PROBING PONDED PASTURES WORKSHOP

UNIVERSITY OF CENTRAL QUEENSLAND

JULY 16 - 18 1991

INDEX

1.0. BACKGROUND

- 1.1 Workshop Structure
- 1.2 Keynote Addresses

2.0. PAPERS PRESENTED TO THE WORKSHOP

- 2.1 Selected Papers
- 2.2 Abstracts

3.0. SEMINAR GROUPS

- 3.1 List of Group Findings
- 3.2 Summary of Group Findings

4.0 CLOSING AND SPEECH BY THE MINISTER FOR ENVIRONMENT AND HERITAGE

- 4.1 Press statement by the Minister for Environment and Heritage

5.0 COMPOSITION OF WORKING GROUP

6.0 CONTACTS

1.0 Background

Ponded pasture establishment has occurred for over 20 years in Central Queensland. The use of ponding banks to store water has enabled increased pasture productivity and length of growing season. In recent years commercial fishermen and members of the Wildlife Preservation Society have raised environmental concerns over the construction of ponding banks and development of ponded pasture. This came to a head after a field trip to visit ponded pastures north of Rockhampton in late 1990. As a result of this trip which involved staff from the Department of Primary Industries, the Queensland National Parks and Wildlife Service, the Wildlife Preservation Society, commercial fishermen and the University of Central Queensland it was suggested by Mr Richard Grimes, Q.NPWS Regional Director, that a forum be convened to discuss the issues involved. The site chosen was the University College of Central Queensland, the workshop being organised by Dr John Parmenter from the Biology Department.
The joint sponsors of the forum were the Department of Primary Industries and the Department of Environment and Heritage.

1.1 Workshop Structure

The workshop process was based on a model provided by Mr Shaun Coffey, the Regional Director, DPI. Submissions in any format eg. scientific papers, letters outlining concerns, anecdotal records etc. were invited from any interested party to gain a range of perspectives. Reviewers presented summaries of this material at the workshop under the subject areas of History and Development, Hydrology and Soil Science, Fisheries, Economics and Environmental Effects.

Discussion on those subjects led to the identification of four habitats of concern:

Marine and estuarine areas

Adjacent plains

Freshwater wetland systems

Other areas

And five major issue areas:

Habitat/ecological - fisheries

Other habitat/ecological issues

Weeds/plants introduction

Guidelines and legislation

Effects on the Grazing Industry

The first day of the workshop was a field trip to ponded pasture areas north of Rockhampton.

The second day involved the presentation of keynote addresses by the following speakers who chaired the following sessions. Copies of these addresses are in section 1.2.

1 Historical Perspectives, Current Status, Future Development Potential and Current Construction Guidelines for Ponded Pastures in Queensland.

Author/Session Leader: Shaun Coffey, QDPI.

2 Hydrological and Soil Science Factors Associated with the Use of Ponded Pastures.

Author/Session Leader: Tony Horton, QWRC.

3 Fisheries Management and Ponded Pastures.

Author/Session Leader: Mark Doohan, Qld. Commercial Fishermen's Organisation.

4 Economic Perspectives for the Use of Ponded Pastures in the Grazing Industry.

Author/Session Leader: Ruth Wade, Cattlemen's Union of Australia.

5 Environmental Issues Associated with the Development of Ponded Pastures.

Author/Session Leader: Eddie Hegerl, Australasian Littoral Society, Brisbane.

The last day involved workshop participants dividing into five seminar groups that were briefed to consider issues of concern in the following areas.

1 Habitat/Ecological - Fisheries

2 Habitat/Ecological - Other

3 Weeds/Plant Introduction

4 Guidelines/Legislation

5 Effects on the Grazing Industry

Seminar groups then reconvened to present their findings.

The workshop was closed by the Minister for Environment and Heritage, Mr Pat Comben.

1.2 Keynote Addresses

PROBING PONDED PASTURES WORKSHOP

17 and 18 July 1991

Historical Perspectives, Current Status and Current Construction Guidelines for Ponded Pastures in Queensland

--- OVERVIEW PAPER ---

by

Shaun G. Coffey
Regional Executive Officer
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1. INTRODUCTION

There are many excellent papers submitted to this conference which outline the historical development of the ponded pasture technology. I will not attempt to summarise these. Rather I seek to extract information which I believe is basic to our deliberations over the next two days.

Thus I will contain my comments to:

a) a brief synopsis of the historical development of ponded pastures.

b) a definition and description of the ponded pasture technology.

c) an overview of Queensland Department of Primary Industries guidelines on the application of ponded pastures technology.

d) a detailed description of the legal requirements of the Water Resources Act, Soil Conservation Act, the Fishing Industry Organisation and Marketing Act and the Fisheries Act in relation to ponded pasture technology.

e) a brief description of the types of issue raised in the submitted papers.

2. HISTORY

(See various papers by Wildin, Middleton, Cummins, Chapman, Howarth and others.)

Ponded pastures are pasture grasses growing in or on the edge of shallow freshwater dams and lagoons. Growing ponded pastures in constructed ponds commenced over 20 years ago. Ponded pastures provide excellent dry season forage for livestock by conserving rainfall runoff. The ponds are also a source of water for domestic and native animals, and attract birdlife.

Landholders have established large areas of ponded pastures in districts throughout Queensland (for example, St Lawrence, Barcaldine, Jericho, Clermont, Charters Towers).

In the central coast and Mackay regions, approximately 22,000 hectares have been planted to ponded pastures, mainly para grass. Much of this area is natural pondage, which does not require construction of levee banks.

Staff of the Queensland Department of Primary Industries have assisted landholders through an advisory and surveying service to establish and manage pondage systems on some 11,000 ha in dryland areas. There banks are well away from marine and estuarine areas. The demand for this service has been greatest in the Rockhampton district.

In addition, it is estimated that some 6,500 ha of ponded pastures have been established in marine and estuarine areas (mainly salt couch and claypan areas) of central and north Queensland (mainly in the Broadsound region) to protect marine plains from soil erosion and salt encroachment and to promote pasture production which is progressively available to grazing cattle as the ponds dry out. The majority of these levee systems were designed by private consulting engineers. The Division of Land Management designed one such system at Koumala (Mackay), whilst Water Resources Commission designed one at Carmila.

The shallow ponding technology designed in Central Queensland has not been adopted in the north (see paper by Kernot) where it is considered that high evaporation rates and minimal dry season rainfall would limit the period of water holding and subsequent usefulness of shallow ponds adapted to para grass.

Deep pondage systems, using hymenachne and aleman, are more attractive in the north. Kernot indicates the existence of 100 hectares of this type of constructed pondage.

Several papers refer to the positive impact that the ponded pasture technology has had on the cattle industry. In fact, this is not disputed as will no doubt be stated in later presentations today.

3. WHAT IS PONDED PASTURE?

Perceptions of ponded pastures vary. There, however, are three systems (see papers by Wildin and Chapman):

- Rain and runoff storage.
- Floodwater retention.
- Water harvesting and controlled ponded systems.

Rain and Runoff Storage

Heavy rain fills natural depressions and runoff water can be stored behind constructed pondage banks on slight slopes or on plains. Size of the earth bank can be constructed to pond from 0.2 m to 2 m at the deepest section close to the bank wall. In inland areas diversion banks with 0.1 to 0.2% slope can increase flows into the ponds. For inland ponding, depth of water at the bank should be at least 1.2 m to overcome rainfall, runoff and evaporation constraints. *Aleman, hymenachne* and other grasses which can grow in deep water are included in the system. Water above 1 m can be released to shallow ponding bays downslope in a controlled system to grow more drought tolerant species like *para grass, watercouch, bambatsi.*

Floodwater Retention

This system is located on the floodplains adjacent to stream and river systems that flood at least once a year. Main banks are constructed nearly parallel to the stream where there is no pronounced levee or from the levee and at about right angles to the stream. The banks may or may not have pipes allowing only inward flow of water. The height of the bank and the depth of water retained can be 0.2 to 2 m depending on normal flood heights. Floodwater retention systems storing more than 1 m of water may be extended to release water into shallow controlled ponding systems downslope. River water may also be pumped into the larger and deeper system and the associated controlled ponding system or both.

Waterharvesting and Controlled Ponding Systems

Large gully dams may be well sited to store large amounts of water. An alternative is to harvest water during floods into storages or ring tanks to hold about 6 m of water in depth. This water can be used particularly during the dry season to grow ponded pastures in very shallow bays holding up to 0.2 m of water in a controlled ponding system. If water storages are available in rivers and streams then water can be pumped directly into controlled ponding systems. Many rivers and streams throughout Queensland can supply water for controlled ponding systems.

Location of ponded pasture systems is also important for the purposes of this workshop (see Coates and Unwin, and various papers from Wildin and Chapman).

1) Those located in marine or estuarine ecosystems, that is, on marine plains where they impede normal tidal flow. This alienates portions of the system.

2) Those located in fresh water or terrestrial ecosystems, but which potentially isolate areas connected to the marine ecosystem. The connection may be continuous, as in the case of permanent coastal streams or rivers, or discontinuous, as in the case of intermittent coastal streams or flood plains from which runoff enters the marine system.

3) Those located in upland, or in strictly freshwater systems which are not directly connected to marine systems.

From the submitted papers it appears that the first two situations are cause for concern, and that the third is not subject of major conflict.

4. CURRENT GUIDELINES FOR PONDED PASTURE

The agricultural sections of the Queensland Department of Primary Industries has a policy of not providing advice for the design of pondage systems on marine plains or permanent freshwater swamps. The Water Resources Commission of the Department will not undertake investigation into ponded pastures in these areas until the proposal has been submitted to the Fisheries Branch for advice on possible impacts (see paper by Horton). Hymenachne, a vigorous grass which grows in shallow water such as on the fringes of lagoons is not recommended for permanent natural pondage.

From a fisheries viewpoint, people who construct ponded pasture systems are encouraged:

- not to block tidal creeks;
- to keep away from mangroves;
- to have a deep reservoir within ponds to prevent fish kills; and
- to notify QDPI Fisheries officers if fish kill is likely so that remedial action can be considered.

There are a number of Acts of parliament which impact on ponded pastures. These have been outlined below and I acknowledge the contribution of staff from the Land Conservation Branch in QDPI in providing the majority of this material. I have included this information as it is essential for an informed discussion of the issues before us today.

A) Water Resources Act: Licensing Requirements.

Administered by the Water Resources Commission in the Queensland Department of Primary Industries.

Where the implementation of pondage banks would require a licence under the Water Resources Act, the inquiry should be referred to the Water Resources Commission. Banks and associated works will require a licence from the Commission if:

(a) The bank is located on a watercourse, defined under the Act as a natural channel, an improved natural channel, or an artificial channel which has changed the course of a watercourse, in which water flows permanently or intermittently. The Act only applies to non-tidal sections of a watercourse. (Tidal sections are administered by the Department of Transport).

(b) The bank forms a levee bank parallel to the watercourse. If the bank is perpendicular to the watercourse, it will not require a licence under the Water Resources Act. However, it may require a permit from the Local Authority if that Authority has invoked Section 47 (24) of the Local Government Act.

(c) The associated works interfere with the bed or banks of a watercourse, eg., diversion works or a drainage outfall to a watercourse would require a licence. In addition, if a River Improvement Trust exists in the Shire, the Trust may be interested in any works impacting on a stream in the shire, and proposals should be submitted to the Trust for its review.

If there are any doubts whether a licence is required under the Water Resources Act, the case should be referred to the local Commission office for a decision.

B) Soil Conservation Act: Approval Requirements.

Administered by Queensland Department of Primary Industries, Land Use and Fisheries Group.

Where the implementation of pondage banks would affect neighbouring landholders an approved plan should be prepared before the works are implemented.

Affected land as defined in Section 10 (3) of the Soil Conservation Act is contiguous land that:

(a) Discharges runoff from >2 ha into subject land, or

(b) Receives runoff from subject land where:

- (i) Area is increased or decreased by >10%, or
- (ii) Location is changed, or
- (iii) Risk of damage is increased.

For approval, plans require:

(a) Written evidence of no objection from all owners of affected land, or

(b) Advertising

It is optional to approve a plan if there is no lower or upper affected land. Plans may be approved under Sections 10 (4), 10 (5), 10 (7), 10 (8) or 10 (9) of the Soil Conservation Act 1986.

C) Fishing Industry Organisation and Marketing Act: Licensing Requirements.

Where the implementation of pondage banks would require a licence under the Fishing Industry Organisation and Marketing Act, the inquiry should be referred to the Land Use and Fisheries Group of the Queensland Department of Primary Industries.

Banks or associated works would require a permit under:

Section 45 as Fishways

A person who desires to construct or erect a dam, weir or other barrier of any kind across a river, creek, steam, inlet of the sea or other waterway should give the Minister three months notice in writing of his intention. If the Minister determines that it is desirable that a fishway should be constructed or erected on the proposed works, then the person may be directed in an order to make a fishway in accordance with approved plans and specifications. Failure to comply with the order or provision of this section carries a $1,000 penalty.

Section 71 Protection of Mangroves and Marine Plants

A person cannot cut, lop, burn, remove or otherwise destroy or damage any mangrove or marine plant unless a permit is granted and issued under this section.

A Penalty applies for failure to comply with this section or the conditions of the permit.

Part M of Fisheries Regulations 1977

M1 Fish Habitat Reserves

A permit from the Minister is required for the following actions in a fish habitat reserve:

(a) remove or cause to be removed any ballast, rock, stone, shingle, gravel, sand, boulders, clay, earth, silt, mud or other material whatsoever from, or disturb or cause to be disturbed any such material therein;

(b) deposit or cause to be deposited therein any filling or other material;

(c) discharge or cause to be discharged therein any matter which may be deleterious to fish, marine products, mangroves or marine plants; or

(d) perform any other action which may cause a direct and substantial alteration to the physio-chemical environment therein; and

(e) take or interfere with any fish or marine product.

M2 Fish Sanctuaries

A permit from the Minister is required to take or interfere with any fish or marine product within a fish sanctuary.

M3 Wetland Reserves

A permit from the Minister is required for the following actions in a Wetland Reserve.

(a) remove or cause to be removed any ballast, rock, stone, shingle, gravel, sand, boulders, clay, earth, silt, mud or other material whatsoever from, or disturb or cause to be disturbed any such material therein;

(b) deposit or cause to be deposited therein any filling or other material;

(c) discharge or cause to be discharged therein any matter which may cause a direct and substantial alteration to the physio-chemical environment therein, likely to be deleterious to fish, marine products, mangroves or marine plants;

(d) erect or cause any building or structure to be erected within a reserve contrary to the maintenance of the area in a state beneficial to fish, marine products, mangroves or marine plants;

(e) use any vehicle or conveyance within or occupy or use the whole or part of the reserve for any purpose that is contrary to or inconsistent with the purpose for which the land is reserved.

The Regulation does not apply in respect of:

(a) any tidal land alienated or licensed from the Crown under any Act prior to the date of the declaration of the reserve: and

(b) any navigable channels defined by navigation markers placed pursuant to the Queensland Marine Act 1958 - 1979.

5. ISSUES

The key issues from the papers revolve around three concerns:

i) the effects that ponded pastures may have on marine and estuarine areas, including habitat alienation

ii) the invasive potential of ponded pasture grasses in displacing native species and altering habitats

iii) the effects that ponded pastures may have on fish biology and migration, and the isolation of nursery areas from the marine system.

In addition, the submission of the Queensland Commercial Fisherman's Organisation to this workshop alleges that QDPI guidelines are not being followed, and that necessary approvals under the various Acts are not being sought. If correct, this obviously emerges as a fourth major concern for consideration.

As previously stated, there is no argument that the ponded pasture technology has had a positive impact on the beef industry. There, however, is little doubt that we require further information before we can judge the wider impacts of the technology.

ENDS

PONDED PASTURES - THE WATER RESOURCES COMMISSION PERSPECTIVE

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ABSTRACT

The paper provides an overview of the Water Resources Commission's approach to the engineering aspects of ponded pasture development, covering investigation, design and construction. Further, current Commission policy relating to such developments is outlined, together with the relevant regulatory requirements of the Water Resources Act.

1.0 INTRODUCTION

The Water Resources Commission has provided advice on the development of ponded pastures for a number of years through its Farm Advisory Officers stationed at such centres as Rockhampton, Mackay, Ayr and Mareeba. The expertise of the Advisory Service lies in the engineering aspects, and we have always relied on the Agricultural Groups of the Department of Primary Industries to guide us (and our clients) on grass varieties and suitable depths of water. Our other primary area of interest is the regulation of watercourses as required by the Water Resources Act.

It is these two elements, the engineering and the regulatory aspects, which I intend to cover in this paper.

2.0 ENGINEERING ASPECTS

The development of a ponded pasture scheme is a three stage process - investigation, design and construction.

2.1 Investigation

The investigation is a two stage process. Initially, after being approached by the landowner, the proposed site is inspected briefly to determine if a scheme is feasible. If so, the landowner pays the relevant fee (currently 5% of the estimated cost of the project or $30/ha, depending on whether it is viewed as a storage or surface irrigation) and a full investigation is undertaken.

This investigation includes a detailed survey of the site, soils investigation of the pond and embankment areas, delineation of the catchment by aerial photos or compass/pace traverse, and assessment of the catchment's topographic, vegetative and soil characteristics which affect runoff.

The embankment dimensions are determined by the nature of the materials used, the maximum height of the bank and the method of construction. The materials determine the batters chosen (generally 3 to 1 upstream, 2 to 1 downstream); the height and method of construction determine the crest width. The crest width has to be such that the phreatic line (or "water table" within the bank) does not intersect the downstream batter. It also has to be wide enough for the construction machinery to work upon. With a bank of over (say) 1.5 m high, it is best to use a scraper with roller compaction. This means a crest width of 3 to 3.5 m. For lower banks, dozer or grader construction may be acceptable, but great care has to be taken to ensure adequate compaction. The advantage is that crest widths as narrow as 1 m are possible.

The flood discharge is calculated using the Rational Formula with coefficients of discharge and rainfall intensities based on 1958 AR & R figures. This is somewhat dated, but we have carried out cross-checks with the 1977 and 1987 editions of AR & R and have found that there is little difference in the values obtained. Really, the acid test is the rate of failure, and we have had no storages or pond embankments overtopped. Generally the 1% probable flood is used as the basis of design. Because of the lower cost of repair of ponded pasture banks, a greater risk of failure would be acceptable. But generally speaking, there would be little saving in cost and any economic benefit would be marginal.

The bywash inlet width is calculated on the basis that the bywash is a broad crested weir. Surcharge is designed at 0.5 m or less, down to 0.4 m say. At greater depths, the velocities are erosive to grass covered earth bywashes. The outlet width is designed to spread the flow sufficiently for the velocities down the return slope to be non-erosive. The upper limit adopted is 2.44 m/s.

Once the design is completed, detailed plans and specifications are prepared and provided to the landowner so that he can approach a contractor for a quote to construct the works.

2.3 Construction

The Commission recommends the use of scrapers as the most economic and manageable method of shifting material, and rollers to achieve full compaction. This is particularly important where the materials are dispersive and/or where the bank is high. Full compaction means at least 8 passes of a suitable roller, layers no thicker than 200 mm, and the material being placed wet of optimum moisture content.

The survey includes the pond area, the areas of proposed embankments, possible bywash and return slope areas, along any catch drains which may be necessary to extend the potential catchment area, and any waterharvesting pump site and associated delivery pipeline route. The survey is carried out by level and staff, with readings recorded directly into a data logger in the shape of a small calculator. EDM survey equipment is not used.

The soils investigation is generally performed by drilling rig or hand auger. Test holes are drilled along the proposed embankment axes to determine the necessary depth of cutoff and in the ponded area to determine general permeability and identify possible borrow areas. These borrow areas should be adjacent to the banks to minimise the cost of construction and to limit the area of deeper storage.

The materials are assessed for engineering suitability, by classifying them under the USBR Unified Soil Classification System via field estimates of particle size distribution and the dry strength, dilatency and toughness of the fine particles. The material is also assessed for dispersiveness. With dams, it is occasionally necessary to carry out lab tests on doubtful materials. But I don't believe that this is necessary with ponded pastures because of the lower risks of failure and the lower cost of such a failure.

2.2 Design

The first step is to assess the yield of the direct catchment, any diverted catchment and the waterharvesting opportunities from any adjacent major stream. We use the USDA SCS Rainfall/Runoff Model to estimate runoff from ungauged catchments and recorded streamflows if they are available on the major stream. If the available runoff is the limiting factor, the size of ponds is determined such that there is about an 80% chance of one fill per year. Otherwise it is a matter for the landowner to say just what area of pond he wishes to have.

The depth of water and thus the height of bank is related to the types of grasses to be grown. With the grasses currently in vogue, the recommended depth is some 1.2 m, leading to a height of embankment of 2.2 m minimum. Of course, the depth will be greater in the borrow areas and in any gully across which the main embankment is constructed.

If there is no dispersive material and the bank is less than 1.5 m high (say), then the requirements may be reduced, such as the material can be used at in-situ moisture content and wheeled construction machinery such as loaded scrapers can be used for compaction. However this is very difficult to control and can prove more expensive than using a roller, so care needs to be if this mode of construction is to be adopted.

The first step in construction is to strip the embankment area of at least 75 mm of topsoil. This should be stockpiled together with the topsoil from the borrow areas for spreading over the completed banks. This assists with the establishment of a grass cover over the banks. The next step is the excavation and backfilling of a cutoff. Generally speaking, a cutoff for a ponded pasture scheme may be less substantial than for a dam because greater leakage rates are acceptable, the hydraulic head is generally less and the borrow areas are not as deep. But it is still necessary to intersect any gravelly and sandy seams which are likely to be exposed or nearly exposed in the ponded area.

The Commission sets out the works and makes 2 or 3 inspections during construction, but the responsibility for supervision of constructions lies with the landowner.

3.0 REGULATORY REQUIREMENTS

The Water Resources Commission has responsibility for the administration of the Water Resources Act, under which a licence is required for (i) the bank if it is located on a non-tidal section of a watercourse as defined in the Act; or it forms a levee bank which influences the flow into or out of a watercourse; and (ii) associated works which interfere with the bed and banks of a watercourse, such as drainage outlets, pumping plant and diversion works.

In some Shires, the Council has invoked Section 47(24) of the Local Government Act. In these Shires, a pondage bank on a flood plain may require a permit from the Council, even if it doesn't require a licence form the Commission.

Again, in some Shires a River Improvement Trust exists. Such Trusts are interested in any works which impact on a stream in the Shire. If a proposed pondage scheme falls into this category, it should be submitted to the Trust for review.

4.0 CURRENT WATER RESOURCES COMMISSION POLICY

There are two relevant Instructions to our Advisers which are current.

The first has been issued for a number of years. It instructs Advisers to notify Fisheries of any proposed works which may result in a change of water flow pattern into or through a Fish Habitat Reserve, Fish Sanctuary or Fish Refuge.

The second was issued some six months ago as a result of the concern of the fishing industry with the impact of ponded pastures on fish breeding grounds and fish movements. This Instruction directs Advisers not to undertake investigations into ponded pastures in tidal areas until the proposal has been submitted to Fisheries for advice on any possible negative impact.

If a pondage scheme does not fall within either of the above categories, then the full range of the Commission's advisory services will be available to the landowner - provided he pays his money.

5.0 CONCLUSION

It cannot be said that there is a single standard to be applied to the design and construction of pondage schemes. Rather there are some basic principles which are applied to varying degrees according to the situation and the engineering judgement of the officer involved.

It is this engineering judgement, and the expertise and experience which lies behind it, which I feel is the most important ingredient in the development of a successful, low maintenance and economic pondage scheme. I would urge anyone who is contemplating such a development to contact their local Commission office for advice.

WORKSHOP PRESENTATION SUMMARY PAPER

FISHERIES MANAGEMENT AND PONDED PASTURES

Commercial and recreational fishermen do not oppose the theory of ponded pasture development. The beef industry is important to the Australian economy, particularly its export earnings. However, there is some concern about the reciprocation of this awareness.

I have read all the submissions presented to this workshop and reviewed in detail those submissions dealing with fisheries matters and strongly disagree with comments like: "The fish kill controversy has attracted little interest because most pondages are nowhere near the tidal margins but a long way inland!"

There are some 6.500 hectares of tidal land under pondage already and this is a great concern to the commercial fishing industry.

All the submissions concerning fisheries identified the need for research into what impacts ponded pasture has on native fish stocks, particularly barramundi. They all attempted to put forward constructive ideas and options.

I have divided this review into three sections:
1. a commercial fishing perspective
2. a scientific perspective
3. fisheries management perspective.

I attempted to collect a number of pertinent statements taken from the submissions which I feel this workshop must address to ensure the joint future of ponded pasture and the commercial and recreational fishing industry.

Commercial Fishing Perspective

The Beef industry is worth more to the economy than the commercial fishing industry. Howver the marginal increase in beef production during the dry season from ponded pasture worth the demise of another self-sustaining primary industry -- the barramundi fishery.

Ponded pastures have been allowed to escalate without assessing the impacts on the marine environment and inshore fisheries. Fish kills -- those that are reported -- are usually dismissed as being of no consequence because fish like the barramundi are very fecund.

Fishermen believe governments and departmental experts and advisers have acted irresponsibly by allowing ponded pasture to be constructed on marine plains.

For many years now governments have required environmental impact assessments (EIAs) on development projects, particularly those in the coastal zone. However ponded pastures have proceeded without EIAs.

Since the introduction of the barramundi closure, barramundi numbers have continued to decline in the broadsound area even though the closure has been respected by both commercial and recreational fishermen.

Fishermen believe this decline coincides exactly with the massive increase in ponded pasture over the past decade.

There is a firm belief that fish life is non-existent in ponded pasture long before they dry out, due to stock trampling, excreting and urinating in the water causing it to be tepid and so low in oxygen it cannot support fish life.

So what do fishermen believe should happen?

There were three main recommendations:

1. That the State Government initiate research into the construction of ponded pasture that will not interfere with the natural flow of tidal water and allow marine fauna access to the sea or to their natural habitat.

2. Following on from 1, until such time a system can be devised and guaranteed, all ponded pasture construction should cease.

3. A total ban of the construction of ponded pastures on coastal wetlands, that is coastal swamps, salt pans, marine plains, mud flats, low lying coastal flood plains and estuarine areas.

Scientific Perspective

From a scientific perspective a lot more research is required to assess ponded pasture impacts on coastal marine plains.

The submissions all identified ponded pastures have the potential to adversely impact on coastal marine plains.

Changes in sedimentation rates, freshwater and salinity levels, relief, tidal flows and water table levels were likely to occur and would have a marked effect on habitats.

A summary of evidence was put forward to show that coastal wetland habitats in northern Australian supports an astonishing diversity of fish fauna even by world standards.

It was suggested that the high species counts resulted from the great diveristy of habitats available to fish within the estuary complex.

The species of highly valued finfish dependent on esutarine and coastal habitats include: barramundi, threadfin salmon, grunter, snapper, mangrove jack, bream and mullet. Estuarine and coastal habitats are critical for refuge, reproduction, feeding, recruitment, nursery and growth for many species of fish.

The consequences for Australian wetlands and their associated biota from rainfall run-off conservation practices to improve season forage for live stock are not well known.

Potential impacts include:
- Interference of nutrient exchange (which could also affect prawn production in adjacent areas);
- Fish kills in impounded waters;
- Reduction of freshwater flows;
- Impact on spawning (the timing of migrations through salinity changes and the inability to migrate because of physical barriers);
- Release of sediment when bund walls are breached or submerged during flooding; and
- Outfall of large concentrations of pesticides, fertilisers and organic matter.

