3 Effect characterisation: evaluation of data and information on potential impacts

3.1 Effects of invasive alien species (IAS)

Invasive alien species (IAS) are non-native organisms that cause, or have the potential to cause harm to the environment, economies, or human health, and are considered to be one of the most significant drivers of environmental change worldwide (Mooney & Hobbs 2000, McNeely et al 2001). The globalisation of trade, travel, and transport is greatly increasing the number of invasive alien species being moved around the world, as well as the rate at which they are moving (McNeely et al 2001). Changes in climate have recently been recognised to be responsible for rendering some habitats more susceptible to biological invasion (Mooney & Hobbs 2000). Invasive alien species can influence species diversity, richness, composition and abundance. The direct effects of invasive alien species at the species level occur through processes such as the predation of invasive alien species on, their competition with, and pathogen and parasite transmission to individual organisms (Wilcove et al 1998, McNeely et al 2001), eventually leading to population declines and resultant species extirpations and extinctions (Simberloff 1986, 2001, D'Antonio & Dudley 1995). However, the success of the establishment of the new organisms depend on many factors. Williamson and Brown (1986), and Williamson (1996) estimated that 1 out of every 1000 organisms introduced into a new environment thrives and become invasive. In most cases, the introduction of biological organisms does not create a problem; either the organisms do not survive in their new conditions without deliberate cultivation and husbandry or their populations are small and easily managed (Mack 2000, Mack et al 2000). Whether or not an invasion of an alien species is damaging depends on how and to what degree the indigenous biotic community is disrupted (Mueller-Dombois 1981).

Russell et al (2004) produced a comprehensive report on the number of terrestrial and marine non-indigenous species established at Ashmore Reef Islands (Table 1).

The tropical fire ant has been recorded on Middle and West Islands since at least 1992, and now it occurs on all three islands. During the Northern Australian Quarantine Strategy (NAQS) survey, Postle (in Curran 2003) observed that there has been an apparent increase in numbers of the tropical fire ant from 2000 to 2003 on East and West Islands. This species of ant lives in large subterranean colonies, and attacks in large numbers, it feeds on insects and other animals including vertebrates. It has been documented that ants of the genera *Solenopsis* are attracted to moisture in the eyes, nose and mouth of young mammals and in the hatching eggs of ground nesting birds and reptiles.

(http://www.tpwd.state.tx.us/nature/wild/insects/fireants.htm)

Vulnerable or tethered animals are susceptible to attack and as such, the ant is regarded as a potentially dangerous threat to ground nesting birds and turtle hatchlings at Ashmore. Russell et al (2004) recommended, as a matter of urgency, that further survey of this ant and other ants species be undertaken to determine the extent of its spread and its possible impacts.

Table 1 Non indigenous terrestrial plants and animals established at Ashmore Reef Islands (modified from Russell et al 2004)

Species	Native range	Distribution at Ashmore	Pest status
Plants			
Tribulus cistoides (beach caltrop)	Native to Africa, but now pantropical	Established on all Ashmore Islands	Weed species, impacts on bird nesting areas
Cenchrus brownie (burr grass)	Native to Central and South America, now widely distributed in SE Asia	Well established on West Island	Weed species
Cenchrus ciliaris (buffel grass)	Native to Africa and India	Established only on West Island	Weed species with potential to form mono-specific stand
Pennisetum pedicellatum (feather grass)	Native to South Africa	Established only on West-Island	Weed species, vigourous coloniser
Bulbostylis barbata (watergrass)	World-wide in tropics-subtropics	Established only on West Island	Weed species, may not pose serious problem
Euphorbia hirta (asthma weed)	Pantropical	Established only on West Island	Weed species, may harbour Poinsettia whitefly pest
Cleome gynandra (cats whisker)	Native to Africa, but now widespread	Established on West Island	Weed species
Insects			
Solenopsis geminata (tropical fire ant)	North America, but now widespread throughout tropical Pacific, including Indonesia and North Australia	Established on all islands	Known pest, potentially dangerous to nesting birds
Teleogryllus oceanicus (black field cricket)	Pantropical	Established on west Island, and with the potential to spread to other islands	Potential pest species
Dermestes spp. (hide beetles)	Cosmopolitan	Established on all islands	Carrion feeder, little ecological impact
Necrobia rufipes (redlegged ham beetle)	Cosmopolitan	Established on all islands	Carrion feeder, little ecological impact
Reptiles			
Hemidactylus frenatus (Asian house gecko)	SE Asia, but widespread throughout Indo-W Pacific	Established on West Island	Potential pest species, may impact on invertebrate fauna
Rodents			
Mus musculus (house mouse)	World wide	Established on East and Middle Islands	Known pest species, potentially dangerous to nesting birds

