

Exotic marine pests: what is being done about preventing their introduction

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Abstract

Exotic marine pest species are a real threat to Territory ecosystems as demonstrated by the infestation of Darwin marinas in 1999 by the black-striped mussel (*Mytilopsis sallei*). The rapid response afforded by the Northern Territory Government resulted in the successful eradication of the exotic bivalve from Australian coastal waters. To ensure the initial eradication event was successful in the long term an Aquatic Pest Management (APM) unit was established with the NT Fisheries Group. This unit has been proactive in the development of risk mitigation protocols in terms of minimising the chance of introduction of marine pest species, and in the monitoring of Territory waters for the appearance of exotic species. The APM is active in three main areas: environmental monitoring, inspection and treatment of high risk vessels, and public education. A total of 103 species of native fouling organisms have been recorded over three years of biological monitoring. Strong seasonal cycles in species composition and water quality are also evident. The Wet Season influx of freshwater renders the artificial environments of the lock-accessed marinas susceptible to invasion by exotic species. The introduction of vessel inspection protocols for high risk visiting international vessels has been rewarded by the interception of a number of exotic species. The monitoring and inspection activities of the APM are complimented by public involvement in detecting and preventing the spread of exotic species.

Introduction

Prior to April 1999, tropical ecosystems were not considered vulnerable to invasion by marine pest species because of the already high diversity resulting in filled niches. The black-striped mussel, *Mytilopsis sallei*, disproved this hypothesis threatening local aquaculture, fisheries, tourism, defence and port industries. In light of the cost associated with the eradication of the bivalve (in excess of \$2.2 million) and the negative flow-on effects to the economy, marina owners and fishing industry representatives requested the Northern Territory Government introduce some means by which to minimise the chance of similar events recurring.

No information was available pertinent to the water quality throughout the year in tropical, marine systems, compounded by a paucity of literature on Northern Territory lock-accessed marina ecosystems. Also, little was known about the ecology of the artificial marinas, with minimal information available for the greater Darwin Harbour area. Recent biological surveys of tropical ports have also found ports to possess their own unique species assemblages (Hoedt et al., 2000).

The vast majority of exotic marine pests have been introduced via vessels either in the ballast water or via biofouling on their hulls, internal seawater systems or fishing equipment. Aquaculture, aquarium trade and floating debris are also sources of potential marine pest species, however these are relatively low-risk in comparison to vessels.

The Australian Quarantine Inspection Service (AQIS) currently manages the risk of marine pest introduction via the ballast water carried by international trading vessels on a national basis. Ballast water is used to stabilise large vessels. AQIS uses the Ballast Water Decision Support System (DSS) to identify vessels carrying high-risk ballast water, which are subsequently prohibited from discharging the ballast water prior to completing ballast water exchange in open oceanic waters.

The potential introduction of marine pests via biofouling on vessels or fishing equipment is not managed nationally at present. The Northern Territory is the only jurisdiction in Australia that subjects non-commercial vessels to a biofouling risk-assessment.

Materials and Methods

The species diversity of fouling communities developing in marina and open water systems of Darwin Harbour have been monitored since May 1999 using a combination of artificial settlement surfaces, time lapse photography of *in situ* surfaces and visual diver inspections.

Concurrent with the biological monitoring is a bimonthly assessment of five primary water quality parameters (temperature, salinity, dissolved oxygen, pH and turbidity) measured using an HORIBA U-10 water quality checker, with data collected since December 1999. This data is complemented by information on the phosphorous, nitrogen and copper levels in the marinas determined on a monthly basis during the period February 2000 and February 2001 as detailed in Sly et al. 2002.

Settlement traps, photography sites and water quality monitoring points are located within each of the four Darwin marinas: Cullen Bay Marina, Frances Bay Mooring Basin, Tipperary Waters Marina and Bayview Marina. Within the open waters of Darwin Harbour, settlement traps and water quality monitoring points are located immediately outside Cullen Bay Marina lock, within Larrakeyah Naval Base, and along side Stokes Hill Wharf and Fishermans Wharf.

In recognition of the likelihood that the black-striped mussel was introduced to Darwin Harbour via a visiting international vessel, all vessels wishing to enter Darwin marinas are subject to a risk assessment process. High risk vessels are subsequently subjected to a visual hull inspection and treatment of their internal seawater systems with a 5% detergent solution for 14 hours. Vessels apprehended off the north Australian coastline are inspected outside of port limits prior to being permitted entry to the Port of Darwin.

