North Coast Floodgate Project

Final Report

Simon Walsh / Marcus Riches / John Huegill
NSW Fisheries

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1 Executive Summary

Floodgate structures are a dominant feature of NSW coastal floodplain landscapes. They exclude tidal flows, primarily preventing brackish or saline water inundation of land, and prevent backflooding that could otherwise occur from rises on the main river system. However the negative impacts of floodgate structures on ecosystems have been shown to include:

- Restriction of fish passage
- Drying out of wetlands
- Proliferation of weed species
- Reduction in drought proof pasture refuges
- Exposure to air of acid sulfate soils
- Reduced water quality

These impacts have been recognised by commercial and recreational fishers and NSW Fisheries for several decades and have often resulted in adverse media due to public disagreements between NSW Fisheries and landholders behind floodgates, the sugar cane industry and floodplain management authorities.

The level of impact was quantified in Williams *et al* (1996). The Williams report provided a complete inventory of all coastal barriers restricting fish passage and tidal inundation in NSW. The report found 4,229 barriers to fish passage and tidal inundation on the NSW Coast. Of these, 1,388 appeared to have some form of mitigation potential. These included 1035 floodgates (99% of the total number of floodgates), with over half of these floodgates (630) occurring on the North Coast of NSW (Tweed, Richmond and Clarence Rivers).

The next step by NSW Fisheries was to organise a workshop entitled *Floodgate Management from a Fisheries Perspective* in 1997. It was seen as an important initiative to discuss the large numbers of floodgate structures in coastal rivers, their impacts upon ecosystems and the ways in which they could be better managed. One technique for achieving this is active floodgate management, which is the controlled opening of a floodgate during non-flood times for the purposes of allowing tidal water to enter the affected waterway.

This three-year project to address the issue was developed by NSW Fisheries based on the positive outcomes of the workshop and the original inventory of tidal barriers by Williams *et al.* (1996). It commenced in early 1999, funded by the Natural Heritage Trust, NSW Fisheries and Kempsey and Tweed Shire Councils and was project managed by NSW Fisheries on behalf of the proponent, the North Coast Regional Catchment Committee. The aims of the project were to:

- achieve sustainable land management on the coastal floodplains of northern NSW through the development of a model approach to improved floodgate management;

- improve coastal floodplain management practices, based on *in situ* trials of floodgate modifications or removal.

This project identified 1004 floodgates on the north coast, from the Manning River at Taree north to the Tweed River on the Queensland border. Each floodgate was audited and then prioritised in terms of its ease of opening (landholder willingness) and overall environmental benefits in doing so. 220 floodgated sites were assigned to a high priority listing for further action. Of these, 36 sites are currently being actively managed, of which 16 are within the original project area. The high priority list has been provided to each of the six local Council's within the project area, so that Councils can make better informed decisions with regards to actively managing their floodgates.

Each river catchment where possible, has also been provided with two demonstration sites, where active floodgate management and its benefits can be seen by other landholders in the catchment. Interest was initially slow in coming but has now snowballed to the point where landholders from as far afield as Queensland, South Australia and Victoria are expressing interest in the project and changing land practices. New styles of floodgate modification have been developed since the inception of the floodgate project and are represented in some of the demonstration sites. Some of these are tidally operated and are less reliant on human intervention to operate.

NSW Fisheries has also provided teams of researchers to monitor the results of opening floodgates on fish populations. Although the results are still forthcoming, initial trends indicate that active floodgate management has definite benefits for fish populations. The involvement of the Fisheries Development and Research Corporation in conducting a number of research programs looking at the impacts of floodgates has also been facilitated by this project.

Since the initial stages of the project, over 150 kilometres of waterway have now been opened (including Clarence and Hastings catchments, see section 4.1) through improved floodgate management. This has provided a whole range of benefits including:

- improved fish passage for feeding, breeding and habitat purposes,
- enhanced water quality conditions,
- better management of acid sulfate soil areas,
- reduced need for landholders to spray or slash weeds in drainage channels, as brackish water kills in-drain weeds without affecting main crop or pasture paddocks,
- allowed landholders greater control in manipulating their drainage systems.

One key result for the project has been the continued support from local Government for active floodgate management. This is shown by in-kind support by Councils in the project area to the value of $ 741, 287 since the project's inception.

Other key results include:

- Over 200 landholders have been involved in floodgate management since the project's inception,
- Out of 1004 sites on the North Coast all were desktop audited and 220 have been fully audited,
- The initial project aim was to achieve 6 demonstration sites. There are currently 16 actively managed sites with several more currently in progress, a further 20 sites are being managed in the Clarence and Hastings catchments,
- The project aimed to improve fish passage and this has exceeded expectations considering the opening of over 80 km of water way that had previously been closed by floodgates within the project area.

Catchments outside the original project area are also actively demonstrating an interest in the goals of floodgate management. Extensive liaison and consultation has taken place between this project and the relevant floodgate management contacts on Clarence River County Council and Hastings Shire Council. The Clarence and Hastings catchments have a total of 236 gates of which 95 have been audited as part of this project. Twenty of these are being actively managed which has opened up over 70 km of water way that was previously closed.

Another project outcome is recognition by the State Government of the importance of this issue. NSW Fisheries has recently sought and gained an additional $522, 950 funding from the Environmental Trust to follow up the success of this initial project. The value of in-kind contributions from Councils and NSW Fisheries will increase this figure to $ 767, 000 over the next two years. This money will be used to support Councils and landholders who have floodgates on the high priority list and are keen to actively manage them. NSW Fisheries will continue to provide an important advisory and coordination role in this on-going active floodgate management process.

2 Introduction

Floodgates on the north coast of NSW date back to the late 19th century, with a large number installed through flood mitigation works after major floods in the 1950's and again through the 1970's. These were mostly funded by Federal : State : Local Government in the ratio of 2 : 2 : 1.

In the catchments on the north coast, local Council's own and manage (maintain) the majority of floodgates within the flood mitigation systems. Many more privately owned floodgates are located on private drains over the floodplains and are managed by Drainage Unions or individual landholders. The majority of floodgates are designed with a top hinged flap that seals against a vertical face. The flaps are made from various materials including wood, steel, fibreglass and aluminium.

Floodgate structures are a dominant feature of NSW coastal floodplain landscapes. They exclude tidal flows, primarily preventing brackish or saline water inundation of land, and prevent backflooding that could otherwise occur from rises on the main river system. However the negative impacts of floodgate structures on ecosystems have been shown to include:

- Restriction of fish passage,
- Drying out of wetlands,
- Proliferation of weed species,
- Reduction in drought proof pasture refuges,
- Exposure to air of acid sulfate soils,
- Reduced water quality.

These impacts have been recognised by commercial and recreational fishers and NSW Fisheries for several decades and have often resulted in adverse media due to public disagreements between NSW Fisheries and landholders behind floodgates, the cane industry and the floodplain management authorities.

The level of impact was quantified in Williams *et al* (1996). The Williams report provided a complete inventory of all coastal barriers restricting fish passage and tidal inundation in NSW. The report found 4,229 barriers to fish passage and tidal inundation on the NSW Coast. Of these, 1,388 appeared to have some form of mitigation potential. These included 1035 floodgates (99% of the total number of floodgates), with over half of these floodgates (630) occurring on the North Coast of NSW (Tweed, Richmond and Clarence Rivers).

At this point, NSW Fisheries staff chose a different path than had been followed previously or was being pursued elsewhere in Australia and one which would eventually devolve responsibility for this natural resource management issue to landholders with financial, technical and administrative assistance from State agencies and local Government.

The first step by NSW Fisheries was to organise workshops entitled *Floodgate Management from a Fisheries Perspective* in 1997. It was seen as an important initiative to discuss the large numbers of floodgate structures in coastal rivers, their impacts upon ecosystems and the ways in which they could be better managed.

A three-year project to address this problem was developed by NSW Fisheries based on the positive outcomes of the workshop and the original inventory of tidal barriers. It commenced in early 1999, funded by the Natural Heritage Trust, NSW Fisheries and Kempsey and Tweed Shire Councils and was project managed by NSW Fisheries on behalf of the proponent, the North Coast Regional Catchment Committee. The aims of the project were to:

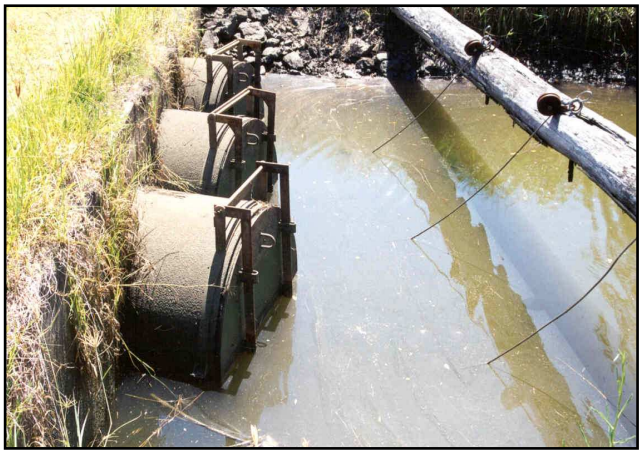
- achieve sustainable land management on the coastal floodplains of northern NSW through the development of a model approach to improved floodgate management;

- improve coastal floodplain management practices, based on *in situ* trials of floodgate modifications or removal.