3.2 Island populations vulnerability and the effect of multiple pressures

Islands are considered to be particularly vulnerable to the impacts of invasion by alien species (Simberloff 1995, 2000b). The risk of the introduction, establishment, and spread of invasive alien species in island systems depends on a number of ecological and socio-economic factors that are context specific and often inter-related (Table 2).

Table 2 Some of the ecological and socio-economic factors that can influence the risk of introduction, establishment and spread of IAS in island ecosystems (modified from UNEP 2003)

Factors	Introduction	Establishment/Spread
Ecological	Species mobility including ability to survive transit	Resource availability (food, habitat etc..)
	Species ability to escape into the environment by means of unintentional introductions	Ability to avoid predation, competition, pathogens and parasites
		Ability to produce viable offsprings
		Ability to establish mutualisms
Socio-economic	Demand for goods and services (import/export), tourism, illegal immigration	Types, routes, timing of pathways
	Modes, frequency, capacity and routes along pathways	Exsistence of effective IAS early detection programs
		Timing of IAS detection and response
		Methods used for eradication or control, as well as timing and scale the response to invasion

From both an ecological and socio-economic perspective, ants are probably the most harmful group of invasive insects on islands (UNEP 2003).

A disproportionate number of bird extinctions in the past century have involved island birds. Diamond (1985) recognised some factors being responsible for island populations being so vulnerable:

- populations sizes are smaller on islands than on continents, and risk of extinction varies inversely with population size;
- the isolation of islands often means that they were not reached naturally by predators, diseases, and competitors with which mainland species evolved and became adjusted. The impact of arrival of these agents on island populations not previously exposed to the agents has often been rapid and catastrophic and;
- islands are distinctive because they are separated by barriers to dispersal of the island birds themselves. Fragmentation of range by dispersal barriers is one factor predisposing populations to extinction.

Habitat destruction and deterioration, are the most important cause of endangerement for island birds (King 1978, 1980). At Ashmore deterioration and reduction of availability of nesting sites due to the spreading of the colonies of tropical fire ant, coupled with the spread of invasive vegetation such as the weed *Tribulus cistoides* (beach caltrop) (Russell et al 2004), might pose a threat to the overall nesting success of ground nesting species. This could cause declines in the turnover rates of populations of the breeding species on the islands. The

effect of the invasive species (ants and plants) on nesting success of ground nesting birds species at Ashmore has not previously been quantified, but it was recommended that a long term monitoring program assessing this risk in a quantitative manner be established for the future (Russell et al 2004).

3.3 Potential impact of the tropical fire ant on native species

3.3.1 Impact on ant communities and other invertebrates

S. geminata is a threat when introduced into new environments as it invades native (or existing ant) communities and may affect many or all of the plants and animals in that ecosystem (Yates 2005). Around the world *S. geminata* has been reported to decrease biodiversity (Taber 2000). They are similar to *S. invicta* (RIFA) where by they can decrease biodiversity through competitive displacement. This can occur through competition for resources such as food, as well as direct interaction between species (Molony & Vanderwoude 2002).

S. geminata can give powerful, multiple stings. Their unusual alkaloid venom is used in offence (for subduing prey) and as a defence mechanism (Taber 2000, Hölldobler & Wilson 1990).

S. geminata are polyphagous (having a wide-ranging diet) although they prefer protein. They tend honeydew-producing pest insects like aphids and mealy bugs and also feed on a variety of arthropods, meats and fats as well as scavenge on dead marine and terrestrial animals, rotting fruit and domestic garbage (Hölldobler & Wilson 1990, Yates 2005, Taber 2000, Way et al 2002).

Another part of their diet consists of harvested seeds which are stored in their nests. This characteristic is known to cause economic damage to a wide range of crops through loss of seed (such as sorghum and tomatoes during planting). They can ringbark and kill young seedlings (such as cucumber, tomato, mango, papaya, citrus, etc.) and can spread weeds that germinate from their storage areas within their nests (Taber 2000). They are also a nuisance to fruit pickers.

