community. Both successes and failures should be reported so that an adaptive management approach can be taken. Given the expected time lag in native fish response to most management interventions it may be appropriate to celebrate interim milestones with the community such as length of river re-snagged etc.

Given the long time frame for the monitoring program (10 years or more) it is important to maintain its integrity through a quality assurance program and to ensure ongoing data analysis and data storage.

Examples of reports, which can be used as a guide, can be found below:

- Hollands Creek Demonstration Reach: Annual progress Report 2008/09. www.gbcma.vic.gov.au

- Dewfish Demonstration reach Monitoring and Evaluation report Autumn 2013. www.condaminealliance.com.au/dewfish-demonstration-reach-resources

Monitoring can take many forms (Photos: Jason Lieschke, Fern Hames, Scott Raymond, Tony Townsend, Milly Hobson, Lara Suiter)

5.2.2 What sorts of results have been obtained so far and what can we learn?

- Demonstration Reaches are regarded as long-term projects and no reaches have been monitored for longer than 5 years, so results must be considered preliminary.
- Results that have been obtained vary from no apparent response to management interventions to increase in abundance of some fish species.
- Natural variability in climatic conditions including flooding will provide a level of background variability, in Hollands Creek demonstration reach for example, flooding has removed or relocated a number of the instream snag placements.
- The size of the demonstration reach and the impracticality of enacting appropriately large scale rehabilitation programs is a significant issue for monitoring in demonstration reaches. When reaches are 100 to 200km long it may be impossible, at least in the short-term, to have a scale of intervention sufficient to elicit a response in the fish community.
- Responses to particular restoration activities may vary between localities, extrapolation is dangerous.

None of the existing demonstration reaches have been monitored for long enough for all the hypotheses to be fully tested, with no post-intervention monitoring undertaken for longer than 5 years. Nevertheless it is worthwhile presenting a brief summary of some of the results obtained so far to provide an indication of how variable ecological responses can be. The following information has largely been taken from a recent review by Boys *et al.* (2014). The reader is referred to this paper for more information.

5.2.2.1 Condition monitoring

Several demonstration reaches have reported against reach scale condition targets, with varying results The Bourke to Brewarrina reach has been unable to detect any response by native fishes to the demonstration reach. Boys *et al.* (2014) suggest that this may be in part due to two factors; large inter-annual variability in fish abundance associated with floods in the Barwon-Darling River, and the relatively small scale of the interventions in relation to the large demonstration reach.

In contrast, preliminary analysis in the Ovens River demonstration reach suggests that Murray cod numbers may have increased since management interventions began. Macquarie perch numbers also appear to have increased in the Hollands Creek demonstration reach.
In the Dewfish demonstration reach the abundance of large bodied native fish, particularly Golden perch, have increased at two sites.

5.2.2.2 Intervention monitoring

Intervention monitoring has been carried out at most reaches with variable results. Here the results from monitoring three particular interventions are discussed to illustrate some of the issues that may be encountered. Two of these management actions have been implemented widely within demonstration reaches and more broadly across river

restoration in Australia. One (re-snagging) illustrates the results of directly monitored fish responses to the intervention while the second (riparian rehabilitation) discusses the use riparian condition as a surrogate. The third (alien fish management) is being implemented in a systematic way at two demonstration reaches only and the results are very preliminary.

Re-snagging (Large Woody Debris)

The most frequently implemented and evaluated management action in demonstration reaches has been re-snagging (five of the seven reaches). However, the impacts of this intervention on native fish populations have varied considerably.

In the Dewfish demonstration reach, preliminary data suggests that re-snagging has resulted in a significant increase in the numbers of Golden perch and Eel-tailed catfish, as well as a return of Murray cod individuals. Recent surveys (Norris, Hutchison and Chilcott, 2014) have confirmed that numbers of Golden perch, Murray cod, Eel-tailed catfish and Bony bream have remained much higher than before the reintroduction of large woody debris. In Oakey Creek in the Dewfish demonstration reach, few juveniles of large bodied species were captured after the 2013 summer spawning season suggesting that strong recruitment is not occurring in the area. The large woody debris may be acting as fish attractive devises only at this stage. There was no evidence that the numbers of small- bodied fish have increased due to re-snagging.