One submission classified ponded pastures in terms of the ecosystems involved, and thereby classified three categories of ponded pastures:

1. Banks located in marine or estuarine ecosystems. These banks interfere with the normal tidal flow and thus alienate a portion of marine or estuarine ecosystems.

2. Banks located in freshwater or terrestrial ecosystems but which potentially cut off areas connected to marine or estuarine ecosystems. The connection may be continuous, as in the case of permanent coastal streams and rivers, or discontinuous, as in the case of intermittent coastal streams or terrestrial flood plains from which runoff water enters marine or estuarine ecosystems.

3. Banks located in strictly freshwater or terrestrial ecxosystems which are not directly conected to marine or freshwater ecosystems.

From a commercial fishery perspective it is the first and second categories that are of most concern.

It is difficult to assess what impacts have and will occur to marine resources with the development of ponded pasture. One sure thing is there's a need for research.

On the basis of what is already known about the life cycle of different fish species, particularly the barramundi, a number of guidelines can be implemented to minimise adverse effects. For example the following guidelines were suggested by Mike Coates and Les Unwin from the University College of Central Queensland at Rockhampton.

1. Banks should not be built which prevent access of juvenile barramundi to nursery areas such as coastal swamps, saltpans, marine plains or flood plains.

2. Banks which prevent access of juvenile or adult barramundi

into tidal creeks should be avoided.

3. Banks should not be built which prevent access of juvenile or adult barramundi to the freshwater reaches of rivers which flow into the sea or into estuaries.

4. Banks should not be built which landlock adult fish, preventing them from reaching spawning areas.

5. In line with the above criteria, it is suggested that areas adjacent to water courses, which normally remain flooded for very short time periods (days) may be the most suitable for ponded pastures as the short time of inundation renders them unsuitable for barramundi nursery areas.

These would be formed using the floodwater retention of flood plains and/or water harvesting with controlled ponding systems with perhaps the addition of some mechanism to exclude juvenile barramundi which might become trapped in areas they would not normally occupy.

Managerial Perspective

From a fisheries managerial perspective of measures that should safeguard coastal wetlands from ponded pasture.

Unfortunately, it appears these measures are being ignored.

The Department of Primary Industries' guidelines on ponded pasture construction prohibit construction on mangroves and the blocking of tidal waterways, but in some cases have been ignored.

Deep reservoirs within bunded areas are not being built to prevent fish kills and notification of likely fish kills are not being reported to QDPO fisheries officers.

It also appears that government approvals required prior to the construction of ponded pastures are not being sought. For example, for works across waterways the Minister for Primary Industries may request the construction of fishways. (It is a provision under the fishing industry organisation and marketing act. If these approvals are being sought then fishing industry organisations such as the QCFO are being ignored and omitted from the decision making process.)

The same could be said about mangrove destruction applications. All mangroves and other marine plants within Queensland, regardless of the state of growth or the tenure of land, are specially protected under section 71 of The Fisheries Act.

The latest policy of the Queensland Water Resources Commission directs persons wanting to construct ponded pastures in tidal areas not to undertake any works until the proposal has been submitted to Fisheries for advice on any possible negative impacts. QCFO has never been asked to comment on such matters.

It is not the Industry's intention to argue or compare the community benefits derived from stock grazed on ponded pastures or the preservation of fish stocks and the environment they depend on, nor does it believe that a comparison of benefits is an issue.

What is required is a compromise that best benefits the community. To do this a coordinated research and management plan is required.

PAPER PRESENTED TO THE PROBING PONDED PASTURES WORKSHOP BY

MARK DOOHAN , QUEENSLAND COMMERICAL FISHERMAN"S ORGANISATION

PROBING PONDED PASTURES
WORKSHOP

17 and 18 July 1991

Economic Perspectives for the Use of Ponded Pastures in the Grazing Industry

--- An Integrating Perspective ---

Ruth Wade
Executive Director
Cattlemen's Union of Australia

1. INTRODUCTION

Very few of the abstracts submitted actually address the economic benefits to the grazing industry of ponded pastures, although many have indirectly indicated benefits which must, by extension, result in economic gains to producers and to the industry generally.

Rather than solely looking at the economics of the grazing industry, ponded pastures need to be considered in the context of the whole system. This will include the environment, other enterprises such as fishing, the multiplier effects to the rest of the economy and the benefits to the grazing industry overall.

2. SYSTEM INTERACTIONS

Figure 1 shows the interactions between native pastures and grazing, environment and fisheries, with and without the addition of ponded pastures.

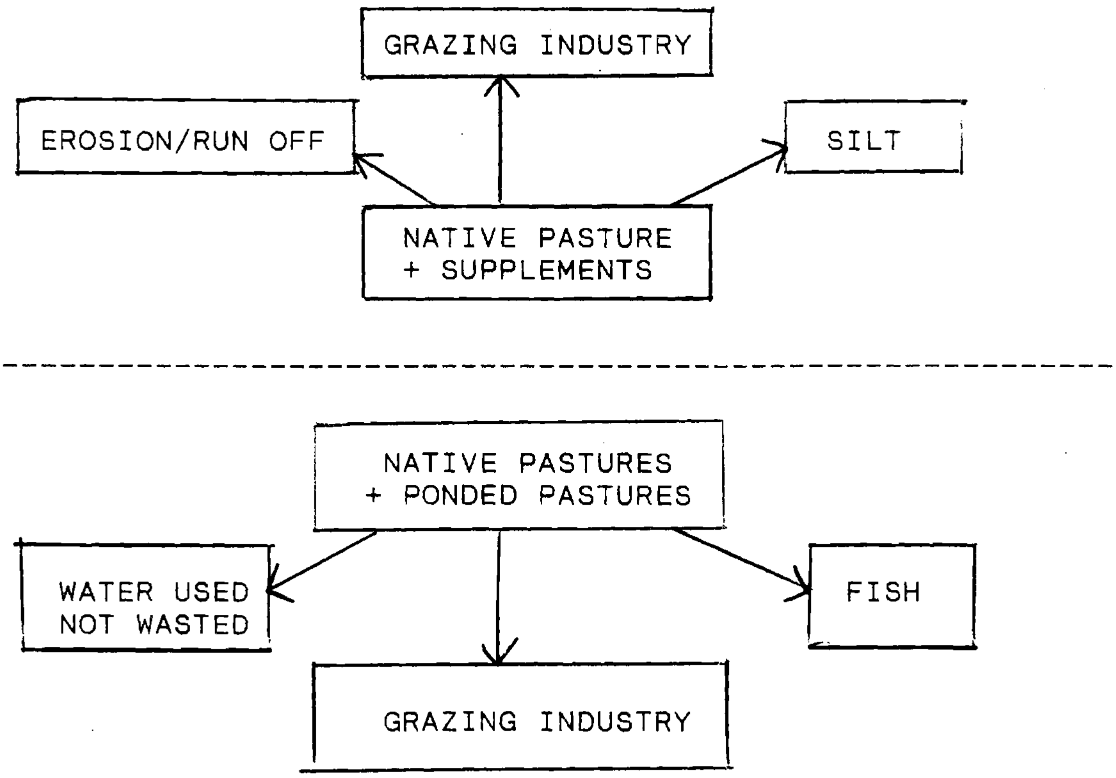

FIGURE 1 - SYSTEM INTERACTIONS

The first scenario (above the dotted line) is the common system of native pastures, with or without supplements, which support grazing. This can lead to erosion and soil loss and silting of waterways and streams.
The comparison (below the dotted line) is a system which incorporates native pastures and ponded pastures to maximize the use of our scarce water resource. I should note,

however, that this system can have more direct effects on industries such as the fishing industry.

I will use this framework as a basis for this paper.

3. NATIVE PASTURE SYSTEM

As discussed by Smith and Olive, Holme and Condon, the native pasture system has limitations, even where supplements are used.

Productivity of the system fluctuates with season, feed supply and erosion/runoff level. Producers must wean and turn off stock before supplies of summer feed run out or decline in nutritional value. Stock held through winter will lose condition on this poorer quality feed. This seasonal decline in feed supply and the consequent turn off of stock in less than prime condition result in reduced and variable returns to producers. Erosion and run off cause a decline in pasture productivity which adversely affects the long term viability of the industry.

4. NATIVE PASTURES PLUS PONDED PASTURE SYSTEM

The addition of ponded pastures offers several advantages and can provide a measure of economic security and stability.

Ponded pastures use water and land resources more efficiently. Producers can achieve better production from the whole herd at no marginal cost. Grazing pressure is reduced elsewhere, by buffering the supply of feed in the dry season. Production is therefore stabilized, permitting the choice of turn off time for stock. Consequently the "right" product can be produced for the market at the most appropriate time. This has the effect of stabilizing the returns to the grower, while placing the industry in a position where it can supply a consistent quality product.

Chuk lists benefits of ponded pasture as increased production, drought proofing, erosion protection, interception of run off (or production wasted) and an improved wildlife habitat.

Smith and Olive also identify ponded pastures as a means of maintaining a viable herd size in hard economic times, without causing land degradation due to overstocking. They also state that there is evidence on areas which have been ponded for over 20 years that soil fertility and pasture quality has increased with the age of the ponded areas.

Geddes, Holme, Condon and Bourne all add to the debate on the advantage of adding ponded pastures to a grazing system.

I would state here, however, that several papers identify the key to ponded pastures as being the ability to produce better cattle throughout the year and giving more management options NOT increasing total carrying capacity.

5. IMPACT OF WATER BALANCE

On the positive side, ponded pastures reduce run off and soil erosion while stabilizing ground cover. The run off which would otherwise be wasted is instead converted to productive pasture.

Conversely, ponded pasture grasses may have the potential to become a weed of waterways. Fisk identifies this potential problem and calls for a comprehensive review of weed management, which could lead to far more restrictive standards being applied to the importation and use of exotic plant species. Risk of disease to both animals and humans may also increase, particularly from mosquito borne diseases (Mottram and Newby).

6. IMPACT ON THE FISHING INDUSTRY

The effects of ponded pastures on barramundi populations are of particular concern. The Queensland Commercial Fishermens' Organisation and Chippendale have both highlighted this concern.

Is the concern primarily about barramundi or are other commercially viable species dramatically affected? If so, the figures for the value of the industry and the income foregone in that industry must be provided (or estimated if they are not available) to aid decision making on future development.

Chippendale is quite explicit in drawing distinctions between three different types of ponded pasture and may help to clarify the position:

- Type 1 do not appear to be a major problem. These incorporate pastures and levy banks on ridges.

- Type 2 does have an impact on mangroves, although some suggestions and ways to minimize this effect have been provided. These are pasture or levy banks on saltpans and mudflats adjacent to mangrove stands.

- Type 3 does have a major impact on the fishing industry as it can render large areas of fish nursery area unproductive. They can also prevent access to fingerlings and may trap adults behind the banks. These are pasture created by constructing levy banks across saltwater channels and saltwater marsh land.

The key question appears to be "What is the future of Type 3 banks?" Land Care Groups and Catchment Management Strategies should identify the percentage of tidal area ponded and calculate the cost to the fishing industry.

7. IMPACT ON THE BEEF INDUSTRY

Borne, Smith and Olive, Condon and Holme have all highlighted the impact of ponded pastures on the grazing industry.

Ponded pastures provide for stable production, stable ground cover, better use of land and water resources, the growing out of cattle and the finishing of cull cows after the bullocks are turned off, timely delivery of the "right" product, better production at no marginal cost, more feed in the dry season, reduced grazing pressure in less suitable areas, and less erosion with the next rains.

Important to note, however, is the contention by many producers that ponded pastures allow the production of better cattle all year NOT an increase in the total carrying capacity of a property.

8. ECONOMICS

Kernot has provided an analysis of costs per weaner in 1991 dollars for three different treatments (i.e. native pasture, fertilized stylo and ponded pastures). Although ponded pasture development costs are site specific, the analysis indicates the significant benefits possible from one applied use of a typical pondage development (Table 1).

TABLE 1. COSTS PER WEANER IN 1991 DOLLARS

YEAR	NATIVE PASTURE	FERTILISED STYLO	PONDED PASTURE
1	25	83	55
2	25	25	25
3	25	25	25
4	25	0	5
5	25	33	5
6	25	0	5
7	25	0	5
8	25	0	5
9	25	0	5
10	25	33	5
11	25	0	5
12	25	0	5
13	25	0	5
14	25	0	5
15	25	0	5
PRESENT VALUE AT 6% DISCOUNT RATE	$257	$174	$138

Work done by Bill Holmes in Townsville shows that, under ideal conditions and perfect management, the development of ponded pastures was very profitable, giving Internal Rates of Return (IRR) in the order of 20%.

These would be reduced by less than perfect management (estimated to reduce the IRR to 8%), the differential between the store and fat markets and the impact of bank failure. Ponded pasture developments are extremely susceptible to structural failure, and Holmes' model indicates that additional capital required to repair flood damage will make the development unprofitable.

Some of the producers who have been involved with ponded pastures in Central Queensland for up to thirty years may have some current estimates on the economic effects of severe flooding and damage to banks following the record floods of January 1991.

Another question raised by Bourne is the multiplier effect of that one extra fat bullock (either domestic or export) on the rest of the economy.

9. FUTURE NEEDS

Future needs to enhance the economic debate surrounding the use of ponded pastures in the grazing industry must include an estimate of the multiplier effect on the broader economy. This is as yet unmeasured and should be measured as a matter of priority. The impact on other industries must also be quantified, as must the potential for weed, disease and insect problems in the future.

Changing market requirements must be assessed. As our trading partners change their product specifications, the grazing industry must place itself in a position to meet these new requirements. Can producers in a large part of Northern Australia ever meet our changing markets without the introduction of ponded pastures to obtain all the advantages that a year round supply of feed will give them?

10. CONCLUSIONS

The bottom line is that ponded pastures provide the potential for major economic benefits to the grazing industry.

To reiterate, these benefits include a more stable income for the producer, more stable ground cover which must result in less erosion, the ability to meet the market at the right time with the right product (i.e. flexibility in harmony with the environment) and a carry over effect to the rest of the Australian economy.

However, several issues need to be addressed. The continued viability of the fishing industry must be ensured. This may include placing some controls on Type 3 banks. The potential of pasture grasses as weeds and of ponded areas as a source of insects and diseases must also be assessed.

The beef cattle industry recognizes that solutions must be found quickly to the problems which are emerging. This must be achieved by consultation between all concerned parties - not be resorting to legislative measures.

2.0 Papers Presented to the Workshop

Not all the papers presented have been selected for publication. Papers were selected from the following topic areas by Mike Chuk (Q.NPWS) and Russ Boadle (QDPI).

1 History

'History of Para Grass in Queensland.', C.H. Middleton, QDPI, Rockhampton.

2 Establishment of Ponded Pastures

(a) 'Ponded Pasture Systems', John Wildin, QDPI, Rockhampton.
(b) 'Construction of Pondage Banks in Central Qld. - Background and Present Status', V.G. Cummins, QDPI, Rockhampton.
(c) 'Planning and Construction Guidelines for Ponded Pastures', David Chapman, QDPI, Rockhampton and Tony Bucknell, QWRC, Rockhampton.

3 Production/Economics of Ponded Pastures

'Productivity of Ponded Pastures', C. Middleton, K. Murphy, J. Wildin, QDPI, Rockhampton

4 Ponded Pasture Grasses

'Aleman, Hymenachne and Other Forage Species for Ponded Pasture Systems', J.H. Wildin, QDPI, Rockhampton.

5 Weed Concerns

(a) 'Ponded Pastures - As a Potential Weed Problem', P. Fisk, Far North Region, QNPWS.
(b) 'The Spread of Pondage Species Beyond the Pasture System - The Risk and Associated Consequences', J.R. Clarkson, QDPI, Mareeba.

6 Cattlemen's View

(a) 'Ponded Pastures - A Cattlemen's View', Ted Smith and Joe Olive, Marlborough Landcare Committee.
(b) 'Ponded Pastures - A Producer's Viewpoint', Bill Geddes, Doonside, Rockhampton.

7 Wildlife and Landscape Management

(a) 'The Effects of Ponded Pastures on Wildlife and Landscape Management', John McCabe, President, Capricorn Conservation Council Inc., Rockhampton.
(b) 'A Discussion of Some Potential Conservation Issues with Regard to Ponded Pastures', Michael Chuk, QNPWS, Rockhampton.

8 Fishermen's Perspective

(a) 'Effect of Ponded Pasture on the Marine Environment and Ecology', Ray Harris, Environmental Officer, Yeppoon Branch, QCFO.

9 Littoral View

'Utilisation of Wetland Habitats by Coastal Fishes in Northern Australia', R.N. Garrett, Northern Fisheries Centre, Division of Fisheries and Wetland Management, QDPI, Cairns.

10 Ponded Pasture Legislation

'A Review of Legislation for Ponded Pastures - Water Resources Commission Licensing Requirements'.

11 Ponded Pastures in North Queensland

'The Current Status and Potential of Ponded Pastures in North Queensland', J.C. Kernot, QDPI, Mareeba.

Following these papers is a list of abstracts of all the papers presented. Individual copies of unpublished papers are available from the contacts listed in section 6.0.

History of Para Grass in Queensland

by C.H. Middleton
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Abstract

Para grass is a vigorous, perennial, stoloniferous grass from tropical Africa and America that has spread to all tropical areas of the world. It is a high quality pasture plant that is adapted to high rainfall or high soil moisture. It was introduced to Queensland from Kew Gardens, England in 1880 by Dr Joseph Bancroft. Also the CSR Company introduced material from Fiji in 1884 to control erosion on the banks of the Herbert River.

By 1930 it had colonised the wet areas along the east coast of Queensland. From 1930 it was widely promoted for use on the high rainfall wet tropical lowlands of north Queensland. Para grass remains the grass most suited to poorly drained soils in frost free coastal Queensland.

In the last 20 years it has been promoted and used in man made pondage areas.

Introduction

Para grass (*Brachiaria mutica* Forssk. Stapf) is a perennial grass native to tropical areas of Africa and Central and South America. It has become widely adapted and used as a productive pasture grass in most other tropical and sub-tropical areas of the world (Whyte et al, 1959). It is a vigorous, sprawling grass growing to one metre high and with long stout stolons that can reach over four metres in length. It roots freely from the nodes. The leaves are 1.0 to 1.5 cm wide and 15 to 30 cm long. (Bailey, 1902, 1909; Graham, 1946; Barnard, 1969; Cameron and Kelly, 1970; Stanley and Ross, 1989)

Para thrives under conditions of high temperature, humidity and soil moisture. It can survive in extended dry periods but is highly susceptible to frost (Barnard 1969, Cameron and Kelly 1970). Its natural distribution is controlled by these factors (Winders 1937).

This paper outlines its introduction to Australia and traces its spread and use as a pasture grass over the last 100 years.

Arrival in Australia

Para grass has been used as a pasture plant at least since 1849 (Cameron and Kelly 1970) when it was introduced to Kew Gardens, England from Barbados, West Indies by Sir William Hooker (Barnard 1969). The first introduction to Queensland in about 1880 was credited to Dr Joseph Bancroft who received seed from Baron von Mueller at Kew (Bailey 1902, 1908). It was commonly called Bancroft grass in the early years.

Like many of the plants of the day the taxonomy of para grass was a little confusing. Not only did it have a host of common names but also many different botanical names had been used. In Queensland alone it has variously been referred to as *Panicum spectabile* (the original introduction from Kew), *P. barbinode*, *P. muticum* and *Brachiaria purpurascens* (Bailey 1902, 1908, Schofield 1945, Cameron and Kelly 1970). Bailey, the Government Botanist of the time was directed by the Honourable Secretary for Agriculture in 1908 to sort out the nomenclature of the so called 'African Wonder Grass'. He indicated the correct name to be *Panicum muticum* (Bailey 1908). Subsequently many of the *Panicum* species were shifted to other genera (Baines 1981) and Para grass became *Brachiaria mutica.*

A second introduction of para grass to Queensland and the first recorded commercial planting took place in 1884. The Colonial Sugar Refining Co introduced it from its Fiji plantations and planted it on the banks of the Herbert River to control soil erosion (Cameron and Kelly 1970).

The Spread of Para Grass in Queensland

After its initial introduction it was extensively planted in the early 1900's on swampy country in northern New South Wales and south eastern Queensland (Barnard 1969). By the mid 1930,s "it was grown in scattered areas right along the eastern seaboard with heavy rainfall, and to a lesser extent in frost free areas up to 100 miles inland" (Winders 1937). Evidence suggests it had already colonised the cleared areas to which it was naturally adapted.

Para grass was ideally suited to the tropical lowlands of North Queensland and its expanded use after 1930 closely parallels the developing beef industry in that area. Small scale development for beef had commenced on the tropical lowlands in the latter part of the 19th Century (Marriott 1960, Bolton 1972). However, several factors collectively limited a viable beef industry prior to the late 1930's. These included the dominance of sugarcane, the decimation of cattle herds by ticks between 1894 and 1902 (Jones 1961, Bolton 1972) and the lack of effective carcase chilling methods until the early 1930's (Seddon and Mulhearn 1939, Jones 1961).

From mid 1930 active development of lowland areas in the wet belt commenced. Prominent among the pioneers was Brice Henry of "Riversdale" Tully who established extensive areas with the "artificial" grasses , para grass and Guinea grass (Jones 1961). Seddon and Mulhearn (1939) in cooperation with Brice Henry were the first to measure animal performance from para and Guinea grass. In relation to the potential of these grasses on the wet tropical lowlands they concluded that "the artificial pastures of para and Guinea grass will fatten bullocks to first quality chiller grade.....at any month of the year.....at not more than 2 1/2 to 3 years of age.....and at a stocking rate of 2 acres per bullock". [Many of today's graziers would settle for this productivity]

These early results, plus work at the Bureau of Tropical Agriculture (now South Johnstone Research Station) near Innisfail, which quantified the quality and yield potential of para, Guinea and other tropical grasses (Schofield 1945, Graham 1946) led to wider use of these between 1940 and 1950. Expanded species evaluation after World War 2 led to the wider use of Guinea grass cultivars and signal grass (Graham 1951, Harding 1972). However, para grass still remains the grass most suited to and recommended for use on poorly drained soils (Teitzel and Middleton 1979, Teitzel and Middleton 1980).

Over the last decade there has been considerable use of para grass grown in man made ponded areas, to provide high quality forage at a time (autumn/winter) when native pasture is both limiting and low quality (Romano 1983, Wildin and Chapman 1988). The extent of its use in this regard is discussed elsewhere at this workshop.

Conclusion

Para grass has been in Queensland for over 100 years. It has proved to be a highly productive grass for beef cattle. Two points should be emphasised. Firstly, it has long since colonised the natural environment areas to which it is adapted. Secondly, there is no immediate likelihood of other grasses replacing it as a pasture grass in the wet areas. The unknown is the extent to which para grass will be planted as forage in man made ponded areas. This will be the subject of other papers at this Workshop.

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Ponded Pasture Systems

John Wildin
Agriculture Branch, QDPI, Rockhampton

Abstract

Ponding water on suitable sites to grow adapted water loving grasses can be achieved by storing rain and runoff water, by floodwater retention on flood plains, and by water harvesting and controlled ponding. Combinations of these can also be designed and implemented to suit needs. Runoff conservation schemes can be designed to hold water at depths of 0.5 to 2 m. Similar water depths can be designed for floodwater retention. Water harvesting into a gully dam or a ring tank can be designed to store water up to 6 m deep. This water can be gravitated to flood bays up to 0.2 m deep in controlled ponding or flood irrigation schemes. Water can also be released from deep runoff conservation ponds into shallow controlled ponding bays downslope. Water pumped from river and other storages can replenish water in any of the schemes.

Ponded pasture systems should be designed to suit the site and the resources, be cost effective with regard to costs per hectare ponded, and fulfill livestock productivity objectives of the landholder.

Designs are always site specific. There is scope for these pasture systems throughout northern Australia and New South Wales and especially along rivers and streams. In many situations controlled ponding schemes can incorporate other species such as leucaena on broad crested banks and other adapted habitats to provide higher quality forages.

Introduction

While the earliest ponded pastures based mainly on watercouch (*Paspalum paspalodes*) and para grass (*Brachiaria mutica*) were established in stored rain and runoff water in gilgais, swamps and small ponds, systems evolved to capitalise on suitable sites with excellent water resources.

Site selection and pondage systems have been discussed by Wildin and Chapman (1988) who gave little more than outlines of the different systems. More detailed schemes for different locations and where controlled ponding will be incorporated will be discussed by them in a future manual on ponded pastures.

Community perceptions of ponded pastures vary. However, in many situations, the perception is a long way from the truth. For example, there are some views that suggest millions of hectares of marine plains are inundated and others that suggest that complete river systems are being blocked. Such views are products of wild imaginations and are not real.

This paper is intended to clarify some of the confusion and outline systems that can be designed and implemented to conserve water, and to use it effectively in a forage production system to overcome some of the climatic constraints that adversely affect livestock production in northern Australia and Queensland in particular.

Ponded Pasture Systems

A short description of the three main systems would clarify some of the misconceptions. Designs and other information can be obtained from Wildin and Chapman (1988) and from the manual to be published.

Rain and Runoff Storage

Heavy rain fills natural depressions and runoff water can be stored behind constructed pondage banks on slight slopes or on plains. Size of the earth bank can be constructed to pond from 0.2 m to 2m at the deepest section close to the bank wall. It is important to correctly site these banks to suit the locality, rainfall runoff co-efficient, evapotranspiration, and catchment area. In inland areas diversion banks with 0.1 to 0.2% slope can increase flows into the ponds. For inland ponding, depth of water at the bank should be at least 1.2 m to overcome rainfall, runoff and evaporation constraints.

Aleman, hymenachne and other grasses which can grow in deep water must be included in the system. Water above 1 m can be released to shallow ponding bays downslope in a controlled system to grow more drought tolerant species like *para grass, watercouch, bambatsi.*

Floodwater Retention

This system is located on the floodplains adjacent to stream and river systems that flood at least once a year. Main banks are constructed nearly parallel to the stream where there is no pronounced levee or from the levee and at about right angles to the stream. The banks may or may not have pipes allowing only inward flow of water.

The height of the bank and the depth of water retained can be 0.2 to 2 m depending on normal flood heights.

Floodwater retention systems storing more than 1 m of water may be extended to release water into shallow controlled ponding systems downslope.

River water may also be pumped into the larger and deeper system and the associated controlled ponding system or both.

Adapted pasture species would be selected for appropriate sites in each ponded pasture system.

Waterharvesting and Controlled Ponding Systems

Large gully dams may be well sited to store large amounts of water. An alternative is to harvest water during floods into storages or ring tanks to hold about 6 m of water in depth. This water can be used particularly during the dry season to grow ponded pastures in very shallow bays holding up to 0.2m of water in a controlled ponding system.

If water storages are available in rivers and streams then water can be pumped directly into controlled ponding systems.

Many rivers and streams throughout Queensland can supply water for controlled ponding systems. On suitable locations adapted legumes would improve pasture quality. Leucaena on broadcrested banks in controlled ponding systems can boost livestock production markedly.

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Construction of Pondage Banks in Central Queensland

Background and Present status

by V.G. Cummins
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Abstract

Growing pastures in water conserved by pondage banks is an increasing practice in Central Queensland.

Early pondage schemes incorporated small banks and shallow ponds. However, with the introduction of grasses that thrive in deeper water, larger and more expensive banks have been implemented in recent years. Presently, some 21 800 hectares of grazing land are ponded by banks surveyed by officers of the Queensland Department of Primary Industries.

As well, it is estimated that about 6 500 hectares of marine plains have been ponded to minimise the effects of soil erosion and salt encroachment. Most of these schemes have been designed by engineering consultants.

