Half a Century On:
Barramundi Research in Australia -
The Linkage between Research and Management

Fishery Report No. 84

Prepared for

The Northern Territory Department of Primary Industry, Fisheries and Mines

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INTRODUCTION

Research on barramundi has been conducted in Australia (and Papua New Guinea) since about 1954 with pioneering work by David Dunstan of CSIRO. Since then a great deal of research into the biology, behaviour and population dynamics of the species has been conducted by various agencies across northern Australia. The purpose of this paper is to provide a chronology of that research, with a major emphasis on the Northern Territory (NT), and to provide some explanation of how the output of that research has influenced management of the resource.

The research outputs have been published in a variety of forms including refereed journal papers, conference proceedings, reports to funding agencies, annual research reports, public information papers and internal departmental reports. There is no consolidated document describing all of the research, although the ACIAR international workshop proceedings of 1986 provide an excellent summary of research and management up to that time (Copland and Grey, 1987). The first effort to synthesise information on research and management of barramundi was in a brief document which summarised the results of a 1979 workshop meeting of virtually all of the scientists studying barramundi in Australia and PNG at that time (Grey and Hill, 1979). The proceedings of the latest international workshop on barramundi research and management, held in July 2005, will be published in 2006.

During that latest workshop it became clear that, at least in the case of the NT, there was a lack of consolidated information available on the history of research and how that research output influenced the management strategy. Corporate memory of the history of management has been fragmented by a relatively high turnover of fisheries management staff in recent years. That situation was exacerbated by the retirement in 2004 of the Principal Research Scientist Roland Griffin and the Senior Technical Officer Graham White who had been involved in almost all of the barramundi research conducted in the NT.

This paper has been prepared for NT Fisheries with a view to providing a historical perspective for future researchers, managers and stakeholders.

RELEVANT MANAGEMENT HISTORY

Management of barramundi fisheries and resources in the NT (and probably Australia generally) goes back to at least the 1950s. This paper will primarily discuss the NT situation. References to actions in other jurisdictions will be made but these are from recollection only without reference to management documents or plans from those jurisdictions.

The earliest documented phase of management of barramundi as a species dates from the early 1960s. References to this era are derived from a search of archived NT Government (actually Commonwealth Government) registry files by the author for the Barramundi Task Force in 1985. Prior to that time the rules for fisheries in the NT appeared to be applied to all fisheries and related primarily to licensing of fishermen, although with virtually zero enforcement capacity it is difficult to see how licensing in reality exerted much influence at all.

An updated chronology of NT barramundi management based on previous chronologies from the 1986 Barramundi Task Force Report and the 1991 Barramundi Management Plan is presented below.

HISTORICAL SUMMARY OF NT BARRAMUNDI FISHERY MANAGEMENT

Pre-1960

1901 - No legislation.

1904 - SA Fisheries Legislation - general licensing.

1911 - NT Fisheries Ordinance — licensed fishermen and prohibited the use of poisons and explosives for fishing.

1949 – Fishermen to provide returns.

1960 to 1980

1962- All fresh waters (non-tidal and enclosed water bodies) closed to gill netting and traps between April and December.

1966 - A minimum mesh size of 6 inches (150 mm) was imposed in all rivers upstream of the mouth.

1966 - A minimum legal length of 23 inches (later translated to 58 cm) was established.

1966 - Some inland and tidal waters closed to netting completely.

1969 - Minimum mesh size in rivers increased to 7 inches (175 mm).

1969 - Closure lines established near river mouths.

1974 - River closure lines readjusted to encourage commercial exploitation in more remote areas.

1974/75 - A major review of the NT fishing industry, including the Barramundi Fishery, was carried out. A consultant resource economist (Professor Parzival Copes of Simon Fraser University in British Columbia, Canada) recommended the introduction of licence limitations for the Barramundi Fishery.

1977 - Introduction of a total seasonal closure from 1 November to 31 January for the commercial fishery.

1978 - Biological research programs on barramundi were substantially increased.

1978 - A review of the Barramundi Fishery was undertaken and several recommendations on management measures were submitted for consideration.

