Aspects of the biology of juvenile barramundi *Lates calcarifer* (Bloch) relevant to production for recreational fisheries and farming, with a note on the proposal to introduce Nile perch *Lates niloticus* (L.) to Australia

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ABSTRACT

The research covered in this thesis concentrated primarily on improving production protocols for juvenile barramundi *Lates calcarifer* through studies on diet and feeding habits, pond rearing techniques, effects of photoperiod on growth, and weaning strategies. Juvenile barramundi are produced in northern Australia for two reasons; to supply seed for the aquaculture industry, and to supply fingerlings for recreational fisheries enhancement programs. Within this context, two related studies were undertaken: firstly, an analysis of the proposal to introduce Nile perch to Australia, which preceded the barramundi production studies; and secondly, an evaluation of the use of circulus patterns on scales for discriminating wild and hatchery-produced barramundi.

A review of the historical and present distribution of barramundi (a catadromous species) in Queensland indicated that barriers (barrages, weirs and dams) built in river systems, coupled with the inability to negotiate even minor stream barriers, have restricted access of this fish to much of its original, natural habitat. Further, while the construction of dams has created vast new aquatic habitats (potentially at least 100 000 ha in Queensland), these have also been inaccessible to barramundi *via* its normal life-cycle movements. To fill the 'niche' made available by the decreasing distribution of barramundi, it was proposed that a congener of barramundi, the Nile perch *Lates niloticus*, be introduced to establish sport fisheries in tropical impoundments. The principal rationale for this introduction was that,

unlike barramundi, the Nile perch reproduces in fresh waters and, hence, once established would be capable of sustaining breeding populations.

Contrarily, however, three lines of evidence suggested that the introduction of the Nile perch would have negatively impacted upon Australian aquatic fauna. The lower temperature tolerance of the species and analysis of water temperatures in rivers in eastern Australia indicated that its range would have extended to temperate regions, thus endangering established fisheries for native species in those areas. The introduction of the Nile perch, an opportunistic predator, to Lakes Victoria and Kyoga in eastern Africa caused a drastic decrease in species diversity and fish biomass. *L. niloticus* is not restricted to lacustrine habitats, and known features of its biology indicate that it could have colonised and adversely affected the fauna in a broad range of freshwater habitats in Australia. The risks associated with the proposed introduction were considered to outweigh the potential benefits, and hence it was abandoned. As an alternative, attention was given to hatchery production of barramundi as a means of supplying fingerlings for stocking fresh waters for enhancement of recreational fisheries in northern Australia.

Hatchery-reared barramundi fry were studied to determine feeding behaviour, diel feeding patterns, stomach evacuation rates, daily food consumption and growth rates. At 16–18 mm total length (TL), the feeding behaviour of the fry changed abruptly from a roving zooplanktivore to that of a lurking predator. A distinct change in pigmentation accompanied the change in feeding behaviour. Fry reared in hatchery ponds were obligate zooplanktivores between 10 and about 17 mm. Between about

17 and 50 mm the diet changed progressively from zooplankton to insect larvae to small vertebrates. The fry were visual feeders, taking food throughout the day, and showed a peak in feeding activity at dusk. Feeding continued at a reduced level under moonlight conditions, but ceased in total darkness. Stomach evacuation rates for 16 mm fry under continuous feeding and non-feeding conditions were 47 and 210 minutes, respectively; for 37 mm fry the rates were 73 and 108 minutes, respectively. The daily rations for these two size groups were 19–86% and 38–56%, respectively. Specific growth rates were 13–16% body weight/day for fry reared in ponds.

Laboratory-based experiments were conducted to determine the vulnerability of different sized barramundi fry to predation by nymphs of the dragonfly *Pantala flavescens*. Mortality of 10 mm mean TL fry was significantly greater in the presence of dragonfly nymphs, whereas 20 mm mean TL fry exhibited comparatively minor levels of mortalities. The results accorded with feeding behaviour patterns of the different sized fry and the development of an escape response in barramundi fry at 16–18 mm TL. An examination of the growth rates of *P. flavescens* in newly-filled ponds, the development of the pond fauna on which the barramundi fry feed, and the growth rates of fry, indicated a rearing strategy to optimise survival of barramundi fry reared in freshwater ponds.

An experiment was conducted to determine the effect of extended periods of light on the growth, survival, feeding pattern and daily food consumption of barramundi fry reared in a freshwater hatchery. There was no significant difference in growth or survival of fry, initially 11–12 mm TL, in either 12, 18 or 24 hours light. Fish

exposed to 12L/12D photoperiod fed continuously during daylight, and ceased feeding in darkness. Under continuous daylight conditions, fish fed throughout the normal daytime period, but ceased feeding at a time corresponding to the normal onset of darkness; feeding started again near midnight. Daily food consumption for 34 mm fish was approximately 40% more in continuous light than in 12L/12D photoperiod. The results clearly showed that there was no advantage to be gained by rearing barramundi fry in extended light regimes.

An experiment was conducted to determine if survival during weaning was affected by the size of the fry at the initiation of weaning. At the outset of the trials, feeding of live zooplankton was discontinued and a commercially available salmon starter crumble was dispensed by automatic feeders every hour for the 12 hours of daylight (photoperiod 12L/12D). Four trials were undertaken using fish initially 12.8, 13.6, 16.7 and 19.6 mm TL. Survival through the 10-day weaning period averaged 39, 58, 97 and 92%, respectively. An asymptotic curve described the relationship between initial size and survival, and indicated that survival of greater than 90% could be expected with fry greater than 16 mm TL at the time of weaning. This is the size at which barramundi fry change their feeding habit from that of a roving zooplanktivore to a lurking predator. Cost-benefit analyses indicated a considerable economic saving in delaying weaning until the fry are 16 mm TL.

A study was conducted to determine if hatchery-reared and wild barramundi could be distinguished by the patterns of circulus spacing on the scales. Proprietary software and digitising equipment was used to obtain measurements of circulus spacing

within one millimetre of the focus of the scales. Discriminant analyses separated the groups with up to 83% accuracy. As the technique utilises innate tags laid down in response to the rearing environment, it has considerable potential for evaluating the efficacy of large-scale enhancement programs. However, because scales from fish larger than 350 mm TL were too thick and heavily pigmented to be reliably read, the applicability of the technique with barramundi is limited to fish smaller than 350 mm TL.

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DECLARATION

I declare that this thesis is my own work and has not been submitted in any form for another degree or diploma at any university or other institution of tertiary education. Information derived from the published or unpublished work of others has been acknowledged in the text and a list of references is given.

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