With the likelihood of fees for design and surveying services from Government agencies, more landholders will elect to design and survey their own schemes. If this is the case, educational and training programs will be needed to ensure that pondage schemes have minimal impact on the environment and on neighbouring landusers.

Introduction

In Central Queensland about 21 800 hectares of grazing land have been ponded by the construction of banks up to 1.5 metres high. These banks are used to trap runoff water to enhance pasture production in the ponded area.

Whilst some graziers have designed their own pondage schemes, the majority of pondage banks have been implemented by graziers with assistance provided by Officers of the Queensland Department of Primary Industries.

This paper outlines some historical aspects, trends in design and construction and the present status with the implementation of pondage banks in Central Queensland.

History of Pondage Bank Construction

The earliest pondage scheme was noted in the 1930's. However, the majority of pondage banks have been constructed since early 1970.

The original schemes were designed to rehabilitate degraded land as well as introducing improved pastures to increase productivity.

Ponding depths of less than 60 cm were recommended in the early schemes to accommodate the growth of para grass (*Brachiaria mutica*) which thrived in shallow water.

During the mid seventies, levee banks were constructed on marine plains in parts of Central Queensland. The purpose of these banks was to protect the marine plains from soil erosion and salt encroachment. It is estimated that some 6 500 hectares of scalded salt pan have been ponded by the construction of levee banks in coastal areas. The majority of these schemes were designed by private engineering consultants.

The scope for deeper ponding schemes increased in the mid eighties with the introduction of hymenachne (*Hymenachne amplexicaulis*) and aleman (*Echinochloa polystachya*). The availability of these new grasses, which thrive in water up to one metre deep, ensured that the ponded pastures remained productive, well into the drier season.

These deeper schemes required larger and more costly banks. Consequently, landholders in recent times have implemented schemes on very flat land to maximise the area of water ponded behind the bank.

Since the mid eighties, pondage schemes have been implemented in drier inland areas. Deeper ponding has compensated for some of the higher evaporative losses experienced in the inland areas. However, the potential for extensive schemes in inland areas may be limited due to unreliable catchment yield.

Area ponded by constructed banks

Since the early pondage schemes in 1970, most activity has occurred in the Central Coast Region comprising the Broadsound, Livingstone and Fitzroy Shires.

Presently some 11 900 hectares have been implemented in these shires on some 170 properties. Most of these pondage schemes comprise relatively small areas with only about 20 landholders having ponded areas over 100 hectares on each of their properties.

Table 1 shows the area presently ponded by constructed banks that have been surveyed by QDPI officers in Central Queensland.

Table 1: Area of constructed ponds as at 1.12.90.

Shire	Area of constructed ponds Hectares
Broadsound	1300
Livingstone	7000
Fitzroy	3600
Calliope	200
Banana	3500
Duaringa	1550
Belyando	3650
Nebo	200
Pioneer	250
Sarina	550
TOTAL	21800

Source: Land Conservation Branch, Queensland Department of Primary Industries statistical records.

Conclusion

With the present trend towards "user pays", it appears inevitable that a fee for an advisory and surveying service will be levied by the Queensland Department of Primary Industries. This scenario will result in many more landholders electing to design and survey their own schemes.

If this is the case, appropriate education and training must be provided to landholders to ensure that pondage schemes are properly designed and constructed to:-

(i) Minimise bank breakages

(ii) Avoid any adverse effects on adjoining landusers.

and (iii) Avoid detrimental impact on the environment.

Planning and Construction Guidelines for Pondage Banks

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Abstract

Ponded pasture systems using runoff from summer storms and waterloving grasses are invaluable in beef cattle production.

The selection of sites with suitable soil types; landscape attributes and adequate bywash areas ensures success of the pasture systems.

Construction techniques are used so that excessive runoff events are safely discharged without damage to banks and bywashes.

The development of simplified local data models for hydrological design of banks would improve design techniques.

Environmental concerns including fish movement and effects to wetland ecology have to be taken into consideration.

Introduction

The original concept of planting para grass (*Brachiaria mutica*) in natural wet areas has expanded into construction of water harvesting and pondage structures with a high benefit/cost ratio. The introduction of deeper waterloving grasses like aleman (*Echinochloa polystachya*) and hymenachne (*Hymenachne amplexicaulis*) since 1985 has lead to larger structures and pondage areas.

With proper planning and construction techniques, banks can capitalise on rainfall and runoff events, can pond water at shallow depths to enhance pasture growth on large areas and can safely surcharge excessive runoff events without endangering banks.

Planning

Site selection: Pondage banks are very site specific.

There are four main considerations in selecting suitable pondage sites:

* relatively impervious soils
* low sloping land
* suitable catchment areas
* safe bywash areas.

Soils: Moderate to heavy clay soils that are impervious are most suited to ponding. Soils that have a light textured surface and impervious clay subsoils are suited if cut-off trenches are adequate.

Banks have been successfully constructed on sodic (dispersible) soils. However, it is recommended by Thorburn and Chapman (1990) that these soils are identified and special compaction techniques employed.

Low sloping lands: Pondage banks built on low rising plains, bounded by low rising country give the most economical storage area/depth ratios.

Areas that pond naturally can be enhanced by building banks in strategic locations. For example, melonhole country and old river courses can be flooded for longer periods by banking.

Only very low sloping country is utilised on grazing properties. However, on dairying farms where winter feed is invaluable, slopes up to 2% have been ponded.

Catchment areas: Most of our grazing lands have an unreliable and variable rainfall pattern. Seasonal floods and droughts occur with an emphasis on a summer wet season and dry winters.

Catchment yield is currently determined by the USDA rainfall and runoff model adapted by QWRC for Queensland conditions and the PERFECT model developed by QDPI. Neither method has substantial local calibration.

Catchment yield drops dramatically from the coast inland to Emerald as shown in Table I.

Table I: Average rainfall and runoff from pasture land that would be equalled or exceeded in three out of four years.

LOCALITY	AVERAGE RAINFALL (mm)	RUNOFF (mm)
St Lawrence	977	58
Marlborough	862	56
Rockhampton	867	29
Dingo	716	15
Biloela	707	8
Emerald	639	7

With low catchment yields, catchment size to fill pondages is important. (See Table II)

Table II: Area (HA) of catchment required to fill 1 HA of pondage to various depths.

LOCALITY	SELECTED PONDAGE DEPTHS (mm)		
	300	600	900
St Lawrence	7	14	21
Marlborough	9	18	27
Rockhampton	36	72	108
Dingo	50	100	150
Biloela	57	114	171
Emerald	58	116	174

Other contributing factors to catchment yield are evaporation, number of runoff events and catchment condition.

In inland areas of low rainfall, runoff events are generally too unreliable for pondage systems (Lawrence 1991). Natural runoff may be augmented by:

* harvesting flood flows from adjacent streams
* diverting other catchments into ponds
* storing and gravitating water from flood retention structures in the upper catchment.

Bywash: The most successful banks are those given top priority to safe bywash provision (Olive pers comm 1988). Unless adequate provision is made to bywash excessive flows, the bank will overtop and breaching occur. The current methods of calculating bywash specifications are based on the Rational method/weir formula combinations. Rainfall intensity zone curves developed by QWRC give bywash widths suited to pondage banks. All methods are subjected to criticism as neither method allows for local validation or flood routing (Titmarsh pers comm 1991). Where runoff measuring installations are located, design is validated. Flood routing calculations are made if justified.

Most bywashes are designed on a return period of one in twenty years. The option is given to the landholder to consider a greater return period if he considers it economically viable.

Bywash areas are selected that are level, free of obstructions, discharge into safe disposal areas and are well grassed.

In areas where barramundi have access to banks, bywash areas are modified to accommodate fish migration. The provision of culvert sections in banks with adjustable 'hungry boards' to release water and fish are in operation. Pipe sections and other adaptations are used successfully to allow migrating fish to move into tidal reaches.

Survey: Banks are located individually or in a series. The lower bank in a series will pond water back to the next highest bank. Banks on 0.5% slope holding 0.5 metres of water will pond water back 100 metres.

In a series of banks there is generally a key bank. The key bank may be the top bank that is located so that roads and boundary fences are not inundated. It may be the lower bank that is located where a safe discharge area back to a natural drainage line is provided without causing erosion.

Slopes are not uniform. The use of a dumpy level can determine 'flat' sections where maximum areas can be flooded by the strategic location of a key bank.

Once the key bank is sited, other banks are surveyed in to gain the optimum pondage with safe outlets discharging into ascending ponds.

Levels are taken across the site to determine bywash location and bank height. Ponded grass species grow in depths up to a metre. Banks may be pegged straight across the site with varying depths as long as bank height is maintained.

The outlets are pegged on rising ground and this level becomes top water level. To determine the area ponded a traverse can be carried out. This procedure also determines the location of the next bank up slope.

If both ends are the same level excess runoff will surcharge at both ends. This is the safest measure and allows maximum bywash width. If only one bank end is used as a bywash, the other end can be pegged marginally higher as an *emergency* bywash.

The surveyed line is pegged at intervals and flagged at bank height.

Although bank configuration is often straight across the flooded area, bank outlets are aligned below the general line of the bank without losing water depth. This leads runoff away from the downstream toe of the bank to avoid damage.

Construction

Bulldozers, graders and scrapers are used to construct banks. The choice of the machinery depends on bank design requirements and site conditions. The bulldozer is more versatile, particularly where depressions require extra fill. Grader built banks consolidate well. There is a limitation of 0.3 metres ponded depth. Scraper built banks allow the importation of good clay and compact well. Compaction can be improved with the use of a water truck and sheepsfoot roller.

Construction points are:

* Clear the bank line and bywash area of trees and debris. Leave the bywash area undisturbed as possible.

* Rip the bank line and construct cut-off trend. Topsoil for cover on the bank.

* Borrow from the lower side of the bank line and use good material.

* Construct the bank when material is slightly moist or use a water truck.

* Compact the bank well.

* Broad base the banks to prevent cracking.

* Provide sufficient crest width to discourage cattle pads forming over the bank.

* Leave bywash areas level. Protect bank ends by logging.

* Angle the ends of the bank downstream so that runoff does not cause erosion into the borrow pits.

* Construct banks in the dry season. If banks are constructed in the wet season, then construct banks to 50% capacity only. Raise outlets to full supply level when banks have consolidated and the summer storm period has passed.

* Encourage a grass cover on the banks by topsoiling and applying seed and fertiliser.

Conclusion

Proper design and construction techniques are essential to ensure the success of pondage bank systems.

Site selection and survey is a relatively straight forward exercise that most landholders can carry out with a little training.

Hydrological design for catchment yield, flood routing and bywash specifications could be improved by developing simplified local data models.

Present bywash designs that facilitate barramundi migratory trends need to be evaluated with environmental concerns in mind.

Ponded pasture systems are a conservative grazing management strategy of prime importance to the beef industry. It can complement other land use options associated with the wetland ecology and add to the productivity of Queensland.

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Productivity of Ponded Pastures

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Abstract

The tropical grasses para, aleman and hymenachne are adapted to wet, swampy conditions and are used as ponded pasture in Queensland. With adequate moisture and nutrients they are capable of producing a high dry matter yield (>30 t/ha/year) of high quality forage. The grasses can give good liveweight gains (0.5 kg/animal/day) and support high stocking rates (0.3-0.6 ha/animal)

Ponded grasses are of most value as a dry season forage source for all classes of stock at a time when native pasture quality and quantity are at their lowest.

Introduction

Para grass *(Brachiaria mutica)* is the most commonly used grass in man-made ponded pasture in Queensland. The use of two other grasses, aleman grass *(Echinochloa polystachya)* and hymenachne grass *(Hymenachne amplexicaulis)* is expanding. Aleman and hymanachne grow in deeper water than para (Wildin and Chapman, 1988). Their description and agronomy has been summarised by Oram (1990).

All three grasses are tropical perennials that are adapted to poorly drained and flooded areas in the tropics. Their introduction to Australia is discussed in other papers at this Workshop.

Most of the published productivity data (dry matter yield, composition and animal performance) is from pasture growing in its natural habitat or from sown pasture in high rainfall or irrigated or poorly drained/swampy situations. Productivity in man-made ponds would be similar to that in its natural habitat except where available water and/or low temperature restrict growth.

This paper gives a brief outline of production levels. While there is a century of published records extolling the virtues of para, there is little published on *Hymenachne amplexicaulis.*

Uses of Ponded Pasture in Queensland

The use of ponded pasture is one option in supplementing the low productivity of native pasture in the dry season. Native pasture accounts for 97.5% of land area utilised for beef cattle production in Queensland (Lloyd and Burrows 1988). McLennan *et al* (1988) reviewed the productivity of native pasture in Queensland. Native pasture growth (2000-4000 kg/ha/yr dry matter) is strongly seasonal with a rapid quality decline in the winter/dry season. Animal growth follows this seasonal pattern. Average animal liveweight gains are about 102 kg/year at stocking rates ranging from one to 10 ha/animal.

Ponded pastures supply high quality green feed in critical times of the dry season. This gives greater flexibility in management on properties as ponded pasture can be utilised in a number of ways. It has allowed cattle to be fattened on country that previously could only produce stores. Bullocks suitable for the Japanese grass-fed market can be 'finished' on ponded pasture in the autumn/early winter at a stocking rate of around 1 ha/animal.
First calf heifers grazed on ponded pasture in late winter/spring show improved body condition and hence higher fertility rates than is possible on native pasture alone.

Dry matter yield

The capacity of tropical grasses to produce large quantities of dry matter under non-limiting growth conditions, is well documented. Annual dry matter yields range from about 12 t/ha (limiting nutrients and/or water) to over 45 t/ha (Table 1).

Table 1 **Dry matter production from para and aleman grass**

Grass	Location	Dry Matter t/ha/yr	Ref No
Para	Innisfail, Q	12*	23
Para	Innisfail, Q	30	8
Para	Uganda	40	18
Para	Taiwan	45	28
Hymenachne	Venezuela	18	22
Para	Venezuela	36	4
Aleman	Venezuela	22	4
Aleman	Florida	57-69	20
Aleman	Colombia	16-25+	15
Para	Florida	110++	9

* first year growth after sugarcane and with no fertiliser
\+ mean of two years with and without N fertiliser
\++ irrigated with sewage effluent plus up to 2600 kg N/ha

The few comparative published data available suggest para grass is higher yielding than aleman grass (Novoa and Rodriquez 1972, Anon 1981)

In Queensland the growth of tropical grasses including para is extremely seasonal. Highest yields occur in the hot, wet summer months (Schofield 1944). Allen and Cowdry (1961a) demonstrated that para growth did not occur until the daily minimum temperature exceeded about 15.5°C. Middleton *et al* (1975) and Miller and van der List (1977) showed peak summer growth rates in North Queensland four to five times winter growth rates.

While the strategic use of nitrogen fertiliser in autumn and winter can 'even out' growth, dry matter efficiency (dry matter produced per kg of nitrogen applied) is less at the lower temperatures. On ponded para grass at "Granite Vale" St Lawrence Middleton (unpublished data) recorded a dry matter efficiency of only 12 kg dry matter per kg nitrogen fertiliser applied mid February and sampled over 12 weeks to mid May. This compares with a normal dry matter efficiency of summer applied nitrogen on tropical grasses of 30-50 kg dry matter/kg applied nitrogen. However, despite this lower response, the mid February to mid May dry matter yield of 5-6 t/ha of high quality dry matter was about double the annual yield from native pasture in the area.

In the Northern Territory Miller and Nobbs (1976) showed that applying fertiliser to para early in the wet season was an unsatisfactory way to increase late season grazing. It merely produced a large quantity of low quality, mature grass. This occurred because of quality decline with age.

While para, aleman and hymenachne are capable of very high yields under flooded or high water table conditions there is some evidence to indicate yield and response to nitrogen is reduced compared to non-waterlogged conditions. Pate and Snyder (1984) on soil high in organic matter recorded a 21% yield reduction in aleman grass grown in a high compared with low water table. They attributed this yield reduction to the availability of soil nitrogen. An interesting but unexplained result was the lower grass quality (invitro organic matter digestibility) in the flooded soils.

Middleton (unpublished data) at "Granite Vale" found that nitrogen response and recovery in para grass was greater when the nitrogen was applied to dry soil and washed in with rain before flooding than when applied directly to flooded pasture.

Animal Production

The literature contains numerous references to para grass but relatively few on the other grasses. However all three are utilised widely for grazing in flooded and poorly drained areas in the tropics of Central and South America. The data shown in Table 2 indicates productivity levels comparable to the better tropical grasses. Average daily liveweight gains of the order of 0.5 kg/animal, stocking rates of 0.2-1.0 ha/animal and production of over 700 kg liveweight/ha are shown. In Queensland the alternative to ponded pasture where it is used is mostly native pasture with a production capacity of only 20-40 kg liveweight gain/ha/yr.

Table 2 **Animal production from para and aleman grass**

Grass	Location	Stocking rate ha/an	Animal Liveweight gain g/day	kg/ha/yr	Ref No
Para	Tully, Q	0.9	520	210	24
Para	Innisfail, Q	0.5	430-590	315-430	1
Para + leg (irrigated)	Mareeba, Q	0.26-0.33	570-608	640-780	13
Para + leg (irrigated)	Ayr, Q	0.24	450	670	3
Aleman	Mexico	0.30	496*	NA	16
Para	Venezuela	NA	413	NA	4
Aleman	Venezuela	NA	653	NA	4
Para	Venezuela	0.17	217	475	7
Aleman	Venezuela	0.17	309	677	7
Para/aleman	Venezuela	0.25	440	642	7
Para/aleman	Venezuela	0.13	185	540	7
Para	Solomon Is	0.28	447	558	26

* summer only

The value of ponded pasture lies in its higher quality and carrying capacity than the native pasture. While grass growth is small in winter, it remains unfrosted and high quality while in water.

The limited data available suggests animal production from aleman grass is as high as that from para grass. Published data show its nutritive value to be comparable to para and other tropical grasses (Combellas and Gonzales 1973, Pezo and Vehnout 1977 and Pate and Snyder 1984). Similarly with hymenachne in Surinam, Bogdan (1977) recorded high crude protein levels (15-23%) and crude protein digestibilities (66-80%). At "Granite Vale", Marlborough we measured the chemical composition (terminal leaves) of ponded para and hymenachne and non-ponded native pasture after fertiliser application in autumn 1988. The results (Table 3) show hymenachne to be higher in nutrient content than para. These results also highlight the vastly inferior quality of native pasture in early winter.

Table 3 **Chemical composition of the leaves of ponded grasses and native pasture at "Granite Vale"**

Grass	Fertiliser kg/ha	Chemical composition* %CP	%P	%K
Para	55N,58P	12.5	0.30	2.97
Para	90N,28P	14.3	0.26	2.93
Para	nil	9.4	0.12	2.39
Hymenachne	55N,58P	13.9	0.36	2.78
Hymenachne	nil	11.2	0.20	2.55
Native	90N,28P	5.6	0.08	0.86
Native	nil	5.4	0.08	0.85

* samples were of the three fully expanded terminal leaves taken on 5 May 1988 after fertilising on 15 February 1988.

At "The Springs", Glen Geddes in 1981 Venamore (1983) compared the performance of bullocks on native pasture (3 ha/animal) and ponded para (0.5 ha/animal). In the Sep-Nov dry period the bullocks gained an additional 32 kg/animal on the ponded pasture. By the following April the cumulative liveweight gain/ha was 272 kg/ha for para and 34 kg/ha for native pasture.

Between 1987-89 we measured the growth rate of yearlings and bullocks over the critical cool/dry season at "Granite Vale" when given access to ponded para and hymenachne. Fertilised, ponded grasses supported yearlings at 0.3-0.7 ha/animal or bullocks at 0.6-1.2 ha/animal. Animal performance was very much dependent on whether animals had access to ponded material. Drought conditions (limited ponded pasture growth) or excessive rain in autumn/winter (limited grazing by *Bos indicus* cattle in deep water) both reduced animal performance. At worst bullocks at 0.6 ha/animal maintained weight between March-July 1988. Performance in the Sep-Dec dry season is shown in Table 4. At this time of year animals on native pasture at 4 ha/animal would be loosing weight.

The key to successful animal production from ponded pasture is to ensure adequate ponded grass is available to animals. It is also desirable for animals to have access to non-ponded pasture areas concurrently.

Table 4 **Liveweight gains of yearling steers and bullocks on ponded pastures at "Granite Vale"**

Treatment/attribute	1988 Mar-July	1988 Oct-Dec	1989 Sep-Dec
Yearlings - no fertiliser			
SR ha/steer	0.75	0.8	0.8
LWG kg/steer	40	43	50
LWG kg/ha	53	54	63
Yearlings - plus fertiliser (54N, 58P)*			
SR ha/steer	0.33	0.66	0.47
LWG kg/steer	13	62	61
LWG kg/ha	39	94	130
Bullocks - no fertiliser			
SR ha/steer	1.33	1.33	1.33
LWG hg/steer	50	30	44
LWG kg/ha	38	23	33
Bullocks - plus fertiliser (90N, 28P)*			
SR ha/steer	0.59	1.18	0.81
LWG kg/steer	-3	43	39
LWG kg/ha	-5	36	48

* kg/ha of nitrogen (N) and phosphorus (P)
SR = stocking rate
LWG = liveweight gain

Conclusion

Most beef cattle in Queensland are grazed on native pasture, the limitations of which are widely known. The provision of any high quality green forage in the critical cool/dry season can have an enormous effect on animal productivity (growth, condition, reproduction). The strategic use of grasses sown in man-made pondage areas is one method of supplying this quality 'out of season' forage. Para grass, aleman grass, and hymenachne are three grasses whose yield potential and nutritive value under ponded conditions can enhance beef cattle performance in Queensland.

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Aleman Grass, Hymenachne and other forage species for Ponded Pasture Systems

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Abstract

Natural ponding grew native grasses which included *Hymenachne acutigluma* on the floodplains around Darwin, *Leersia hexandra*, *Paspalum paspalodes* and *Pseudoraphis spinescens*. Until recently, para grass (*Brachiaria mutica*) introduced to Queensland in 1880 was the main grass planted in natural pondage and in constructed systems. Aleman (*Echinochloa polystachya*) and hymenachne (*Hymenachne amplexicaulis*), released as commercial grass cultivars in 1988, can grow in water up to 1.2 m deep. This has started a new era in ponded pastures which had previously been restricted to 0.6 m depth of water which was the limit for para grass. The relative palatability of these grasses, their water depth tolerances, reactions to low soil fertility status and insect pests, can now be considered in developing ponded pasture systems. Monocultures or admixtures of several grasses may be grown to suit the location or the objectives of the grazier.

Several other exotic species, some already introduced, may add to future pondage systems providing forage for dry season grazing.

Introduction

Graziers have utilised native grasses in natural pondage systems as they have dried out in the dry season. The important palatable native grasses include *Hymenachne acutigluma* in the floodplains around Darwin in the Northern Territory, and throughout northern Australia, rice grass (*Leersia hexandra*), watercouch (*Paspalum paspalodes*) and spiny mudgrass (*Pseudoraphis spinescens*).

Para grass (*Brachiaria mutica*), introduced to Queensland in 1880, was the main grass planted in natural and constructed pondage systems until 1988. Para grass has been and will continue to be a valuable ponded pasture grass. Its main attributes are its drought hardiness, high palatability and planting material and seed are readily available. Main limitations of para grass are that it prefers very shallow water and will not grow in water deeper than 0.6 m, and in wet winters it is susceptible to damage by a minute sucking insect - a reddish brown leafhopper (*Toya* sp.). The damage is seen as large dead patches of grass known as 'hopper burns'. This leafhopper only attacks para grass.

Aleman grass (*Echinochloa polystachya*) and hymenachne (*Hymenachne amplexicaulis*) are not affected by 'hopper burns'. Because they can grow in water up to 1.2 m deep, they can be used in deeper ponds to extend the green feed available in the dry season. Hymenachne sets high quality seed from late autumn to early spring each year while aleman is sterile but is very palatable and fast growing.

Ponded pasture systems have expanded to include deeper storages and this has encouraged graziers in inland areas to consider ponded pastures. Systems have evolved to include more than one grass species.

There are several other grasses which can be included in pondage systems. Bambatsi and Makarikari grasses (*Panicum colaratum*) are already commercialised grasses. They tolerate shallow water, are drought hardy, and although they stop growing in winter, they are very frost hardy.

There are several other grasses already introduced, and others to be introduced, require evaluation. There are some legumes adapted to the shallow and wet margins of pondage systems. *Neptunia oleracea* Lour is a well known noduated legume species grown in wet or aquatic habitats in south east Asia and is used as a vegetable by many people (Yana sugondha and Buranakarl 1981). It will grow in ponds flooded to 1 m deep.

After a thorough literature search in 1986 on grasses adapted to aquatic habitats, D.G. Cameron (pers comm) concluded that aleman and hymenachne were potentially very valuable plants and it seems most unlikely that they will prove any problem to fish habitats nor any worse weeds than para grass in irrigation channels and ditches. Other grasses and legumes, not yet commercially released in Australia, may have special niches in ponded pastures and not cause any problems for fish habitats nor weeds status above that for para grass. New grasses, legumes and especially *Neptunia oleracea* require early evaluation for possible inclusion in ponded pasture systems.

Olive Hymenachne (*Hymenachne amplexicaulis* (Rudge) Nees)

This broadleaf, dark green perennial grass is native to the Carribean and tropical American region. It occurs in dense stands in small waterholes along drainage lines and is seasonally flooded plains.

The leaves and stems are smooth and hairless. The stems can grow to a thickness of 12 mm but remain succulent and palatable. Olive hymenachne flowers from mid April and produces viable seeds which germinate readily on damp bare ground (Wildin and Chapman 1988). Hymenachne is not as vigorous or palatable as aleman or para and is not as drought hardy as para grass. However it will grow in water up to 1.2 m deep where para cannot survive and the sucking brown leafhopper (*Toya* sp) which can devastate para grass in winter does not affect Olive hymenachne. Because of its tolerance to deep water, good seed production to assist colonisation in pondage systems and resistance to the brown leafhopper Olive hymenachne has a major role to play in ponded pasture systems. A detailed description of Olive Hymenachne is given by Wildin 1989a.

Amity Aleman Grass (*Echinochloa polystachya* (HBK) Hitchock)

A native of the Carribean and tropical American region where it grows along stream banks and in seasonally flooded areas. It is a hairless, vigorous perennial which spreads by long horizontal runners. Roots develop quickly from the nodes and once the area is colonised shoots grow upwards. Amity aleman can grow 2 m high under good conditions.

It is more palatable than para and Olive hymenachne. It is not affected by hopper burns. Amity aleman grass is sterile and flower heads produce no viable seed. Because of its vigorous growth and high palatability it is favoured for regular controlled ponding systems. It also has a place in ponded pastures where ponding to 1.2 m is essential for extension of grazing into the dry season. A detailed description of Amity Aleman grass is given by Wildin 1989b.

Other Grasses

Bambatsi (*Panicum coloratum*)

Bambatsi and makarikari grasses are commercially released perennial grasses which can grow in shallow water, are very drought hardy and are quite frost resistant although they make little or no growth during the cold months. They have outstanding spring growth. Seed is commercially available for Bambatsi but the other makarikari grasses have to be planted out by runners.

Tanner grass (*Brachiaria radicans* Napper)

This perennial is closely related to para grass. It occurs naturally throughout tropical Africa on swampy ground at the margins of lakes and streams where it can form extensive colonies of leafy herbage when grazed. The cultivated form is named after Joe Tanner who took material from a farm near Durban to the Marandella Grassland Research Station in Zimbabwe. It was grown as a pasture grass and later introduced to South America and Puerto Rico where it was considered a successful pasture grass (Bogdan 1977).