S. geminata is a predator of many invertebrates and in some situations is considered a beneficial insect. They kill fly maggots, ticks such as the tropical bont tick and cattle tick, giant African snail (*Achatina fulica*), as well as some pest insects such as weevils (eg cotton boll weevil), grasshoppers , caterpillars (eg armyworm), and green vegetable bugs (*Nezara viridula*).

The impact of *S. geminata* on specific native ant species is not widely documented. However, *S. invicta* (RIFA), *Pheidole megacephala* (coastal brown ant) and *Iridomyrmex humilis* (or *Linepithema humile* the Argentine ant) are a few species known to out compete *S. geminata*, mostly through direct conflict for food and habitat (Taber 2000, Hölldobler & Wilson 1990).

There have been several insect fauna collections at Ashmore prior to the current one:

- Pike in March to May 1992
- Brown in May 1995, May 1999 and June 2002.
- Postle Feb 2000 (West and Middle islands only)
- Postle and Williams Feb 2003 (East and West islands only) and Mar 2004 (all three islands).

They have mostly been very brief surveys and at different times of the year which, in effect, provides only a collection of small snapshots of the insect fauna at Ashmore Reef.

Only three ant species have been recorded from Ashmore Reef prior to this survey, *S. geminata*, *Paratrechina longicornis* and *Tetramorium* sp. The general insect fauna is relatively rich given the small area of the islands and harsh and hostile environment.

3.3.2 Impact on birds and reptiles

The tropical fire ant, is an opportunistic feeder, taking advantage of whatever food resource is at hand. They actively prey on invertebrates, vertebrates, and plants. Any animal that is relatively immobile and unable to run away from attacking ants is susceptible. Nestlings and 'pipped' eggs (which have just started to hatch and have a hole broken in them), especially of ground-nesting birds, turtles and lizards, are particularly vulnerable to predation (Moulis 1981, Mount et al 1981, Allen et al 2001).

Birds

The ants of the *Solenopsis* genera have been documented to prey on hatching birds, in particular of ground nesting species (Johnson 1961, Sikes & Arnold 1986, Wilson & Silvy 1988, Drees 1994, Lockley 1995, Giuliano et al 1996, Pedersen et al 1996, Teel et al 1998, Mueller et al 1999, Allen et al 1994, 1995). A quantitative study of the impact of imported fire ant predation on a population of the least tern (*Sterna antillarum*) in Mississippi (USA), demonstrated that reproductive success is lower in sites affected by the presence of invasive ants (Lockley 1995).

The impact of the tropical fire ant on the breeding success of ground nesting species such as the sooty tern and common noddy has never been documented or investigated in a quantitative way. This project aimed to gain a preliminary understanding of the ecological risks of the tropical fire ant to seabird colonies of Ashmore Reef, in particular, identifying the key vulnerable species and locations on the three islands.

Reptiles

There is evidence that predation from ants of the *Solenopsis* genera may dramatically alter the chances for survival of sea-turtles and other reptiles in general (Moulis 1997, Le Buff 1990, Mount 1981, Mount et al 1981, Wilmers et al 1996, Allen et al 2001, Wetterer & Wood 2001, Wetterer & O'Hara 2002). As such, the presence of the tropical fire ant at Ashmore could represent a potential threat for the breeding success of the turtles species breeding at Ashmore.

3.4 Overview of status and conservation of breeding seabirds species at Ashmore Reef

Overall 26 species of seabirds have been recorded for Ashmore Reef, and of these 15 species have been reported breeding. Two species of egrets are also breeding: the little egret (*Egretta garzetta*) and the eastern reef egret (*Egretta sacra*) (ANPWS 1989, Milton 1999). Below is a brief description of the distribution, status and conservation of the breeding species of seabirds and egrets, and of the potential threat to these species by tropical fire ants.

3.4.1 Wedge-tailed Shearwater (*Puffinus pacificus*)

Distribution

The wedge-tailed shearwater is a marine pelagic species widespread across the tropical Indian and Pacific Oceans (Bailey 1968, Lindsey 1986, Carboneras 1992, Marchant & Higgins 1990). In Australia it is a common breeding and non-breeding visitor to coastal and pelagic waters of east and western Australia (breeding on offshore islands of WA), and a vagrant to waters of north and south Australia (Marchant & Higgins 1990). Approximately 30 active nesting burrows of this species were counted during a survey at Ashmore Reef West Island in 2001 (Swann 2001).