2.1. Passive floodgate management

Floodgates traditionally operate passively as 'one-way' structures by draining water from land on the upstream side and excluding tidal ingress from downstream.

When the water level behind the floodgate (upstream) is higher than that of the water in front of it (downstream), the gate opens and upstream water is discharged. Water at the same level either side of the floodgate, or higher on the downstream side, causes the floodgate to close thus restricting the movement of water upstream. Floodgates also prevent backflooding that could otherwise occur as a result of rain induced rises on the main river system.



Plates 1 & 2: Floodgates during non-flood and flood times respectively

Over the years, this style of passive floodgate management has had impacts on farmland productivity and the natural environment. Adverse environmental and agricultural impacts which occur through passive floodgate management include:-

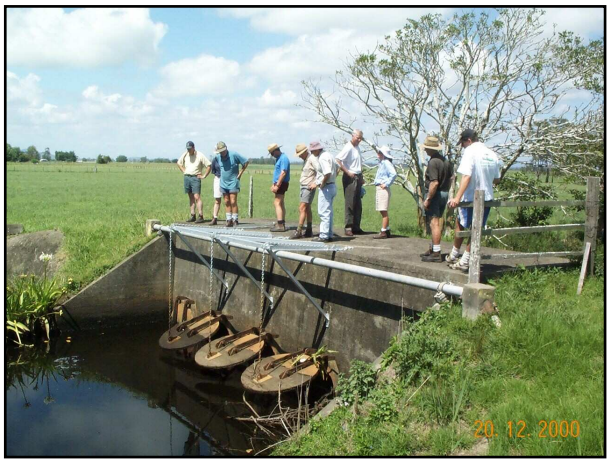
- exposure and oxidation of acid sulfate soils
- prevention of brackish water from neutralising acid drainage from soils
- drying out of wetlands
- overdrainage of backswamps
- groundwater lowering
- prevention of fish passage;
- poor water quality;
- proliferation of hardy weed species in waterways;
- changes in plant species from water tolerant to water intolerant;
- scalding of some low lying pasture areas;
- changes to the soil structure;
- reduced land productivity.

2.2. Active floodgate management

Active floodgate management is the controlled opening of a floodgate during non-flood times for the purposes of allowing tidal water to enter the affected waterway. Numerous opportunities for active floodgate management exist in North Coast catchments and a number of alternatives exist for floodgate management. In recent times an increasing number of landholders, local Councils, industry organisations and land management agencies have become more aware of drain

management issues and how they can impact on agricultural productivity and the environment. Landholders particularly have expressed an interest in becoming more directly involved in managing floodgates and drains during non-flood periods.

The benefits of active floodgate management can include:-



- improved fish passage;
- improved water quality and overall waterway health;
- improved soil and pasture through better watertable management;
- neutralisation of acid discharges;
- reduced weed infestations in waterways;
- the controlled retention of water in wetlands for drought fodder;
- enhancement of native water tolerant pasture vegetation;
- better aquatic fauna habitat;
- overall improvement in biodiversity values;
- improved landholder involvement in resource management.

Plate 3 & 4: Actively managed Floodgates

3 Methodology

With over 1000 floodgates on the North Coast, the project had to develop an efficient way of prioritising and auditing the floodgates in each catchment for active management. The areas chosen for incorporation into the project included the Tweed, Brunswick, Richmond, Bellinger, Nambucca, Macleay and Manning River catchments. Similar floodgate management projects were also undertaken in the Hastings and Clarence catchments and liaison with these two catchments continued throughout the project.

Key criteria and a scoring system were used to audit each floodgate. The criteria included a mix of fish habitat attributes, physical habitat characteristics and landholder willingness to implement a changed management regime to their floodgates and drains. The criteria included naturalness of the waterway, waterway length, habitat value and landholder willingness.

This last criterion was the most important in determining floodgates that could be opened. Each landholder on a floodgated drainage network was sent a brief survey requesting their feedback on issues with their drainage and floodgate system, and to determine whether they were interested in active management of the floodgate. This was followed up with a phone call and face-to-face meeting to discuss active floodgate management in more detail.

Those floodgates with 100% landholder support for active management received a higher score than those with limited or no support. This was a time consuming part of the process but the outcomes achieved demonstrate the value of this time spent. In addition, the convinced landholders then proved to be the best advocates for changes to floodgates at other locations in the same valley.

3.1. Timeframe

Project start date: 8th February 1999

Project finish date: 30th April 2002

3.2. Assessment

A desktop assessment was applied to floodgates identified by Williams e*t al* (1996), and the DLWC floodgate database, to prioritise them as potential sites for active floodgate management. The floodgates were assessed and scored against the following criteria:

1. **Is the floodgate on a natural watercourse? – Y (10), YN (6) or N (4), where: Y = Yes, N = No and YN = a combination of natural and constructed (drain).**

Natural watercourses historically provided fish habitat, and supported other aquatic fauna prior to the construction of floodgate. Floodgates on natural watercourses therefore scored higher than constructed drains.

2. **Extent of watercourse - 0 - 300m (3), 300m - 1km (6) or >1km (9).**

Longer watercourses were considered, in general, to have higher value as fish habitat than shorter ones.

3. **Fish Habitat value 'at a glance' - High (9), Med (6) or Low (3).**

This assessment included attributes such as:-

- watercourse dynamics (bends, changing widths and depths, etc),
- the amount and types of overhanging and bank vegetation,
- presence / absence of fish and other aquatic biota,
- Acid Sulfate Soil (ASS) indicators (concrete cancer, rusting structures, scalding, iron stains, water colour, presence of acid tolerant plant species, etc)

4. 'Landholder willingness' to trial active floodgate management - High (9), Med (6) or Low (3).

Finally, and most importantly, a determination of 'landholder willingness' to trial or implement active floodgate management on their properties was required. An assessment against this criterion includes more than just the landholder on whose property the floodgate(s) is located. The views and opinions of all other landholders affected by the drainage system must also be included in the assessment to ensure full consultation and consensus on the active management program.

A number of factors were considered in allocating either a High, Medium or Low score for criterion 4:-

- the number of properties of the drainage area;
- the size of the properties;
- the number of landholders affected;
- the amount of waterway involved;
- a determination of the critical areas of the drainage system.

Each landholder and the secretary of each drainage union (if applicable) were sent a letter outlining the project and explaining the principles of active floodgate management.

Those floodgates allocated a score greater than 20 (at least two top ranking attributes) were considered priority floodgates for active management. Results of the floodgate audit were compiled into a database stored at the NSW Fisheries office at Ballina.

3.3. Audit

Immediately following the desktop assessment and prioritisation of the floodgates, a comprehensive environmental audit (including photographs) of each of the identified high priority floodgates was conducted. This was completed in descending order from the highest ranked floodgate. A specific Floodgate Audit Form was developed for this purpose which is attached in Appendix 1. Catchments with relatively few floodgate structures such as Brunswick, Bellinger and Nambucca were completely audited.

3.4. Floodgate Management Plans

Floodgate Management Plans (see example provided in Appendix 2) provide the blueprints for the operation of individual floodgates. These are necessary in formalising the devolvement of responsibility for floodgate management (outside periods of flood events) from local Councils to landholders; and provide an avenue for insurance for floodgate operators.

The aims of Floodgate Management Plans include increasing fish passage, drainage channel flushing, aquatic weed control, habitat improvement, and acid sulfate leachate control and neutralisation.

A Floodgate Management Plan specifies:

- the responsibilities of each party;
- the reasons for actively managing the floodgate (desired outcomes);

- details of the floodgate to be actively managed;
- when it will be opened/closed;
- who will open/close the floodgate;
- contingencies and closure triggers;
- modifications required to make opening / closing safe, simple and effective;
- reporting, monitoring and Management Plan revision;
- training requirements and insurance arrangements;
- legal liability.

The first step in developing a Floodgate Management Plan is for local landholders to form a Floodgate Management Advisory Committee (FMAC). The FMAC represents the interests of all landholders with property adjoining the floodgated watercourse or drain, and those in the vicinity whose properties and income may be affected by any changes to traditional management practices. Individual landholders, or groups of landholders, may approach the relevant authority for advice and assistance in establishing a local FMAC.

It is important that any Floodgate Management Plan developed reflects the mutual desires of the landholder(s) and the local Government Authority whilst simultaneously seeking to achieve appropriate positive environmental outcomes for the drainage system.

3.5. Floodgate Management Advisory Committees & Section 355 Committees

Section 355 of the *Local Government Act, 1993* states that a function of council may be exercised by a committee. An important function in forming a FMAC is that it provides an avenue for Council, through a resolution, to recognise the Group as a '355' Committee of council and receive delegated authority to operate the nominated floodgate(s). Becoming a 355 Committee allows volunteer insurance provisions to apply to the FMAC under Council's delegated authority in so far as it acts in accordance with the Floodgate Management Plan.