Echinochloa haploclada (Stapf) Stapf

This is a tufted perennial grass in tropical east, north east and south east Africa from sea level to about 1800 m altitude. It forms extensive colonies in seasonal swamps or waterlogged ground usually on black clays. It is well grazed when young. It is a good seed producer and can be easily established from seed. It is normally a tetraploid but diploids also exist (Bogdan 1977).

Antelope grass (*Echinochloa pyramidalis* (Lam) Hitche and Chase)

Antelope grass is a tall reed like perennial distributed throughout tropical Africa in seasonal swamps where it forms extensive colonies. It can withstand long periods of drought. It has been cultivated in tropical South Africa and Zimbabwe as a dryland pasture. The plants are usually tetraploid but diploids and triploids exist so that antelope grass can be quite variable and types can differ in habit and herbage quality (Bogdan 1977). At Lawes in the 1950's, CSIRO grew antelope grass under dryland conditions. Although it grew tall, sheep grazed that accession of antelope grass into the ground (R. Milford pers comm). North of Yeppoon, cattle grazed antelope grass before aleman and Olive hymenachne (J. Bryant pers comm). Good quality seed have been set and good germination in the field has been observed.

Echinochloa stagnina (Retz) Beauv. Bourgou

This is a perennial grass with stems up to 2.5 m high arising from long rhizomes or creeping and rooting stem - bases often floating in water. It occurs throughout tropical Africa and also in India, Sri Lanka, other parts of Asia and the Philippines at river banks and lake shores, often in water up to 2 m deep. It can be very productive and the herbage is highly palatable at nearly all stages of growth and is reputed to be of high nutritive value. It is grazed when the water recedes and it has also been used for making hay. Plants of different ploidy exist (Bogdan 1977). It produces viable seed.

Bungoma grass (*Entolasia imbricata* Stapf)

Bungoma grass is a tufted perennial 40 to 80 cm tall with soft erect or ascending stems. It occurs in eastern tropical Africa at about 1500 m altitude in swamps with poor soils, deficient in nitrogen. At a grass nursery at Kitale, Kenya, this grass showed outstanding palatability and crude protein content above 15 percent. Isolated plants formed no seed but seeded well in mixed populations with the progeny varying in habit, leafiness, vigour and some other features. Samples originating from four sites were mixed to form cultivar Nzoia. At Kitale, Bungoma grass was one of a few grass species undamaged by army worms (Bogdan 1977).

Eriochloa meyeriana (Nees) Pilget

A strong perennial which can produce long creeping stems when grown on bare ground. It is a good grazing grass common on swampy ground, river banks and other wet situations in semi arid areas of tropical Africa (Bogdan 1977). A more upright form has been identified in ponded pasture areas in Central Queensland and around the Burdekin.

Carib grass (*Eriochloa punctata* (L.) Desv. ex Hamilt)

(*E. polystachya* H.B.K. is a better known synonym).

Carib grass is an annual or short lived perennial which occurs in tropical and subtropical America and the West Indies. It is often found in wet situations (on river banks, lake shores, seasonally flooded areas) where it can form large colonies. The soft herbage is well grazed by cattle and has medium to high nutritive value (Bogdan 1977). There is a local South American form *E. punctata* var. *montevidensis* (Griseb) Osten.

Hymenachne pseudo - interrupta C. Muell

This perennial is similar to *H. amplexicaulis* in habit and in floral parts but the leaves are narrower, linear to linear - lanceolate and not cordate at the base. It is distributed in the Indo - Malayan region in habitats similar to those of *H. amplexicaulis*, often as a lower storey in reed (*Phragmites* spp.) communities. This grass is well liked by buffaloes (Bogdan 1977).

Hymenachne acutigluma

This perennial is native of northern Australia. It is dominant on clay floodplains near the coast around Darwin. It grows in swampy situations, along creek banks and floodplains but it is not found in lagoons on the uplands away from the floodplains. The leaves are narrower than *H. amplexicaulis* and it may be a synonym of *H. pseudo-interrupta*. It is excellent fodder especially for buffaloes. Overgrazing by feral buffaloes prior to the BTEC scheme destroyed large areas of hymenachne on the floodplains of the Top End of the Northern Territory. Small areas established at Granite Vale near St Lawrence did not persist under the cool conditions in winter while Olive hymenachne thrived under those conditions.

Leersia denudata Launert

This swamp grass is a non rhizomatous perennial rather similar in appearance to the native *L. hexandra* but the leaves are not sharply scabrid and the plant is more readily grazed than *L. hexandra*. *L. denudata* only occurs in East, Central and South Africa (in contrast to the more pan tropic *L. hexandra*) and forms extensive colonies at 1500 to 2300 m altitude (Bogdan 1977). It may be useful for cooler environments in Australia.

Panicum elephantipes Nees

This grass is known as Paja de agua in Venezuela and Gamalote or Canutillo in Argentina. It is a robust glabrous perennial floating in water with the help of slightly spongy lower parts of stems, which can be up to 2 cm in diameter, and spongy lower leaf sheaths.

It is usually spread in tropical and subtropical America from the Carribbean area in the north to La Plata in Argentina, mostly in the lower reaches of large rivers, sometimes very numerous and forming extensive 'floating meadows'. In Venezuela it is common in seasonally flooded areas where flood water comes from rivers. In such areas the grass floats only during the floods. It is considered an excellent fodder (Bogdan 1977).

Vossia cuspidata (Roxb) Griff

This is a perennial grass with floating or submerged stems which can also creep on the ground when the water recedes. Stems root freely from numerous nodes and erect stems reach up to 1 m high. Leaves reach up to 1 m long and 15 to 20 mm wide and somewhat fleshy.

It occurs on swampy ground, lake margins and along streams and rivers of northern Nigera, Sudan, Uganda, Kenya, Zaire, Zimbabwe, Malawi and India. It is also common in the upper Nile River area. It is readily eaten by buffaloes and cattle if the animals can reach it. In Kenya on the southern shores of Lake Baringo it provides, together with *Cynodon nlemfluensis*, a considerable amount of grazing. This species can be considered a counterpart of South American grasses of similar ecology, such as *Hymenachne amplexicaulis* and *Panicum elephantipes*.

Other Grass Species

There are many more grass species which grow in wet and seasonally flooded areas throughout the tropics and subtropics. Some promising South American species which may be useful in ponded pastures and and described by Ramia (1974) in Venezuela include:

1. *Echinochloa spectabilis* (Nees) Link
2. *Hymenachne donacifolia* (Raddi) Chase
3. *Luuziola bahiensis* (Steud.) Hitchc.
4. *L. pittieri* Luces
5. *L. spruceana* Berth
6. *Panicum dichotomiflorum* Michx.

Legumes

Legumes for very shallow ponded areas may include those annuals adapted to waterlogged conditions. They are *Macroptilium lathyroides, Centrosema pascuorum* and *Aeschynomene americana* commercially released species. The Australian native annuals include *Aeschynomene indica, Sesbania cannabina* and *S. formosus*. In cooler climates, strawberry clover may be adapted to the margins of ponded pastures.

Neptunia oleracea Lour., a perennial legume herb, is found in wet or aquatic habitats in many countries of south east Asia. The succulent young tops or shoots are used as vegetables in those countries. In Thailand vegetable farmers growing this crop in ponds or flooded fields, where water is 0.5 to 1.0 m deep, heavily fertilise it with nitrogen to produce a high value vegetable. High yields can also be achieved when an effective Rhizobium is used to inoculate this vegetable legume (Yanasugondha and Buranakarl 1981). This noduated legume which is well adapted to deep water may be a valuable source of nitrogen for ponded grass pastures as well as offering quality grazing to livestock.

Earth banks may be constructed within ponded pastures to heights above ponding level to grow legumes not adapted to waterlogged conditions. These may include herbaceous species and scrub and tree legumes such as leucaena (*Leucaena lencocephala*).

Future

There are many grasses, and several legumes which could play an important role in future ponded pasture systems. Some of these grasses are already in Australia and many others need to be collected and introduced for evaluation in Australia. They have not been considered harmful to fish and wildlife habitats and they have not been considered as weeds where they occur. As Amity aleman grass and Olive hymenachne posed no more of a weed than para grass introduced into Australia in 1880 then the same can be concluded for the other exotic grasses and legumes. Other water weeds like cumbungi and Ludwigia are more serious threats to wetlands and crops. Ponded pasture systems are likely to evolve into more productive systems if the available pasture species can be expanded further.

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PONDED PASTURES - AS A POTENTIAL WEED PROBLEM

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ABSTRACT

Ponded Pastures technology presents a potentially serious weed problem for conservation interests. More specifically, Hymenachne and Aleman Grass are assessed to be a major threat to native wetland systems in the Tropics. Procedures for assessing the weed risk of introduced species was examined for this workshop and found to provide inadequate protection for both rural and conservation interests. The basic requirements for weed management which will protect the widest range of interests is discussed. It is recommended that restrictions on the further distribution and use of Hymenachne and Aleman Grass be implemented until their weed potential is investigated in more detail.

PONDED PASTURES - AS A POTENTIAL WEED PROBLEM

(A) Are Ponded Pastures Likely to Become Weeds ?

One of the fundamental truisms surrounding the issue of introduced plants is that any given species can be either a benefit, a cost or irrelevant to different sectors of the community. Ponded pastures is not just an issue for the pastoral industry. For Q.NPWS there is convincing evidence that these grasses will spread from grazing areas to become weeds in native wetlands resulting in significant impacts on conservation values. From our perspective ponded pastures technology is a weed problem.

There is no need, at a forum such as this, to explain the costs of weeds - the pastoral industry has more than its fair share of weed problems. However what does need to be raised, is the notion of "conservation weeds". Plants which by their "weedy" characteristics, create serious impediments to achieving conservation goals.

Para-grass as a Weed Problem

Para grass **(Brachiara mutica)** is very similar to the other ponded pasture species that are either already established or are planned to be introduced in the near future. It is instructive to examine this species as a weed as it will indicate the type of problem that, in our opinion, is likely to result from the continued use of ponded pasture species.

<u>Para Grass is a problem for rural industries</u>

Para Grass is a serious weed problem in some rural areas, especially those of the wet sugarcane lands of North Queensland. Their primary impact is in clogging up the irrigation and drainage works associated with these areas. In the Babinda sugarcane district, for example, it is estimated that approximately $23,000 is spent every year on chemicals alone to control this weed.

There is also a clear indication in the literature of the importance of this species as a weed to rural interests. For example, a literature search on Para Grass produced approximately 40 references - of which nearly 50 % concerned control measures of the plant as a weed in a variety of countries including Florida, Hawaii, Thailand, Phillipines, Puerto Rico, Africa, Jamaica.

<u>Para Grass as a problem for protected conservation areas</u>

Para-grass has become a weed in a number of protected conservation areas in Australia, such as the Townsville Town Common Environmental Park and Eubanangee National Park. On the Town Common it has invaded, and now dominates, large areas of seasonal swamp habitat formerly occupied by a mosaic of native species.

This results in a number of conservation impacts :

the weed displaces a range of native species which are meant to be protected by the conservation reserve; ponded pastures, as weeds, occupy the margins of swamps and it is along these margins that the greatest diversity of plant and animal species occurs - protecting these margins is essential to protecting the species of these ecosystems,

the fauna dependant on the plants of the swamp margins are also disadvantaged in this process - thus in the Town Common, the Broglas which feed on Bulkuru bulbs suffer a serious decline in food resources with the decline in native swamp species,

the para grass produces large amounts of dead organic material which changes the topography of the swamps and permanently alters the hydrological system - this in turn results in changes to the associated plant assemblages,

in this park the control of weeds, including Para Grass, is resulting in significant costs in terms of labor and resources.

Put simply, para grass is one of the major factors rapidly undermining the chances of achieving most of the major conservation goals of this Environmental Park.

<u>Para Grass is a problem for rural area conservation</u>

Outside of conservation tenures, para grass and other ponded pastures will result in similar impacts on the wetland resources found throughout the pastoral lands. These resources are an essential part of any strategy to protect the flora and fauna of freshwater swamp ecosystems. Waterfowl, for example, cannot be given sufficient protection with only the wetlands found within National Park areas. They move widely over all tenures, variously exploiting temporary occurrences of wetland habitat.

Wetland conservation strategies must involve the wetlands occurring on private land, even if these are in some way disturbed by the surrounding land use activities. It is the behaviour of ponded pastures in disturbed, as well as pristine, wetlands that is of concern to conservation agencies. The potential weed problem is not just restricted to conservation tenures.

Getting Back to the Ponded Pastures Technology

Does anyone know if these ponded pasture species are going to become weeds for other sectors of the rural community ? Will they, for example, infest the shallow "balancing storages" used by Water Resources Commission in their irrigation systems ? Will they become a problem for rice paddies ? Will they change the ecology of natural wetlands sufficiently to reduce the ability of aboriginal hunters to get waterfowl ?

All the evidence reviewed for this workshop suggests that ponded pasture species have a high risk of becoming weeds in the native wetlands. For conservation agencies this issue is already one of appropriate weed management within Queensland. The established Hymenachne (**Hymenachne amplexicaulis**) and Aleman Grass (**Echinochloa polystachya**) species are seen to be potentially major weeds of important conservation areas, especially in the tropics.

Given this assessment it is recommended that:

> the further distribution of Hymenachne and Aleman Grass into the tropics should be prohibited until there is conclusive evidence that these species will not result in weed problems throughout the wetlands of the North.

(B) The General Problem of Managing Weeds

The perceived problems surrounding the introduction and subsequent distribution of ponded pasture species highlights the need for an overall review of how plant introductions are assessed for their weed potential and how they are subsequently managed.

This is in line with a number of recent moves to improve aspects of the current system of dealing with weed issues. For example, the most authoritative attempt at developing a more effective approach was published by Hazard (1988) from the Australian Weeds Committee. This paper is central to our understanding of an appropriate weed management approach and is used as a guide throughout the following section.

<u>What are the basic requirements for adequate management of weeds</u>

The basic requirements for protecting the interests of all sectors of the rural community should define the minimum standards for managing the problem of weeds in the rural environment. For conservation interests, these minimum requirements must be implemented if we are to avoid major problems in the future.

We briefly examined the procedures for managing weeds in Australia and Queensland and could identify five areas, discussed below, where the existing approach to weed management could be improved.

1. Adequate Protection for All Rural Industries

This is almost the only component of the proposed Front Line which currently applies. The best features of the existing system should be strengthened to provide protection for all rural based industries from the introduction of weeds. Conservation strategies in rural areas are in many ways dependant on rural activities being sustainable. The current assessments of introduced plants is helping to make these activities sustainable and is therefore integral to any conservation approach to weed management.

2. Changes to the Standards Applied to the Importation of Plants

Hazard (1988) focuses on this level of management and the conclusions and recommendations reached are seen as fundamental to protecting conservation interests.

The overall philosophy of approach should be very cautious - it is estimated that the direct and indirect costs of weeds in Australia is approximately $ 500 million per annum. Potential weeds should be closely examined to assess the risk of them further contributing to this cost.

Hazard identified two key areas of management as being where controls need to be tightened up. The first relates to the standards and guidelines which are applied as the initial filtering of imported plants to identify those which are clearly either safe or of high risk.

He recommended formal guidelines for assessing the weed potential be adopted which apply to all plants being imported into Australia. A draft set of guidelines was presented.

These guidelines should be reviewed to assess their value in providing a basic screening for conservation weeds.

The second area of concern is in dealing with those imports which are of uncertain weed risk but which have significant potential benefit to some sector of the community. It is these plants which should be referred to the State authorities and/or research institutions for more detailed assessment.

The list of recommendations concerning the assessment procedures and the controls to be put in place over the distribution and use of uncertain species is fully endorsed as appropriate to maintaining an adequate level of protection against conservation weeds.

It is at this level of detail that some assessment of the behaviour of a plant as a weed should include how it may react to different climatic and land use conditions. The established ponded pasture species, for example, should be assessed for their weed potential in the very different conditions prevailing in the Tropics.

3. Developing a More Consistent and Coordinated Approach to Managing Weeds within the State

Within Queensland, various aspects of weed management come under the under the Rural Lands Protection Act, the Plants Protection Act, and the

Agricultural Standards Act. The Departments of Primary Industry, and Lands (especially the Rural Lands Protection Board) and local authorities all have major roles in different aspects of the this issue. Each of these levels of review can operate separately and with very little integration.

Further complicating this scene is the apparently inconsistent use of standards and legal requirements for assessment. The Herbage Plant Liaison Committee, for example, has the role of evaluating introduced pasture species and approving (or not) the plant's distribution for this industry. It is therefore a potentially important filter in stopping the spread of "pasture weeds". Unfortunately there is no requirement for private importers of pasture species to have their imports assessed by this committee. It is also illuminating to note that many of the people directly involved in weed management are apparently unaware of this level of assessment.

There is clearly a need for a much simpler series of assessment procedures which apply equally over all introduced plants.

4. Adequate Funding and Other Support Should Be Available for Managing Weeds

The level of support for weed management appears to be insufficient. For example, there are only 25 regional inspectors attached to the Rural Lands Protection Board whose responsibility is to provide extension services to local authorities, monitor the occurrence of weeds on all rural lands and report on appropriate management actions. This is obviously an impossible task which must be changed if monitoring and surveillance is to be an effective element in the management of weeds.

The assessment resources at the point of entry for importations are also overtaxed and are probably having trouble coping with the current level of assessment. This situation would be exacerbated if the recommendations for tightening controls outlined above are to be implemented.

Conclusion

The introduction and promotion of the Hymenachne and Aleman grasses within the pastoral industry of the Tropics has greatly alarmed people with responsibilities for conservation in this region. Available evidence indicates to us that these plants will return to haunt us as weeds of the freshwater wetlands in the years to come. The review of procedures for controlling the importation, and subsequent management, of weeds also suggests to us that these types of problems will arise again in the future.

The introduction of ponded pastures technology must become the catalyst for a comprehensive review of weed management and should lead to far more restrictive standards being applied to the importation and use of exotic plant species.

THE SPREAD OF PONDAGE SPECIES BEYOND THE PASTURE SYSTEM

- The Risk and Associated Ecological Consequences

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ABSTRACT

The spread of ponded pasture species beyond the pasture system is considered a potentially serious problem. Factors contributing to the risk of spread are considered. The adaptation of ponded species to aquatic situations heightens the risk of spread. Ecological consequences of spread to non target areas are discussed. A worst case scenario might see environmental effects worse than those caused by para grass. Some shortcomings of the screening process for importation and commercial release of plants are highlighted. A review of the current system is suggested.

INTRODUCTION

The impact of ponded pastures on fisheries resources in the central Queensland area has been the subject of considerable media debate and has prompted several interdisciplinary evaluations of the technology. The focus of these reviews has largely been directed to the situation in central Queensland. The technology is now being adopted or trialled by primary producers in many areas of northern Queensland. This move is being actively encouraged by agricultural extension officers. The potential for development of ponded pastures is even being used to advertise properties being offered for sale (Figure 1).

These northern areas are far removed from central Queensland. They are subject to quite different environmental conditions and the technology is being applied in markedly different ecological situations (see Kernot 1991). The environmental risks associated with pondage in these areas are not the same as those experienced in central Queensland. In the far north the risk of habitat degradation caused by the spread of introduced deep water grasses beyond the ponded pasture system is considered to be potentially the most serious problem. This paper discusses the factors which contribute to the risk of this spread occurring and explores the possible ecological consequences.

ONE MAN'S WEED IS ANOTHER MAN'S WILDFLOWER

Associated with the introduction of any species, native or exotic, outside of its natural range, is the risk that the plant will spread beyond the place of introduction. This is used to advantage by pastoralists to establish introduced pasture species under rangeland conditions. While this is a legitimate land use in areas set aside for grazing, it can lead to serious conflicts of interest when the plant spreads beyond the grazing system (target area) to areas where grazing is not the primary land use (non target area) e.g. cropping areas, urban areas, conservation reserves etc.

Many of the ecological problems posed by introduced species in Australia have stemmed from a failure to recognise this conflict of interest and to adequately weigh the cost of habitat degradation in non target areas against the benefits which prompted the introduction. In years past, when many of the ecological concepts we take for granted now were simply not understood perhaps some of these introductions can be excused. Given our present knowledge of the often complex interrelationships which exist in nature and the value the community places on the environment the time has come to give more detailed consideration to such matters prior to introduction or release.

WHAT MAKES PONDED SPECIES AND AQUATIC SYSTEMS DIFFERENT

Pasture scientists are faced with the dilemma that many of the desirable characteristics of pasture species predispose the plants to behave as weeds. Firstly the species must be able to establish following sowing into areas where often little or no seedbed preparation is possible. Secondly they have to disperse and establish away from the place where they were sown. Often the grazing animal is relied upon as the major agent for dispersal but some of the species currently being used have other equally efficient dispersal mechanisms which do not rely on cattle. Finally the plants have to be able to persist under harsh environmental conditions, survive grazing pressures and remain competitive. It is impossible to have a grazing industry dependant on introduced species and not live with some of these risks, however the risks are not uniform from species to species. For some species the benefits may outweigh the risks, for others the risks may simply be too great. The plants utilised for ponded pastures differ from most other pasture species in that they are adapted to exist in an aquatic environment where the risk of spread is exceptionally high.

Introduced aquatics have a particularly bad record of spread in Australia. Most of the species which have become particularly troublesome weeds were introduced initially for aquarium or horticultural use. These include *Alternanthera philoxeroides* (Alligator Weed), *Salvinia molesta* (Salvinia), *Eichhornia crassipes* (Water Hyacinth) and *Mimosa pigra* (Giant Sensitive Plant). *Brachiaria mutica* (Para Grass), the only ponded pasture species to have been introduced sufficiently long ago, has become a widespread weed in coastal Queensland. There is no evidence to suggest that the more recently introduced ponded species will not follow a similar pattern.

In aquatic situations a failure to set seed is no impediment to spread. Flooding can break plants into small pieces which are then swept downstream to colonise new areas. Severe flooding also tends to disturb stream bank vegetation thus reducing competition from native plants as the newly arrived introduction attempts to become established.

Until the introduction of the deep water grasses *Hymenachne amplexicaulis* and *Echinochloa polystachya* the aquatic environment was not seen to be the realm of the grazing industry. Their use of aquatic systems was limited to stock watering and grazing of native grasses which grow on the margins of natural swamps and rivers and on flood plains. Para grass (*Brachiaria mutica*) was the only introduced species available which was adapted to growth in naturally flooded systems or artificially constructed pondages however its inability to grow well in water much deeper than 30 cm limited its use. With the introduction of the deep water grasses the range of options open for utilization of aquatic systems has been increased.

POSSIBLE EFFECTS OF SPREAD

It is difficult to accurately predict what effects might stem from a spread of introduced deep water grasses to non target areas. A worst case scenario might see environmental effects equal to, or perhaps worse than, those caused by para grass. The ability of the newer grasses to grow in much deeper water than para grass supports the latter.

Given fairly uniform substrate, water quality and flow rates, water depth is perhaps the single most important factor governing the distribution of aquatic plants within a single water body. Variation in depth provides niches which can be colonised by a range of species. This variation is greatest around the margins and therefore it is here that the greatest diversity of plants and the animals which are dependent on them is found. This is the area which will be colonised by the ponded grasses.

As native species are displaced, species diversity falls. Few native rooted aquatic plants could survive in water too deep to sustain either *Hymenachne amplexicaulis* or *Echinochloa polystachya*. As the diverse assemblage of plant life around the margin is replaced by a monospecific stand of grass many of the animals which are dependant on these areas for food and shelter, e.g. wading birds, are forced to move elsewhere. Not all animals will be affected in the same way, some may even be favoured by the presence of dense stands of grass. In general though more species are likely to be disadvantaged than favoured. In areas set aside primarily for nature conservation, such shifts in the balance of species is undesirable.

A TALE OF TWO ESTABLISHMENTS

Following introduction of ponded pasture species, the measure of successful establishment will vary depending on the viewpoint of the observer. From a producer's perspective, establishment will probably be rated as unsuccessful if the end product of introduction is not a productive pasture, that is, unless there is a significant increase in the biomass of the introduced species compared with that planted. The pasture will also have to persist and maintain productivity from season to season under prevailing environmental conditions and the pressures of grazing.

From a biological view this quantum increase in biomass following introduction is not essential for establishment to be rated successful. Even if only a small fraction of the initial planting material survives from season to season, the plant can be judged to have become established. The continued presence of the plant, even if only in small numbers, provides a source of propagules which may be carried to other localities. Under rangeland conditions there are many examples of introduced species which have remained present in small numbers and localised in occurrence for many years before spreading and becoming weedy. The catayst for spread has often been an infrequent natural event such as wildfire, drought, flooding or a succession of wet years. Overgrazing or a change in management practices (e.g. switching from sheep to cattle) also have the potential to initiate spread. The trigger in the case of introduced ponded species is likely to be flooding and this is far from an infrequent event in many areas being explored for ponded pastures in the far north.

Having made this distinction, it is obvious that reports from producers or pasture agronomists of failed attempts to establish ponded pastures in certain areas cannot necessarily be taken to mean that the species is absent from the catchment. It also suggests that care should be taken in using the experiences of producers in an attempt to establish where the deep water pondage species might or might not be likely to establish under natural conditions. Given the scanty information available in the literature this is likely to be attempted.

LAKEFIELD NATIONAL PARK - A CLASSIC CONFLICT OF INTEREST

A classic example of how ponded pastures can contribute to the conflict of interest which can develop between the grazing industry and the conservation of environmentally sensitive areas can be seen is the catchment of the Normanby and Kennedy Rivers in southern Cape York Peninsula. The total area of this catchment is about 24600km^2 and within it is situated Lakefield National Park covering approximately 5,300 km^2, Lakefield is Queensland's second largest national park. It was gazetted in 1979 to conserve amongst other natural features a large number of lakes and lagoons developed on the flood overflow of the lower reaches of the Kennedy and Normanby Rivers and their associated tributaries (Figure 2).

There are less than 20 pastoral leases within the catchment. Lakefield itself was once a pastoral holding. Ponded pastures have already been investigated on a small scale on at least two properties within the catchment and at least one major development is currently being considered on a third. Should the deep water grasses prove to be as invasive as some fear they may be, the park's wetlands are at serious risk of degradation.

POTENTIAL FUTURE INTRODUCTIONS - A TIME BOMB IN THE MAKING?

Already there have been suggestions of further species which might have potential for use in ponded systems. Some of the species which have been suggested by Wildin (1985) include,

Brachiaria radicans	Tropical Africa
Echinochloa haploclada	Tropical Africa
E. pyramidalis	Tropical Africa
E. stagnina	Tropical Africa, parts of Asia, Philippines
Entolasia imbricata	Tropical Africa
Echinochloa meyeriana	Tropical Africa
E. punctata	Tropical and sub-tropical America, West Indies
Hymenachne pseudo-interrupta	Indo-Malaya
Leersia denudata	Africa
Panicum elephantipes	Tropical and sub-tropical America

Paspalum distichum	North and South America
Vossia cuspidata	Africa

Wildin suggested four species, *Echinocholoa stagnina, Eriochloa meyeriana, Panicum elephantipes* and *Vossia cusipdata*, worthy of early introduction and evaluation in artificially ponded systems. *E. meyeriana* has since been introduced. With the introduction of further species the risk that eventually one of the introduced ponded species will become invasive in non target areas increases. *Echinocholoa stagnina*, one of the suggestions for early introduction, was one of 23 species listed by Michael (1989) as a weed of potential Quarantine concern to Northern Australia. *Panicum elephantipes* has the ability to form floating meadows and *Vossia cuspidata* can be a nuisance in irrigation canals and ditches. Despite this, in proposing the introduction of these grasses, Wildin states, 'these grasses have never been reported to be weeds in lakes, streams and rivers where they originate' and 'they are unlikely to be objectionable in Australia'. Past experience has shown that weedy introduced species seldom behave as weeds is their native habitat. Can this apparent dismissal of the risk of spread or a failure to adequately review the literature pertaining to proposed introductions be condoned. This example serves to highlight the need for more careful review of species prior to introduction.