Results

The information collected revealed distinct Wet and Dry Season influences on both water quality, the species composition of biofouling communities and the number of visiting vessels. Wet Season conditions prevailing from February through to April contrast strongly with those of the Dry Season (May through October).

Water quality

Seasonal influences were evident in the majority of water parameters measured, largely as a result of the influx of freshwater during the Wet Season, and the subsequent lack of freshwater input during the Dry Season. The enclosed marina sites generally exhibited stratification (thermal and saline) during the Wet Season which was not apparent at the open water Harbour sites (Figures 1 and 2).

Nutrient levels (nitrogen and phosphorous) were generally below the analytical detection limits. Where slightly elevated readings were detected, these could be attributed to increased vessel activity in the marinas as opposed to seasonal influences.

During the application of copper sulphate, concentrations of copper in marina waters generally exceeded 1000 µg/L (Parry et al., 1999). These concentrations had dropped by 50% within two to five weeks of application, and by 90% within 2 months (June 1999). Concentrations have been relatively stable since the end of 1999 (Sly et al., 2002). It is clear that the sediments of Cullen Bay Marina, Frances Bay Mooring Basin and Tipperary Waters Marina possess elevated levels of copper. However the results of toxicity tests on sediment samples from October 2000 showed the sediments to have no toxicity to the two test species, an infaunal amphipod and an epibenthic mysid (Parry and Munksgaard, 2001).

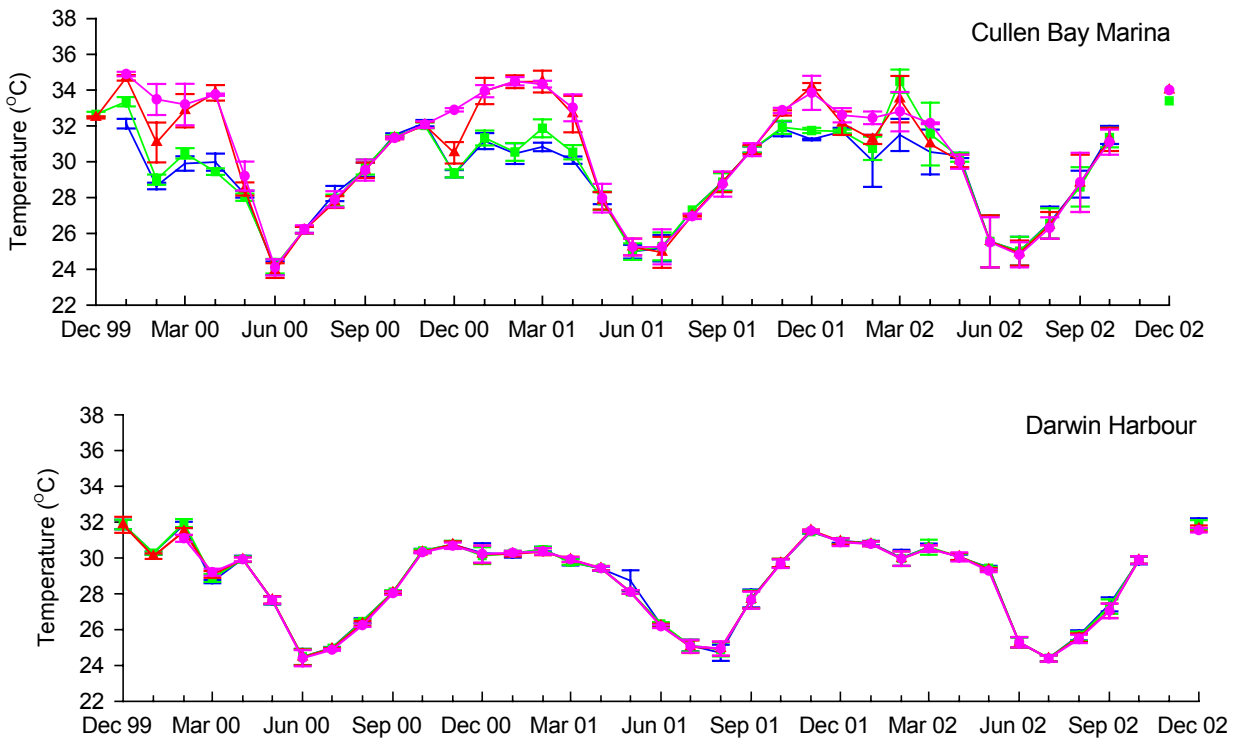


Fig 1: Monthly temperature (mean °C ± standard error) recorded in Darwin Harbour and Cullen Bay Marina at 0.5m (—), 1.0m (—■—), 2.0m (—▲—) and 3.0m (—◆—) between December 1999 and December 2002