Each FMAC nominates those members it wishes to be trained to operate the floodgates (Floodgate Operations Team). Floodgate operators will always be members of the FMAC. Normally three to five operators will be trained to ensure that a backup is available at all times. The Floodgate Operations Team (FOT) will be responsible for the implementation of the Floodgate Management Plan on behalf of the FMAC, and in consultation with the relevant Council.

4 Results

One of the key project results has been the identification of numerous floodgates not identified by previous studies. Previous works (Williams *et al.* 1996) found 630 sites on the north coast (Tweed, Richmond and Clarence Rivers), whereas this project has identified an additional 46 structures in the same area.

A total of 1004 sites were identified from the Manning catchment north to the Queensland border. These were all subject to a desktop audit as part of this process and each assessed in terms of their system length, 'naturalness' and habitat value. Those sites with high scores were then further assessed to establish landholder willingness to participate in trials of floodgate management. Sites with high overall scores (>20) were ranked and placed onto the priority list for further action. A total of 220 sites have been included on this priority list and each was entered onto a database located at the NSW Fisheries office in Ballina.

Complete audits including photographs, were undertaken of each of the high priority floodgates located in the Tweed, Brunswick, Richmond, Bellinger, Nambucca, Macleay and Manning catchments. The Clarence and Hastings catchment land management authorities provided similar data for their areas. This information is incorporated into the following table:

4.1. Summary table of floodgate sites audited, managed and opened to date

Catchment	No of floodgates (desktop audited)	Identified priority sites (fully audited)	Actively managed	Approximate kilometres of habitat opened
Tweed	250	34	9	36.5
Richmond	240	40	4 (+ 2 in progress)	17
Brunswick	1	0	Not required, gate already removed	0
Clarence *	186	45	7	55 +
Bellinger	5	None suitable	Potential for inundation of low lying land	0
Nambucca	8	None suitable	Potential for inundation of low lying land	0
Macleay	180	26	3 (+ 3 in progress)	27
Hastings *	50	50	13	15.5
Manning	84	21	2 in progress	0
Totals	**1004**	**220**	**36 (+ 7 in progress)**	**150 +**

* N.B. These two catchments are technically outside of the original project scope, although liaison has continued with the relevant contacts in each area to facilitate active floodgate management goals.

4.2. Floodgate database and Geographic Information Systems

The results of the audit conducted into the high priority floodgates were compiled into a database. This database is located at the NSW Fisheries office in Ballina and will form part of the State-wide "Barriers to Fish Passage" database. For a list of the fields selected for inclusion into the database, see the floodgate audit form in Appendix 1. Results contained in the database are now being used by state agencies and natural resource management committees for priority target setting for active floodgate management.

Upon project completion, the results were handed over in a catchment summary report to the respective councils to continue to implement the project and to work through the priority list with landholders.

4.3. Community involvement

A great deal of support and demand has now been created by demonstrating the benefits of active floodgate management and word of mouth has spread this positive message far and wide. Sixteen floodgates are currently being managed within the original project area. Thirty six floodgates are currently being actively managed within the Manning – Tweed area. It appears that the landholders participating in active floodgate management trials generate significant interest amongst their peers, who in turn contact NSW Fisheries and local Councils expressing an interest in pursuing similar outcomes. Over the three years of the project, ever increasing numbers of landholders have approached NSW Fisheries and Councils regarding this approach. In addition to

the structures currently being actively managed, several other sites are also in the process of being formally managed.

4.4. Local Government involvement

Since the inception of the NSW Fisheries floodgate project, there has been greater than expected support and resourcing from local government.

In the Clarence Valley the Clarence River County Council (CRCC) had indicated some willingness to address the issue at the 1997 NSW Fisheries workshop *Floodgate Management from a Fisheries Perspective*. With this interest, NSW Fisheries was able to convince CRCC that a more ambitious plan was possible and as a result the Clarence Floodplain Project was formed. Its objectives were:

- To rehabilitate fish and other wildlife habitat of the Clarence Floodplain
- To develop best practice flood control and floodplain management
- To improve water quality of the Clarence River and its tributaries
- To achieve the above objectives by working with all stakeholders including landowners, industry groups and environmental interests

As a result local Councils have now changed their focus from flood mitigation only, to include improved management of the floodplain and are actively pursuing aquatic, riparian and backswamp environmental objectives.

Due to the success of the Clarence Floodplain Project and the valuable relationship established between CRCC and NSW Fisheries, the Department pursued the development of a similar project with Kempsey Shire Council.

In January 2000, NSW Fisheries granted Council $40,000 to assist with the employment of a part-time Project Officer to set up the Macleay River Floodplain Project. One of the Project Officer's key tasks was to seek funding for a range of projects to improve fish passage and water quality from the floodgate and drainage network within the Lower Macleay floodplain.

Five funding applications were developed in consultation with NSW Fisheries, the Department of Land and Water Conservation and NSW Agriculture.

In October, Council was notified that $108,700 of Natural Heritage Trust funding had been granted for the first year of a large two-year project to implement land and water management projects in the Lower Macleay floodplain. The project has focused on the Upper Belmore River, Kinchela Creek, Rafferty's and Frogmore drainage areas in the Macleay floodplain, and the Upper Maria River-Connection Creek drainage area. These areas have experienced chronic problems with acid discharges or low dissolved oxygen, often resulting in fish kills.

Kempsey Shire Council has continued to maintain the impetus through hosting the recent 2002 Floodplain Management Authorities Conference held from 30th April – 3rd May 2002. The focus of this conference was flood mitigation works, the natural wetting and drying of floodplains and active floodgate management.

With the success of floodgate openings beginning to spread there was increasing recognition that the success or otherwise of these changes in meeting the stated objectives needed to be documented. As a result of efforts by commercial fishers, NSW Fisheries and NSW Agriculture, a complex research proposal was prepared for funding by the Fisheries, Land & Water and Sugar Research and Development Corporations. This is the only project ever funded jointly by these

Research & Development Corporations and the success of the research undertaken by NSW Fisheries and NSW Agriculture is already being seen in changed management practices.

Recognising the potential legal implications of damage to farmland, the project convinced participating Councils to adopt the formal but simple approach developed by the Clarence Floodplain Project. This involves the preparation of a management plan, which is agreed to and signed off by landholders (or a Drainage Union) and Council. The management plan must also address occupational health and safety management (eg. safe opening mechanisms, hand rails), training of landholders on how to safely open and shut the floodgate and insurance cover.

The management planning model currently being used by the Tweed and Kempsey Shire Councils and CRCC is the establishment of a landholder group as a floodgate operating team. This team is then declared a section 355 committee of Council, under the Local Government Act. Such committees are covered by Council's public liability insurance while operating a floodgate under a Council approved management plan. The management plan should remain an active document and requires regular review to ensure it is working effectively.

The project has demonstrated performance in delivering on the ground management actions throughout a number of river catchments from the far north to the mid-north coast of NSW. In particular because six demonstration sites were originally intended, and a further two additional sites have been achieved outside the original project boundaries.

NSW Fisheries has also been successful in creating a significant amount of support and ownership from local government. This support and ownership has been driven by councils recognising the benefits of the floodgate project in floodplain and water quality management, it demonstrates the environmental credentials of Councils, and overall it encourages better links and partnerships with floodplain stakeholders. The total expected contribution from Councils in the original project area during the three years since project commencement, is now estimated at $ 741, 296 compared with the original estimate of $25,000 per Council per year (or $225, 000 projected total). This equates to over three times as much funding support being derived from Councils as was originally anticipated.

A further $1, 912, 089 has been spent in the Clarence catchment on floodgate management since the project's inception. This figure has not been added to the above total, although it should be noted that there was extensive NSW Fisheries liaison and consultation with Clarence River County Council, with regards to the pursuit of active floodgate management outcomes.

4.5. Project funding table

	(a) **NHT Funds**	(b) (funds and in-kind) **NSW Fisheries**	(c) (funds and in-kind) **NCRCC**	(d) **Local Councils**	**Total** (a+b+c)
Funds received Year 1	67, 900	68, 050	14, 900	Tweed 3 yr total = 69, 628	150, 850
Funds received Year 2	109, 000	134, 000		Richmond 3 yr total =285, 000	243, 000
Funds received Year 3	119, 900	134, 000		Macleay 3 yr total = 386, 668	253, 900
Council 3 year total				741, 296	647, 750
Total Income = (a+b+c+d)	**296, 800**	**336, 050**	**14, 900**	**741, 296**	**1, 389, 046**

4.6. Industry involvement

The NSW Fisheries floodgate project has facilitated an attitude change to floodgate management across the board. Industry support has been enormous and is continuing to create demand. For example, the NSW sugar cane industry is now extremely supportive of becoming involved in active floodgate management and continues to pursue further openings. The Clarence River Fishermen's Co-operative is also working towards opening a number of floodgate structures to improve fish passage and increase the available habitat.

Another good outcome so far has been the transfer of the project to Queensland where the Department of Primary Industry and Fisheries has shown a key interest in actively managing floodgates in the Cairns and Maroochydore areas. NSW Fisheries staff have attended a field day for Queensland cane industry representatives in Maroochy catchment to promote the benefits of active floodgate management. It is anticipated that the project will continue to spread to other areas, as the model is adaptive and workable in benefiting not only fish, but also the health of coastal floodplains generally.