Conservation status

The wedge-tailed shearwater is **not globally threatened**. It is abundant and widespread with a total world population of well over 1 million breeding pairs. Nevertheless, predation by alien fauna, especially foxes, cats, rats and dogs, and direct exploitation by man (eg harvesting of young birds in the Seychelles) is causing a decrease in numbers of local populations (Croxall et al 1984).

Potential threat by tropical fire ant

The nest of this species is a chamber at the end of a burrow, one or two metres long. One single egg is incubated by both parents in shifts of two to five days. When parents are brooding they do not leave the nest. The chicks, when they hatch, are brooded only for the first day and then abandoned, visited only to be fed. The growth of the chicks is very slow and chicks take at least a week to double their hatching weight (Lindsey 1986, Marchant & Higgins 1990, Carboneras 1992).

The consequences of an invasion of tropical fire ants in the nesting burrow is unknown, but given that both adults and chicks spend long periods of immobility in the nest, ants might represent a factor of disturbance. A factor of potential concern is that pipping to hatching can take up to 3 days (Roberts et al 1974), and pipped eggs are probably at this stage more susceptible to ant attack. When chicks are left alone in the nest for relatively long periods while their parents forage at sea, young newly hatched small chicks might become vulnerable to ant attack. If nesting fails, in this species, there is usually no replacement laying (Marchant & Higgins 1990).

3.4.2 Masked Booby (*Sula dactylatra bedouti*)

Distribution

The masked booby has an extensive distribution in tropical and subtropical parts of the Indian, Pacific and Atlantic Oceans (Lindsey 1986, Marchant & Higgins 1990). In the Australasian region, it breeds on Cocos-Keeling, at several islands along the Great Barrier Reef and in the Coral Sea, and at Lord Howe, Norfolk and Kermadec Islands. In Western Australia it has been recorded breeding at Bedout and Adele (Marchant & Higgins 1990) and Ashmore Reef Islands (Burbidge et al 1987, Milton 1999, Swann 2001, Curran 2003). The individuals occurring on the islands of Western Australia belong to the subspecies *bedouti.*

Conservation status

The masked booby is a **nominate species not globally threatened**. Although not globally threatened race *melanops* is declining rapidly and the few remaining sizeable colonies are threatened (Feare 1978). Colonies in the Caribbean (2500 pairs), South Atlantic (5000 pairs) are subjected to exploitation by local people, who take eggs or even kill adults. Introduced

predators and development associated with recent booms in the tourist industry are also considered threats (Croxall et al 1984, Harrison 1990, Croxall 1991, Carboneras 1992). The national status of the breeding population of the subspecies *bedouti* has been determined independently of the global status (Gardenfors et al 1999). The Australian population of *bedouti* breeds at fewer than five locations (Burbidge et al 1987, Stokes & Goh 1987, Burbidge & Fuller 1996), including West and Middle Islands (Figure 8) at Ashmore Reef, and as such its conservation status is listed as **Vulnerable** (Garnett & Crowley 2000).

Potential threat by tropical fire ant

Masked boobies nest on the ground and no nest is built (Figure 9). The normal clutch is two eggs but there is some evidence to suggest it may vary with the season (Nelson 1978). Although two eggs are laid, seldom more than one chick is successfully fledged (Drummond 1987, Anderson 1989a&b). Chicks less than 5–6 days old cannot thermoregulate and they are brooded continuously until they are 3–4 weeks old. Evidence suggests that chicks may die after only 20 minutes of exposure to tropical sun (Marchant & Higgins 1990). The impact of tropical fire ants on this species has not been quantified, but any form of disturbance to the adult or to the chick, during the first weeks of hatchling, could potentially pose a threat to the success of the survival of the young fledged chick.

Figure 8 Masked booby on nest at Middle Island

3.4.3 Brown Booby (*Sula leucogaster*)

Distribution

The brown booby is the most common booby occurring through all tropical oceans approximately bounded by latitudes 30ºN and 30ºS (Marchant & Higgins 1990). In Australia it breeds at a number of offshore islands including Ashmore Reef (Milton 1999, Swann 2001, Curran 2003) and Adele Island in Western Australia along the tropical northern coast to Torres Strait, the Coral Sea and south to the bunker Group off central Queensland (Lindsey 1986, Marchant & Higgins 1990) (Figure 9).