1979/80 - Actions resulting from the 1978 review of the fishery
- Barramundi licences made non-transferable
- Closed season extended from October to January inclusive
- Maximum net length of 1500 m were imposed
- Amateur bag limit of five fish per person per day was imposed.
- The seasonal closure was also applied to amateur fishermen for the 1979/80 season.

1980 to 1985

1982 - The amount of net permitted per licencee was further reduced to 1000 metres; however, those fishermen who could demonstrate that they had been using in excess of 1000 metres (up to 1500 metres in years 1979, 1980, 1981) were entitled to use an additional 500 metres.

1982 - The amount of net approved under a licence was unitised, each unit being equivalent to 250 metres up to a total of 4 units or 1000 metres.
- Those fishermen who were approved to use the additional 500 metres did not have this additional net unitised.

1982 - A net buy-back scheme was introduced:
- individual net units or the entire licence (up to 4 net units) could be sold back at $100 per unit;
- the buy-back scheme did not apply to the additional 500 metres of net approved to some fishermen;
- where a fisherman who was entitled to use an additional 500 metres of net wished to take advantage of the buy-back scheme, first had to surrender the 500 metres with no monetary compensation.

1982 - From 1982 onwards, the licence fee structure was changed to a net unit basis.

1982 - Fees increased to $60 per unit.

1983 - The net unit formula was changed from 250 metres per unit to 100 metres per unit.

1984 - Fees further increased to $100 per unit.
- Same formula was applied until 1985.

1983 - The buy-back scheme operated along the same lines as that which applied in 1982:
- in 1983 it was $1000 per unit;
- in 1984 it was $1000 per unit with a 50% bonus if all units on a licence were sold back.

1986 to 1991 – Mary River Fish Management Zone to Barramundi Fishery Management Plan

1986 - The Mary River was closed at the mouth to commercial fishing for half of the fishing season (Feb-May) for 1986 and 1987.
- Restriction on transferability of licences was lifted when effort was reduced to 35,000 hundred metre net days.

1988 - The Mary River Fish Management Zone was declared. Within that zone:-
- The Mary River was closed to commercial fishing at the mouth.
- The recreational size limit was 50 cm.
- The recreational bag limit of two per day and possession limit of four per person was imposed.
- Cast nets were prohibited.
- The recreational seasonal closure between 1 October to 31 January introduced downstream of Shady Camp crossing.
- The East Alligator River was closed to commercial fishing by the Federal Government (Australian National Parks and Wildlife Service ANPWS).

1989 - The Mary River Fish Management Zone was extended and all closures and special rules were applied to the extended area.
- The Daly River and parts of Anson Bay were closed to commercial fishing.
- Recreational fishing season closed in the lower Daly River and Anson Bay from 1 October to 31 January.
- The 50 cm recreational minimum size limit was extended to all of the NT.
- The South Alligator River, the West Alligator River and the Wildman River were closed to commercial fishing by the Federal Government (ANPWS).

1990 - The Barramundi Fishery Advisory Committee was initiated.

1991 - The Barramundi Fishery Management Plan was adopted.
- The Roper River was closed to commercial fishing at the mouth.
- Minimum size limit rules were rationalised by increasing the recreational size limit to 55 cm and reducing the commercial size limit to 55 cm. Minimum size for fillet and headless carcass were introduced.
- Rules were introduced to protect small barramundi at Shady Camp barrage – only single point hooks could be used and the use of live bait was prohibited.

1992 to 2005

1993 -Commercial closure line on the Victoria River was moved downstream to the mouth of the West Baines River.

1998 - Closure of Darwin Harbour and Shoal Bay to commercial fishing.

2002 - Closure of the McArthur River to commercial fishing.

2004 - Closure of the Adelaide River to commercial fishing.