Floodplain management has in recent times become a critical issue for all stakeholders associated with our coastal environments. Recent fish kills on the north coast have highlighted the consequences of inaction and poor land management practices. The work of NSW Fisheries has increased the desire to better manage our floodplains and specifically the drain networks and structures associated with them.

A great deal of support and demand has now been created by demonstrating the benefits of active floodgate management and word of mouth has spread this positive message far and wide. Requests for further information have come from interstate locations including Victoria, Queensland and South Australia. Recent workshops on the findings of studies into the 2001 fish kills in the Richmond and Macleay Rivers, and acid sulfate soil management, have also highlighted landholder and local Government interest and desire to better manage our drain and creek systems for all users of our coastal floodplains.

Most importantly floodgate management is now not seen as a NSW Fisheries' project, or a project of the relevant Council or County Council, but one which individual landholders, the cane and fishing industry and the above organisations all work together to achieve commonly agreed environmental improvements. This is not common in the management of the aquatic environment.

NSW Fisheries worked closely with numerous of State and local Government Agencies, Fishermen's' cooperatives, agricultural industry organisations and representatives, conservation groups, Regional and local Catchment Committees, in addition to a multitude of interested landholders. By utilising the existing networks provided by these organisations, this provided a platform for the project to inform participating landholders of project benefits, proposed outcomes and support required, thereby reducing the need for multiple individual contacts.

Some of these groups include:

Department of Land and Water Conservation, NSW Agriculture,Tweed Shire Council, Richmond Valley County Council, Clarence River County Council, Bellinger Shire Council, Nambucca Shire Council, Kempsey Shire Council, Hastings Municipal Council, Greater Taree City Council, Clarence River Fishermens Cooperative, NSW Sugar Milling Cooperative, numerous Drainage Unions, Wetland Care Australia, Southern Cross University, University of Wollongong, Richmond Floodplain Committee, Macleay Floodplain Project.

4.7. Improved environmental outcomes

Through the active management of a number of floodgated systems since the inception of this project over 80 kilometres of waterway have been opened within the project area. This has led to the following environmental benefits:

- Improved fish passage and biodiversity values

The reopening of floodgated systems means that fish now have improved access to over 80 km of waterway habitat. Fish and other species can utilise these 'new' areas for feeding, breeding, shelter and migratory purposes.

- Re-wetting of wetlands

It should also be recognised that many of these re-opened systems provide additional access to once cut off wetland systems, further increasing the benefits to aquatic species in particular, and biodiversity values in general. Wetland and riparian vegetation species; avifauna (bird life) including threatened species under the *Threatened Species Conservation Act, 1995* such as the Jabiru, Comb-crested Jacana, Brolga and Osprey; aquatic reptiles such as freshwater turtles and snakes; amphibians and a range of invertebrates have all benefited from the re-wetting of these areas.

- Improvement in drought proof pasture refuges.

Re-wetting of areas can also provide additional fodder for dry periods as a backup resource for landholders with stock (see Plate 4).

- Reduced exposure to air of acid sulfate soils

Some Councils and land management agencies are approaching active floodgate management with the aim of improving the management of acid sulfate soil areas. The re-wetting of badly scalded areas leads to a reduction in the likelihood for oxidation of further potential Acid Sulfate Soils lying close to the soil surface. This in turn results in a reduction in the amount of acid products generated from these 'hot spot' areas.

- Improvements in water quality parameters

Improvements in floodgate management lead to further benefits in terms of water quality parameters. As discussed above, reduced exposure of acid sulfate soils to air, leads to higher pH values (reduced acidity levels). Active management also prevents water from stagnating behind floodgates and facilitates higher dissolved oxygen levels (necessary for aquatic organisms) in a more dynamic aquatic environment.

Regular flushing also helps to reduce the build-up of 'mono-sulphidic black ooze' (MBO's), a highly reactive sludge which can accumulate in drainage channels over time. When disturbed by flood events, large quantities of MBO's can rapidly strip the water column of oxygen leading to fish kills.

- Reduction of weed species

The active management of floodgates particularly in areas within the lower estuaries of river systems leads to saline water re-entering natural watercourses and drainage systems. Research has established that the salt water does not intrude further than 3 – 4 metres beyond the watercourse (NSW Agriculture Research Project, 2001), ensuring viable farmland where it does not exceed the confines of the drain.

Aquatic and riparian weed species are killed off by the salt-water intrusion. This in turn has benefits for landholders as they do not need to spend time and money spraying weeds in these drainage systems. The reduced use of herbicides has additional flow on environmental benefits for aquatic organisms.

A Tweed cane grower has related that he has not needed to spray for weeds in his drains since active floodgate management trials commenced 12 months previously (Riches, M., pers. comm.)

Plate 5: Before active floodgate management, Condong Creek (4/98).

Plate 6: Eleven months after active floodgate management, Condong Creek (3/99).

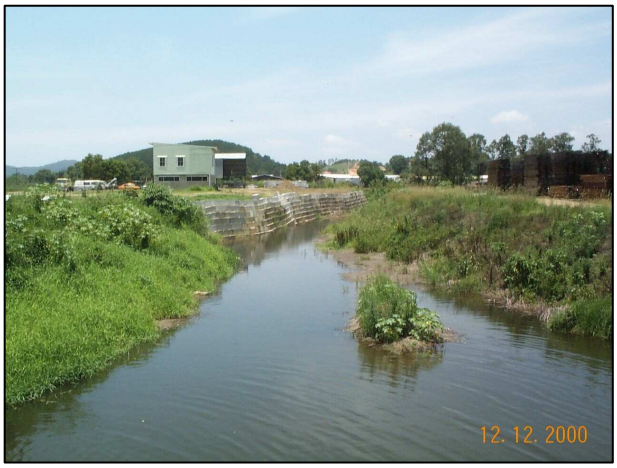


Plate 7: Two and a half years after active floodgate management, Condong Creek (12/00)

The above photographs clearly illustrate channel development and a significant reduction in weed infestation following the opening of the floodgate at Condong Creek, Tweed Shire.

4.8. Research

It was recognised as important to determine if the objectives of active floodgate management were being realised. A large integrated research project is currently being implemented on the Clarence and other coastal catchments. As the Clarence catchment has similar characteristics and fish species to most of the North Coast catchments the results can be used to make management decisions elsewhere.

The research project is a joint initiative between NSW Agriculture and NSW Fisheries with funding from the Land and Water, Fisheries and Sugar Research and Development Corporations and the Acid Sulfate Soil (ASS) Program. NSW Fisheries is examining the relationships between fish recruitment and the opening size of the gate, and the frequency and timing of the opening of floodgates (Kroon, 2001). The researchers are also looking at the behavioural responses of fish recruiting into drainage systems with low levels of ASS drainage water.

NSW Agriculture are researching the effects of floodgate management on groundwater and surface water drainage processes, soil water chemistry and the agricultural productivity of land adjacent to tidal drains and in low lying acid backswamps.

The results of the research projects, although not peer reviewed as yet, are indicating improvements to fish populations, water quality and land productivity; particularly in the management of acid sulfate soils.

Of most significant value is the role that NSW Fisheries and the Clarence Floodplain Project have taken to ensure that researchers involved in the Clarence communicate their results before they are published, to such an extent that landholders and fishers in the catchment as well as their representatives could explain the results and their ramifications well before the research is finished.

4.9. Monitoring

One of the key components of the project is monitoring of the impacts of active floodgate management. This has been achieved in examining changes in three key areas, namely:

1. Fish stocks

Dr Fredericke Kroon, Scientific Research Officer from NSW Fisheries, has conducted a number of research studies into fish and prawn stocks at locations before and after floodgate management trials have commenced. This forms part of a three year project examining the impact of floodgates and acid discharge on water flow and quality, and on the habitat, movement and recruitment of fish and prawns. Most of the studies conducted by Kroon have been based in the Clarence River catchment, although the results of those studies are applicable to other north coast catchments as well.

2. Water quality and water levels

The measuring of water quality parameters, before and after floodgate trials have commenced, are another key component of any successful monitoring program. Some of the key attributes to be measured include dissolved oxygen, pH, temperature, salinity, conductivity and turbidity. Using a Horiba U-10 water quality meter, these parameters can be checked quickly and accurately. Horibas are routinely used by NSW Fisheries and some local Councils such as Richmond River County Council. Some landholders are also checking water quality parameters, particularly salinity and pH using basic hand held kits.

Another tool for measuring water quality variables are dataloggers, which record a series of parameters in the field over a longer time scale (local Councils, DLWC, NSW Sugar). Some of

these have the option of being read remotely from another location through the Internet (Kempsey Shire Council, Richmond River County Council), with added potential for floodgate managers to access real time data.

Water levels are closely monitored by landholders and Council staff during the floodgate trial. As the gate is progressively opened over a range of tidal cycles, the water levels are monitored particularly at lower lying areas of land to ensure that no flooding of those areas occurs.