In contrast, monitoring of the impacts of re-snagging on fish populations in the Bourke to Brewarrina reach has failed to detect any significant effect on Golden perch or Murray cod numbers. Further to this, measurements of hydraulic and geomorphic indicators showed no response to the re-snagging either.

Although further monitoring is required to understand the reasons for the contrasting results for this management action, the differing results do highlight the need for monitoring even when the intervention is widely thought to be of benefit to native fishes and river health in general. It may also suggest the impact of re-snagging could be site specific and that the placement of snags may also be important.

Riparian rehabilitation

Riparian restoration is widely practiced in Australia and the links between the riparian zone and fish habitat are well documented (provision of large woody debris, input of energy via leaf litter, shading, bank stability etc.). Riparian restoration is occurring in all demonstration reaches; however monitoring of its benefit to demonstration reaches is only occurring at the Upper Murrumbidgee and Dewfish reaches. Even here, monitoring of riparian related activities only relates to riparian condition, using this as a surrogate for fish condition. The focus has been on riparian health and not the impact that this may have on fish populations. However, some inferences have been made in the Dewfish demonstration reach, where extensive and better condition riparian vegetation has protected native grasses during drought and recent flood scouring. Fish assemblages at these sites have been more stable throughout variable climate conditions than at other sites with less healthy riparian vegetation.

Alien fish management

Integrated Carp Management Plans have been developed for the Dewfish and Upper Murrumbidgee demonstration reaches. Both plans require a large number of coordinated actions to be taken to reduce Carp numbers. The Upper Murrumbidgee demonstration reach has only just started to implement the plan and at the moment on the focus is on gathering more knowledge. The Dewfish demonstration reach has been removing Carp from sections of the reach but has yet to implement all of the components of the management plan. However, Carp numbers have been kept at a low level at a number of sites. Monitoring of the impact of interventions to control Carp is complex as there will be a large number of activities that will be required in order to have a significant impact. It is most likely that combined impacts will be noticed during condition monitoring rather than intervention monitoring.

5.3 Monitoring community engagement

- A monitoring and evaluation program is essential to ensure that communication and engagement activities are 'best practice' and effective.
- To date rigorous monitoring has not been undertaken at any existing demonstration reach.
- Surrogates can be used to give some indication of the effectiveness of communication activities but given the importance of community support for river rehabilitation and demonstration reaches, they are no substitute for direct monitoring.
- A monitoring and evaluation framework similar to the Boys *et al.* (2008) document needs to be developed for monitoring community engagement.

All existing demonstration reaches were required to develop Communication and Engagement Plans, which clearly identify all stakeholders and develop strategies for engagement (see Planning Pillar). These plans all lack a comprehensive monitoring component. Although this has long been recognised as a deficiency in demonstration reaches, and most NRM activities, it has not been acted upon, largely due to funding constraints.

There are a myriad of communication activities that can be undertaken when implementing a demonstration reach (e.g. brochures, websites, school presentations, public meetings etc.) and without adequate monitoring and evaluation it is not possible to evaluate their effectiveness and ensure that resources are being allocated in the most cost effective way.

5.3.1 Suggested steps for developing a community engagement monitoring and evaluation program

The logic behind any monitoring and evaluation program for community engagement should be similar to the biological monitoring, that is:

1. Establish the communication goals.

2. Determine how these goals could be achieved within the stakeholder community. (Hypotheses to be tested).

3. Develop the set of actions/activities to be undertaken

(The above would all be articulated in the Communication and Engagement Plan).

4. Develop a monitoring and evaluation plan using appropriate expertise.

5. Undertake pre-intervention monitoring of the proposed target audiences including control groups.

6. Undertake regular post intervention monitoring of control and post intervention groups.

7. Modify communication and engagement activities as appropriate.

Consideration must be given to choosing the appropriate indicators and sampling methods, experimental design and analysis methodology. If a monitoring and evaluation framework is developed for communication and engagement, this could identify the array of types of monitoring that could be undertaken, their pros and cons, as well as issues to be mindful of when monitoring communities.