PLANT INTRODUCTION REVIEW - WHO PAYS THE PIPER CALLS THE TUNE

For a number of years there have been calls from certain sections of the agricultural community, primarily those involved with weed research, for stricter guidelines to be applied to the introduction of crop, pasture and ornamental plants into Australia. These calls have largely gone unheeded. While strict sanctions apply to the introduction of biological control agents, most plant introductions encounter few if any barriers and enter the country with little consideration of benefits or costs. This constitutes a serious inconsistency in import regulations. The Australian Weeds Committee have suggested a scoring system for rating plants for introduction (Hazard 1988). It is doubtful if deep water pondage grasses would satisfy the conditions for introduction.

Within each state, Herbage Plant Liaison Committees (HPLC) exist to consider submissions for commercial release of pasture species. Within Queensland, membership of this committee comprises pasture agronomists from CSIRO, QDPI and university agriculture departments and representatives of seed growers and merchants associations. There is no representation from cattle producer organisations nor any organisation involved with weed control or nature conservation. This body, drawn wholly from groups with a vested interest in plant introduction, sits in judgement on submissions made from persons with the same interests. There is surely scope within HPLC for someone from outside the grazing industry to play the role of devil's advocate.

Shortcomings in the current system are highlighted by the retrospective registration of *Hymenachne amplexicaulis* and *Echinochloa polystachya*. By the time QHPLC met to consider commercial release of these grasses in 1988 they were already in widespread use by graziers.

WHERE TO FROM HERE

Based on the demonstrated behaviour of introduced aquatics there is little doubt that the deep water grasses *Hymenache amplexicaulis* and *Echinochola polystachya* will spread beyond the pasture system. The likely impact of the spread is difficult to predict with accuracy but perhaps somewhat academic given the species have already been commercially released. The dilemma this poses has been discussed by Hopkinson (1991) and is not perused further here.

This workshop may be focused on ponded pastures but this issue represents only a small part of what is a growing concern that pasture species are having an increasing impact outside of areas set aside for grazing. It is likely that is the not too distance future there will be stronger calls to tighten restrictions on the importation and commercial release plants. Rather than hold out against these pressures, the grazing industry would do well to recognise the intrinsic weedy nature of pasture plants and to take the initiative of seeking out concerned groups with a view to developing a screening process which are acceptable to all parties. Those critical of the spread of pasture plants would have to recognise the value to introduced plants to the pastoral industry and their contribution to the rural economy. Without this mutual understanding there would be little room for compromise. It is hoped that this workshop might provide a platform from which work towards this agreement might be launched.

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Page 20 — Tablelands Advertiser, Wednesday, April 3, 1991

21,400 ha for sale in the Gulf

"Forest Home", a well known and improved Gilbert River property can be developed to irrigated pastures, stylo or ponded pastures.

This is an opportunity to purchase a securely watered Gulf property, ideally located on a sealed highway to markets.

Only on rare occasions does an operating cattle station with as much scope for increased productivity become available for sale in this closely held area.

It is situated on a sealed highway 407 km southwest of Mareeba, 560 km northwest of Charters Towers and 59 km west of Georgetown and all services.

It covers 21,400 hectares of 53,000 acres.

It has a highway frontage, 240 volt rural power, phone, weekly mail, primary school, hostel and hospital at Georgetown, liveweight selling at Mareeba and Charters Towers.

The country is mainly flat river frontage open box running to areas of lighter forest country.

It is well grassed with spear and other native grasses.

A small area has been planted to Secca and Verano Stylo which is well established.

Buffel grass is also being established.

The large natural swamps and lagoons lend themselves to the planting of ponded pasture.

There are extensive areas suitable for Stylo and Buffel pasture development.

The property is well watered with double frontage to the Gilbert River, three bores, two dams, numerous natural waterholes, swamps and lagoons.

The abundance of natural water makes this a very safe property.

For inspection arrangements, contact Elders Real Estate Mareeba on 92 3722.

Figure 1. Advertisement for the Tablelands Advertiser of Wednesday 3rd April 1991. Note the suggestion that 'natural swamps and lagoons' lend themselves to the planting of ponded pasture.

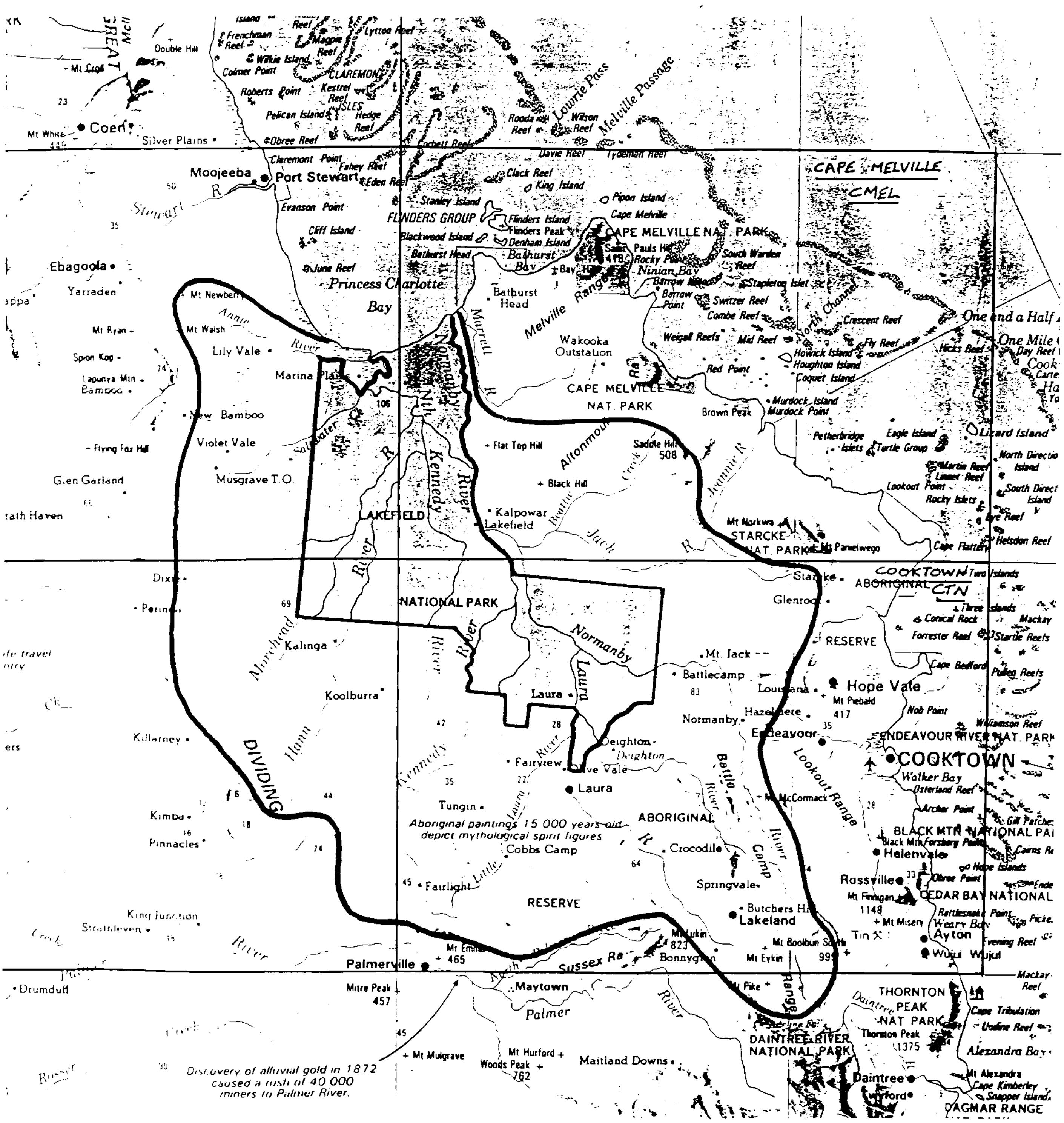

Figure 2. Catchment of the Kennedy and Normanby Rivers and the boundaries of Lakefield National Park.

Ponded Pastures - A Cattleman's View

by Ted Smith and Joe Olive
for the Marlborough Land Care Committee

Abstract

Ponded pastures are nothing new, they are an essential part of a cattle management strategy to offset the variability of the seasons in Central Queensland.

On suitable country, ponded pastures are the most cost-efficient way of maintaining animal nutrition and minimising stock losses in the dry season.

By having adequate pastures in the dry season, stress on native pastures on other parts of the property is minimised thus avoiding over use and degradation of pastures and land.

Ponded pasture provide many benefits to wildlife. Areas that were previously dry and devoid of birds and animals are transformed to wildlife habitats that appeal to the community at large.

Discussion

Extreme seasonal conditions are par-for-normal in this part of the land. It is not unusual to have over abundance of water during the summer months with drought conditions existing for the latter part of the same year.

The grazing industry has always had the problem of livestock losing condition during the dry season due to the decreasing quality of the existing pasture. It is at this period that the livestock on this land suffers, and as a result the more fertile, or better pasture areas tend to be overgrazed. With the result that land and pasture degradation is increased due to these stocking pressures.

Pondage pastures are one of the few avenues by which the quality of dry season pastures can be improved. It was found that high quality pastures could be established for use during long periods of dry weather by ponding water on what would normally have been low-lying infertile country. Destocking ponded pastures through the wet season is the normal practice. This allows ponded grasses to grow and build up bulk for reserves in the dry season.

On the coastal country pondage pastures can be the factor that determines the viability of a grazing enterprise, as it is the most cost efficient way of maintaining animal nutrition in a dry season. Ponded pastures are generally utilised by breeders in the dry season to prevent stock losses. In a period of hard economic times such as now, a viable herd size has to be maintained without causing land degradation due to overstocking.

The pondage pasture system is not a new innovation and its economic and management benefits to the cattle industry have been well proven over many years.

PONDED PASTURES - A PRODUCER'S VIEWPOINT

Bill Geddes, "Doonside", PMB, Rockhampton, Q. 4702

QUEENSLAND has a predominantly summer rainfall. Most years, heavy rain falls from December through to April followed by relatively dry months. To survive this pattern, nature has evolved large areas of natural swamplands which have proved their capabilities to support so many species of animals, birds and fish. These areas stretch from the far south-western corner where the Channel Country has its vast spread of swamps, flood plains and lakes through to the coastal regions which have a far more reliable rainfall.

These flat swamplands are nature's most efficient means of using and conserving the seasonal rainfall and therefore provide an environment and habitat for all animals, birds and fish. It has been from this aspect of nature that the development of ponded pasture has emerged. These ponded pastures, constructed with a respect for nature foremost in mind, have further stabilised the ecology we must endeavour to maintain. Imported grasses suited to swamplands have added value to the wetlands' ability to support fauna all year round. As a bonus, it greatly improves the productivity of cattle breeding operations while at the same time protecting the quality of the land.

As caretakers of our land for a very short time in terms of our lifespan, it is our responsibility to help Nature make better use of her resources. Increasing world demands have placed greater pressure on Nature's reserves. The greatest way landholders can assist is by maintaining and improving the quality of their land. The logical way to do this is through conserving soil, vegetation and WATER. Ponded pasture, properly constructed, DOES improve the quality of land. Trials carried out on ponded pasture at Doonside have shown tremendous results. One such trial resulted in a 25 pc weight increase together with a 600 pc stocking rate increase achieved during the dry early summer period from September to December. Ponded pasture used for winter/Spring grazing for breeding cows is an even greater aasset because of reliability of feed.

From experience gained at Doonside over 18 years associated with ponded pasture development, it has been found that ponds holding 1.2 m of water at the deepest undisturbed point are the best producers. Soil used to construct the bank should be excavated from the water catchment side. This construction design approach has a number of important aspects. The area adjacent to the bank where water depth can reach 2.3 m gives a long-lasting water supply for stock and also provides a safe fish and wildlife habitat. In these areas, we can improve on the way nature designed her own swamps as very few natural swamps have significant areas where water lasts the whole year around to totally support birds and fish. Where a bank has a corner, more soil is required and in these areas a deeper hole can be constructed to give the ponds even greater reliability.

Aleman and Hymenachne grasses are the two species of swamp grass that will grow well in water 1 m deep and will creep out over the deeper water in the excavation. Both grasses provide excellent grazing as the water dries back. Beef production from aleman grass at Doonside is spectacular.

In areas where water depths of 0.5 m graduate back to dry ground, para grass and other water couch species thrive. These grasses are all very high producers of quality stock feed.

Pangola and humidicola are two grasses that will thrive in the dry area adjacent to the next bank and will grow up over the banks to provide good binding cover to protect them from erosion. All these grasses are able to grow on top of their own mulch. As the years progress, this aspect has resulted in the continuing improvement on the white soils at Doonside.

A big problem faced by the development of ponded pasture is the damage done to banks by a heavy deluge of rain. In Queensland, this sort of rain is very much a part of our world. The ponds must be designed in such a manner so that the banks can withstand these deluges. The best way to alleviate this problem is to restrict the inlet. Where there is a series of ponds in an area, this can be achieved by having the turn-up at the end of each bank finishing close to the bank above. This allows just a small gap for the inlet and restricts entry unwanted run-off into the ponded area.

At the initial top bank or even for a single bank, a contour bank can be built above the system to divert the main flow of water from the catchment area. Only the water volume that can be handled by the by-wash is allowed entry.

Outlet pipes can be installed to gravitate water from one pond to another. This is good management practice as in seasons when rain is plentiful, it provides a reserve of stored water. It is also a good idea to leave a pond empty in some years to allow good grazing in the wet months or to establish grasses in areas where the water is usually deeper. Pipes through the banks give better control of water.

The whole concept of a large ponded area is to have better control and use of rain. Nature uses the water from our western river systems in much the same way. Slow flowing water is held in swamps and water holes which allows for better usage of rain that falls many miles away. Australia is the world's driest Continent. Water is the supporter and regulator of life and should be our No. 1 concern. Government should help and encourage all landholders to conserve water in every possible way.

The Effects of Ponded Pastures on Wildlife and Landscape Management

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Abstract:

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The Effects of Ponded Pasture on Wildlife and Landscape Management

Ponded pasture is acknowledged to have some positive environmental values in management of grazing land but is also perceived to have negative environmental effects by encouraging expansion of production into coastal saline environments and vegetation communities of marginal productivity which might other wise act as de facto conservation sites.

While there is evidence that the coastal grazing industry and wildlife species (apart from a few susceptible species) has co-existed there is concern that agricultural researchers are leading the industry in the direction of greater productivity in a manner which will be to the detriment of environmental diversity.

Introduction

Forms of freshwater retention and tidal exclusion barriers usually comprising earth mounds have been employed in various areas of Queensland for at least 60 years. There has over the past decade been an increasing public concern over the perceived effects of ponded pasture, mainly with respect to fishery management particularly barramundi (Lates calcarifer). There is also widespread concern over the effect of vigorous grass species utilized in ponded pasture such as para grass. There have been calls to ban or restrict the spread of ponded pasture. On the other hand active field naturalists have long recognised that areas where artificial embankments have been constructed can be sites with a great diversity of waterfowl populations. Other observers, with a primary concern for sound land management, have recognised that effective ponding can assist in the minimisation of soil erosion by reducing the intensity of water flow.

Separate consideration of inland and coastal ponded pasture locations may help to clarify the implications of ponded pasture from a conservation viewpoint.

In inland areas ponding does not usually represent an attempt to completely change a landscape by excluding a natural process such as tidal flow.Inland ponding systems may actually serve to "normalise" catchment flow which in typical pastoral situation has been destabilised by clearing of the tree layer, reduction of the ground (grass) layer, and by compaction of soils by livestock.There is,however, a danger that inland ponding systems may cause salting of land by increased evaporation where infiltration and runoff is reduced.Draw-off of water from streams for ponding may also lead to reduced water quality.

Ponding of tidal locations, particularly where minor to medium stream channels are involved may have a significantly adverse effect although this cannot always be stated with certainty. Tidal exclusion barriers may create conditions which disrupt fish and crustacean breeding and movement while also eliminating significant habitat such as the high tide roosts of a range of wading bird species. Such ponding may however increase the diversity and /or numbers, of waterbirds as well as prolong the occupation of certain sites.

The perceived positive and negative effects of ponded pasture can be summarised as follows:

Positive Effects:

- Assists in soil conservation and water control

- Concentration of stock feeding on productive ponded areas enables spelling of more fragile upslope sites

- Ponded pastures can provide waterbird habitat particularly for species such as ducks, herons egrets, and swamp-hens. This is particularly so where reeds and sedges are present in addition to grass species.

Negative Effects:

- Alteration to tidal flow and freshwater/saltwater interactions may affect marine productivity.

- Potential for diversion of freshwater and excess evaporation leading to loss of quality in freshwater streams.

- Exotic pasture species are a factor in ecosystem change at site of ponding and can become a major problem when introduces to non-grazing situations such as road reserves, urban parks, conservation reserves etc.

- Ponded pasture can be a major source of mosquito breeding where natural controls cannot work effectively

- Ponded pasture may be a cost effective system which has enabled the expansion of beef cattle grazing into sites which would otherwise enjoy de facto conservation status

- While ponded pasture favours certain native wildlife species it has an adverse effect on others. In addition it can concentrate wildlife in areas rated as prime sites for stock production. Pressure to cull wildlife can result.

Discussion

PONDED PASTURE IN CENTRAL QUEENSLAND

Early ponding works in Central Queensland occurred in locations such as Broadmeadows on the Fitzroy River and in tidal saltmarsh areas such as Boyd's Plain in the catchment of Corio Bay north of Farnborough (1943). Other locations include the northern marine plain areas on Curtis Island, locations around the Fitzroy estuary, and more recently in the valley of the Don River, and at locations around Broadsound extending to beyond St. Lawrence. These latter areas would appear from aerial photography and Landsat imagery to be the most extensive zones of ponding in the region.The high tidal ranges in the Broadsound area make it difficult to define a terrestrial/marine interface but it is obvious that some areas have involved extensive alteration to tidal zones. However there are also significant ponded areas set well inland on gently graded lands.

PONDING TIDAL LOCATIONS

An apparent incentive to pond tidal locations in Central Queensland has been the extensive naturally occurring unvegetated saltflats (or salt pans which are often dismissed as having no intrinsic value and contributing little to productivity of marine systems.This argument has been used particularly when land is proposed for reclamation in industrial, and tourist development situations. The productivity and contribution to the stability of estuarine systems which salt flats may provide is an area needing extensive research.

The Capricorn Conservation Council is working on a proposal for the reservation of Balaclava Island in the Fitzroy estuary as a benchmark reserve containing significant salt flat systems together with fringing mangroves and littoral rainforest types occurring on both hard rock and beach cheniers. All these systems occur in other locations where ponding has been constructed such as Rosewood Is. in the delta of the Styx River. It is therefore of value to have at least one benchmark area which can assist research into the impacts of changes to the system.

Ponding for pastoral production may be only a minor component in future proposals to alter tidal salt flat systems. Other threats include oil shale and magnesite mining, power station ash dams,salt evaporation works, fish and prawn farms and reclamation for industrial development such as the proposed 800 hectare Targinnie reclamation scheme.

MARGINAL LAND DEVELOPMENT

There is evidence that ponded pasture techniques have allowed development of marginal woodland areas which might otherwise have remained uncleared (see attached ref. Gladstone Observer 24/1/90). This may be particularly so in the Melaleuca viridiflora woodland zones where low fertility and poor soil structure has deterred some clearing. If the ponding techniques are applicable in locations such as the Gulf Rivers catchment the clearing of vast tracts of woodland may result. There could be severe consequences particularly if the ponding embankments have a short life span due to the unstable fine soils and intense weather conditions experienced during wet seasons.

PONDED PASTURE SPECIES AS WEEDS

A major concern regarding ponded pasture is the plant species used in these enhanced production system. Grasses such as para grass, hymenacne and aleman are vigorous species with the capability of taking over many natural open water bodies in addition to the ponding systems they were introduced. Para grass is now a major weed species in urban areas where it obstructs the free flow of streams causing various problems from enhanced mosquito breeding to loss of streamside vegetation. In a revegetation trial in an urban creek in Cairns trees which grew as much as 5 metres in the first year after planting were still smothered by excess para grass growth when control lapsed. The cost of herbicide or mechanical control is considerable and may be impossible when this species is a problem in large reserve lands or major horticultural areas free of grazing. There may be a real possibility the further introduction of forage species (including legume species) will raise new problems.

Despite 150 years of disasters in the introduction of plant and animal species to Australia it seems that the introduction of plants for enhancement of forage production is still conducted in a relatively unplanned manner. Many of the grasses and forage shrubs and vines constitute major problems away from grazed areas. The literature evaluating the use of various grass and legume species for fodder purposes never appears to include an assessment of known or possible effect when the inevitable escape to non-grazed environments occurs. It must be expected that there is a ponded pasture suited plant somewhere in the world with all the invasive characteristics of Mimosa pigra which some keen experimentalist is keen to trial.

The problem is not confined to ponded pasture systems but can occur to a greater or lesser degree with many introduced pasture species.

There is some evidence that nutrient depletion, formation of vegetation mats, or other factors as yet unknown can cause decline of the introduced grasses and a resurgence of reeds and sedges in ponded situations. This can have a particularly beneficial effect on waterbird populations particularly species such as brolga which feed on tuberous root systems. However this may represent an unacceptable drop in productivity for the grazier.

PONDED PASTURE AND WILDLIFE

Despite the reference above to ponded pasture species as weeds there are obvious wildlife values in most well designed ponded systems. Species such as the Intermediate Egret (Ardea intermedia) will congregate in relatively large numbers on the mats of grass and feed on frogs and possibly insects. Swamp hens (utilise the grass as cover and nest sites and a range of small passerines such as Red-backed wrens, Reed warblers and cisticolas also find the habitat quite satisfactory. Initial settlement in Central Queensland as well as other areas often lead to early attempts to drain or cultivate the broad shallow,intermittent swamps which carried the greatest numbers and diversity of waterbirds. To some degree ponded pasture simulates this type of habitat and may help to redress some of the early loss of habitat.

The drying out of ponded pasture in extended periods without rain and the consequent loss of water dependent species such as fish may be seen as an environmental negative but this is characteristic of natural events which occur throughout Australia wherever there are shallow waterbodies. It is possible with effective design to minimise some of the extremes of wet and dry season. There are many published design ideas for incorporating wildlife features into farm dams including shallow and deep water zones, shelter plantings, stock exclosure zones etc. It is possible to incorporate some of these ideas into ponded pasture. A deeper water retention area towards the overflow system of ponded pasture may sustain sufficient depth to allow fish species to survive until the next wet period and minimise some of the concerns which have been expressed over barramundi losses.

There remains the concern that many graziers have over large aggregations of birds such as Magpie Geese, although the basis of this concern is not fully understood. The vast natural wetland aggregations of the Fitzroy River Valley and adjacent coastal areas occur almost totally within freehold and Crown Lands used for grazing purposes rather than within conservation reserves. The fact that most bird species still retain significant populations within the region is indicative that grazing and waterbird conservation can be compatible. It is in the interests of the grazing industry to ensure that this demonstration of co-existence is maintained rather than put aside. The Magpie Goose must be considered one of the key indicator species of environmental change brought about by the introduction of the stock grazing industry to Australian wetland environments. The disappearance of the species from the wetlands of south-east Australia is indicative of the sensitivity to change.

Locally in the lower Fitzroy River system, Magpie geese have built up in numbers from the very sparse population which existed before the wet seasons of 1974 to 1976. While reduced shooting may also have lead to this population increase there is clearly no assurance that a reversal of population growth cannot again occur. All of the major open wetland habitats of Central Queensland on which Magpie Geese are found are subject to grazing as a primary land use with conservation of habitat being incidental to that use.

If ponded pasture can be said to represent the latest technological advance in productivity of livestock in seasonally dry environments then it must be assumed that further research will seek greater productivity methods. The spike rushes (Eleocharis spp) and other rush and sedge species which are believed to be major seasonal food resources for species such as Magpie Geese and Brolga are not species which find acceptance as desirable stock grazing material. It must be assumed therefore that future research may be directed towards elimination of these species by various techniques including spraying with specific herbicides such as 2,4D or by further physical alteration to the topography. In the literature on ponded pasture systems, and introduced fodder crops there is no mention of known or postulated effect on wildlife populations or landscape management. While in the past researchers may have assumed they have no responsibility in these fields it is essential that the ecological consequences of their recommendations and species introductions should be evaluated and published.

Ponding of tidal salt flats between Rockhampton and Townsville may have implications for the Radjah Shelduck (Tadorna radjah),another species which has suffered reduction in numbers throughout Australia. This species is frequently found on the tidal flats where the only vegetation is the algal mat which desiccates during dry periods and springs to life following inundation from spring tides and rain. Algal material is significant in the diet of the Radjah Shelduck and it must be assumed that a reasonable population of the species remains between Townsville and Rockhampton because of the large extend of relatively undisturbed tidal salt flats. Salt flats and associated fringing sedges are the habitat of one of Australia's rarest birds,the Yellow Chat (Epthianura crocea). The demise of this species from one recorded east coast location over 6 decades ago may well have been associated with the early tidal exclusion barriers at Broadmeadows on the lower Fitzroy River.

Para grass foliage and seed is listed as a known food source for a number of bird species including the Radjah Shelduck. While the importance of para grass in the overall diet is unknown it must be assumed to have some value as a food source. Other species in which para grass has been found in stomach contents include, Straw-necked ibis (Threskiornis spinicollis), Magpie Goose (Anseranus semipalmata) Wandering Whistle-duck (Dendrocygna arcuata), Plumed Whistle-duck (Dendrocygna eytonii),Hardhead (Aythya australis), Maned duck (Chenonetta jubata), Cotton pygmy-goose (Nettapus coromandelianus),Masked lapwing (Vanellus miles),and Peaceful dove (Geopelia placida),(Reference ,Barker and Vestjens. (1989) The Food of Australian Birds, 1 Non-passerines).

Conclusion

Ponded pasture is no different to any other development of an agricultural system in that there is a process of ecological change which can have negative and positive effects on landscapes and naturally occurring plant and animal species.

It is important that evaluations of these changes take place before a system is widely recommended or adopted.

Given that there is an inadequacy of conservation reserves over major wetland systems covering the bulk of Australian waterbird populations more effort should be made to acquire additional areas where conservation is the primary purpose.

The grazing industry by adopting management systems which can accommodate habitat for a range of wildlife including species susceptible to habitat modification can ensure a future for wildlife on rural production lands. If the capacity to do this is demonstrated the need to secure conservation reserves other that key benchmark and special refuge sites will be reduced.

As a follow up to the Coastal Management Green Paper produced by the Queensland Government there should be an evaluation of competing land-use pressures on the intertidal zones. There is an urgent need to evaluate the extent, ecological condition and contribution to productivity of the tidal salt flats of Central Queensland and the Gulf of Carpentaria coast.

Ponded pasture set to transform coast holding

G.O 24.1.90

Installation of massive earthworks to control annual flood run-off across totally unproductive coastal ti tree swamp country in the Yeppoon hinterland near Rockhampton is set to fransform a 730ha holding into a commercial cattle breeding and fattening showplace.