3. Vegetation (aquatic and riparian)

Aquatic and riparian vegetation changes are monitored through two techniques. The first involves the use of photopoints where photographs of upstream vegetation are taken of floodgates before and after trials commence. A period of 12 months is usually required before major changes become apparent.

An additional method involves the use of on-ground trials to determine species present before and after trials begin. University students in particular have proved a valuable resource in this instance, with a number of studies being completed for the floodgate project by Southern Cross University.

A good example of an integrated approach using all these methods, is at the Empire Vale site on the Richmond catchment, where the Richmond River County Council has initiated a monitoring program. The program includes:

- an examination of fish recruitment pre- and post-floodgate opening by NSW Fisheries (Kroon, 2000),
- water quality monitoring using 24 hour data loggers by the sugar industry and DLWC,
- vegetation community changes – being undertaken by a Southern Cross University student,
- monitoring of flow levels and soil and water chemistry by NSW Agriculture,
- monitoring of water levels within the drainage network at various opening regimes and tidal levels – being completed by landholders.

All of this information will feed into the management of the floodgate at this and other locations.

Other monitoring parameters which will be tailored to each demonstration site include:

- visual water quality observations (changes in water colour),
- measured water quality changes (monitoring by council with data loggers, or landholders may use hand held probe to check pH and salinity),
- photo points to measure vegetation community changes in the drain and on banks of the drain.

University students have completed monitoring programs at the two demonstration sites in the Richmond River, for example. In the Empire Vale system (including Empire Vale and Sneesby's lane floodgates) Anderson (2000) studied water quality, fish species and aquatic / riparian vegetation parameters, before and after active floodgate management trials.

Anderson concluded that " *the Sneesby's Lane sluicegate was opened on the 20/9/00. Immediately there were improvements in water quality. Dissolved oxygen levels increased, remaining above the guidelines specified by ANZECC. There was a rise in water temperature as the warmer river water flushed the drain. pH and turbidity remained relatively constant whilst the freshwater area of the system became fully estuarine. The saline conditions and increased water velocity removed over 90% of the aquatic weeds, allowing increased water movement throughout*

the system. Fish surveys identified fish species ranging in habitat from oceanic to freshwater. It is expected that more estuary orientated species will be present in future as saline conditions continue."

The Dungarubba Creek site has been studied as part of another Southern Cross University project by Henry (2001), who has completed a survey of environmental parameters before active floodgate management trials took place. A follow up study is planned for 12 months after this initial trial, to examine the changes in water quality and aquatic / riparian vegetation.

4.10. Communication and media

The project demonstrates genuine and transparent public accountability through the following methods of reporting and feedback:

- Presentation of final catchment reports to all local governments involved in the project including Tweed, Richmond, Bellinger, Nambucca, Macleay and Manning.
- The success of the project was acknowledged by **Natural Heritage Trust television advertisements** highlighting the floodgate project as a regional success story.
- Press releases – in local print media regarding floodgate openings and trials.
- Field days – Open days and displays were held at landholder attended events such as the Primex shows.
- Presentations to Councils and Floodplain Committees – numerous presentations have been made to these bodies during the project.
- Landholder liaison – through letters, surveys, phone calls and on-site inspections and meetings.
- Attended and presented at the Coastal Acid Sulfate Soils Program (CASSP) workshop held at Kempsey on 29th May 2001.
- Provided a guided inspection of floodgate demonstration sites in the Tweed catchment for the International Society of Sugar Cane Technology Congress on 19th September 2001.
- Attended and spoken to various meetings and groups such as the Tweed Canegrowers AGM, Byron Shire Council, ASS Forum, Tweed River Advisory Committee, Nambucca Branch NSW Farmers Association and conducted radio interviews for ABC Radio.
- Have had numerous meetings with the Manager - Agricultural Services, NSW Sugar Milling Co-Operative, Broadwater Mill.
- Queensland DPI have shown interest in the project model and are proposing a similar trial project for the Maroochy River catchment. Elizabeth Cotterell, Policy Officer with QDPI, has visited here and did a tour of many of the floodgate sites of the Richmond and Tweed catchments. QDPI have also held a field day for landholders of the Maroochy catchment. This was attended by NSW Fisheries Senior Conservation Manager Craig Copeland and Robert Quirk (cane farmer from the Tweed).
- Have continued attending & speaking at meetings and workshops throughout the geographic region of the project including Upper Belmore Community Workshop, North Coast Spatial Information Group Seminar, a presentation at Southern Cross University and a further phone interview for ABC Radio National's "Rural Report".

Design / implementation of new active floodgate management process

With over 1000 floodgates on the North Coast, the project had to develop an efficient way of prioritising and auditing the floodgates in each catchment for active management. Key criteria and a scoring system were used to audit each floodgate. The criteria included a mix of fish habitat attributes, physical habitat characteristics and landholder willingness to implement a changed management regime to their floodgates and drains. The criteria included naturalness of the waterway, waterway length, habitat value and landholder willingness.

This last criterion was the most important in determining floodgates that could be opened. Each landholder on a floodgated drainage network was sent a brief survey requesting their feedback on issues with their drainage and floodgate system, and to determine whether they were interested in active management of the floodgate. This was followed up with a phone call and face-to-face meeting to discuss active floodgate management in more detail.

Those floodgates with 100% landholder support for active management received a higher score than those with limited or no support. This was a time consuming part of the process but the outcomes achieved demonstrate the value of this time spent. In addition, the convinced landholders then proved to be the best advocates for changes to floodgates at other locations in the same valley.

4.11. Devolution of floodgate management

The North Coast Floodgate Project has changed the focus of a major natural resource management issue away from State Government to local landholders and Councils. This was probably the key to the success of the project. The landholders and Councils knew they had administrative, technical and financial support but importantly felt that they were in control of what actions happened.

This allowed them to proceed at their own pace which initially was very slow but which has now picked up so much momentum Councils and NSW Fisheries are developing additional funding proposals so that all high priority floodgates on the North Coast can be actively managed.

The project has assisted in developing a sense of trust with landholders, in acknowledging that they know the best way to manage the gates for the environment and their own benefit. Once a floodgate management plan is in place, it may be the catalyst for farmers to consider other environmental projects to improve land and water management, such as wetland management and riparian zone management along drains and creeks.

Equally important is devolving resources to councils and landholders to assist in getting active floodgate management underway. This does not necessarily mean money, but may involve technical expertise on best ways to modify the gates, management plan templates, and assistance with funding applications for major works or projects.

4.12. Support for initiatives into design of new styles of floodgates

When this project commenced there was only one way to allow for changed management of floodgates but as a result of interest by farmers, Councils and others a number of new designs have been installed on the North Coast and more are being developed. Some of these designs are shown below:

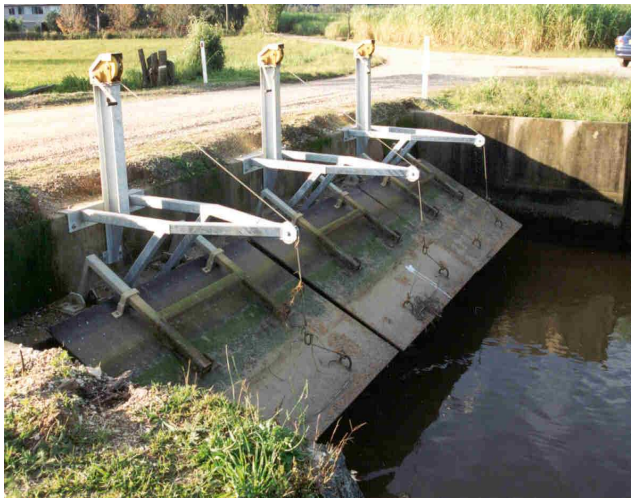


Plate 5: Installation of lifting devices (derricks and winches) on headwalls

Plate 6: Sluice gates in existing structures

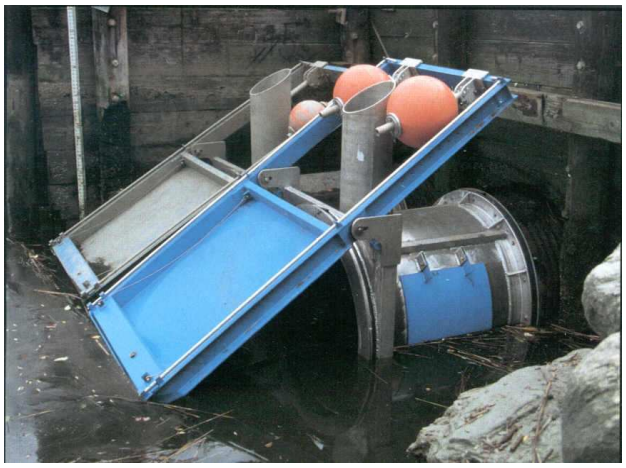


Plate 7: Automatic tide regulated floodgates

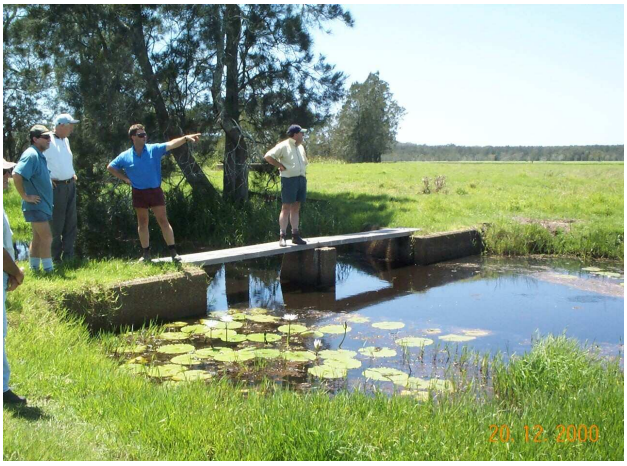


Plate 8: Drop Boards

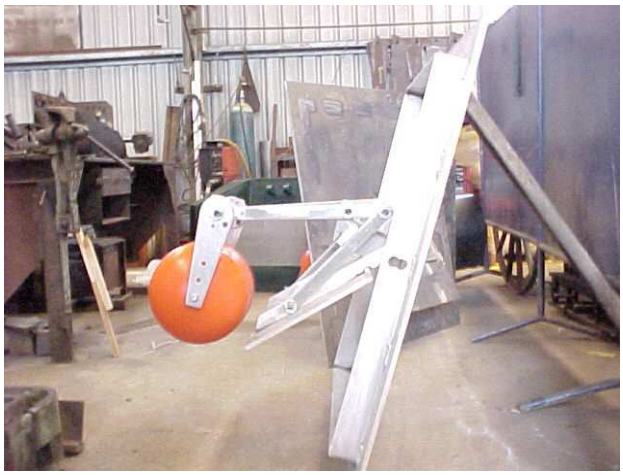


Plate 9 : Upstream tidally operated floodgate

Plate 10 : Liquid levelling regulator

These new styles of floodgates include tidally operated modifications. These are stimulating great interest amongst Councils and landholders due to the reduced need for on-going management and maintenance. Being operated by relative water levels up or downstream of the floodgate, rather than by personnel physically needing to be present to manipulate the floodgate, frees up landholders / Council staff to accomplish other tasks.

4.13. Recognition of NSWF role as action agency

The three-year floodgate project has promoted recognition of NSW Fisheries as a key action agency in promoting active floodgate management and devolving responsibility to local Government, landholders and industry organisations. Prior to this project, some Councils were initially reluctant to pursue the goals of floodgate management but following NSW Fisheries lead are now proceeding to implement these at an ever increasing scale. Figures on expenditure by local Government which has been greater than expected, are provided in Table 2 (see section 4.5). This shows the amount of Council expenditure on floodgate management over the last three years and further demonstrates local Government's ongoing commitment to the process.

NSW Fisheries has also helped local Councils by seeking and securing additional funds to support the provision of on-ground works. For example, the Ministerial Advisory Council for Fish Conservation granted $20,000 to Kempsey Shire Council to assist with floodgate modifications to improve fish passage at five priority floodgates in the Lower Macleay.

An application has been made for recognition by the *National Riverprize award* detailing the achievements of the project.

5 Future direction

The results have been handed over in a catchment summary report to the respective council to continue to implement the project and to work through the priority list with landholders. NSW Fisheries will continue to assist with expertise and resources to keep the project going post-NHT.

Additional funding to ensure the continuation of the projects objectives has been sought and secured from the NSW State Government's Environmental Trust. Over the next two years $ 522, 500 will be funded, primarily on on-ground works within the north coast of New South Wales.

An additional $ 62, 500 will be spent on cash contributions by local Councils, and a further $ 175, 000 through Council based in-kind contributions. NSW Fisheries will contribute a further $ 7, 000 as in-kind contributions, leading to a total expenditure on actively managing floodgates of **$ 767, 000** over the next two years.

Funds will also be used to continue the existing Floodgate Manager position within NSW Fisheries for the duration of the project. This will ensure a sense of consistency and fulfil an important communication, advisory and coordination role for the continued pursuit of active floodgate management within New South Wales.

6 Conclusions / Recommendations

The following conclusions and recommendations have been drawn from this project to date:

- the techniques and lessons learned from this project can be applied to other coastal floodplains in Australia,

- active floodgate management should be promoted as one method of enhancing wetland management in coastal floodplains in Australia,

- active floodgate management has a range of additional benefits including:

    1. providing improved fish passage and habitat,
    2. enhancing biodiversity values,
    3. facilitating management and remediation of acid sulfate soils,
    4. leading to improvements in water quality parameters,
    5. providing additional drought fodder for landholders,
    6. improved weed management in some drainage systems.

- 'landholder willingness' and 'landholder control' are the keys to managing coastal floodplains and wetlands through active floodgate management,

- methods of assessing landholder willingness' and engaging landholders in the initial stages of wetland management projects are critical to their success. Without their interest, involvement and cooperation, success of a project can be very limited and inefficient,

- some of the key challenges have included maintaining implementation of management plans in the longer term, particularly if property changes hands, or circumstances change. Therefore it is important to ensure that the management plan is adaptable and reviewed by Council and the landholders.

- continued promotion of active floodgate management goals to the broader community will aid in the wider adoption of the aims and objectives of the process,

- new styles of floodgate modifications involving systems that require less on-going attendance / maintenance (ie. tidally regulated) may prove to be more successful in the long term,

- further research and trials are required on the best opening devices to be used on particular floodgate structures,

- monitoring is still a challenge to implement and keep going in the longer term,

- the initial project success needs to be followed up with continued funding support to follow up the gains made by this project,

7 References

ANZECC. 1992 *Australian Water Quality Guidelines for Fresh and Marine Waters*. Australian and New Zealand Environment and Conservation Council, Australia.

Auld, K. 1998. *Wetland Rehabilitation on the Lower Clarence River Floodplain*. Ocean Watch, Sydney.

Ferguson, A. and Eyre, B. 1995 *Local and Regional Impacts of Acid Runoff from Acid Sulfate Soil Environments in the Lower Richmond River Catchment*. Final Report Environmental Research Trust, Southern Cross University, Lismore.

Pollard, D.A., and Hannah, J.C. 1994. *The ecological effect of structural flood mitigation works on fish habitat and fish communities in the lower Clarence River system of South-eastern Australia*. Estuaries 17:427 - 426.

Riches, M. & Huegill, J. 2001. *Sustainable Land Management of Coastal Floodplains in Northern NSW: - Tweed River Catchment Final Report.* Natural Heritage Trust , NR1008.98. NSW Fisheries, Office of Conservation, Ballina.

Riches, M., Walsh, S. & Huegill, J. 2002. *Sustainable Land Management of Coastal Floodplains in Northern NSW: - Richmond River Catchment Final Report.* Natural Heritage Trust , NR1008.98. NSW Fisheries, Office of Conservation, Ballina.

Riches, M., Walsh, S. & Huegill, J. 2002. *Sustainable Land Management of Coastal Floodplains in Northern NSW: - Macleay River Catchment Final Report.* Natural Heritage Trust , NR1008.98. NSW Fisheries, Office of Conservation, Ballina.

Smith, R.J. 1998*. Sportsmans Creek – Everlasting Swamp – Floodgates and Drains: Possible improvements in Management*. Report to Clarence River County Council.

Smith, R.J. 1999. *Improving Floodgate and Drain Management on the Hastings Floodplain*. Hastings Estuary Management Committee.

Sammut, J., White I. and Melville, M. D. 1994. *Stratification in Acidified Coastal Floodplain Drains. Wetlands Australia*, 13, 1994. 49 - 64pp

Walsh, S., Riches, M. & Huegill, J. 2002. *Sustainable Land Management of Coastal Floodplains in Northern NSW: - Manning River Catchment Final Report.* Natural Heritage Trust, NR1008.98. NSW Fisheries, Office of Conservation, Ballina.

Walsh, S., Riches, M. & Huegill, J. 2002. *Sustainable Land Management of Coastal Floodplains in Northern NSW: - Bellinger River Catchment Final Report.* Natural Heritage Trust , NR1008.98. NSW Fisheries, Office of Conservation, Ballina.

Walsh, S., Riches, M. & Huegill, J. 2002. *Sustainable Land Management of Coastal Floodplains in Northern NSW: - Nambucca River Catchment Final Report.* Natural Heritage Trust , NR1008.98. NSW Fisheries, Office of Conservation, Ballina.

Williams R.J., Watford F.A. and Taylor M.A. 1996. *A summary of aspects of FRDC Project 94/041. "Restoration of Estuarine Fisheries Habitat Relevant to tidal Restrictions in New South Wales Estuaries*". Fisheries Research Institute Cronulla, NSW.

White, I., Melville, M.D., Wilson, B.P., Price, C.B. and Willett, I.R. 1993. *Understanding Acid Sulfate Soils in canelands*. In: R. Bush (Ed.) The proceedings of the national conference on acid sulfate soils, 24 - 25 June 1993.

White. I., Beale, J., Heath, L. and Melville, M. 1999. *Ecological Impacts of Flood Mitigation and drainage in coastal lowlands*. Australian Journal of Emergency Management. Spring 1999. 9 - 15pp.