Note on size limits: The basis of the original NT commercial minimum legal length (MLL) of 58 cm is not at all clear. It is not a size referred to by Dunstan in his pioneering work. The first reference to a number close to 58 cm is by Reynolds and Moore (1982) who determined that length to be at about the age of three years. Davis and Kirkwood (1984) derived a similar size at the age of three. The original NT recreational MLL of 50 cm was intended to provide protection for fish during their first two years based on the estimates of Davis and Kirkwood. Information gained during the Mary River monitoring program in 1986 and 1987 showed that a proportion of the commercial catch (taken with the legal minimum 6 inch mesh) was smaller than the 58 cm MLL. As the majority of such fish were already dead, to discard them would be unnecessarily wasteful. Thus it seemed sensible to reassess the MLL. At about the same time monitoring of recreational catches and populations in the Mary River revealed a strong year class from the 1988/89 spawning season. It was clear that this year class would be substantially protected for almost another year by raising the recreational MLL to 55 cm. Thus a decision was made to adopt a single MLL of 55 cm for both sectors of the fishery, largely

ensuring protection for most fish well into their third year of life. It appears that at the same time Barramundi Fishery managers in Queensland were also reviewing size limit rules. They decided to increase their MLL from 55 cm to 58 cm which would have brought it into line with the NT commercial limit. The result was the current disparity in MLL regulations. Queensland also introduced a maximum size limit of 120 cm (applied to both sectors) to protect the largest of female fish. At that time a maximum size limit was also considered in the NT but exploitation of such fish by anglers in the NT was considered to be at a relatively low level and such a limit was not justifiable. In Western Australia formal management rules for barramundi were not introduced until much later. In the late 1990s a minimum size of 55 cm and a maximum size of 80 cm were introduced to protect both juvenile fish and post-transition females. Given that only a very small proportion of barramundi would be female at 80 cm the upper size limit is probably somewhat conservative.

CHRONOLOGY OF BARRAMUNDI RESEARCH

1955 to 1965

The first research on barramundi in Australia was conducted by David Dunstan of CSIRO in Queensland at the request of the Queensland Government, over a four year period from 1952. Dunstan then conducted very similar research on barramundi in Papua New Guinea (PNG). That research provided the first published information on the basic biology of the species in the region, although sporadic research had previously been conducted in the Indian region. Dunstan provided information on growth, feeding, habitat requirements, seasonal movement, and spawning area and season, as well as a description of the commercial fishery in Queensland. The growth estimates provided were based on limited and somewhat biased data and were shown by later research to be quite inaccurate. The results were published in 1959 and 1962. It was possibly this research which formed the basis of some of the original fishery rules in the NT. It is interesting to note that these rules appear to have been devised by NT Public service administrators with no known expertise in biology or natural resource management. Advice may have been sought from others outside of the NT (possibly Dunstan himself or others in Queensland or PNG) but no record of such advice has been discovered. It is even rumoured that some of the rules were first promulgated *ad hoc* during a particularly unsuccessful fishing excursion by some of the top-level NT administrators of the time.

The early 1970s

The next significant phase of research on barramundi was undertaken by Fred Reynolds and Ray Moore in PNG from 1970 to 1974. That work provided excellent detailed information on growth, seasonal movements, reproduction (including discovery of the sex change phenomenon), life cycle and detail of microhabitat use by juveniles. Reynolds and Moore used extensive tagging in upper waters of the Fly River system and coastal waters of the Gulf of Papua. They identified a distinct pattern of migration to coastal spawning areas quite remote from the river. Moore provided excellent detail on the morphology of early life cycle stages and their habitat requirements. The work was published between 1978 and 1982 in the Australian Journal of Marine and Freshwater Research (see bibliography).

The NT Fisheries Research Section commenced its first research on barramundi in late 1972, with a sampling and tagging program on the Mary River. That work continued on a fairly sporadic basis until 1974. Field work included some fishery sampling in the Victoria and Roper Rivers. Field notes and data from that time are retained at Fisheries Research but have never been recorded in the research database. The severe impact of Cyclone Tracy on staff and facilities in Darwin led to the cancellation of that program (along with most others as well) and there was no further NT based study of barramundi until 1978.

