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Prawn hatchery modifications and adaptions for temperate marine fish culture in northern NSW, Australia

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ABSTRACT

Marine fish culture is a new farming opportunity for NSW prawn farmers. To address current seed-stock supply issues two Palmers Island brackish-water prawn hatcheries (of Australian and Taiwanese design) were examined for conversion to mulloway (*Argyrosomus japonicus*) production. Both hatcheries were easily adapted with minimal cost and modification; the Australian design (1062 m^2) was the simplest and cheapest to convert. The Taiwanese design (695 m^2), required more work due to the permanent built-in nature of the concrete tanks, their rectangular shape and drainage. Fingerling output from the Australian hatchery was calculated at 630,000 × 40 mm (1 g) fingerlings or 150,000 larger 100 mm (12 g) fingerlings using a single annual hatchery run of 3 or 5 months, respectively, at a water temperature of 20–25 °C. The smaller Taiwanese hatchery had a theoretical maximum production of 320,000 × 40 mm (1 g) per batch or 50,000 × 100 mm (12 g); if pure oxygen was used in the nursery area this could be increased to 100,000 × 100 mm. Both hatcheries could operate with 3 to 4 staff and use of these facilities, in conjunction with staff training, would resolve the current poor availability and high cost of juveniles for grow-out.

1. Introduction

The Australian prawn farming industry is concentrated on the east coast of Australia and produces more than 4000 t of prawns per year, valued at AU$61.5 million in 2011–2012, making it the fifth most valuable species in Australian aquaculture (Savage, 2014). The New South Wales (NSW) industry is situated in Palmers Island, near Yamba, on the Clarence River and is the state's most valuable land-based aquaculture sector (Creese and Trenaman, 2014). Production is based on the black tiger prawn (*Penaeus monodon*) and all farms have established hatchery infrastructure, are managed intensively and produce one summer crop per year (Queensland Department of Primary Industries and Fisheries (QDPIF), 2006).

The NSW prawn industry, however, is in decline due to increased competition from cheaper imported Asian product and rising wage, water and energy costs (Guy et al., 2014; Kerr and O'Sullivan, 2005) and needs to explore diversification opportunities to remain competitive (Basurco and Abellán, 1999; McMaster et al., 2007).

In 2008 the National Marine Science Centre (NMSC) commenced research to determine the feasibility of farming mulloway (*Argyrosomus japonicus*), a carnivorous, temperate, euryhaline finfish of the family Sciaenidae, in prawn ponds (Guy and Cowden, 2012; Guy and Nottingham, 2014) and an emerging industry is developing (O'Sullivan, 2010a). Several other government, academic and industry research projects also commenced at this time which explored tropical species such as cobia (*Rachycentron canadum*), Flowery Rockcod (*Epinephelus fuscoguttatus*), the Goldspot Rockcod (*Epinephelus coioides*) and giant grouper (*Epinephelus lanceolatus*), for diversification within the Queensland prawn industry (O'Sullivan, 2010b).

The temperate research initiative on mulloway identified several factors that were likely to limit the expansion and profitability of land-based farming in northern NSW. One key constraint was the poor availability and high costs of juveniles for grow-out (Guy and Cowden, 2014). This has been recognised internationally as one of the main bottlenecks to commercial expansion for emerging species (Schwarz et al., 2009). At present Port Stephens Fisheries Institute (PSFI), is the only facility in NSW that maintains broodstock of mulloway (Fielder and Heasman, 2010) and fertilised eggs can be purchased at a commercial price of AU$0.012 per egg or AU$1.05 per 35 mm fingerling (Allan, 2008). This high cost for fingerlings is currently acting as a disincentive for prawn

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farmers to invest in mulloway farming. This has also been the case for cobia, which sells in the southern USA for about US$2.0–2.75 per fingerling, restricting development (Alvarez-Lajonchère et al., 2007; Schwarz, 2004). By contrast, barramundi (*Lates calcarifer*) fingerlings, a highly regarded and established farmed product in Australia, are sold commercially for AU$0.012–0.015 per mm (AU$0.48–0.60 per 40 mm fingerling; 2015 price) (David Borgelt, hatchery manager, Jungle Creek Aquaculture Pty. Ltd., personal communication). PSFI is also located at least 6 h away from Yamba (by road), and at times high mortalities have occurred in transport.

One option, to reduce cost and achieve reliability, is to adapt existing on-site prawn hatchery facilities to finfish production, as many of the requirements of prawn and estuarine fish hatcheries are similar. Both require similar water quality in terms of filtration, disinfection and acceptable levels of contaminants; both require production of algae and require laboratory facilities for holding axenic cultures, and scaling up production to tens of thousands of litres; both require *Artemia* as a live food for the larval stages, requiring both hatching and enriching facilities; both require similar aeration infrastructure throughout the hatchery complex (Colt and Huguenin, 1992; Huguenin and Colt, 2002). For full marine fish species, this is more complicated, as the rotifer-brine shrimp combination alone is often inadequate, and specialised copepod production facilities are required (Lee et al., 2005).