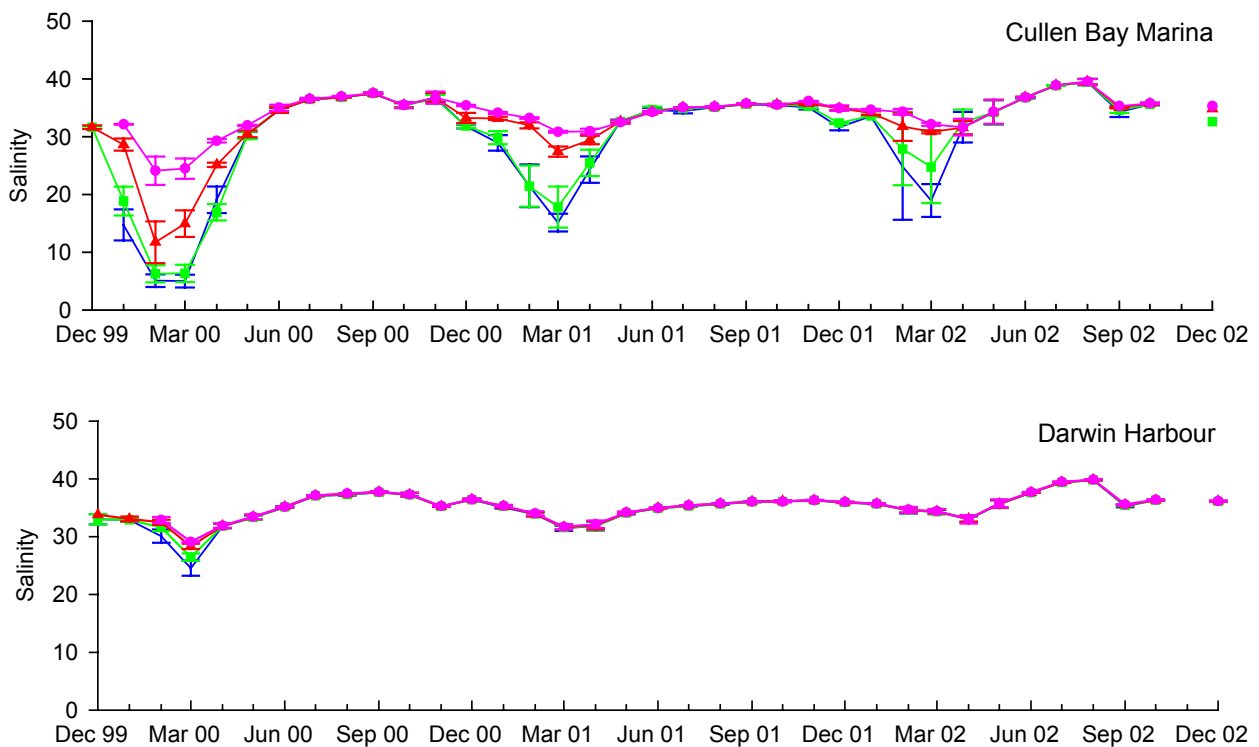


Fig 2: Monthly salinity (mean ± standard error) recorded in Darwin Harbour and Cullen Bay Marina at 0.5m (—), 1.0m (—■—), 2.0m (—▲—) and 3.0m (—◆—) between December 1999 and December 2002.

Biological diversity

A total of 103 species of sessile fouling species were recorded from the artificial settlement surfaces deployed within the Port of Darwin. No exotic or marine pest species have been detected since May 1999. A greater number of species have been recorded from the open waters of Darwin Harbour than from within the four marinas (Table 1). The composition and biomass of fouling communities developing on artificial surfaces deployed in the four Darwin marinas were largely influenced by the seasonal changes in salinity and temperature. Significant die-back of the fouling community was observed during the Wet Season as a result of the influx of freshwater from rainfall and stormwater runoff.