The late 1970s

In the late 1970s there was a renewal of interest in barramundi, largely stimulated by industry concerns at the sharp decline in catch rates in the NT commercial fishery from 1975 to 1978. An analysis of the available catch and effort data and review of the fishery in 1978 and 1979 (Grey and Griffin, 1979) indicated that the fishery was being subjected to substantial over-fishing. That review resulted in a range of actions aimed at reducing effort in the commercial fishery. Even before the review, action by both industry and Government was under way to obtain up-to-date biological information on barramundi in the NT and Queensland. A joint project by CSIRO, the NT and Qld, was funded by the Fishing Industry Research Trust Account (FIRTA) - the precursor of the Fisheries Research and Development Corporation. The project was led by Dr Tim Davis of CSIRO. Field work in the NT commenced in 1978 and was completed in mid 1980. NT scientific and technical staff were extensively involved in that field work. After extensive analysis the results were published in various journals between 1982 and 1988. That study was quite comprehensive and was able to build on previous work in Queensland and PNG. It confirmed basic biology for NT stocks. Extensive tagging provided good information on movements (within and between rivers), and much improved definition of growth (although it mainly showed that growth was very variable). The study also showed that barramundi in Australia are protandrous (as they are in PNG) and provided good fecundity estimates. Dr Davis attempted to compute mortality rates but without much real success, mainly due to the large number of uncontrollable variables. The results provided particularly good definition of seasonal habitat use, particularly for small juveniles. One of the definitive parts of the work was conducted in the nursery swamp adjacent to Shoal Bay near Darwin, areas that have since been drained to control saltmarsh mosquitoes. The parameters derived from that research have been used extensively in modelling of the fishery since then.

The 1978/79 review of the NT Barramundi Fishery identified the rising significance of recreational fishing for barramundi and in 1978 surveys commenced to address the lack of information about that sector. A broad-scale modification of the access point survey method was used to obtain data on recreational fishing effort in the areas of the NT accessible from the Arnhem Highway, which was at that time virtually the only access road to the Mary River and the large area now known as Kakadu National Park. The results of that work established that the harvest of barramundi by the recreational sector was indeed quite a significant part of the total fishery (Griffin, 1982) and the data was very useful for establishing the initial recreational regulations. A comparative survey series using the same methods, in the same location, was conducted during 1986/87 (Griffin, 1988). Comparative surveys were conducted on May Day and Picnic Day weekends until 1991 when the practice was discontinued largely because traffic levels and speeds at the Arnhem Highway survey site had become too dangerous. Data for the earlier survey series (1978/79) was not computerised and reports were based on data analysis by hand or by calculator. During 2003 this data was entered into the Fisheries Research database but no further analysis was conducted. The dataset contains useful information about catches, equipment, boat size etc which is not included in published reports to date.

The early 1980s

Queensland

Following on from the joint CSIRO/NT/Qld research work in Queensland, Rod Garrett and John Russell commenced a program of research for the Queensland government both in the Gulf of Carpentaria (GOC) and on the east coast. That work focused on spawning, early life history and juvenile habitat usage. The issue of habitat was a particularly important one for Queensland where loss of coastal habitat was probably a major factor contributing to declines in the barramundi population, particularly on the east coast. The work of Russell and Garrett was very important in the framing of Queensland's barramundi management regime, including the seasonal closures and recognition of the significance of habitat. More recently the same researchers in Queensland have been primarily concerned with research into the effects of fishing and

issues to do with aquaculture and stocking. The author is not familiar with the detail of the Queensland situation and cannot report on that in any further detail.

General

A recognised shortcoming of early modeling of the Barramundi Fishery was that the fishery was treated as a single stock. Early research clearly indicated that this was most unlikely to be true. From 1980 to 1983 a FIRTA-funded study of the genetics of barramundi across northern Australia was conducted by Dr James Shaklee and Dr John Salini of CSIRO using the then relatively new electrophoretic methods. The aim of the study was to determine the nature and extent of barramundi stocks. The results of that research were published in 1985 in the Australian Journal of Marine and Freshwater Research. Those authors determined that there were numerous genetically distinguishable stocks across northern Australia, generally associated with major river systems. The outcome was that future modeling tended to assess stocks in different areas separately, wherever appropriate data were available. It also led to concerns about the danger of translocating genetically different barramundi between regions as part of the developing barramundi aquaculture industry.