Wilson, B.P., White, I., and Melville, M.D. 1999. *Floodplain Hydrology, acid discharge and water quality associated with drained acid Sulfate soil*, Marine freshwater Research, Vol 15, pp140 -157.

Appendix 1: Floodgate Audit Form

FLOODGATE AUDIT FORM

1.Site ID:

2. Catchment:

Assessor

Name:

3. Area: | **4. Dist:** | **5. Along:** | **6. From:**

7. Common Name: | **8. Other ID:** | **9. Source:**

10. Watercourse: NAT RIV CRE CON DRA COM

11. Main Channel Length: approx

12. System Length: approx

13. Depth @ Floodgate: mm

14. Channel Width @ floodgate:

15. Av. Depth Main Channel: 0.5–1m 1.1-2m 2.1-3m 3.1-4m >4m

16. Av. Width Main Channel: 0-3m 3-7m 7-15m >15m

17. Land Use: SUG BEE DAI TEA HOR HOR URB CRO IND OTH

18. Elevation: @ Floodgate: @ Lowest Point:

19. Wetland in System: YES NO

20. Tidal Range: (charts) m

21. Lag: hrs

FLOODGATE DETAILS:

22. Owner: SC ~ PV DU

23. Shape: SQU RND

24. Material: STE ALU FIB WOO CON

25. Cells:

26. Size: X

27. Condition: GOO FAI POO LEA OTH

28. Type: FLA GUI SHU SLU

29. Floodgate Modifications: WIN PUI SLU DRO OTH

30. Invert Level: AHD

31. Invert to Waterway Bed: upstream side: mm downstream side: mm

32. Other Structures/Barriers In Drainage Area:

	FLG	DRO	WEI	DAM	PUM	CUI	BRI
No.							

ASS OCCURRENCE RISK (from ASS Risk Maps) WITHIN SITE DRAINAGE AREA:

33. High Prob. @: BED 0-1M 1-2M 2-4M >4M

34. Low Prob. @ BED 0-1M 1-2M 2-4M >4M

35. 'Hotspot' ID: YES NO

36. Visual Indicators: JAR SCA CAN RED VEG OTH

AQUATIC FAUNA:

37. Fauna: Now MUL BAS BRE JAC FLA WHI GAM CRA PRA EEL TUR LAR TAD

GAR GOB TRU STR FLO GUD BUL CAT CAR HER RAI OTH

38. Fauna: Hist. MUL BAS BRE JAC FLA WHI PRA CRA EEL TUR OTH

39. Known Fish Habitat Area: YES NO UNK

40. Prev. Comm Importance: YES NO UNK

41. Fish Kills: YES NO UNK

42. Recorded: NSWF YES NO

43. No.:

44. Known Locally YES NO

45. No.: past 12 mth 1-5yr: 5 yr

46. Research Data: YES NO UNK

47. Rare or threateneds? NO YES

48. 8 Part Test? YES NO

AQUATIC & RIPARIAN VEGETATION:

49. Aquatic Veg: UL RUS COU ALG RIR PHR HYA SAI ALI PAR SED CUM

50. Riparian Upstream from gate: WEE GRA MAN CAS MEL FUC CAL OTH

51. Spray: YES NO

52. Riparian Downstream from gate: WEE GRA MAN CAS MEL FUC CAL OTH

53. Spray: YES NO

54. Research Data: YES NO UNK

55. Rare or Threateneds? NO YES

56. 8 Part Test? YES NO

FLOODGATE AUDIT FORM EXPLANATIONS

1. **Site ID:** Six figure grid reference from 1:25,000 series Topographic maps
2. **Catchment:** Which catchment is the floodgate in, eg Tweed.
3. **Area:** Which area within the catchment, eg Dulguigan.
4. **Dist:** Distance in kilometres **From.**
5. **Along:** Which road, levee, etc, eg Dulguigan Road
6. **From:** Reference point or direction, eg Dulguigan Creek bridge.
7. **Common Name:** Has the floodgate got a local or common name, eg The Barrage.
8. **Other ID:** Other Authorities or agencies may have already assigned an ID to the floodgate.
9. **Source:** Who else has named the floodgate, eg Tweed Shire Council.
10. **Watercourse:** Description of the floodgated watercourse. Codes: **NAT** = Natural; **RIV** = River; **CRE** = Creek; **CON** = Constructed; **DRA** = Drain; **COM** = Combination.
11. **Main Channel Length:** Approximate length of main channel, measured in situ or from DLWC Drainage Maps.
12. **System Length:** Approximate length of entire waterway including connecting drains and watercourses.
13. **Depth @ Floodgate:** Drain depth in millimetres, from top of bank to watercourse bed, at floodgate site.
14. **Channel Width @ Floodgate:** Width in metres at floodgate site.
15. **Av Depth of Main Channel:** From DLWC Drainage Maps or measured in situ.
16. **Av Width Main Channel:** From DLWC Drainage Maps or measured in situ.
17. **Land Use:** Land uses of the drainage area affected by the floodgate. Codes: **SUG** = Sugarcane; **BEE** = Beef farming; **DAI** = Dairy farming; **TEA** = Teatree; **HOR** = Horticultural; **HOB** = Hobbyfarm; **URB** = Urban lots/area; **CRO** = Cropping; **IND** = Industrial use; **OTH** = Other.
18. **Elevation @ Floodgate and @ Lowest Point:** Height in AHD of land at the floodgate site and at the lowest point in drainage area.
19. **Wetland in System:** Is a wetland connected to this drainage area.
20. **Tidal Range:** Height, in metres, of Mean High Water Springs (near Solstices) to Mean Low Water Springs.
21. **Lag:** The difference in time from the river mouth to the floodgate for high or low tide to occur.

Floodgate Details:

22. **Owner:** Who owns the floodgate. Codes: **SC** = Shire Council; **CC** = County Council; **PV** = Private; **DU** = Drainage Union.
23. **Shape:** Codes: **SQU** = Square; **RND** = Round.
24. **Material:** What is floodgate, including headwall and wings, made from. Codes: **STE** = Steel; **ALU** = Aluminum; **FIB** = Fibreglass; **WOO** = Wood; **CON** = Concrete.
25. **Cells:** How many cells in the floodgate structure.
26. **Size:** In millimetres. In the case of round floodgates, diameter in millimetres.
27. **Condition:** An assessment of the floodgate condition. Codes: **GOO** = Good; **FAI** = Fair; **POO** = Poor; **LEA** = Leaking; **OTH** = Other (inoperable, broken or removed).
28. **Type:** Codes: **FLA** = Flap; **GUI** = Guillotine; **SHU** = Shutter; **SLU** = Sluice.
29. **Floodgate Modifications:** What has been added to the structure. Codes: WIN = Winch; PUL = Pulley; SLU = Sluice gate within main flap; DRO = Dropboard; OTH = Other.
30. **Invert Level:** In metres AHD.
31. **Invert to Waterway Bed:** Distance in millimetres from invert sill to bed of waterway, upstream and downstream of floodgate.
32. **Other Structures/Barriers, and numbers, in Drainage Area:** Codes: **FLG** = Floodgate; **DRO** = Dropboard; **WEI** = Weir; **DAM** = Dam; **PUM** = Pump; **CUL** = Culvert; **BRI** = Bridge.

ASS Occurrence Risk (from ASS Risk Maps) Within Site Drainage Area:

33. **High Prob. @:** There will be a high probability of risk to disturbing ASS soils within the indicated depths. The shallower the depth, the greater the risk.
34. **Low Prob. @:** There will be a low probability of risk to disturbing ASS soils within the indicated depths.
35. **'Hotspot' ID:** Have any 'Hotspots' been identified, from DLWC 'Hotspot' mapping, within the drainage area.
36. **Visual Indicators:** Of acid discharges. Codes: **JAR** = Jarosite; **SCA** = Scalds; **CAN** = Concrete Cancer; **RED** = Red Iron Stains/Scums; **VEG** = Presence of acid tolerant plant species; **OTH** = Other.

Aquatic Fauna:

37. **Fauna Now:** Codes: **MUL** = Mullet; **BAS** = Bass; **BRE** = Bream; **JAC** = Mangrove Jack; **FLA** = Flathead; **WHI** = Whiting; **GAM** = Gambusia; **CRA** = Crab; **PRA** = Prawn; **EEL** = Eel; **TUR** = Turtle; **LAR** = Mosquito Larvae; **TAD** = Tadpole; **GAR** = Garfish; **GOB** = Goby; **TRU** = Trumpeter Fish; **STR** = Stripey; **FLO** = Flounder; **GUD** = Gudgeon; **BUL** = Bullrout; **CAT** = Catfish; **CAR** = Carp; **HER** = Herring; **RAI** = Rainbow Fish; **OTH** = Other.
38. **Fauna Hist.:** What used to be caught there. Codes: As for 37.
39. **Known Fish Habitat:** Was the area known as a good place to catch fish prior to modifications and flood mitigation. Codes: **UNK** = Unknown.
40. **Prev Comm Importance:** Prior to flood mitigation, was the watercourse commercially fished.
41. **Fish Kills:** Have fish kills occurred in the watercourse.
42. **Recorded NSWF:** Have they been officially reported to NSWF.
43. **No:** How many fish kills have been officially reported for the watercourse.
44. **Known Locally:** Are other fish kill incidences, which have not been reported or recorded, known.
45. **No & When:** How many and within what time frame.
46. **Research Data:** Is there any available research data on aquatic fauna and fish kills for the watercourse.