The investor behind the ambitious ponded pasture project is Rockhampton-based building industry identity John Bryant, who confidently predicts the intensively managed operation will carry 500 breeders and support a 1000 head capacity feedlot within three years.

Located in the Bungundarra district where annual rainfall averages about 1300mm, the property has in past years been inundated with up to 2.5m of slow moving floodwater across a 1km frontage after high intensity summer rains.

Working in co-operation with Queensland Department of Primary Industries senior agronomist John Wildin, a noted authority on ponded pasture establishment, and David Chapman, QDPI Soil Conservation Branch adviser, Mr Bryant has built 4km of major contour banking to more than 2m high.

These banks will control and protect the pasture development, conserve run-off, and then redirect the flow into the Hedlow Creek - Fitzroy River system.

A Rockhampton earthmoving contractor using 245kw Komatsu crawlers has built the primary banks and follow-up excavation and trimming has been done with Mr Bryant's Cat D5 and Cat D6 dozers.

Mr Bryant bought the original 202ha seven years ago and immediately pulled, stick-raked and blade ploughed the mature ti tree swamp country. An aerial application of 1.2kg/ha of para grass seed with 125kg/ha of Crop King 88 fertiliser followed.

Mr Bryant said he encountered plenty of problems with prolific ti tree regrowth, an invasion of native grasses and no control over the swamp run-off water.

Mr Bryant acknowledges this experience taught him some valuable lessons.

His advice now is to only tackle development on a scale which can be handled comfortably.

Although there was ample run-off for eight months of the year, water must be properly ponded and conserved to maintain pasture for the dry winter months. A Bonel offset plough behind a 67kw Belarus tractor is renovating the ti tree regrowth and an Aproplow has been bought to renovate established ponded para grass.

Water can be backed up over the initial 80ha para grass pasture development and a 6ha dam at the head of the property will be used to top up the para pondage during dry periods.

But major development centres on the adjoining 480ha holding, bought two years ago.

The earthworks have been designed to keep 121ha free of water for the breeding cattle but the balance can be control flooded using simple concrete and timber sluice gates to back up the water through a system of diversion channels and pondage banks.

The channel system can be topped up from a 100ha water storage area using a pump with an output of 1.3m litres/hr.

Hymenachne pasture, a water loving species, has already been sown over 24ha of specially prepared laser levelled bays using seed harvested from nursery plots established two years ago.

Last year, Mr Bryant headed 60kg of clean seed with a market of $70/kg. Mixed with sawdust, hymenachne is being sown at a high rate of 2.5kg/ha with the intention of producing commercial seed.

Ponded water on these seed production areas will be only 10cm deep and can be drained off as required to facilitate harvest.

A significant ponded grazing area has already been sown to hymenachne with a strong establishment of parent plants. QDPI recommends a conventional sowing rate of 1kg/ha.

These areas are now awaiting the first storm rains of 1990.

Mr Bryant aims to rotationally graze his breeders on 4ha electric fenced blocks.

Fertiliser application will be essential on these poor clay based soils and Mr Wildin has advised late summer annual applications of phosphorus and potassium based products plus 120-150 units of nitrogen.

A Harvestore with a 190t dry matter capacity has been erected and an under-cover 78m by 21m steel shed will initially house a 500 head capacity feedlot on an elevated gravelled site.

'A DISCUSSION OF SOME POTENTIAL CONSERVATION ISSUES WITH REGARD TO PONDED PASTURES'

Michael Chuk

Queensland National Parks and Wildlife Service

Rockhampton

JUNE 1991

Abstract:-

The establishment of Ponded Pastures in the Central Queensland has helped increase land productivity in terms of grazing capacity and stock turnoff. Whilst there is a range of information available on the establishment of such pastures, relatively little information exists on the costs or benefits to the environment. This paper examines these issues with particular reference to wildlife habitat and identifies areas where further research is necessary.

40 Adelaide St..
Yeppoon,
29-4-91,

Dr.C.J.Parmenter,
Chairman,
Steering Committee.
Ponded Pastures,

Dear Sir,

I thank you for your invitation to comment on the Ponded Pasture issue and will submit comments on the position as we see it.

We are concerned with the effect of ponded pastures on the Marine Enviroment and Ecology including the Marine Plains ,Mangroves areas, creeks, estuaries, etc.,etc., and all aspects of the effects on the inter relationship and importance of the fresh and sea water wetlands to Marine life.

Our biggest concern, and the situation is actually farcical, in that, the Ponded Pastures have been allowed to escalate and that nobody really has any factual recorded information on the detrimental effects that Ponded Pastures may have on the Marine Enviroment and Inshore Fisheries.

Government Biologists have tended to say that there is no problem,but they are only giving an opinion and there is no factual evidence to support their opinions.

In fact the massive fish kills that have occurred suggest quite a large problem exists and the only information available indicates drastically reduced catches of Fish such as Barramundi in other wise undeveloped areas where ponded pastures have proliferated.,

When you discuss these massive fish kills with the Government Biologists, the kills are usually dismissed as of no consequence because the biologists claim that fish like Barramundi are very fecund.

We are not in a position to provide data that proves Ponded Pastures are detrimental to the Marine Enviroment and Ecology,but neither are the supporters of Ponded Pastures able to provide data that proves they are not detrimental to the Marine Enviroment and Ecology.

While we acknowledge the value of Ponded Pastures to the Grazing Industry, we believe that Governments, including their Biologists *and Expert Advisers have acted quite irresponsibly in allowing Ponded Pastures to be constructed that infringe upon or are adjacent to the Wetland Areas of the Marine Enviroment.*

For many years now for any development of any size, Governments have required Enviromental Impact Studies be undertaken by Developers and others before developments are allowed to proceed.

At the same time the same Governments have allowed ponded pastures to be created, with no Enviromental Impact requirements and no factual knowledge of the effect of some of these pastures on the Marine Enviroment and Ecology.

No one ever seems to worry about the effect of the Ponded Pastures on fishes other than Barramundi. Attention is usually focussed on Barramundi because they are bigger and are readily seen by the naked eye. The pastures could be a complete disaster for many species of inshore Fishes,no one knows, even our experts are only guessing.
For the purpose of this exercise I will refer mainly to Barramundi but our concern covers all other inshore species.

<u>THE CENTRAL QUEENSLAND AREA INCLUDING THE FITZROY RIVER, SHOALWATER BAY AND BROADSOUND.</u>

Prior to the proliferation of ponded pastures in Central Queensland, the area was considered to be one of the major Barramundi producing areas of Queensland and the Shoalwater Bay and Broadsound Inlets were considered to be the best producing part of Central Queensland for this fish.

With the construction of the Barrage on the Fitzroy River without a successful Fish ladder the whole life cycle of Barramundi and all other fishes in that estuary has been altered and will remain altered until such time as a working fish ladder is erected.

With the advent of the ponded pastures in the Shoal water Broadsound area, the situation has arisen where the catch of Barramundi has declined to such an extent that one of the Fish Managers of the Queensland Fish Management Authority suggested that in this area Barramundi be declared an Amateur only species.

Unfortunately there is no factual data available to measure the decline in the Barramundi Population in this area, other that catch records for the past few years.

<u>ONLY EVIDENCE AVAILABLE</u>

The only Tangible evidence available on the effects of Ponded

Pastures on the Marine Ecology and Enviroment is the massive fish kills that periodically occur in or adjacent to these pastures and the decline in both the Amateur and Commercial fish catches.

The fish kills usually involve Barramundi and are very seldom witnessed by people in Authority or by members of the General Public.

They are usually seen by people who work on the properties where ponded pastures exist,and who are reluctant to speak out for fear of loss of their jobs, or are sometimes seen by people who are trespassing on the properties.

People tend to only see what they look for and if the monitoring of all ponded pastures by competent people for fish kills and other detrimental effects was possible, a very grim picture may well emerge.

The other aspect is that kills usually occur in areas that are not easily accessable.

The incidence of fish kills is always played down by those who support ponded pastures and usually these people point out that these kills occur in nature any how.

One of the difficulties is that none of us know how many fish kills there are, because in most cases observers are not allowed on the properties where the pastures are and it would be quite an expensive exercise to monitor all the areas involved.

Information from one source that has regularly witnessed kills of small Barramundi advises of kills of not hundreds, not thousands,but millions of young Barramundi dying that have been trapped in the pastures as the water dries up.

THE PONDED PASTURE, THE PERFECT FISH TRAP.

Many ponded pastures are perfect fish traps, which allow the fish to enter during the wet season but do not allow the fish to return to the sea when the floods subside. The majority of fish trapped in Ponded Pastures die, and are lost to the fishery.

Many experts suggest that when the floods return again the following year that any fish that survive have the opportunity to return to the sea. The problem is that the Fish do not know this when their natural instincts are driving them upstream.

There is not only small Barramundi involved,it is a natural instinct of all Barramundi to go upstream,usually in periods of *rainfall run off and it is quite common to see large fish right up in the fresh water areas of places like Corio Bay at certain times of the year. There is no doubt that the same thing occurs with ponded pastures and that many large fish are trapped by the pastures.*

Ponded Pastures are usually situated along creek banks, around estuaries and where the fresh water meets or runs into the sea,basically where the fresh water drains from the land into the sea.
Unfortunately it is those areas that are targeted by and are most important to some species of fish.
For example, you very rarely, if ever see small Barramundi trying to swim up a headland or a beach, they always go up the drainage channels, the reality is that they have no where else to go.

If all the drainage channels in an area are subject to ponded pastures, as is happening in some areas, then the fish kills in those areas of small juvenile Barra could be potentially 100% of all fish spawned. There is evidence to suggest that this could have happened and there is no evidence to suggest that it has not happened.

There are reports of large numbers of Barramundi going up the Fitzroy River via Yeppen Crossing, bypassing the barrage during the recent floods, unfortunately there is no factual data available nor do we know if this has been a normal occurrance in past times.

The one thing that we do know is that the Barramundi will survive in the fresh water in the Barrage and may even return to the sea to breed eventually.
The same cannot be said for most ponded pastures and the major problem is that the pasture cannot have a deep water channel to allow the fish access to return to the sea, because the intrusion of the sea water would destroy the Ponded Pasture.

VALUE OF RESOURCES

It is impossible with the information or lack of information available to even try to compare the benefits to the community between using the littoral resources for ponded pastures or for the preservation of fish species.

We do not believe that a comparison of benefits is an issue, we are really talking about the extinction of entire fish species and we do not believe that any Government or group of people have the right to place the resources which belong to future Generations AT RISK.

FUTURE OF PONDED PASTURES

Obviously ponded pastures have a future ,but they should be constructed in such a way that they do not interfere in any way with the Inshore Fishes, the Marine Enviroment and Ecology.

RECOMMENDATIONS

1.
Until such time that a system can be devised that does not interfere with the flow of sea water or restricts Marine creatures freedom of access to the sea or to their natural habitat,that the construction of all ponded pastures cease.

2.
That all existing ponded pastures that interfere with the natural flow of sea water or restricts Marine creatures freedom of access to the sea or to their natural habitat. be opened to the sea.

3.
That the Government initiate research into the construction of ponded pastures that do not interfere with the natural flow of sea water or that restricts Marine creatures freedom of access to the sea or to their natural habitat.

Yours Truly,

Ray Harris, Ray Harris

Enviromental Officer,
Yeppoon Branch,
Queensland Commercial Fishermans Organisation.

UTILIZATION OF WETLAND HABITATS BY COASTAL FISHES IN NORTHERN AUSTRALIA

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May 1991

ABSTRACT

Coastal wetland environments of northern Australia support a rich and varied ichthyofauna, including the young of many of our most valuable fishes. Wetlands perform an essential ecological role in maintaining natural resources by providing habitats for refuge, reproduction, feeding, recruitment, nursery and growth for many coastal fishes. The levels of fisheries production in inshore waters appear directly related to the quality of adjacent coastal wetlands.

Urban, rural and industrial developments involving wetland areas can diminish their ecological value, and adversely impact fisheries. Planning requirements for such developments should include assessment of the consequences to fisheries resources, and detail the appropriate strategies for compensation, amelioration and restoration of lost wetland function.

INTRODUCTION

Coastal wetland habitats in northern Australia support an astonishing diversity of fish fauna even by world standards. Blaber (1980) recorded 91 species from the Trinity Inlet system in north-east Queensland, and Blaber *et al.* (1989) found 197 species in a northern Gulf of Carpentaria estuary. More than half of these fishes (106) were caught only inside the estuary. Even the mangrove-lined inlets of the arid north-west Australian coast possess a rich and exclusive fish fauna, compared with open shore areas (eg Blaber *et al.* 1985).

The high species counts result from the greater diversity of habitats available to fish within the estuary complex, from open-water channels, mangrove creeks and inlets, submerged aquatic vegetation, intertidal areas, and supralittoral flats. Blaber *et al* (1989) found most species inhabited open-water channels, but fish biomass was highest (by a factor of nine) for intertidal mudflats adjacent to mangroves. Russell and Garrett (1983) established that temporary pools, created by high seasonal tides on the extensive areas of saltpan and supralittoral mudflats adjacent to many Gulf of Carpentaria river mouths, were used by juveniles from 37 fish species. Davis (1988) recorded a similar number of species entering tidal marshes near Darwin, Northern Territory.

Among this recorded fish fauna are a number of species of significant economic importance. Barramundi *Lates calcarifer* is a highly prized foodfish targeted by commercial gillnet fishermen and anglers. It is a catadromous species generally spending its first years in the upper parts of rivers, and moving down the estuary to spawn (Davis 1982; Griffin 1985; Garrett 1987). Postlarvae enter coastal swamps on high spring tides (Moore 1982; Russell and Garrett 1983; Davis 1985), and young-of-the year fish then move up upstream, remaining in the upper freshwater reaches until they are sexually mature.

Threadfin salmon (Polynemidae) form a major component of coastal gillnet catches in river mouths and adjacent waters. Neither blue salmon *Eleutheronema* *tetradactylum* nor king salmon *Polynemus sheridani* enter freshwater, but they do move upstream with saltwater intrusion (Griffin 1985). Threadfins spawn in offshore waters (eg Kowtal 1972) and juveniles become reasonably abundant in the lower estuary, infrequently entering tidal swamps (Russell and Garrett 1983; Davis 1988).

Grunters (Pomadasyidae), snappers and jacks (Lutjanidae), and bream (Acanthopagridae) are valued by recreational fishermen in particular. Grunters and bream breed in shallow areas near the estuary month (Day *et al.* 1981; Pollock 1982). Jacks such as *Lutjanus argentimaculatus* spawn in reef areas offshore and, like barramundi, their young can penetrate into freshwater reaches and remain there until mature.

Substantial commercial net fisheries operate in more sub-tropical waters for mullet (Mugilidae). Several different species are involved, but the cosmopolitan *Mugil cephalus* (the sea mullet) is taken in greatest numbers. Adults breed in inshore waters outside the river mouth, after having spent adolescence in the upper estuary.

Because of the association of economically important fisheries resources with estuarine and coastal habitats, it is instructive to explore the relationship in more detail. Further, it would be appropriate to examine the likely implications for fishery resources of changes to natural water regimes associated with urban and rural developments along the coast. As we shall see, appropriate management of wetlands should involve strategies that consider the wider ecosystem rather than just those which are much more narrowly focussed.

FISH DEPENDENCE ON WETLANDS

As noted above, wetlands provide important habitats for many species of highly valued finfishes. Various studies (eg Pollard 1976; Morton 1990) have shown that the majority of fish species taken in commercial and recreational fisheries along the east coast of Australia are associated with such habitats for part or all of their life cycle.

The degree to which various inshore fishes may depend on coastal wetlands, particularly as nurseries and refuges for the juvenile stages, has received considerable attention around the Indo-West Pacific basin (eg Day *et al.* 1981; Lenanton 1982; Wallace *et al.* 1984). Work by Bell *et al.* (1984) confirmed that mangrove habitats in temperate Australia are important nurseries for fishes inhabiting adjacent estuarine and inshore marine habitats as adults. Blaber *et al.* (1989) argued that very few temperate water species could be considered truly estuarine dependent and cited evidence by Lenanton (1982) that inshore marine environments provided alternative nursery areas. In sub-tropical and tropical regions, however, estuaries may provide the most important nursery areas for many species (Blaber 1980).

Fish species may be characterised as estuarine dependent when estuaries, and access thereto, form an essential habitat for at least one stage of the life cycle and without which a viable population would cease to exist (Blaber *et al.* 1989). These authors found at least a third of the 197 species recorded in a tropical north Queensland estuary fitted this category and these made up at least one half of the fish biomass in all associated habitats. Represented were many of the most numerous species as well as the larger species like *Lates calcarifer.* As well, mangroves, seagrasses, saltmarsh areas, and upper estuary areas provide sanctuary and nursery habitats for the juveniles of species such as the jacks *Lutjanus argentimaculatus* and *L. russelli*, sicklefish *Drepane* sp, grunter *Pomadasys kaakan*, flathead *Platycephalus* spp and trevallies (Carangidae) where the adults are normally found further offshore.

THE ECOLOGICAL ROLE OF COASTAL WETLANDS

As I will attempt to show, the affinity of fish assemblages for specific coastal wetland habitats is well documented. There is consistent evidence in the published literature of the ecological value of these habitats for refuge, reproduction, feeding, recruitment, nursery and growth for many coastal fishes. Such areas appear to perform these functions better than do alternative inshore marine locations where these exist (Lenanton and Potter 1987).

Our understanding of the role played by vegetated habitats in coastal wetlands is largely based upon overseas experiences. Data on Australian wetland fauna requirements are meagre, and sadly there is an almost complete lack of information about seasonal and cyclical patterns of variation in wetland flora and fauna especially in freshwater and brackish environments (Arthington and Hegerl 1988; see the review by Hatcher *et al.* 1989 for details of the requirements outstanding for marine habitats). However, we can conclude that both submerged and emergent vegetation (in eg seagrass beds, mangrove swamps, tidal and freshwater marshes) function as refugia and foraging areas for many organisms. Vegetated areas support much higher densities of decapod crustaceans and juvenile fishes than do adjacent non-vegetated habitats (Heck and Thoman 1984). The structural complexity of the vegetation may be more important than plant biomass in supporting fish abundance, even at low densities (Rozas and Odum 1987).

Many resident fishes benefit from the productivity of wetlands as secondary consumers (Shenker and Dean 1979). Vegetated areas appear important as habitat for forage fishes that are prey for larger species of fishery importance, and increasing the yield of prey species can improve their ultimate availability to predators (eg Boesch and Turner 1984). It is tempting to propose that the availability of an abundant supply of forage species may be essential in the recruitment of the juveniles of species like barramundi to the adult stock, but this has not been tested.

Non-vegetated areas of the estuary can be productive components of the estuarine system as well, and provide a significant habitat for recruitment of juvenile fish. Russell and Garrett (1983) demonstrated that the critical nursery habitat for barramundi in the southern Gulf of Carpentaria is the extensive supratidal and high tidal mudflats and saltpans around the estuary margin. Saltpan areas may also be found in east coast areas, especially where cyclones have destroyed the vegetation and regeneration has been inhibited by subsequent establishment of hypersaline conditions (Spenceley 1976). These too are utilized by barramundi juveniles and other fishes (eg in the Princess Charlotte Bay area; see Russell and Garrett 1985). Among such areas may be locations identified by Timms (1990) for scald reclamation using waterponding in the grazing industry.

Recent research by Ridd *et al.* (1988) has shown that these tropical salt tidal flats are the major areas for exchange of nutrients in the Gulf intertidal zones. The saltflats support an abundant algae growth which may be a major source of primary production. The authors suggest the nutrient outwelling (primarily of silicate, orthophosphate and nitrate) from the flats is of significant ecological benefit to young penaeid prawns in the rivers (Staples 1980) and which support northern Australia's most valuable fishery. It seems likely that interference with the export of nutrients in these situations could well impact adversely on the productivity of estuarine environments and their capacity to promote and sustain associated invertebrate and vertebrate populations.

SEASONAL MOVEMENT OF FISHES FROM WETLANDS

Although circumstantial evidence overwhelmingly supports the link between the presence of critical coastal wetland habitats and high fishery production (see below), the eventual recruitment to local fisheries is affected by a number of ecological and environmental regulators.

Quite often the coastal habitats which serve as major nursery and juvenile areas contain water or are topped-up only seasonally and so possess limited carrying capacity. Most fish and crustacean colonisers are utilised as forage by the juveniles of predatory species such as barramundi (eg Fore and Schmidt 1974; Russell and Garrett 1985). Once these forage species are consumed, cannibalism can occur. Davis (1985) postulated heightened autospecific predation by barramundi in already-occupied nursery grounds as limiting the recruitment potential of successive influxes of postlarvae, and Moore (1980) reported high levels of cannibalism in barramundi in New Guinea nursery swamps.

As the dry season progresses, the juvenile fish habitats slowly dry out, and small fish are forced out into the river. Griffin (1987) reported a high incidence of predation by adult barramundi accompanies this seasonal abundance of juveniles in the lower estuary areas. Fish not able to escape may perish as the waters disappear (Moore 1980; Russell and Garrett 1985) or suffer increased cannibalism with diminishing food resources in deeper water refuges (Griffin 1987), where water quality problems can arise. The latter author noted that prey availability was limited in both size and abundance in freshwaters, particularly in closed freshwaters, and this contributed to reduced resident population sizes.

The creation of artificial semi-permanent shallow-water impoundments has been promoted as one means of enhancing returns to local fisheries (Vass 1991). However, it seems likely that fish populations trapped in such locations are likely to face the same struggle for survival as those in equivalent natural waterbodies.

FISHERIES PRODUCTION AND COASTAL WETLANDS

Fisheries production in northern Australian waters is centred on a small number of species of high unit value - mainly penaeid prawns, barramundi, threadfin salmon, reef fishes and mackerel (Griffin 1985; Trainor 1991). Most of the commercial catch derives from species which utilize coastal and estuarine waters. Typically, these species have evolved life history patterns that make use of a variety of shallow-water habitat types (eg mangrove swamps, coastal marshes, seagrass beds, mudflats) during life.

A considerable body of scientific evidence from overseas work supports a strong linkage between coastal wetland habitats and fisheries production (Odum 1984). For example, Turner (1977) established that annual yields of prawns and intertidal wetland area were highly correlated, on a worldwide basis. Snedaker (1978) identified a close and possibly obligatory relationship in tropical latitudes between fish harvests and the extent of coastal wetlands. As quoted in Boesch and Turner (1984), Nixon (1980) showed that coastal ecosystems lacking wetlands could match commercial finfish and shellfish yields from those possessing large marsh areas, only when deep ocean upwellings provided large nutrient subsidies.

Published Australian studies that demonstrate a correlation of habitat with fisheries production include those of Coles and co-workers (eg Coles *et al.* 1987), who found penaeid prawn production on the east Queensland coast was directly related to the area of inshore seagrass nurseries. In an examination of the linkage between coastal wetland nursery areas and the life cycle of barramundi, Russell (1987) proposed a direct relationship between barramundi stocks and juvenile areas, but this remains untested. However he and others were able to show (Russell and Garrett 1985; Russell 1986) that young barramundi were unable to make use of alternative nearshore habitats for nursery purposes when coastal wetlands were destroyed. Russell (1986) suggested that the observed decline in Queensland east coast barramundi fishery landings was due in part to the destruction of wetlands associated with coastal developments.

IMPEDIMENTS TO FISH MIGRATIONS

In coastal Queensland, habitat modification and destruction, including stream barriers of various sorts, appear significant modern-day regulators of fish populations. Numerous barrages, weirs and flood control and water retention devices have been constructed across coastal streams to impound water supplies for domestic, agricultural, grazing, and industrial use. Harris (1984) identified that between a third and one half of wetland and stream habitat potentially useable by migratory fishes in coastal drainages of south-eastern Australia have been affected by the construction of physical barriers to fish passage. These man-made physical barriers interfere with the movements of economically important species like sea mullet and barramundi at critical times of the life cycle. The catadromous movements of mature adults to breed in the sea (eg Garrett 1987), entry to nursery habitats by juveniles, and subsequent dispersal of larger immatures through the upper freshwater reaches (Griffin 1985) are all affected.

The fishways incorporated into the designs of such impoundments, where provided, have not proved effective (Kowarsky and Ross 1981; Harris 1984; Russell 1991), and the structures can present an insurmountable obstruction to the free passage of migrating fishes. Upstream populations then become dependent for recruitment on fish below the barrier which can bypass the obstacle during floods (Harris 1984).

The impacts of impediments to fish passage, especially to larvae and juveniles, are manyfold. Migrating fish can become concentrated above and below the constriction, and suffer high mortalities through deterioration in water quality (Brown *et al.* 1983), intensive fishing activities, and density-dependent predation (Harris 1984). Further, through a reduction of available habitat, the carrying capacity of a river system for particular species is reduced. This can occur even if the affected species is able to complete its entire life cycle in downstream (ie. estuarine) waters (Russell 1991). This in turn reduces the potential harvest in contiguous fisheries.

FISH KILLS IN IMPOUNDED WATERS

Fish mortality has been regularly and widely observed in lagoons, billabongs, swamps and other permanent waterbodies throughout tropical and sub-tropical coastal Australia. While some incidents probably relate to pollution and the intrusion of toxic effluents of agricultural and industrial practices (eg Dunstan 1959, 1960), many others appear to have natural causes. Harbison (1984) offered that kills can occur around Australia when water quality fluctuates wildly, especially in shallow, sheltered, heavily vegetated and nutrient rich locations when water temperatures are high and there is little water exchange. Low oxygen levels and low water pH kill fish, as does the exposure to low water temperatures of warm-water adapted animals. Dunstan (1960) observed barramundi deaths in the upper freshwater reaches of the Fitzroy River and rivers south of the Tropic of Capricorn when water temperatures fell to 15.5°C.

In more northern areas, environmental perturbations in freshwater regularly cause major mortalities among barramundi populations, but these have been little investigated. Brown *et al.* (1983) noted that these mortalities occurred at the end of the dry season, when stress upon the aquatic biota is at its greatest due to the progressive deterioration of water quality in lagoons and waterholes through the dry season. The authors examined one such kill in detail, and established that the probable cause of fish deaths was the entry to the waterhole of storm rain run-off, acidified in the black soil catchment. Toxic aluminium leachates from the soil were also involved. From the range of species affected, they concluded that barramundi were among the least tolerant of fish species to low pH water (see also Olsen 1983). Dense stands of the hydrophyte *Hymenachne acutigluma* contributed to the mortalities by restricting the flow-through of contaminated water.

Bishop (1980), in an earlier study of a Territory fish kill, implicated low dissolved oxygen levels brought about by the exposure of maturing barramundi to anoxic bottom waters disturbed by flood rain flows. The mortality occurrences are so severe and so widespread in the Northern Territory that Griffin (1987) speculated that having moved downstream, mature barramundi remain in tidal waters as a strategy to avoid these lethal exposures.

Paradoxically, in some localities, summer storms might increase the value of impounded waterbodies for juvenile fishes. Hopkinson *et al.* (1985) found that winds off summer thunderstorms completely overturned stratified shallow water estuarine lakes in Louisiana, USA. Without the storm-induced mixing, environmental stresses on resident fish were high, leading to anoxic conditions and fish kills. Storm action significantly improved water quality and the quality of life for resident fishes.

STREAM-FLOW MODIFICATIONS AND FISHERY IMPACTS

It is thought that wetland ecosystems can remain stable over time, and fully perform their ecological roles, only if their hydrological environment remains stable (Gopal 1987). All activities - such as drainage, diversion of water flow, nutrient enrichment - that directly or indirectly impinge upon the hydrology disturb the whole system. Because they are dynamic systems, wetlands respond swiftly to human disturbance.