The Northern Territory

1979 to 1984 – commercial fishery monitoring

In the early 1980s barramundi research essentially became a distinct and major program for NT Fisheries Research. From 1979 to 1984 field work focused on monitoring of the commercial fishery, mainly in the Daly River, but occasionally in the Mary River. Extensive data was obtained on the size, sex, maturity and condition of barramundi taken by the commercial fishery. Major logistical constraints unfortunately meant that the data obtained was relatively sparse, very patchy, and subject to serious biases which limited its usefulness. In the breeding seasons of 1981/82 and 1982/83, when the commercial fishery was closed, fishery independent sampling was undertaken, primarily to obtain information about spawning activity. The data from those efforts was to prove useful in countering arguments that the commercial fishery would have severe impacts on spawning whenever the wet season monsoon was delayed. It was able to do so because it was clearly demonstrated that spawning had largely been completed by season opening on 1 February, regardless of whether or not monsoon rains had commenced. Despite this information the same issue continues to be raised every time the monsoon is delayed. During monitoring of the commercial fishery and the fishery independent, closed season monitoring, data was also collected on the biology of king threadfin. That data clearly showed that king threadfin are also protandrous and have a spawning season virtually the same as barramundi. The information collected was relevant in that it indicated that management measures introduced primarily to protect barramundi would have a similar impact on king threadfin.

1982 to 1985 – Recruitment monitoring

A seasonal focus of barramundi research from 1982 to 1985 was on juvenile habitat requirements and recruitment. The juvenile habitat work focused sampling of supralittoral swamp habitats adjacent to Shoal Bay. Innovative hide-traps were used to sample barramundi of 5-25 mm in length from shallow, remnant tidal pools. The study confirmed the significance of such habitats to juvenile barramundi, as well as the monthly, tidal-based spawning cycle. Those swamps closest to residential areas were subsequently severely impacted by drainage to control saltmarsh mosquitoes (Griffin, 1985). Abundance of young of the year recruits was monitored during their upstream migration at Daly River as well as at coastal swamps adjacent to Anson Bay. Because of constraints on access and sampling methods the results were not particularly conclusive but indicated that there was a strong relationship between rainfall and recruitment. It was also demonstrated that recruitment was very high in 1984 when the spawning stocks were probably around the lowest level, due to impacts of the fishery. Thus it was shown to be quite likely that recruitment was

dependent more on seasonal conditions than on spawning stock, and that the spawning stock at the time was more than adequate to maintain the population given suitable seasonal conditions.

BIGTAG '83 – Daly River

During the dry season of 1983 the Barramundi Research Unit (minus team scientist Griffin, who was on 12 months of long service leave and sabbatical in Europe and the USA) undertook an extensive sampling and tagging project in the upper tidal waters of the Daly River (known as BIGTAG '83). Tag recoveries from that operation provided detailed information on the timing of downstream movement prior to the spawning season. The focus of the exercise was on catching numbers of fish so the mesh size was not well controlled as a corollary the data is not particularly useful for assessment of size/age structure, but data from various mesh sizes is useful for comparison with later sampling. The major results were published in an American Fisheries Society Symposium Proceedings in 1987.

1986 – Daly River / Liverpool River Comparison Study

In June/July of 1986 a major project (funded by the NT Fishing Industry Research and Development Trust Fund – NTFIRDTF), known as the Two Rivers Study, was undertaken. That study used standard sets of four gillnets (5", 6", 7" and 8") fished over several days to compare population abundance and age structure in the heavily exploited Daly River and the virtually unexploited Liverpool River. It was concluded that at the Liverpool River there was a lower numerical abundance of barramundi but a higher proportion of larger mature fish, as would be expected given their respective exploitation histories. The results were published in Asian Fisheries Science in 1988.

1986 to 1987 – Mary River Assessment

In the mid-1980s there was considerable concern about status of barramundi stocks in the Mary River, where the management measures put in place after 1979 had been somewhat less effective than they were elsewhere. The rapidly expanding recreational sector was also focusing heavily in the Mary River region. To provide the information to properly assess the situation, a major two-year project was commenced in 1986 in order to, as one industry official somewhat optimistically put it, "undertake a complete biological assessment of the Mary River". While the assessment was far from "complete" it was intensive and produced a substantial body of information on which re-assessment of the situation was based. The results were published in a report entitled "Mary River Monitoring Program, 1986-1987". The study focused on intensive monitoring of the commercial Barramundi Fishery through on-board measurement and biological sampling of catches, and observation and recording of operational details. It was during this period that measurements were made to determine the relationship between whole fish length and fillet length and head length in order that future size limit regulations could provide for fillet and headless length limits. Specific on-site surveys of the recreational fishery in the Mary River were undertaken to supplement information from the concurrent Arnhem Highway surveys (mentioned previously). It was during this period that general public access was provided to the Shady Camp area and a properly formed road replaced the very marginal track to the area, leading to a substantial increase in angler effort in the area. Barramundi stocks in the Mary River area were surveyed by a variety of methods with the aim of assessing recruitment and size/age structure of the inland population. Basically the study demonstrated that the stock in the Mary River was substantially overexploited, with a greatly reduced abundance of mature fish (compared to earlier sampling in 1980 and 1981). It also showed that there was good news in the form of an extraordinarily strong year class produced by the 1983/94 spawning season which was enhanced by the best, extended wet season for several years. This year class showed the resilience of the population and its ability to produce high numbers of recruits from a diminished mature adult population.