Conservation status

The brown booby is **not globally threatened**. It is possibly the most numerous and widespread species of booby, but populations are often scattered and thus it is difficult to estimate total numbers (Carboneras 1992). In historical times, numbers have been severely

reduced mainly due to exploitation by humans for food or bait, and long established traditions of egg-collecting, which still persist in certain places. Human disturbance caused by tourism, may also adversely effect breeding birds (Croxall et al 1984, Humphrey & Bain 1990, Harrison 1990)

Potential threat by tropical fire ant

The brown booby nest is variable and may be a mere scrape in the ground, or a substantial structure of sticks, seaweed and other vegetation. The normal clutch is two eggs but it is rare for more than one chick to be reared successfully (Lindsey 1986). As for the other species of boobies young fledged chicks are vulnerable and totally dependent on adults for brooding. As such, any disturbance caused at the nest to adults or chicks may pose a threat to chick survival. Replacement of lost clutches is low in this species, as the clutch can constitute over 8% of the female's weight, and this makes replacement laying more improbable for this species (Carboneras 1992).

Figure 9 Brown booby adult at East Island

3.4.4 Red-footed booby (*Sula sula)*

Distribution

The red-footed booby is the smallest of boobies with an extensive distribution over tropical regions of the Indian, Pacific and Atlantic Oceans. It is not particularly common in the Australasian region but it breeds on Christmas and Cocos-Keeling Islands, Raine Island, Pandora Cay and a number of islands in the Coral Sea. At Ashmore Milton (1999) has recorded the red-footed booby breeding at Middle Island (Lindsey 1986, Marchant & Higgins 1990, Curran 2003) (Figure 10).

Conservation status

The red-footed booby is **not globally threatened.** Although not globally threatened populations are widely scattered on a myriad of small islands around the tropics, and few

colonies are protected. Due to its tree-nesting habit it has suffered greatly from habitat destruction, especially in the West Indian Ocean. Other factors limiting numbers include egg-collecting, poaching, predation by rats and disturbance caused by tourism (Feare 1978, Croxall et al 1984, Carboneras 1992).

Figure 10 Red-footed booby on nest at Middle Island, November 2004

Potential threat by tropical fire ant

Unlike other boobies the red-footed booby almost always nest in trees (Figure 10). The colonies vary in size and density, ranging from a few pairs to concentrations of thousands. Nelson (1978) recorded 5000+ pairs at Christmas Island. The nest is a structure of sticks, sometimes lined with a few leaves. At Middle Island, birds have been observed nesting on bushes of *Argusia argentea* and *Scaevola taccada* (Milton 1999). In its breeding habits the red-footed booby shows those characteristics common to seabirds adapted to the tropical deep-water regions of the world's oceans, where food is often scarce and the supply unpredictable (Lindsey 1986). Therefore, it has a small clutch size, it lays only one egg and there are no confirmed records of more (Nelson 1978). The incubation of the single egg is shared by both parents. At hatchling the chicks are naked, helpless and grow slowly, and chicks are fed for several months thereafter. As for the other species of boobies, there is no literature available on the impact of tropical fire ants on this species. Nevertheless, the position of the nest above the ground may protect this species from being a major target by ant attack, especially when nestlings of other species might be available and easily accessible on the ground.

3.4.5 Great frigatebird (*Fregata minor)*

Distribution

Frigatebirds are strictly marine, living around both coastal and pelagic waters. They have an ample distribution around the warm seas and oceans of the tropics and subtropics. Two main factors dictate their distribution: an abundant source of food, preferably flying-fish, and a suitable wind regime, as their lifestyle depends a lot on soaring and gliding (Orta 1992a). Great frigatebirds have been recorded as nesting at Ashmore Reef (ANPWS 1989, Milton 1999a&b).