Changes to river drainage patterns to accommodate urban and rural developments are commonplace around Australia, but the consequences for Australian wetlands and their associated biota of modifications such as flood mitigation works and rainfall run-off conservation practices to improve dry season forage for livestock (eg Wildin and Chapman 1988) are not well known. From the fisheries viewpoint, stream flow changes have many important sequelae. Three are considered here.

Firstly, water storage reduces freshwater flows, at least seasonally. South African workers (eg Marias 1988) found that any factor that decreased freshwater inflow to an estuarine system altered the salinity gradient and the fish communities attuned to it. Lindall (1974) noted an increase in estuarine salinity accompanying reduced freshwater run-off in Florida, and periods of hypersaline conditions became more acute. Commercial and sportsfish production was reduced under widespread and prolonged hypersaline conditions because of migration or death of fauna and the loss of habitats provided by sensitive vegetative species. Odum (1970) found even a gradual increase in salinity caused a significant loss of protective nursery areas for juveniles in estuaries, because the increased salinity allowed entry of many more marine predator species. Further, several authors (eg Lindall 1974; Bayly 1975) suggest increasing estuarine salinities cause a loss of the chemical clues by which young fish and prawns find their way to nursery areas. The statement of

Ruello (1973) that continued reduction of the freshwater flow into many Australian estuaries would permanently reduce stocks of commercially important penaeid prawns reinforces this concern. As several authors have identified (eg Ruello 1973; Glaister 1978), commercial catches of prawns on the east coast of Australia are closely correlated with river discharges, so low flow rates correlate with low catches.

Brief mention has already been made of altered stream flow regimes modifying existing fish habitats and blocking fish and crustacean life cycles. Saenger (1979) produced evidence that modified mangrove areas supported reduced populations of juvenile fish. Middleton (1985) indicated that reduced flows prevented adequate flushing of upstream plant communities, leading to their eventual demise.

Thirdly, altered flow states can create "new" habitats which present biota with new challenges. Morton (1989) considered the conversion of intertidal habitat into subtidal habitat, associated with an urban development in a sub-tropical estuary in south-east Queensland. This activity resulted in an apparent decreased presence of macrobenthic carnivores and detritivores, many of which were of direct importance to fisheries, and a corresponding increase in less esteemed planktivores and microbenthic carnivores. Life cycle impacts include interference with the migration patterns of fishes, especially the timings of migrations (Knudsen and Herke 1978), the diminished recruitment of fishes to impounded habitats (McGovern and Wenner 1990), and disruption of the estuary food web leading to reduced faunal diversity and abundance (Middleton *et al.* 1985; Plumstead 1990).

Unfortunately, there are very few studies that have successfully identified and quantified the direct effects on fisheries production (or on other natural attributes of coastal wetland ecosystems) of destroying or damaging the habitat. Lewis (1982) estimated that a 40% loss of wetlands in a major Florida estuary caused a 20% decline in Florida's Gulf Coast fisheries. In El Salvador, a 50% loss of mangrove habitat coincided with a 50% decline in the prawn catch (Daugherty 1975). Reductions in reptile, bird, and mammal populations were also apparent.

We must conclude that water management practices impact wetland habitats and affect their capacity to function ecologically. Understanding the functional relationships between fishery productivity and coastal wetlands, then, becomes of great practical importance in attempting to quantify the impact of wetland loss or modification on fishery yield. As Boesch and Turner (1984) state, it is conceivable (but not demonstrated at least outside aquaculture) that a modification which results in the loss of particular wetland habitat may enhance the value of that area for fisheries production. They caution against pursuing a strategy of "creative wetland modification", and warn that signals for declining fisheries production resulting from wetland modification may be masked, for a time, by increased fishing effort. The key to fishery management of estuarine dependent species must be coastal habitat protection and enhancement.

MANAGING WETLAND HABITATS FOR FISHERIES RESOURCES

In this paper I have attempted to demonstrate that coastal wetlands are critical habitats in the life cycles of fish and prawns that provide northern Australia's premier fisheries. While measures of direct correlation between critical habitats and fishery production are not widely available, the available evidence strongly supports the view that the consequences of modifying or destroying critical wetland habitats must be a decline in fishery landings.

Understanding and appreciation of the functional relationships inherent in the ecological roles of coastal wetlands are necessary in evaluating, designing and managing activities affecting wetlands. These include dredging and filling, drainage, pondage, and channelling. Thus cost-benefit studies or impact statements for water conservation and flood mitigation projects should include assessments of consequences to commercial and recreational fisheries (Ruello 1973; Middleton *et al.* 1985). Further, the integrity of wetlands is directly linked to the integrity of their catchment, and so catchment management, to conserve downstream wetland areas, is a crucial part of wetlands management (Arthington and Hegerl 1988).

How best to manage the coastal habitat for fisheries resources? Certainly an immediate management strategy must be to minimize the further loss or alienation of wetland area. Valuable fishery resources can be protected while present in critical habitats at key life stages. This is the rationale for a closed fishing season on barramundi while they spawn around river mouths. Specific types of habitat can be protected - hence wetland reserves and habitat reserves - but many species utilise a variety of wetland types during their life cycles. Perhaps the key to effective habitat preservation is the holistic or ecosystem approach espoused by several authors (Odum 1984; Middleton *et al.* 1985), where the complete sequence of life cycle habitats from river headwaters to estuary to offshore coral reef areas may be involved. For much of the east coast of Queensland, isolating such a managed area from influences exerted by neighbouring unmanaged ecosystems would prove difficult.

Within this context, desirable considerations for the future management of our coastal wetlands include policies for environmental compensation and habitat restoration, and an integrated approach to catchment management involving all responsible authorities (Middleton *et al.* 1985). Programme initiatives such as these, coupled with an increasing public environmental awareness, should help sustain the long term integrity of coastal wetlands for their vital role in natural resource production.

ACKNOWLEDGEMENTS

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A REVIEW OF LEGISLATION FOR PONDED PASTURES

Water Resources Commission Licensing Requirements

Where the implementation of pondage banks would require a licence under the Water Resources Act, the enquiry should be referred to the Water Resources Commission. Banks and associated works will require a licence from the Commission if:

(a) The bank is located on a watercourse, defined under the Act as a natural channel, an improved natural channel, or an artificial channel which has changed the course of a watercourse, in which water flows permanently or intermittently. The Act only applies to non-tidal sections of a watercourse. (Tidal sections are administered by the Department of Transport).

(b) The bank forms a levee bank such that it has an influence on keeping water, including floodwater, within a watercourse; or has an influence on the flow of water out of that watercourse. In some cases, banks located on a floodplain may require a permit from the Local Authority if that Authority has invoked Section 47 (24) of the Local Government Act.

(c) The associated works interfere with the bed or banks of a watercourse, eg., diversion works or a drainage outfall to a watercourse would require a licence. In addition, if a River Improvement Trust exists in the Shire, the Trust may be interested in any works impacting on a stream in the Shire, and proposals should be submitted to the Trust for its review.

If there are any doubts whether a licence is required under the Water Resources Act, the case should be referred to the Local Commission Office for a decision.

Fisheries Branch Licensing Requirements

Where the implementation of pondage banks would require a licence under the Fishing Industry Organisation and Marketing Act, the enquiry should be referred to the Fisheries Branch of the Queensland Department of Primary Industries.

Banks or associated works would require a permit under:

SECTION 45 AS FISHWAYS

A person who desires to construct or erect a dam, weir or other barrier of any kind across a river, creek, stream, inlet of the sea or other waterway should give the Minister three months notice in writing of his intention. If the Minister determines that it is desirable that a fishway should be constructed or erected on the proposed works, then the person may be directed in an order to make a fishway in accordance with approved plans and specifications. Failure to comply with the order or provision of this section carries a $1,000 penalty.

SECTION 71 PROTECTION OF MANGROVES AND MARINE PLANTS

A person cannot cut, lop, burn, remove or otherwise destroy or damage any mangrove or marine plant unless a permit is granted and issued under this section.

A Penalty applies for failure to comply with this section or the conditions of the permit.

PART M OF FISHERIES REGULATIONS 1977

M1 Fish Habitat Reserves

A permit from the Minister is required for the following actions in a fish habitat reserve:

(a) remove or cause to be removed any ballast, rock, stone, shingle, gravel, sand, boulders, clay, earth, silt, mud or other material whatsoever from, or disturb or cause to be disturbed any such material therein;

(b) deposit or cause to be deposited therein any filling or other material;

(c) discharge or cause to be discharged therein any matter which may be deleterious to fish, marine products, mangroves or marine plants; or

(d) perform any other action which may cause a direct and substantial alteration to the physio-chemical environment therein; and

(e) take or interfere with any fish or marine product.

M2 Fish Sanctuaries

A permit from the Minister is required to take or interfere with any fish or marine product within a fish sanctuary.

M3 Wetland Reserves

A permit from the Minister is required for the following actions in a Wetland Reserve.

(a) remove or cause to be removed any ballast, rock, stone, shingle, gravel, sand, boulders, clay, earth, silt, mud or other material whatsoever from, or disturb or cause to be disturbed any such material therein;

(b) deposit or cause to be deposited therein any filling or other material;

(c) discharge or cause to be discharged therein any matter which may cause a direct and substantial alteration to the physio-chemical environment therein, likely to be deleterious to fish, marine products, mangroves or marine plants;

(d) erect or cause any building or structure to be erected within a reserve contrary to the maintenance of the area in a state beneficial to fish, marine products, mangroves or marine plants;

(e) use any vehicle or conveyance within or occupy or use the whole or part of the reserve for any purpose that is contrary to or inconsistent with the purpose for which the land is reserved.

The Regulation does not apply in respect of:

(a) any tidal land alienated or licensed from the Crown under any Act prior to the date of the declaration of the reserve: and

(b) any navigable channels defined by navigation markers placed pursuant to the Queensland Marine Act 1958-1979.

Land Conservation Branch Approval Requirements

Where the implementation of pondage banks would affect neighbouring landholders an approved plan should be prepared before the works are implemented.

Affected land as defined in Section 10 (3) of the Soil Conservation Act is contiguous land that:

(a) Discharges runoff from >2 ha into subject land, or

(b) Receives runoff from subject land where:

- (i) Area is increased or decreased by >10%, or
- (ii) Location is changed, or
- (iii) Risk of damage is increased.

For approval, plans require:

(a) Written evidence of no objection from all owners of affected land, or

(b) Advertising

It is optional to approve a plan if there is no lower or upper affected land. Plans may be approved under Sections 10(4), 10(5), 10(7), 10(8) or 10(9) of the Soil Conservation Act 1986.

It is proposed that the Branch Policy on Ponded Pastures will state that Land Conservation Branch staff should only design and survey pondage banks in dryland areas. They should not be designed in the following areas:

- (i) marine or estuarine plains;
- (ii) permanent freshwater swamps;
- (iii) permeable soils where the construction of pondage banks may result in a rise in the watertable; and
- (iv) where they would require a licence under the Water Act or Fisheries Act.

THE CURRENT STATUS AND POTENTIAL OF PONDED PASTURES IN NORTH QUEENSLAND

J.C. KERNOT

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ABSTRACT

The advent of the deep water grasses, Hymenachne and Aleman, has resulted in a high level of interest in ponded pastures in North Queensland. Although pondage is still in its infancy early indications are promising and grazier confidence is high. Technological modifications may be necessary to suit the tropical climate with its highly seasonal rainfall. Inherent advantages in the north are a higher likelihood of filling pondages and greater growth potential of the deep water grasses. An analysis of weaner feeding costs comparing ponded pastures with fertilized stylo and supplementary feeding indicates the potential for substantial long term benefits. The future potential of pondage in the north is significant although development may be gradual.

This paper will address the current status and potential of pondage in North Queensland. For the purpose of the paper, North Queensland is defined as that area north of a line between Townsville, Greenvale and Mt Isa and west of the Great Dividing Range. Aspects covered will be the current extent of ponded pasture, climatic and industry factors affecting pondage, an economic perspective and future potential.

Although widespread throughout North Queensland, Para grass has not had a major impact in the pastoral zone. Areas suitable to Para grass, such as seasonal swamps and watercourses, invariably have a high stocking pressure that results in the suppression of desirable species such as Para grass. Few attempts have been made to manage these areas to the benefit of Para grass. Similarly pondage technology designed for Para grass in Central Queensland has not been adopted in the north. Northern graziers have concentrated on improvements on the extensive scale such as fencing, more stock waters and increasing the Brahman content of the herd in preference to developing intensive areas. In addition the high evaporation rates and minimal dry season rainfall in the north would limit the period of water holding and subsequent usefulness of shallow ponds adapted to Para grass.

The release of the deep water grasses, Hymenachne and Aleman, has however made ponding more attractive for northern regions. Their ability to provide quality green feed in the dry season has created considerable grazier interest but, since the deep water grasses have only been widely available in the north in recent years, pondage is still in its infancy. Although the technology is yet to be fully proven early indications are promising and the enthusiasm and confidence of graziers currently developing pondage areas in the north is high.

There are currently two properties in the north with substantial areas of constructed pondage, both having in the vicinity of 100 hectares. The properties had problems with breached banks in the 1990/91 wet season and are both still establishing their ponds. Approximately ten further properties have smaller areas behind pondage banks. A larger group of properties have planted the grasses into existing bodies of water ranging from turkey nests and dams to seasonal swamps. These areas are being used for evaluation and familiarisation with the deep water grasses as well as acting as nursery areas for future plantings. Evidence is already emerging from these areas that plantings with uncontrolled stock access have limited success in establishing.

Northern pondage areas are currently relying on technology transferred from central Queensland. However, differences in the cattle industry and the climate in the north have implications for the management and design of pondage areas. The tropics have a greater seasonality of rainfall with a well defined wet and dry season. The reduced likelihood of dry season rainfall is coupled with higher temperatures, evaporation and humidity. In order to prevent ponds drying out too early into the dry season greater water depths may be required in the north. This would result in higher development costs associated with bigger banks and could lead to problems with establishment. A possible strategy to overcome this problem would be to gradually increase water depth over a number of years to allow the grasses to become established before the final target depth was reached. The greater water depth could also leave the grasses more prone to flooding and require careful management prior to the wet season.

On the positive side the reliable wet season also has the major benefit of virtually guaranteeing that ponds will be filled every year. This overcomes one of the main limitations of pondage in drier regions. A further benefit is that the potential growth of the ponded grasses is greater under tropical conditions although the extent of this benefit is yet to be quantified.

The northern cattle industry is based on native pasture of lower quality, poorer soils and operates in a harsher climate than in central Queensland. This results in lower calving and turn-off rates, higher age of turn-off and higher death rates. Typical Gulf and Peninsula properties have a branding rate of 45-50% and an annual turn off of 12-15%. This lower industry base level means that there is more potential for large productivity gains in the north than in central Queensland.

Utilization of pondages will vary across the north but the major uses are likely to be steer fattening and weaner feeding. Pondage has the potential to allow breeding properties to turn off bullocks and properties currently selling 4-5 year old bullocks to turn-off a younger, higher quality animal. With markets becoming increasingly quality orientated northern graziers will find demand for their traditional product decreasing.

The benefits of early weaning in increasing calving rates and reducing cow death rates has been well documented, but the weak link in the system for northern graziers has invariably been weaner nutrition. Feeding weaners to gain weight during the dry season of their weaning year produces younger, heavier bullocks and more fertile breeders as well as reducing the 10-20% death rate of unfed weaners. This can be achieved with pondage but graziers also have the option of supplementary feeding or dryland improved pastures. An analysis of costs from a weaner nutrition demonstration at Foresthome Station near Georgetown can be used to compare the three options.

<u>Option 1</u>. Native pasture plus supplements

Supplement fed - 0.5 kg/day of cottonseed meal for 90 days. Cost per weaner $20.00 + 150 days of standard dry lick and cottonseed meal at $0.80/head/month plus freight. Cost per weaner $5.00.

Total cost $25 per weaner

<u>Option 2</u>. Fertilized stylo pasture without supplement

Pasture costs -
- Seca stylo at 2 kg/ha + Verano stylo at 1 kg/ha. Cost $25/hectare
- Fertilizer; 50 kg DAP/hectare. Cost $26/hectare. Applied at planting and every 5th year.
- Planting and freight. Cost $7/hectare

Total pasture costs for establishment $58/hectare.

Stocking rate of 1 weaner per hectare after allowing 3 years for establishment of pasture (3 years of supplementation required).

<u>Option 3</u>. Ponded pasture

Development costs -	Site specific; typical range $100 - $200 per hectare
Stocking rate -	5 weaners per hectare for 6 months
Cost range -	$20 - $40 per weaner. Average $30 per weaner for establishment.
Supplementation -	Young weaners may require a short period of protein supplement. Average cost $5 per head.
Establishment period -	3 years.

The analysis compares the three weaning options over a 15 year period to estimate the present value of each development option using a 6% discount rate and not taking into account salvage rates.

TABLE 1. COSTS PER WEANER IN 1991 DOLLARS

YEAR	NATIVE PASTURE	FERTILISED STYLO	PONDED PASTURE
1	25	83	55
2	25	25	25
3	25	25	25
4	25	0	5
5	25	33	5
6	25	0	5
7	25	0	5
8	25	0	5
9	25	0	5
10	25	33	5
11	25	0	5
12	25	0	5
13	25	0	5
14	25	0	5
15	25	0	5
PRESENT VALUE AT 6% DISCOUNT RATE	$257	$174	$138

Although pondage development costs are site specific the analysis indicates the significant benefits possible from one applied use of a typical pondage development.

For many northern graziers the economic assessment of pondage is more simplistic, being a comparison between the cost of pondage development with the cost of fattening country in more favoured areas.

Pondage also has the potential to play a major role in land care in the future. The heavy reliance of northern properties on river frontages for dry season pasture has resulted in their severe degredation. Pondages promise to reduce grazing pressure from frontages allowing some scope for frontage rehabilitation.

The future potential for pondage in the north is significant but development may be gradual as producers become familiar with the new concept and make the technological modifications necessary for the success of pondage in their area. Pondage will be a part of integrated property developments utilizing legumes, supplementation and other management practices to improve productivity depending on individual circumstances. Considerable scope exists for the development of existing seasonal swamps and it is likely that in the short term much of the pondage development will utilize these areas. Development costs for the small banks needed to increase the depth of these swamps to the required level would be low although competition from existing aquatic species may be a problem.

PROBING PONDED PASTURES

ABSTRACTS

These abstracts are presented as per the submissions received, except when the author did not provide an "abstract", "conclusion" or obvious summary. In such cases, an explicatory statement has been drafted by the organisers, and can be readily recognised by the fact that it is presented between square brackets.

Persons registered for the workshop may obtain full copies of submissions on request. Clearly list the name of the author and the title as printed in these abstracts, and send to Dr. C.J. Parmenter, Chairman Ponded Pastures Steering Committee, School of Applied Science, University College of Central Queensland, Rockhampton M.C., Qld 4702. Please enclose $1 per paper (to cover production, handling and postage).

BOURNE, A.

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Ponded Pastures - an Economic Perspective

Under the right conditions and management ponded pasture can be quite profitable. The importance of proper site selection and design is paramount since profitability is seriously affected by structural failures. Any development of this nature requires detailed financial analysis since general economic analysis is not specific to the site or the property management.

The un-measurable benefits require careful consideration. More work on general economic multipliers arising from any ponded pasture improvement is urgently required.

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BYRON, G.

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The potential effects of ponded pasture development on mangrove and seagrass habitats.

Ponded pastures have been developed in Queensland on the basis of improved grazing potential of lowland areas in the dry season. There has been minimal investigation of the environmental and social impacts of this form of land management.

Ponded pastures have the potential to adversely impact on existing and future distributions of coastal marine habitats, such as mangrove stands and seagrass meadows.

Changes in sedimentation rates, freshwater and salinity levels, relief, local tidal flows and water table levels are likely to occur and will have a marked effect on these habitat types.

The predicted sea level rise and climatic change as a result of the greenhouse effect could make the existing coastal marine plains into highly productive mangrove forests in areas which are currently being alienated under ponded pasture. Ponding of these areas therefore may limit future options.

A program of inter-related research is necessary to address the significance of the biological, physical and social impacts. In particular the downstream effects on mangrove, seagrass and other marine ecosystems need to be considered.

An appropriate cost/benefit analysis is also considered necessary to evaluate the overall value of ponded pastures at the community level in the longer term.

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CHAPMAN, D.[1] AND T. BUCKNELL[2]

1. QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES, LAND CONSERVATION BRANCH, ROCKHAMPTON
2. QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES, WATER RESOURCES COMMISSION, FARM WATER SUPPLY BRANCH, ROCKHAMPTON

Planning and Construction Guidelines for Pondage Banks.

Ponded pasture systems using runoff from summer storms and waterloving grasses are invaluable in beef cattle production.

The selection of sites with suitable soil types; landscape attributes and adequate bywash areas ensures success of the pasture systems.

Construction techniques are used so that excessive runoff events are safely discharged without damage to banks and bywashes.

The development of simplified local data models for hydrological design of banks would improve design techniques.

Environmental concerns including fish movement and effects to wetland ecology have to be taken into consideration.

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CHAPMAN, D.[1] AND P. THORBURN[2]

1. QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES, LAND CONSERVATION BRANCH, ROCKHAMPTON
2. QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES, LAND MANAGEMENT RESEARCH BRANCH, BILOELA

Do Ponded Pastures Contribute to Water Table Salting?

A range of sixteen ponded pasture systems where salinity problems may occur, were inspected to assess the effects of water table salting.

The sites were found to be selected on impermeable soils and adjacent to incised water courses. Consequently, water table salting problems did not occur.

In several cases, the ponds resulted in the reclamation of saline areas. Care with site selection is essential as these ponds may aggravate salinity problems.

Further investigation to quantify ground water hydrology associated with ponds in areas with high risk of salting may by warranted.

More objective criteria to determine soil permeability and dispersibility is suggested in future site selection. Some criteria that could be applied are described.

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CHIPPINDALE, W.G.

SHOALWATER BAY, VIA KUNWARARA

Submission on Ponded Pastures.

[A submission based on facts arrived at during 20 years experience as a Master Fisherman, and on private research in the Broadsound area over that time period.]

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CHUCK, M.

QUEENSLAND NATIONAL PARKS AND WILDLIFE SERVICE,
CENTRAL REGION, ROCKHAMPTON

A Discussion Paper of Some Potential Conservation Issues with Regard to Ponded Pastures.

The establishment of ponded pastures in Central Queensland has helped increase land productivity in terms of grazing capacity and stock turnoff. Whilst there is a range of information available on the establishment of such pastures, relatively little information exists on the costs or benefits to the environment. This paper examines these issues with particular reference to wildlife habitat and identifies areas where further research is necessary.

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CLARKSON, J.R.
QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES, MAREEBA

The Spread of Pondage Species Beyond the Pasture System.

The spread of ponded pasture species beyond the pasture system is considered a potentially serious problem. Factors contributing to the risk of spread are considered. The adaptation of ponded species to aquatic situations heightens the risk of spread. Ecological consequences of spread to non target areas are discussed. A worst case scenario might see environmental effects worse than those caused by para grass. Some shortcomings of the screening process for importation and commercial release of plants are highlighted. A review of the current system is suggested.

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CONDON, R.W.
RANGELAND CONSULTANT, YOWIE BAY, N.S.W.

Some Approaches to Improved Productivity in Northern Australia : Water-Spreading; Water-Impounding and Ponded Pastures; Old Man Saltbush.

[A series of papers and other writings on water-spreading, water-impounding, ponded pastures, and the plant best able to use such waters, the Australian native, old man saltbush (***Atriplex nummularia***).

The submission includes:

1. copies of two papers on water-spreading presented to international conferences in 1984 and 1985.
2. extracts from a report to the Conservation Commission of the Northern Territory - "A Land Conservation Strategy for the Victoria River District, N.T."
3. copies of two paper presented to soil salinity and rangelands conferences at Albury, N.S.W. (September 1989) and Carnarvon, W.A. (September 1990) providing information on the old man saltbush (***Atriplex nummularia***).]

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CUMMINS, V.G.
QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES, ROCKHAMPTON

Construction of Pondage Banks in Central Queensland Background and Present Status.

Growing pastures in water conserved by pondage banks is an increasing practice in Central Queensland.

Early pondage schemes incorporated small banks and shallow ponds. However, with the introduction of grasses that thrive in deeper water, larger and more expensive banks have been implemented in recent years. Presently, some 21,800 hectares of grazing land are ponded by banks surveyed by officers of the Queensland Department of Primary Industries.

As well, it is estimated that about 6,500 hectares of marine plains have been ponded to minimise the effects of soil erosion and salt encroachment. Most of these schemes have been designed by engineering consultants.

With the likelihood of fees for design and surveying services from Government agencies, more landholders will elect to design and survey their own schemes. If this is the case, educational and training programs will be needed to ensure that pondage schemes have minimal impact on the environment and on neighbouring landusers.

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DOOHAN, M.

QUEENSLAND COMMERCIAL FISHERMEN'S ORGANISATION, BRISBANE

Official View of the QCFO on Ponded Pastures.

Coastal wetlands have a pivotal role to play in the maintenance of marine productivity and the sustainability of the commercial fishing industry. This role is now threatened by ponded pasture development.

Both the preservation of coastal wetlands and ponded pasture development have their community benefits, whether economic, social or both.

However, ponded pasture development to date, has been at the expense of marine productivity and the commercial fishing industry. To obtain optimum community benefit a co-ordinated research and management plan is required to eliminate the development of one use at the expense of another. From a commercial fishing perspective the major objectives of the plan should be:

1. A total ban on the development of ponded pastures in coastal wetland areas (subtidal, estuarine).
2. Development of ponded pastures in areas above highest astronomical tide, provided works effective in preventing fish kills are installed.

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ELDER, R.J.

QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES, ROCKHAMPTON

Insect Pests of Ponded Pastures.

There are 3 pests of ponded pastures in Queensland, 2 species of armyworms and a leafhopper. They are all regarded as minor pests, although major outbreaks of armyworms and leafhoppers occasionally occur. If necessary, they can be readily controlled with insecticides. A species of caddisfly is sometimes found, but does not warrant control.

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FISK, P.

QUEENSLAND NATIONAL PARKS AND WILDLIFE SERVICE,
FAR NORTH REGION, CAIRNS

Ponded Pastures - as a Potential Weed Problem.

Ponded pastures technology presents a potentially serious weed problem for conservation interests. Most specifically, Hymenachne and Aleman grasses are assessed to be a major threat to native wetland systems in the tropics. Procedures for assessing the weed risk of introduced species was examined for this workshop and found to provide inadequate protection for both rural and conservation interests. The basic requirements for weed management which will protect the widest range of interests is discussed. It is recommended that restrictions on the further distribution and use of Hymenachne and Aleman grass be implemented until their weed potential is investigated in more detail.

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GEDDES, B.

"DOONSIDE", PMB ROCKHAMPTON

Submission on Ponded Pastures.

[A submission from a landholder on the effectiveness of ponded pastures based on 18 years experience of their operation on the property "Doonside".]

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HARRIS, R.

QUEENSLAND COMMERCIAL FISHERMEN'S ORGANISATION, YEPPOON

Submission on Ponded Pastures.