The results of the research were the subject of some controversy and opinions differed, mainly along sectoral lines, as to the real status of the stocks. Independent assessment of the situation was sought and Professor William Fox of the University of Miami (one of the leading stock assessment modelers of the time) was engaged to undertake such an assessment. Professor Fox and a graduate assistant undertook a review of the available information, in collaboration with local researchers and managers, and he was able to demonstrate to stakeholders that the Mary River barramundi stock was indeed subject to significant growth over-fishing (but not recruitment over-fishing) and that urgent action was required to control exploitation in the future and to allow the population to rebuild. That assessment led to much more widespread (though not quite unanimous) acceptance of the need for urgent, targeted management measures. The result was the Mary River Barramundi Management Plan. This plan included the new 50 cm minimum size for anglers, a seasonally closed area to protect spawning fish during the spawning season and a reduction of the possession limit to two fish per person.

1987 to 2005 – BARRACADE

Following the Mary River Monitoring Program of 1986 and 1987 the concept of annual assessment of the barramundi population of the Corroboree Billabong was devised. In 1987 and 1988 an assessment methodology based on depletion methods was developed. Since then annual assessment by standardised methods has been conducted at the same site in Corroboree Billabong every September. The method has enabled estimation of abundance, recruitment and age distribution. Perhaps the most significant finding has been that recruitment is extremely variable, as is the abundance of catchable fish in the billabong. Over the long period of sampling it became apparent that recruitment success, which was initially thought to be very strongly influenced by rainfall, was in fact closely related to the strength of the previous year class. This probably occurs because a very strong year class suppresses the succeeding year class by predation and competition for resources. Thus strong recruitment was observed only in alternate years, regardless of the amount of rainfall.

Examination of this data in relation to data from recreational surveys showed that angler catch and effort is not closely related to fish abundance (Griffin 2002).

Very similar sampling was undertaken at Yellow Waters billabong in Kakadu National Park in 1993, 1995, 1996, 1997, and again in 2000. The work was funded by Parks Australia North. The sampling was not as comprehensive as that at Corroboree but a similar alternation of year class strength was observed for the first four years but it did not persist into later years. In 2000 the abundance of barramundi in Yellow Waters was observed to be extraordinarily high.

1989 to 1995 Recreational Fishing Surveys

These intensive surveys provided annual estimates of angler catch and effort for the Mary River. These surveys used both roving creel and access point methods and, while they do have some limitations due to cost and logistical constraints (e.g. no survey of night-time activity, time of surveys not strictly randomised), the results are considered to have provided reasonable estimates of catch and effort. The information on catch per unit effort is considered to be very reliable. That information was very useful in assessing the size and impact of the recreational fishing sector in the area and also enabled officers to receive direct feedback from recreational stakeholders in the field. The information was published in two Fishery Reports and several internal update reports.

It was initially intended to conduct structured surveys of recreational fishing in the Daly River also from 1989. Surveys were conducted from 1989 to 1991 but operational constraints prevented proper structuring of those surveys and, while the data is available, it was not as useful as that for the Mary River. Useful catch per unit effort data for that period for Daly River is available but was not published.

1995 – FISHCOUNT

From 1993 to 1995 a Territory-wide survey of all recreational fishing activity was developed and undertaken. The innovative survey methodology was developed by Anne Coleman of NT Fisheries and Laurie West of Kewagama Research in Queensland. The year-long survey provided estimates of angler effort and catch for the whole Northern Territory for 1995. The results were reported by Anne Coleman in Fishery Report 43 in 1998. The methodology was further developed and used for the National Recreational and Indigenous Fishing Survey conducted in 2000.