5.3.2 Use of surrogates

In the absence of a monitoring and evaluation program, demonstration reaches have used surrogates to give an indication of the success of engagement activities. These can include number of "hits" on a website, attendance at meetings, level of involvement at demonstration reach activity days, number of newspaper articles, number of brochures used etc (see Planning Pillar). While they do provide a "feeling" for the level of community engagement and can indicate some things that may not be working (e.g. unused brochures), they do not provide the same level of feedback as a monitoring program.

Comprehensive evaluation of community engagement is important (Photos: Fern Hames)

5.4 References for Monitoring Pillar

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5.5 Appendices for Monitoring Pillar

5.5.1 Appendix 5a - Example of monitoring outcomes modifying intervention requirements – Dewfish demonstration reach

Ongoing monitoring of the Dewfish Reach has identified two issues that need to be addressed through additional interventions, these are:

1. *Decline in abundance of small bodied species.*

There has been an ongoing decline of small bodied species at the tributary intervention sites probably due to the loss of macrophytes and emergent vegetation habitats (these are susceptible to flood events). As a result active reintroduction of key habitats will be targeted. This includes the installation of rock and gravel beds, finer submerged bank-side snags and re-introduction of aquatic vegetation.

2. *Recruitment of large bodied species has been limited.*

Very few juvenile or small individuals of large bodied species have been recorded during monitoring surveys. This situation is unsustainable and needs to be addressed. The provision of spawning structures (hollow logs, pipes etc.) for Murray cod and gravel beds for nest building for Eel-tailed catfish has been recommended to start addressing this issue.

Without a comprehensive monitoring program it is unlikely that these issues would have been detected and there would have been no opportunity to undertake the necessary management interventions to address them.

5.5.2 Appendix 5b - Examples of rehabilitation goals

Demonstration Reach	Intervention	Rehabilitation Goal
Bourke to Brewarrina (from Boys *et al.* 2009)	Re-snagging	• Increased hydraulic diversity in re-snagged reaches. • Creation of deep hole habitat in re-snagged reaches. • Increase in abundance of native fish species utilizing treated sites. • Trajectory improvement in native fish numbers in the whole demonstration reach.
Dewfish (from Dewfish Demonstration Reach Final Report 2009-2011. Condamine Alliance	Multiple interventions along length of reach	• Enhance aquatic habitat that supports native fish by improving river health.
	Re-snagging	• Create increased habitat heterogeneity which can support increased abundance of native fish.
	Fish Passage	• Reinstate fish migration pathways and longitudinal habitat connectivity.
	Integrated Carp eradication program	• The removal of Carp will allow populations of native fish to increase, especially key species such as Tandans

5.5.3 Appendix 5c- Intervention monitoring being undertaken at each existing demonstration reach (after Boys et al. 2014)

	B to Bre	Namoi	Dewfish	Hollands	Ovens	M'Bge	Katfish
Re-snag	*		*	*	*	*	
Alien			*			*	
Riparian			*			*	
Passage		*	*		*	*	
Habitat				*			
Screening		*					
Flows							*
Stocking		*	*	*		*	

5.5.4 Appendix 5d - Examples of sampling methods and environmental indicators from existing demonstration reaches

Demonstration Reach	Intervention	Sampling Method	Parameters Measured	Environmental Indicators
Hollands Creek	Reach Scale and Re-snagging	Backpack electrofisher, non-baited fyke nets. Electrofishing using Sustainable Rivers Audit protocols – Eight 150 second shots at each site.	Species identified, all fish counted, measured total or caudal length to nearest mm.	• Total fish community per site across years. • Total native fish community per site across years. • Total alien fish community per site across years. • Total fish community within re-snagged sites across years. • Total fish community within non-snagged sites across years. • Individual fish species per site across years including length frequencies.
Condamine River (Dewfish Reach)	Reach Scale, Re-snagging, Carp removal	Boat mounted electrofisher, non-baited fyke nets. Electrofishing undertaken in a structured fashion over a fixed area of 50m by 15m at each site with a "power on" time of 300 seconds.	Species identified and all fish counted. First 20 fish captured at each site measured (fork length)	• Total Fish community per site across years. • Nativeness metrics across sites across years. • Diversity indices across sites across years. • Individual species abundance across sites across years. • Individual species length frequencies across sites across years.