[A position paper on behalf of the Yeppoon Branch of the Queensland Commercial Fishermans Organisation, expressing concern with regard to the impact of ponded pastures on Barramundi stocks. Three recommendations are presented:

1. Until such time that a system can be devised that does not interfere with the flow of sea water or restricts Marine creatures' freedom of access to the sea or to their natural habitat, that the construction of all ponded pastures cease.
2. That all existing ponded pastures that interfere with the natural flow of sea water or restricts Marine creatures' freedom of access to the sea or to their natural habitat, be opened to the sea.
3. That the Government initiate research into the construction of ponded pastures that do not interfere with the natural flow of sea water or that restricts Marine creatures' freedom of access to the sea or to their natural habitat.]

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HOLME, R.W.

"GLEN DHU", MT. GARNET

Submission on Ponded Pastures.

[A submission from a landholder supporting the use of ponded pastures in tropical beef production.]

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HOPKINSON, J.M.

QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES, WALKAMIN RESEARCH STATION

Ponds, Wetlands and Co-existence - A View of Prospects in North Queensland.

The potentially great advantages of pondage systems to the grazing industry in north Queensland are offset by risks of escape of introduced grasses into native wetland communities of high conservation value. There is no easy way to reconcile the opposing points of view that arise from this situation. Limitation of spread of pondage grasses through existing legislative or voluntary control systems appears impracticable. There are needs to investigate the prospects for a compromise in the form of localised restrictions on the use in sensitive catchments, to monitor escape, and to seek management systems that minimise impact on invasion of native communities.

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HORTON, A.J.

QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES, WATER RESOURCES COMMISSION, RURAL ADVISORY SERVICES, BRISBANE

Ponded Pastures - the Water Resource Commission Perspective.

The paper provides an overview of the Water Resources Commission's approach to the engineering aspects of ponded pasture development, covering investigation, design and construction. Further, current Commission policy relating to such developments is outlined, together with the relevant regulatory requirements of the Water Resources Act.

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HOWARTH, B.

SOIL CONSERVATION OFFICER, ROCKHAMPTON DISTRICT (1968-1979)

Early Days of Ponded Pasture.

Para grass (***Bracharia mutica***) was first mentioned in the Q.A.J. in 1921. Some early attempts to pond the grasses were made prior to 1970.

In 1970, Q.D.P.I. officers became involved with the design and extension of ponded pastures. Following the implementation of successful schemes, publicity followed and small schemes were surveyed. The introduction of other waterloving grasses that colonise areas has led to larger schemes.

Para grass has many attributes that make it valuable in a ponded pasture grazing management scheme.

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KERNOT, J.C.

QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES, MAREEBA

The Current Status and Potential of Ponded Pastures in North Queensland.

The advent of the deep water grasses, Hymenachne and Aleman, has resulted in a high level of interest in ponded pastures in North Queensland. Although pondage is still in its infancy early indications are promising and grazier confidence is high. Technological modifications may be necessary to suit the tropical climate with its highly seasonal rainfall. Inherent advantages in the north are a higher likelihood of filling pondages and greater growth potential of the deep water grasses. An analysis of weaner feeding costs comparing ponded pastures with fertilized stylo and supplementary feeding indicates the potential for substantial long term benefits. The future potential of pondage in the north is significant although development may be gradual.

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LAWRENCE, P. AND A. KEY

QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES, LAND MANAGEMENT RESEARCH BRANCH, BILOELA

Are Runoff-fed Ponded Pasture Systems Reliable in Central Queensland?

A simulation model called POND with inputs of monthly rainfall, runoff and evaporation was used to assess the hydrological reliability of ponded pasture systems at Theodore and Rockhampton. Reliability was judged on the basis that a pond configuration contained an average of 60 cm depth of water between March and May when supplied by surface runoff. At Theodore, this criteria was only achieved by having a large catchment (>350 ha) draining into a small (5-10 ha) pond with a pondage wall of 200 cm. A ratio of pond area to catchment area of 1:20 is needed for inland areas, whereas coastal areas require a pond to catchment area ratio of 1:2 due to the higher volumes of runoff and lower rates of evaporation. The unreliable storage of water, the economic viability of a small area of pond on which to graze animals and proximity to permanent water need to be considered before transferring ponded pasture systems from a coastal environment to the drier inland.

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MIDDLETON, C.H.

QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES, ROCKHAMPTON

History of Para Grass in Queensland.

Para grass is a vigorous, perennial, stoloniferous grass from tropical Africa and America that has spread to all tropical areas of the world. It is a high quality pasture plant that is adapted to high rainfall or high soil moisture. It was introduced to Queensland from Kew Gardens, England in 1880 by Dr. Joseph Bancroft.

Also the CSR Company introduced material from Fiji in 1884 to control erosion on the banks of the Herbert River.

By 1930 it had colonised the wet areas along the east coast of Queensland. From 1930 it was widely promoted for use on the high rainfall wet tropical lowlands of north Queensland. Para grass remains the grass most suited to poorly drained soils in frost free coastal Queensland.

In the last 20 years it has been promoted and used in man made pondage areas.

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MIDDLETON, C., K. MURPHY AND J. WILDIN

QUEENSLAND DEPARTMENT OF PRIMARIES INDUSTRIES, ROCKHAMPTON

Productivity of Ponded Pastures

The tropical grasses para, aleman and hymenachne are adapted to wet, swampy conditions and are used as ponded pasture in Queensland. With adequate moisture and nutrients they are capable of producing a high dry matter yield (>30 t/ha/year) of high quality forage. The grasses can give good liveweight gains (0.5 kg/animal/day) and support high stocking rates (0.3-0.6 ha/animal).

Ponded grasses are of most value as a dry season forage source for all classes of stock at a time when native pasture quality and quantity are at their lowest.

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MOTTRAM, P.

QUEENSLAND DEPARTMENT OF HEALTH, DIVISION OF ENVIRONMENTAL AND OCCUPATIONAL HEALTH, BRISBANE

Ponded Pastures, Can it be a Health Risk?

Ponded pastures are no doubt beneficial to the grazing industry and a contribution to soil conservation. However, ponded pastures involve the impoundment of vegetated areas which in turn can provide ideal breeding habitats for mosquitoes. These mosquitoes may include the vectors of encephalitis and Ross River viruses as well as malaria. In order to minimize vector-borne disease risks in the areas around ponded pastures a number of actions should be considered.

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MUIR, J.

N.S.W. DEPARTMENT OF AGRICULTURE AND FISHERIES, HAY

Ponded Pastures in Southern New South Wales?

[A submission outlining the progress of a small demonstration plot of ponded pasture species established in 1989. Potential areas for the use of ponded pastures are noted, climatic and soil characteristics of the area are presented, and present grazing alternatives are listed.]

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NEWBY, R.
DEPARTMENT OF BIOLOGY, UNIVERSITY COLLEGE OF CENTRAL QUEENSLAND

Ponded Pastures and Parasite Potential.

Ponded pastures are effectively creating new aquatic habitats that may provide suitable environments for the development of parasite communities. There are insufficient scientific data to argue against the development of ponded pastures on this basis, however the potential for a problem warrants the establishment of a monitoring program.

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O'NEILL, C.J. AND J.E. FRISCH
CSIRO DIVISION OF TROPICAL ANIMAL PRODUCTION, TROPICAL CATTLE RESEARCH CENTRE, ROCKHAMPTON

The Relationship of Plasma B-Carotene to Calf Crops of Hereford X Shorthorn and Brahman Cows Grazing Irrigated of Dry Land Tropical Pasture.

Data were collected on calf crops and plasma B-carotene concentrations of lactating Hereford x Shorthorn and Brahman cows grazed on irrigated and dryland pasture during a drought. Calf crops were higher for Hereford x Shorthorns and for the cows grazing irrigated pasture. Differences in weights and weight gains did not account for the difference in calf crops. Within each breed and pasture type a positive relationship was found between calf crop and plasma B-carotene.

The interaction between genetics and nutrition on fertility is discussed with reference to the use of ponded pasture as a means of improving the suboptimal reproduction of cattle in northern Australia.

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SMITH, T. AND J. OLIVE
MARLBOROUGH LAND CARE COMMITTEE

Ponded Pastures - A Cattleman's View

Ponded pastures are nothing new, they are an essential part of a cattle management strategy to offset the variability of the seasons in Central Queensland.

On suitable country, ponded pastures are the most cost-efficient way of maintaining animal nutrition and minimising stock losses in the dry season.

By having adequate pastures in the dry season, stress on native pastures on other parts of the property is minimised thus avoiding over use and degradation of pastures and land.

Ponded pastures provide many benefits to wildlife. Areas that were previously dry and devoid of birds and animals are transformed to wildlife habitats that appeal to the community at large.

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TAPLIN, R.
C/- P.O. CLERMONT

Reward Swamp.

Until 1972 Reward Swamp centred on a group of gilgais in the black soil flats north of Retreat Creek. In 1972, a local sapphire miner, Mr. Max Mackormick, dammed the gully outlet of Reward Swamp. The result was to back up the water in Reward Swamp so that it could fill to a maximum of 1.2 metres depth in the area of the original gilgais and spread to an area of over 500 square metres in area.

Ponded pastures, designed to promote the growth of grass for cattle and thus involving both land clearing and pasture improvement, are plainly less potentially beneficial to wildlife than this created pondage. Land clearance removes cover and nest sites for wild species, the introduction of exotic species generally does not favour native species large and small.

The breeding potential for species like mosquitos is raised with attendant risk of human disease, as is the breeding potential for a species like "the Itchies", and this in an environment where natural predators would be relatively scarce.

Ultimately it is just another way of changing the face of Australia for the end of financial gain, neither better nor worse, one supposes, than the land clearance and pasture introductions already widely practised.

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TOON, R.

YEPPOON

Submission on Ponded Pastures

[A submission from a commercial fisherman concerning the trend of Barramundi catch in the Broadsound during the last ten years, with inferences concerning the development of ponded pastures.]

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VAN BEEK, P.

QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES, IPSWICH

New Perspectives on Complex Problems : Overview of Inquiry Methods
Demonstration Case : The Conflict about Ponded Pastures.

[Notes on the methods of inquiry and evaluation used in the analysis of complex issues, with implications for strategies for settlement of conflict. Uses the Ponded Pastures issue as a case study.]

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WILDIN, J.

QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES, ROCKHAMPTON

History of Ponded Pastures in Queensland.

Ponded pastures have evolved in Queensland over about 60 years. Observations that green grass in gilgais and swamps provided green forage in the dry seasons lead to construction of banks to create shallow lagoons to encourage native swamp grasses to grow. Planting runners of the exotic para grass in gilgais, wet depressions and small artificial ponds was the next phase. In the 1930's some salt water gutters had earth banks constructed across them to stop inundation with sea water in exceptionally high spring tides, and thus prevent damage to good grazing on the plains. The resultant ponded fresh water grew vigorous palatable grasses and para was also introduced to these sites.

Primarily for soil and water conservation purposes, long earthen sea walls were designed, and construction supervised by consulting engineers to preserve freehold land on marine or tidal plains.

Pioneers of larger artificial ponded pastures in the Burdekin and around St. Lawrence and Stanage Bay created more interest in ponded para grass. The Queensland Department of Primary Industries in Central Queensland assisted those interested in developing pondage banks. Ponded para grass was mainly confined to the coastal areas until Amity aleman and Olive hymenachne were released. These deep water grasses offered green forage longer into the dry season if pondage banks were designed and built to pond water up to 1.2 m deep to overcome evapotranspirational losses. Controlled ponding is also gaining popularity. Ponded pastures have had a strong beneficial impact on the environment and cattle productivity.

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WILDIN, J.

QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES, ROCKHAMPTON

Ponded Pasture Systems.

Ponding water on suitable sites to grow adapted water loving grasses can be achieved by storing rain and runoff water, by floodwater retention on flood plains, and by water harvesting and controlled ponding. Combinations of these can also be designed and implemented to suit needs. Runoff conservation schemes can be designed to hold water at depths of 0.5 to 2 m. Similar water depths can be designed for floodwater retention. Water harvesting into a gully dam or a ring tank can be designed to store water up to 6 m deep. This water can be gravitated to flood bays up to 0.2 m deep in controlled ponding or flood irrigation schemes. Water can also be released from deep runoff conservation ponds into shallow controlled ponding bays downslope. Water pumped from river and other storages can replenish water in any of the schemes.

Ponded pasture systems should be designed to suit the site and the resources, be cost effective with regard to costs per hectare ponded, and fulfil livestock productivity objectives of the landholder.

Designs are always site specific. There is scope for these pastures throughout northern Australia and New South Wales and especially along rivers and streams. In many situations controlled ponding schemes can incorporate other species such as leucaena on broad crested banks and other adapted habitats to provide higher quality forages.

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WILDIN, J.H.

QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES, ROCKHAMPTON

Aleman Grass, Hymenachne and other forage species for Ponded Pasture Systems.

Natural ponding grew native grasses which included ***Hymenachne acutigluma*** on the floodplains around Darwin, ***Leersia hexandra***, ***Paspalum paspalodes*** and ***Pseudoraphis spinescens***. Until recently, para grass (***Brachiaria mutica***) introduced to Queensland in 1880 was the main grass planted in natural pondage and in constructed systems. Aleman (***Echinochloa polystachya***) and hymenachne (***Hymenachne amplexicaulis***), released as commercial cultivars in 1988, can grow in water up to 1.2 m deep. This has started a new era in ponded pastures which had previously been restricted to 0.6 m depth of water which was the limit for para grass. The relative palatability of these grasses, their water depth tolerances, reactions to low soil fertility status and insect pests, can now be considered in developing ponded pasture systems. Monocultures or admixtures of several grasses may be grown to suit the location of the objectives of the grazier.

Several other exotic species, some already introduced, may add to future pondage systems providing forage for dry season grazing.

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WILDIN, J.H., A.L. GARSIDE AND E.R. ANDERSON

QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES, ROCKHAMPTON

Weeds in Ponded Pastures.

Weeds or unwanted species quickly colonise newly created habitats. Artificially created wetlands for ponded pasture development are invaded by water loving native species. Native water grasses are competitors and not considered as weeds because they are grazed in the dry season. Planted grasses usually compete successfully against most of these invaders. Serious invaders include sag (***Eleocharis*** spp.), rushes (***Juncus*** spp. and ***Gahnia*** spp.), sedges (***Cyperus*** spp.), frogsmouth (***Philydrum*** sp.), smartweeds (***Polygonum*** spp.), water primrose (***Ludwigia*** spp.) and bulrush or cumbungi (***Typha*** spp.), which can be the most troublesome once well established. The poisonous buttercups (***Ranunculus*** spp.), which grow in swampy situations and creek banks in southern Queensland, have not been reported in ponded pastures. Alligator weed (***Allernanthera philoxeroides***), a native of South America is a major pest of waterways in south eastern USA and has been recorded in New South Wales. Established ponded pastures are relatively free of troublesome weeds and early vigorous stands of grasses leave no space for weed invasion. Grazing management to encourage vigour and persistence of planted grasses will maintain a weed free pasture.

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WILSON, R.

DEPARTMENT OF BIOLOGY, UNIVERSITY COLLEGE OF CENTRAL QUEENSLAND

Feeding Ecology of Magpie Geese *Anseranas semipalmata* and Implications for Ponded Pastures.

Magpie geese ***Anseranas semipalmata*** are primarily herbivores feeding on grass blades throughout the year and ***Eleocharis*** sp. bulbs and grass seeds when seasonally available. During the wet season they camp on freshwater swamps dominated by ***Eleocharis*** sp.. Such swamps are being turned into ponded pastures with the planting of ***Hymenachne***, ***Brachiaria*** and ***Alaman*** grasses. The geese feed by grazing, probing, digging, and tugging at submerged vegetation, behaviour which may interfere with the establishment of ponded pastures.

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3.0 Seminar Groups

Five seminar groups were selected so that as far as possible a balance of people representing the various interested groups were present in each group.

These met to consider issues, concerns or areas requiring action under the following topics.

1 Habitat/Ecological - Fisheries

2 Habitat/Ecological - Other

3 Weeds/Plant Introduction

4 Guidelines/Legislation

5 Effects on the Grazing Industry

3.1 The following is a list of all the issues raised within the seminar groups, these have not been edited in any way.

1 Habitat/Ecological - Fisheries

Total Fisheries management.

Support for Integrated Catchment Management.

Prohibit all ponded pasture development below HAT.

Guidelines for primary production in coastal zones.

No invasion of marine plains by any development.

Keep all existing banks.

Remove all existing banks.

Stock ponds with fish.

Harvest birdlife, not fish.

Provide deep water behind banks and fish ladders.

Assess soil erosion benefits/hazards.

Research fish survival with and without ponding banks.

Require an EIS for ponded pasture establishment in zones 1 and 2.

Develop a consultation process for marine plain developments.

Need for public education.

Programme of value of wetlands to fisheries.

Fisheries to go from DPI to DEH.

Map coastal ponded pasture development.

Pump saltwater behind banks to charge habitat.

Fish movement structures to be tax deductible/funded by government.

Fishing rights to be purchased by graziers.

Fishermen be compensated.

Need to show proof of approval of ponding banks.

Investigate nutrient cycling.

Investigate transient hydrological cycles.

Provide artificial fish hatcheries.

2 Habitat/Ecological - Other

Increased research into wildlife in ponded areas benefits/costs.

Compare habitat between ponded and non ponded areas.

Research effect of ponded pasture on insects.

Define sensitive habitats/endangered species, protect from development.

Effect of ponded pasture on seasonal water flows.

No ponded pasture in identified high value freshwater swamps.

Research effects of siltation.

Investigate management of changed wildlife numbers.

Research human health aspects.

Incorporate structures to allow for multiple land use.

Identify sensitive catchments for ponded pasture species release.

Identify areas of coast suitable for ponded pasture.

Define habitat use of wildlife in ponded and non-ponded areas.

Do a cultural inventory of sites prior to ponded pasture construction.

Consultative management of wildlife in ponded areas.

Encourage voluntary removal of banks.

3 Weeds/Plant Introduction

Develop guidelines for the introduction of exotic plants.

Wider representation/more teeth for plant introduction authorities.

Moratorium on introduction of ponded pasture species in sensitive catchments.

Test species for weed potential before introduction.

Weeds should be defined as plants having no commercial use.

Moratorium on further plant introductions.

Let us get in plants whilst we can.

Measure spread of ponded pasture.

Develop management strategies and control measures for introduced species.

Identify trees suitable for ponded areas.

Control blue-green algae in ponded pastures.

Declare existing ponded pasture species as P4 species to provide legal controls over further spread.

Map current distribution of ponded pastures.

There should be no change to the present introduction processes.

Assess sensitive/non sensitive catchment by conservation values.

Quarantine authorities should implement 1988. Hazard guidelines.

Weed management within the state be reviewed and overhauled.

4 Guidelines/Legislation

Collate legislation into a single bulletin.

Define landholders rights - if denied the right to construct banks on freehold land then compensation should be paid.

Area below HAT to be controlled by one body.

Develop guidelines for building and decommission banks for each region.

Respect landholders rights.

Streamline decision making process.

Map potential area for ponded pasture in Queensland.

Clarify landholders/fishermen/community rights over a particular resource.

Develop a post workshop timetable for research/moratoriums.

Fund an advisory service for graziers to avoid impacts in zone 1.

Seek approval from neighbours when building banks.

No moratorium on establishment of ponded pasture.

Promote liaison between Fisheries and Agriculture within DPI.

Develop over-riding legislation on all land below HAT.

Define ambulatory boundaries -

make consistent in regard to tidal areas.

Require an EIS for all costal development.

Promote self regulation through Landcare.

Place responsibility for all marine and tidal areas within one Department.

Enforce deep water areas behind ponding banks.

Develop a landholder awareness campaign.

Breach banks across tidal creeks.

Make approvals mandatory for banks across tidal creeks.

Develop a Green Paper on ponded pasture for public discussion.

Promote the marine environment as a community resource.

5 Effects on the grazing Industry

Acknowledge the value of ponded pasture.

Document, present and promote the positive environmental and economic effects of ponded pasture.

Determine potential ponded pasture areas in Queensland.

Promote ponded pasture as erosion control.

Determine nutrient cycling/increase in productivity over time.

Investigate use of ponded areas for cropping.

Encourage the building of more ponded pasture.

Promote ponded pasture through Landcare.

Protection/assurance for landholders so they will allow research.

Provide rate rebates if restrictions are placed on land use.

Research effect on waterfowl on ponded pasture.

Promote more liaison between opposing groups.

Redirect drought relief to tax deductibility for ponded pasture.

Develop ponded pasture techniques to reclaim salted land.

Seek more funds for ponded pasture research.

3.1 List of Group Findings

From these lists Mike Chuk (QNPWS) and Rex Fisher (QDPI) selected areas of concern common to all the groups. These points have been referred to the working group for further action.

1 Habitat/Ecological - Fisheries

Develop total landuse/fisheries management.
Clear development guidelines for coastal zones.
Provide deep water/fish ladders, investigate aquaculture.
Support Integrated Catchment Management (ICM)
Research fish habitats - compare ponded and non ponded areas.

2 Habitat/Ecological - Other

Research relationship between wildlife and ponded pasture.
Investigate effect of ponded pasture on hydrological cycles.
Determine effect of ponded pasture species on wildlife habitat.
Develop consultative wildlife management.

3 Weeds/Plant Introduction

Revamp plant introduction authorities and guidelines.
No new plant introductions until evaluation of weed potential.
Moratorium on introduction of PP spp. in sensitive catchments.
Map distribution of ponded pastures.
Review weed management.

4 Guidelines/Legislation

Uphold/clarify landholders rights.
Collate relevant legislation into one clear document.
Guidelines for PP establishment (by region) including decommissioning.
Sort out ambulatory boundaries.
Promote self regulation through landcare.
Streamline the approval process.
Map potential ponded pasture areas.

5 Effects on the Grazing Industry

Promote positive (economic and environmental) values of ponded pasture.
Investigate the significance of ponded pasture to the beef industry.
Research nutrient cycling in ponded pastures.
Identify potential PP areas in Qld (including potential economic benefit).
Investigate financial incentives/compensation.
Promote inter group liaison.

4.0 Closing Recommendations and Speech by the Minister for Environment and Heritage.

After the presentation of the workshop group findings the workshop convened briefly under the chairmanship of Mr Richard Grimes and Mr Shaun Coffey.

The general feeling of the participants was that the following actions were necessary:

1. All participants should get copies of the workshop proceedings and presented papers.

2. A working group should be convened to address the issues raised by the seminar groups.

3. A further meeting (early 1992?) should be organised to discuss further developments and directions.

At this point Ms Ruth Wade proposed that a motion be voted on that there be 'a moratorium on the establishment of ponded pastures below highest astronomical tide'. This was voted on and passed by the majority of workshop participants.

The Minister for Environment and Heritage, the Honourable Pat Comben then closed the workshop. Mr Comben congratulated the workshop on its approach to addressing some of the disputed issues that have arisen over the development of ponded pastures in Central Queensland. He noted the motion recommending a moratorium on the development of ponded pastures below highest astronomical tide and indicated that he was now Minister responsible for the approval of levee bank construction in this zone. Accordingly, he indicated that he would institute a moratorium on such development to take place immediately. Mr Comben stressed the value of coastal wetlands to a wide range of organisms both marine and terrestrial. He looked forward to the reconvening of a further meeting to discuss progress with issues raised at the workshop.

4.1 Press Statement by the Minister for Environment and Heritage Pat Comben. 26/7/91.

MEDIA STATEMENT

Hon. Pat Comben, MLA
Minister for Environment and Heritage
19th floor 160 Ann Street, Brisbane
PO Box 155, NORTH QUAY QLD 4002 · Telephone (07) 227 8819 · Facsimile (07) 221 7082

Friday, July 26, 1991

STATEMENT BY ENVIRONMENT AND HERITAGE MINISTER PAT COMBEN

COASTAL PONDED PASTURES MORATORIUM NOW UNDERWAY

The Environment and Heritage Minister, Mr Pat Comben, today said a moratorium on ponded pastures in wetland areas had been implemented.

The Minister said the moratorium was necessary to protect the environmentally sensitive wetland areas along the Queensland coast at a time of growth of this relatively new form of improved pastures.

Ponded pastures were formed by building long levee banks on flat coastal areas in an attempt to dam fresh water run-off and to prevent the intrusion of salt water inland.

The end product, particularly with the introduction of fast-growing aquatic grass species from overseas, was vastly improved pastures for the grazing industry during winter. More ponded pastures had been constructed in recent years because of their economic benefits to primary production.

Mr Comben had endorsed the call for a moratorium raised at last week's workshop on ponded pastures in Rockhampton, which the Minister closed. The Cattlemen's Union executive director, Ruth Wade, had proposed the moratorium and received widespread support at the workshop.

A steering committee with government, industry, academic and conservation group representatives was also established at the workshop.

"There are wide spread concerns about the possible environmental effects of ponded pastures in wetland areas, particularly in central Queensland. This moratorium will allow those concerns to be investigated and addressed," Mr Comben said.

"These concerns are shared by all groups, including the fishing and cattle industry and conservationists, so I am confident the steering committee will provide worthwhile recommendations on ponded pastures in the coastal zone.

"I believe the moratorium is an excellent government decision and can only result in improved environmental management of the Queensland coast," he said.

Members of the steering committee are representatives of the Queensland Commercial Fishermen's Organisation, the Cattlemen's Union, the Capricorn Conservation Council, the Australian Littoral Society, the University College of Central Queensland and the Departments of Primary Industries and Environment and Heritage.

The Minister said the environmental concerns were triggered in central Queensland with a fish kill of barramundi.

He said the suspected environmental effects of ponded pastures in the coastal zone included interruption of tidal flow and drainage patterns, loss of habitat, unwanted invasion of introduced plants and disruption to waterbirds particularly migratory birds.

Consequently the steering committee would address the following issues:

- developing legislation to control ponded pasture development on marine plains
- reviewing existing legislation
- investigating the run-off and siltation in ponded pasture areas
- investigating the relationship between ponded pastures and wildlife
- investigating the procedures used when introducing new plants from overseas
- developing clear guidelines for landholders planning to build ponded pastures on their properties
- promoting the positive values of ponded pastures
- investigating the effect of ponded pastures on future fish stocks.

The steering committee hopes to hold another workshop after these issues have been addressed.

"Obviously it could take many years research to find all the answers to the questions about the effects of ponded pastures on wetland ecosystems, but it is important that work begins now to collate available information," Mr Comben said.

"The Government's Coastal Protection Strategy, released earlier this year as a Green Paper, will also address the issue of ponded pastures in the coastal zone

Mr Comben said he had discussed the moratorium with his colleague, the Primary Industries Minister, Mr Ed Casey.

The Minister also congratulated the representatives at the workshop for their readiness to recognise a potential problem and their willingness to investigate solutions.

For further information contact Roslyn Murray (07) 227 8819

5.0 Composition of Ponded Pastures Working Group

As indicated in the closing recommendations it was agreed that a working group be established to consider issues raised by the workshop. This working group will meet regularly with the aim of convening a further workshop to report an progress in early 1992.

The working group consists of the following:-

Mr Shaun Coffey	DPI	Rockhampton
Mr Richard Grimes	QNPWS	Rockhampton
Mr Mark Doohan	QLD Commercial Fishermen's Association	Brisbane
Mrs Ruth Wade	Cattlemen's Union	Rockhampton
Mr Eddie Hegerl	Australian Littorial Society	Brisbane
Dr. John Parmenter	University of Central Queensland	Rockhampton
Mr Kel Roberts	Water Resources Commission	Rockhampton

6.0 Contacts

Persons wishing to obtain copies of papers presented to the workshop but not published, or seeking further information on ponded pastures in Central Queensland should contact:-

Russ Boadle
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Rockhampton Phone: (079) 360 211

Mike Chuk
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