1982 to 2005 – Recreational Tagging and Fishing Tournament Information

In 1982 a collaborative program (AMTAG) managed by NT fisheries and Amateur Fishermen's Association of the Northern Territory to allow anglers to tag barramundi commenced. That program was continued until the mid 1990s when it was severely scaled back and recreational tagging effort was concentrated on major tag and release fishing tournaments. The most notable of those was the Barra Classic which has been run annually since 1982. Tag returns from the program were sporadic with the information frequently missing or misleading. Mass tagging was discontinued when it was deemed not to be cost-effective. All NT barramundi tagging programs after the mid-1990s were severely affected by a lack of cooperation from disgruntled commercial operators, with most refusing to report recaptures. Cooperation from anglers in relation to tag returns was always thought to be very high. The data from the general AMTAG program was not considered particularly useful due to a relatively high degree of missing or unreliable information and a low tag reporting rate, and no definitive analyses were produced from it.

The Barra Classic however came to be a very valuable information source, particularly since consolidation of the venue at Daly River from 1990. The data from the Barra Classic was analysed and published in a report by Graham White (Fishery Report 44) in 1998. That analysis demonstrated a quite strong relationship between angler catch rate during the tournament and flow in the river at the time. The same data has frequently been cited by recreational stakeholders as evidence of the benefits of closure of the Daly River to commercial fishing. What the data more realistically reflects are differences in flow between years and a general increase in abundance which is also seen across the fishery generally over the same time period. With the release of between 500 and 1000 tags in the Daly River over a similar five-day period each year there is a considerable body of information generated by the Barra Classic. The tag returns are unfortunately limited because of lack of cooperation by commercial fishermen but with some assumptions it was shown that exploitation rate, as indicated by tag recoveries, was in general agreement with estimates from population modeling. Continued collection of that data will be a valuable and cost-effective research tool. Information has also been collected from other fishing tournaments as it became available. That information is stored in hard copy only at Fisheries Research. If collected in a consistent manner over a number of years such information can prove quite valuable.

1990 – 1991 Radio Tracking Study of Behaviour

During 1990 and 1991 studies of small-scale movement of barramundi using radio transmitter tags were undertaken at Corroboree Billabong and at Shady Camp. This was the first known use of this method in Australia. Most of the tracking was conducted in conjunction with recreational fishing surveys and other work at Corroboree Billabong. The study showed that rather than being a "lie-in-wait" predator, as was the common belief, barramundi cover quite substantial distances; in the order of kilometers per day. The use of the radio tags to study movements in relation to the Shady Camp barrage was inconclusive due to the small sample available, crocodile predation and loss of signal in the saltwater environment. Results were published in the Proceedings of the Third Asian Fisheries Forum in 1994.

1989 – 1991 Further Refinement of Stock Definition

This program, funded by the Fisheries Research and Development Corporation (FRDC), comprised two parts; scale chemistry and genetics. Analysis of scale chemistry by Peter Pender and Roland Griffin (published 1996 in Transactions of the American Fisheries Society), showed that (as proposed by some fishermen) catadromy in barramundi is not obligatory and that a substantial proportion of the population in Chambers Bay does not have a freshwater phase and has lived entirely in the marine waters. This finding provided support for the prevailing management strategy which was based to a large degree on the premise that commercial fishing, restricted by law to the marine waters, was largely separated from recreational fishing which was concentrated in freshwater.

The genetics phase of the project was undertaken by Dr Clive Keenan of Queensland Department of Primary Industry and Fisheries and was published in 1994 in the Australian Journal of Marine and Freshwater Research. This work re-examined and extended the previous work by Shaklee and Salini across northern Australia. Keenan concluded that the genetic differences between barramundi stocks are most likely due to "founder effects" associated with major changes which occurred following the last ice age, rather than as specialised adaptations to conditions in various regions. As sea levels rose after the ice age new areas of habitat for barramundi (most notably, the GOC) progressively became available and new populations were established. It is likely that the genetic makeup of those populations reflects the genotype of the relatively small number of initial immigrants which established the population in the new area. This result is of significance to the debate on possible effects of translocation of barramundi for aquaculture purposes. This did not however specifically resolve the issue of the "Weipa" stock which is sexually precocious, suggesting that the genetic difference does have a biological significance and that care should be taken in relation to translocation of those stocks.