Clearly, applied research is needed, as fertilised eggs can be purchased at a cost-effective price and there is the added possibility of making use of existing facilities and services; but at present no detailed information exists on the potential of using this existing prawn hatchery infrastructure for mulloway fingerling production. Additionally, reliable supplies of cheap, high quality fingerlings are also essential for developing a viable industry (Schwarz et al., 2009). The strategy here is to build a new supply capacity in northern NSW by providing prawn farmers with the knowledge to produce their own fingerlings from purchased eggs. This is expected to provide growers with another option for annual farm stocking that would potentially halve their fingerling cost, eliminate transport issues, and help increase profitability, sustainability and viability of farms while also providing a basis for expansion of the industry (Bird, 2010).

Presently within Australian aquaculture there is a lack of information on the potential for temperate marine fish culture in aerated brackish-water prawn ponds, especially species selection, seed availability, cost of production, viability and market. There are also few published hatchery design studies, although important information exists for the juvenile production of tropical species such as barramundi (Anderson, 2004; Schipp et al., 2007).

This paper was motivated by the desire to inform industry how a possible change from prawn to finfish culture could be implemented and to our best knowledge, presents the first technical information on how the prawn hatchery infrastructure of Palmers Island can be utilised for mulloway production. It provides details of the production facilities and support systems necessary for estuarine fish larviculture and documents conversion and production costs. This information will be useful for commercial decision making by Australian prawn farmers, potential investors or developers.

2. Existing prawn hatchery facilities and layout

2.1. Location and climate

Both hatcheries are located at Palmers Island, in the warm temperate coastal zone of northern NSW, about 10 min inland from the east coast town of Yamba (29.4°S, 153.3°E). Since the 1980s prawn farms have been established on land adjacent to the Clarence River, which is the source of brackish-saline water at the farms. Palmers Island varies in altitude/elevation from about 5 m to 7 m above sea level and has typical summer (November to April) air temperatures of 25–35 °C. The prawn farms and Palmers Island have been previously described in Smith (1996) and Kankaanpää et al. (2005).

2.2. Australian hatchery

The Australian hatchery is part of Tru Blu prawn farm (36.93 hectare (ha)) which has been in production since 1984 and is the oldest farm specializing in culture of black tiger prawns in NSW. At the peak of production in 2003 Tru Blu had 26 ponds with a total area of 21.6 ha. The hatchery was built in 2002 to fulfil the requirements of producing 20 million postlarvae 15 days from the megalopa stage (PL15s); the preferred age as PLs are easier to harvest, transport and stock at this size. The hatchery was operated only four times before the downturn in the industry; it is currently idle with a recorded maximum output of around 8 million PL15s. Site visits were conducted during 2012 and information gathered from interviews with current owners, past managers and employees.

2.2.1. Layout, descriptions and dimensions

Exterior: The hatchery building is a 21.19 m × 48.45 m t-clad COLORBOND® steel shed anchored to a concrete slab. These industrial buildings are common in rural Australia with numerous sliding doors for entry and transparent walls and roofing used to assist in light penetration. There is also an adjacent building (26 m × 9 m) with an insulated broodstock and hatching room and accommodation (kitchenette and a bedroom) (Fig. 1). Distribution of water to the two hatchery supply ponds is by an aqueduct system that is fed directly from the pump station situated on the nearby banks of the Clarence River. The supply ponds are lined with a black high density polyethylene plastic and equipped with a centrifugal pump and 80 mm supply lines to the hatchery. The water, prior to hatchery use, passes through an enclosed top mount sand filter (300 L capacity) and then a series of four cartridge and two fine bag filters. There is also a water temperature control and heating system (using a bottled gas boiler) to ensure that the water temperature remains between 26 and 30 °C which is stored in 3 × 30,000 L polyethylene rain water tanks, adjacent to the hatchery (Fig. 1). An aeration bank (3× side channel blowers; 50 Hz 3 phase electric motor) behind the storage tanks provides air to the hatchery and storage tanks via a network of PVC pipes.

Interior: The main sectors are shown in Fig. 1 and include areas for storage and cold stores, laboratory and office (for refrigeration, washing of glassware as well as general service to the hatchery including benches for microscope work), algae laboratory (to maintain pure stocks of *Chaetoceros, Skeletonema, Tetraselmis* and *Chlorella* and equipped with a laminar flow cabinet and sink), algae room (for open-topped cost effective mass production of algae which is pumped directly into the 20,000 L half barrel tanks for larval rearing), *Artemia* production and packing. All slopes are 1 in 200 (i.e. 5 cm every 10 m) draining to plastic grated drains. The hatchery is dominated by the 20 × 20,000 L half barrel larval rearing tanks (7.5 m long × 2.4 m wide × 1.54 m high; AU$8350 each-2012 pricing) (Fig. 1(b)). All larval rearing (nauplii to PL15) is conducted in these tanks (stocking density 100 nauplii per litre with around 50% survival rate to PL 7–10) and there is no separate nursery stage. There are also 6 × 1000 L white translucent tanks (for mass culture of algae), 7 × 1000 L (black) and 4 × 3000 L *Artemia* hatching tanks, an alarm system to the accommodation as well as an air and water delivery system to all tanks which passes through a wall-mounted ultra-violet (U-V) lamp system (single lamp, 185 W, magnetic ballast).