The difference between open water site fouling communities and those of the marinas may be attributable to the influences of tides and the more natural environment prevailing in Darwin Harbour in comparison to that in the enclosed, artificial marina environments.

Table 1: Comparison of mean numbers of taxa found on settlement plates in Darwin marinas and the open water.

Higher Taxa	Overall number of species identified	Number of species recorded from :				
		Cullen Bay	Frances Bay	Tipperary Waters	Bayview	Darwin Harbour
Protozoa	3	3	2	2	2	1
Algae	25	12	9	11	14	18
Sponges	7	4	1	2	4	5
Hydroids	6	1	1	0	4	4
Polychaetes	7	5	6	4	6	3
Molluscs	7	3	0	0	4	5
Bryozoans	23	9	1	3	8	11
Crustaceans	6	5	4	4	4	5
Ascidians	19	9	5	5	7	12
TOTAL	103	51	29	31	53	64

Vessel inspections

A total of 606 visiting vessels have been inspected with 4% quarantined under the Regulations of the Northern Territory *Fisheries Act* due to the presence of potential marine pest species such as unidentified bryozoan species, black-striped mussel and Asian green mussel. To date 20 marine pest species have been excluded from Darwin marina environments corresponding to a potential saving against the eradication of marine pests corresponding to \$44 million.

A similar proportion of apprehended vessels were infested with exotic marine pest species. Four percent of the 125 vessels inspected were either denied entry to the Port of Darwin or destroyed as the result of black-striped mussel or Asian green mussel being present on their hulls. All five vessels carrying exotic marine pests were of the same design and from the Province of Probolinggo.

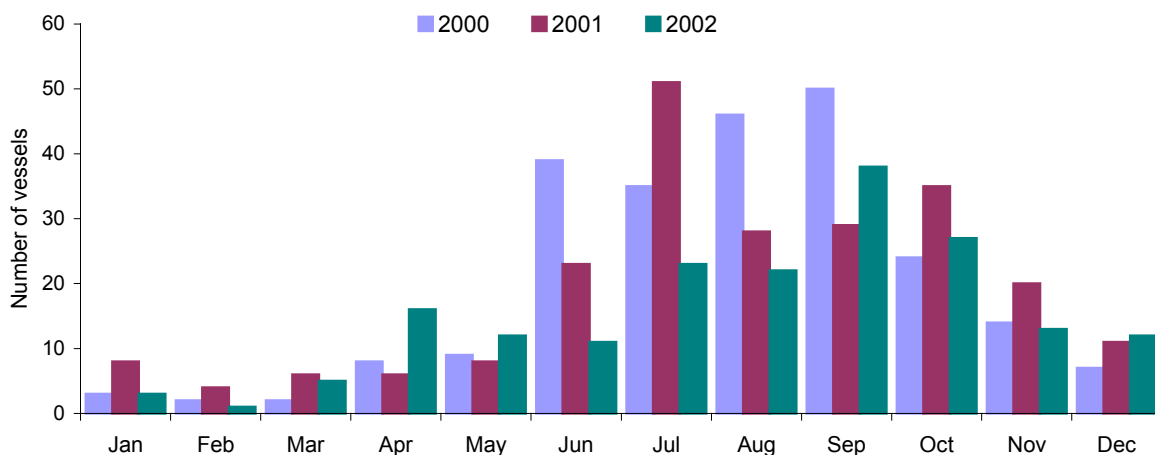


Fig 3: Seasonal influence on the number of high-risk visiting vessels inspected for aquatic pest species on entry into the Port of Darwin

Discussion

The Wet Season freshwater influx renders Darwin marinas more susceptible to invasion by exotic pest species. The multitude of microenvironments created by stratification provides various environmental niches within which marine pest species can gain a foothold from which to radiate into open waters.

Environmental disturbance is well recognised as opening a window of opportunity for the establishment of new populations of aquatic pest species (Hobbs and Huenneke, 1992). The vulnerability of the marina systems as a consequence of their artificial nature, combined with the high level of international boating traffic, confirms the need for continued environmental monitoring for the appearance of aquatic pest species.

In general, water traffic in Darwin Harbour is due to increase with the development of the international Port of East Arm in conjunction with the completion of the national railway link in 2003. Surveillance for marine pest species in the Port of Darwin provides important information on natural assemblages, enabling more effective recognition of exotic and aquatic pest species.

References

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