Conservation status

The **g**reat frigatebird is **not globally threatened**. The world population is estimated at half a million to one million birds. The main threats are habitat destruction and disturbance (Croxall et al 1984, Orta 1992a)

Potential threat by tropical fire ant

The nest is built in trees or bushes, consisting of a substantial platform of sticks, twigs and leaves, or it can be a platform rising from the ground. The breeding cycle of the frigatebirds is amongst the longest of all seabirds, and the general pattern is that birds can only breed successfully every two years, as the entire breeding season lasts for at least 14 months (Nelson 1978). One egg is laid, it is not known if replacement laying occurs when nests fail (Marchant & Higgins 1990). The chick grows slowly and is cared for by both parents for up to six months. No literature is available on the possible impact of tropical fire ants on this species. Nevertheless, as for the red-footed booby the position and structure of the nest may be an advantage for this species, and it may not be a major target of attack by ants. Any impact of tropical fire ant would be likely to affect the survival of the young stages of the chicks, or annoyance and disturbance to adults.

3.4.6 Lesser frigatebird (*Fregata ariel)*

Distribution

The lesser frigatebird is widespread throughout the tropical waters of the Indian, west and central Pacific Oceans with isolated populations in the Atlantic Ocean off Brazil (Marchant & Higgins 1990). It is the most common and widespread frigatebird in the Australian seas. It breeds at a number of islands in the Coral Sea, along the Great Barrier Reef and tropical coast of the Northern Teritory and Queensland. Birds regularly occur as far south as Fraser Island on the Queensland coast. In Western Australia, it has been recorded breeding at Adele and Bedout Islands, and at East and Middle Islands at Ashmore Reef (Marchant & Higgins 1990, Milton 1999a, Curran 2003) (Figure 11).

Figure 11 Lesser frigatebird juvenile at Middle Island

Conservation status

The lesser frigatebird is **not globally threatened.**The world population is estimated to be around several hundred thousand birds. The main threats are habitat destruction, disturbance and direct exploitation by humans for food (Croxall et al 1984, Marchant & Higgins 1990, Orta 1992a).

Potential threat by tropical fire ant

The nest consists of pieces of grass and other fragments of local vegetation. At Ashmore Reef, birds have been recorded using dead *Suriana maritima* bushes for nest sites (Milton 1999). As for the other species of frigatebird, one single egg is laid and the chicks are brooded for several weeks. The period of dependence of young is so long that many frigatebirds are still caring for young of the previous season at the peak of the following breeding season (Diamond 1975). This suggests that a pair of frigatebirds would be unable to breed successfully more than once in two years (Lindsey 1986). As for the great frigatebird, lesser frigatebird chicks grow slowly and are cared for by both parents for a long time. No literature is available on the possible impact of tropical fire ants on this species. Nevertheless, as for the red-footed booby the position and structure of the nest may be an advantage for this species and it might not be a major target of attack by ants.

3.4.7 White-tailed tropicbird (*Phaeton lepturus lepturus*)

Distribution

The white-tailed tropicbird is a pelagic seabird of tropical and subtropical areas. It is found throughout the central and west Pacific, south tropical Indian and Atlantic Oceans, and Caribbean Sea (Marchant & Higgins 1990). In Australia the species has been recorded breeding at North-Keeling Islands (40–50 pairs), at Rowely Shoals in Western Australia (1 pair), and on the three island of Ashmore Reef (<10 pairs) (Stokes et al 1984, Stokes 1988, Marchant & Higgins 1990, Burbidge et al 1996).

Conservation status

The species is listed as **not globally threatened**. The main threats to this species come from introduced predators to oceanic islands (rats and foxes), which cause considerable losses of both eggs and birds. Numbers at Christmas Island have declined due to clearing of habitat for mining (Stokes 1988, Marchant & Higgins 1990, Orta 1992b). The Australian population of the white-tailed tropicbird contains fewer than 250 mature individuals and as such the national status of the breeding population is assessed independently of the global status, and listed as **endangered** (Gardenfors et al 1999, Garnett & Crowley 2000).

Potential threat by tropical fire ant

No nesting material is used for the nest, and both sexes incubate in shifts of approximately four to six days. At West Island birds have been observed nesting in well hidden clumps of *Spinifex littoreus* out in the open grassland area (Swann 2001). The young are altricial and nidicolous, constantly brooded at first and then left for long periods in the nest while the adults are foraging at sea (Lindsey 1986, Marchant & Higgins 1990). As for the other species of seabirds described above the impact of tropical fire ants on the white-tailed tropicbird has never been quantified or recorded at Ashmore, but it could potentially affect the breeding success if ants get into the nest when chicks are young and defenseless. As in a number of other seabirds, the breeding cycle is not necessarily annual (Lindsey 1986), therefore, potential risks of nesting failures should be taken into consideration and avoided.