47 & 55. Rare or Threateneds?: From NPWS Schedule. Are any present?

48. & 56. 8 Part Test: Only if YES for 47 &/or 55.

Aquatic Vegetation & Riparian Vegetation:

49. **Aquatic Veg:** Codes: **LIL** = Waterlily; **RUS** = Rushes (Juncaceae); **COU** = Water Couch; **ALG** = Algae; **RIB** = Ribbon Weed; **PHR** = Phragmites; **HYA** = Water Hyacinth; **SAL** = Salvinia; **ALL** = Alligator Weed; **PAR** = Para Grass; **SED** = Sedges (Cyperaceae); **CUM** = Cumbungi.
50. **& 52 Riparian Upstream from floodgate:** Codes: **WEE** = Weeds; **GRA** = Grass; **MAN** = Mangrove; **CAS** = Casuarina; **MEL** = Melaleuca; **EUC** = Eucalyptus; **CAL** = Callistemon; **OTH** = Other.

51. & 53. Spray: Is there evidence the riparian zone has been sprayed.

54. **Research Data: Is there any available research data on the aquatic & riparian vegetation of the site.**

Appendix 2: Floodgate Management Plan example

FLOODGATE MANAGEMENT PLAN

EMPIRE VALE LOWER RICHMOND ESTUARY

1. Introduction

This Draft Management Plan outlines the tasks and responsibilities for a floodgate management trial at Sneesby's Lane and Empire Vale Floodgates.

The aim of the trial is to assess the effects of alternative floodgate management on water quality, fish passage and aquatic weed control in the Empire Vale Creek drainage system.

This Plan has been prepared in consultation of all stakeholders. The degree of involvement, methodologies, timing and evaluation is detailed below.

2. Floodgates:

The trial will include both the Sneesby's Lane and Empire Vale Creek floodgates

Sneesby's Lane – 4 cell 1.5m square box culverts
Empire Vale - 4 cell 1.5m square box culverts

2. Location :

Empire Vale Northern Eastern NSW (lower Richmond River estuary)

4. Involvement in the development of this Management Plan:

NSW Cane Growers
(Landholders) John Elliott, Terry Lowe, Jim Walsh, Steve Flatley
Richmond River County Council
NSW Agriculture
NSW Department of Land and Water Conservation
NSW Fisheries

5. Floodgates and trial

- Richmond River County Council (RRCC) will conduct the trial. However, as the trial progresses and methodologies are successfully tested, RRCC will consider gate operation by landholders.

- All the actions to be undertaken are consistent with past and established management practices and in consultation with State Government agencies.

- RRCC will regularly communicate with landholders through meetings, onsite visits and Cane industry Newsletters to ensure that landholders are involved and kept informed.

- RRCC has designed and manufactured adjustable sluice gates and attached one to a central gate at Sneesby's Lane and Empire Vale Creek floodgates.

- Each sluice gate has been designed to have a maximum aperture of 0.6m^2

- A 'T' piece extension key has been be designed to close and open the sluice gate, which will also provide some security, preventing unauthorised gate manipulation.

- The under road pipe at Sneesby's Lane has been sealed to prevent any influence on in-drain water levels and fish passage survey.

6. Gate opening and closure

Gate Opening:

- The' sluice gate' at Sneesby's Lane will be opened incrementally with adjustments made according site monitoring of in-drain water levels. This process will be on going to determine the range of gate apertures that will allow full drain flushing but not over top banks.

Gate Closure:

- A tidal height above 1.8 metres or a flood warning would trigger a lowering of the gate to a safe level (25% aperture or 15 cms)

- The routine drain maintenance to control weeds would also require the closure of the gates to ensure drain water levels are normalised. Otherwise, it is envisaged that the sluice gate would be kept open.

- The sluice gate will allow opening under a range of tidal heights without relying on seasonal low tides.

7. Timing

- It is envisaged that the initial opening of the sluice gate will take place in the week following September 16 /2000 (Monday 18 –Saturday 24) to allow for a pre-trial fish survey by NSW Fisheries.

8. Monitoring

- **Drain water quality - *datalogger***

Drain water will be monitored using a datalogger, which has been deployed by NSW Sugar Industry. This data will be compared with pre trial data (Department of Land & Water Conservation DLWC).

- **Drain water quality – *spatial***

Landholders and RRCC have selected three sites along the drain system for RRCC and NSW Fisheries to test with Horiba U-10 meters. Monitoring at Wardell prior to the trial (RRCC) to determine salinity levels.

- **Groundwater monitoring**

NSW Agriculture will monitor Groundwater for salt intrusion in the Pippo's Tomato farm area.

- ***Water levels***

Landholders, RRCC staff and agency officers will monitor water levels at three points along the system. Those monitoring will communicate between sites and floodgates using mobile phones and two-way radios.

9.Vegetation and fish surveys

- Bank and in-stream vegetation will be monitored using photo points and plant identification. (NSW Fisheries)

- The Clarence Project research team will monitor fish species and movement in the drain (NSW Fisheries).

- University student projects to be utilised in monitoring in-stream vegetation, water levels and water quality.

10. Measuring and Evaluation of the Trial

- Council, landholders and recognised specialists in hydrology and water quality, will evaluate the trial.

- All data collected will be made available to those individuals and organisations listed in Item 5 of this plan. This includes data collected from the in-stream data logger deployed by Sunshine Sugar (NSW Sugar), Spatial water quality monitoring collected by RRCC, Sunshine Sugar, NSW Fisheries and David Anderson (Southern Cross University)

11. Measurable outcomes will include

- increased water quality (Dissolved Oxygen)
- no deleterious effect on surrounding landuses
- increased fish passage
- less fish kills
- cleaner drains and
- reduced problems with odours from stagnant water

12. Contingency plan

- the gates will be shut if there is a risk of flooding (general flood warning from the Bureau of Meteorology
- localised flooding and risk of drain bank overtopping
- storm surges and
- any significant concerns by landholders after consultation with all stakeholders

13. Changes to Management Plan

- Council will review the management plan regularly and consult with local landholders

14. Contacts

NSW Fisheries	ph 0266 862018 fax 0266 868907
Cane Growers Association	ph 0266 208257 fax 0266 828330
Paul O'Sullivan Michael Wood (Coordinator) (Richmond River County Council)	ph 0266 218314 fax 0266 221181 ph 0266 218314 fax 0266 221181
Peter Haskins (Department of Land and Water Conservation)	ph 0266 530126 fax 0266 523936
Dr. Peter Slavich NSW Agriculture	ph. 0266 261200 Fax 0266 281744

Framework for trial opening of Sneesby's Lane floodgates Empire Vale

Below are submissions from the Department of Land and Water Conservation, NSW Agriculture, NSW Fisheries (attached) and NSW Sugar for the proposed Empire Vale floodgate trial management plan. This list is not exhaustive and presented to the Working Group for discussion and further evaluation.

Richmond River County Council (RRCC)

Gate operation

As owners of the floodgates Richmond River County Council (RRCC) is responsible for their upkeep and operation. RRCC is also mindful of its legal responsibilities in regard to flood protection, issues covered by work cover and occupational health and safety. With this in mind Council feels that it would be better suited to undertake the trial gate operation. Landholders would be involved in a support and monitoring role, however, as the process of trial progresses and sound methodologies and contingency plans are in place Council may then devolve operations to a landholder committee. Until this occurs Landholders will be involved with monitoring water heights and quality. Landholders will be kept informed through regular communications and site visits.

Gate opening

Richmond River County Council (RRCC) has discussed a range of options to open the gates and proposing that a sluice gate be attached to the existing floodgates. This option is considered to be the best for the following reasons:

- for ease of operation under a range of tidal heights
- so that water flowing through the sluice gate can be accurately calculated
- and to provide a range of controlled opening options

RRCC will fabricate sluice gates and attach them to both Sneesby's Lane Floodgates and then possibly at Empire Vale Creek gates. The dimensions of the sluice gates will be approximately 1m wide x 0.6 m.

As the aperture is the constrictor of flow not the drain, the greater the range of opening options will allow for greater control of flows. For example, the sluice gates will be narrower on higher tides and wider on lower tides.

Monitoring of the trial

The trial takes place when River salinity levels are low. Council staff will monitor water quality within the drain using a (Horiba U10 water quality checker) and along with landholders monitor water heights within the drain system.

Maintenance

Maintenance of the gates will be RRCC's responsibility. Also routine maintenance in the Empire Vale canal system is another issue that the trial will have to take into account ie. that the system will have to returned to pre trial condition for weed control.

Timing and Frequency of gate opening

The Working Group will discuss this; however, as Council will be opening the gates the timing of opening and closure is undertaken under councils staffs achievable time frames.

Trial Duration

To allow for a range of seasonal effects RRCC proposes that a twelve month period would be appropriate time frame for the purposes of the trial as this will allow for any seasonal effects to be taken into consideration.