1992 and 1995 McArthur River population sampling

Two brief sampling efforts were undertaken in response to concerns from local stakeholders that stocks were being depleted and that action was required to conserve them. Sampling occurred at several locations over some 30 km of the river using standard 5", 6", 7" and 9" gillnets. Unpublished departmental reports on the work compared abundance and size/age structure with other locations on the McArthur and with other rivers (Liverpool and Daly). The results indicated that abundance of mature fish was in fact comparatively high and the stocks did not appear to suffering from overexploitation.

1989 to 1997 – Salt water intrusion and habitat changes in the Mary River region

In the mid to late 1980s it became obvious that major habitat changes had been occurring in the coastal habitat of the Mary River and Chambers Bay. Tidal intrusion of salt water into freshwater wetlands had been observed to be evident further inland each year and several thousand hectares of paper-bark swamp forest has been killed by salt water. The situation was immediately apparent at Shady Camp where a low earthen barrage was built to prevent further intrusion of salt water into the upper section which had become quite saline. The barrage was a source of some controversy because it would have the obvious effect of limiting access to fish as well as to saltwater. The earthen barrage was washed away in the first wet season but was immediately replaced by a concrete structure which has survived until the present time. Between 1989 and 1993 substantial research effort was put into assessing the likely impacts of the barrage on barramundi populations. It was concluded that the barrage hindered, but did not prevent, movement of barramundi (and other fish). The situation was improved somewhat by addition of baffles to the spillway area of the barrage to break up the sheet flow and provide resting places for fish moving over the barrage. During the intensive sampling at the barrage and the recreational fishing surveys in the area, considerable information was gathered which was of relevance to management. One effect of the barrage was to concentrate migrating young-of–the-year barramundi as the floods receded, as well as larger fish feeding on the concentrations of

migrant fish. It also served as an ideal fishing platform and concentrated effort targeting those aggregations of barramundi. In the course of research sampling, numerous instances of angler caused injury and mortality were observed which were attributed to hook damage during catch and release of undersized fish. To counter this impact special regulations (single hooks only, no live bait) were introduced for the area of the barrage. Results are available in an internal report - “Shady Camp Situation Report”.

In addition to the main barrage at Shady Camp a number of small barriers to salt water intrusion had been built across tidal channels on the eastern side of the Adelaide River and along the coast of Chambers Bay and Finke Bay. Clearly these had considerable potential to impact on movement of barramundi, particularly movement of very small juveniles into coastal nursery habitats. To address these potential problems a series of projects were instigated, with substantial funding from FRDC and the Natural Heritage Trust (NHT). The first project aimed to describe and map nursery swamp habitats along the western part of the Van Diemen Gulf coast. A helicopter was used to access 13 sites at which hide traps were used to sample very small juvenile fish on a monthly basis. Vegetation, salinity, and temperature were recorded. Results were published in a final report to FRDC in 1995. Several sites were identified as barramundi nursery habitat and others shown to be not so. The characteristics of sites shown to be used as nursery habitat were identified.

That study was followed up by a much more comprehensive, four year study of the relationship between coastal wetlands and barramundi with particular reference to the impacts of saltwater intrusion (SWI) control measures. One phase of the study involved a two-way trap installed in the spillway of a small SWI control barrage. Fish entering and leaving the wetland above the barrage were recorded and tagged. The second phase of that study was a paired comparison of the fish fauna of bunded creeks with and without a spillway. Those studies clearly showed the benefits of spillways in saline intrusion control bunds to allow access for barramundi to the extensive wetlands above the obstructions. A great deal of detailed information on the ecology and hydrology of coastal wetlands was also accumulated. Recoveries of fish tagged during the study also provided more information on the movement of juvenile barramundi. (Fishery Reports by de Lestang et al 2000 and 2001). Those studies have greatly improved understanding by researchers, stakeholders, and other government agencies of the significance of the coastal wetlands and the potential impacts of saline intrusion control measures on barramundi and other aquatic life.

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