3.4.8 Red-tailed tropicbird *(Phaeton rubricauda)*

Distribution

The red-tailed tropicbird is widespread in tropical and subtropical regions of the Indian and western Pacific Oceans (Lindsey 1986, Marchant & Higgins 1990). In Australia the species has been recorded in all States. At Ashmore Reef a very limited number of pairs have been recorded (ANPWS 1989, Milton 1999a&b, Swann 2001, Curran 2003) with the largest populations located at Christmas Island (1400 pairs), Lord Howe Island (200 pairs), Norfolk Island (200 pairs), and North-east Herald Cay (250–300 pairs) (Marchant & Higgins 1990, Garnett & Crowley 2000).

Conservation status

The red-tailed tropicbird is not globally threatened (Orta 1992b). Althought not globally threatened the national status of the breeding population in Australia is determined independently of the global status, and listed as Near-Threatened (Gardenfors et al 1999). There has been a decrease in density over half of the species range in Australia; there are no recent breeding records from Rat Island, Rottnest Island or Busselton, and the number breeding on Sugarloaf Rock has declined from up to 34 pairs to just a few (Garnett & Crowley 2000). The largest sub population on Christmas Island is threatened by the yellow crazy ant (*Anoplolepis gracilipes*). These ants, which occupy about 15–18% of the island, are numerous on the terraces where the red-tailed tropicbirds nest and they are likely to kill nestlings (O'Dowd et al 1999, Garnett & Crowley 2000). Some populations in the Pacific Oceans, largely dependent on areas of upwelling, seem to be adversely affected by the Southern Oscillation of El Niño (Orta 1992b).

Potential threat by tropical fire ant

The red-tailed tropicbird nests alone or in loose colonies. A single egg is laid which is incubated by both parents in shifts varying from about two to six days until it hatches. Hatchlings are covered in down, and fed by both parents at intervals of a day or two. Impact of the tropical fire ants on this species has never been quantified or recorded at Ashmore, but it is likely to potentially affect the breeding success if ants get into the nest when chicks are young and defenseless. As for a number of other seabirds, the breeding cycle is not necessarily annual (Lindsey 1986) therefore, potential risks of nesting failures should be taken in consideration and avoided.

3.4.9 Bridled tern (*Sterna anaethetus*)

Distribution

The bridled tern has a range distribution through tropical and subtropical coasts and waters off east and west Africa, Asia, Carribean and Australia. In Australia it nests on small rocky islands all around the north coast, from the Great Barrier Reef in Queensland to the coast of Western Australia as far south as Cape Leeuwin (Lindsey 1986, Marchant & Higgins 1996). Several large bridled tern colonies have been recorded during aerial and ground surveys between 1990 and 2001 along the coast of the Top End of Australia. The main areas were located in NE Arnhem Land, SE Groote Eylandt and the Sir Edward Pellew Islands (Chatto 2001). Very little is known of their movements after breeding, but it is assumed that they disperse widely through the tropical seas. In Western Australia, at most breeding colonies, most adults and fledgings usually leave early to mid-April (Dunlop & Jenkins 1992). The estimates of 3000–4000 breeding pairs of bridled terns at Ashmore make it one of the five largest colonies recorded in Australia (Higgins & Davies 1996, ANPWS 1989, Milton 1999).

Conservation status

The bridled tern is **not globally threatened**. The population figures are unknown, but the world total population probably exceeds 200 000 pairs. Surveys conducted by ANPWS (1989) between 1983–1988 estimated 3000–4000 pairs regularly breeding at Ashmore Reef (Gochfeld & Burger 1996, Milton 1999).

Potential threat by tropical fire ant

The bridled tern lays one single egg and as for some other tropical seabirds, has an unusual breeding cycle. Instead of breeding annually, it breeds every seven or eight months. The nest is a shallow scrape in the sand or soft soil, often sheltered by boulders or shrubbery (Lindsey 1986). The incubation is by both sexes and at hatching the young are semi-precocial, needing brooding by parents for about three days after hatching (Hulsman & Langham 1985). The season for breeding changes according to the location: in East-Queensland it occurs mostly in spring and summer, in Western Australia, in late spring and summer (Hulsman 1977b). The stages of pipping eggs/ hatching and the first days of life of the young are the most vulnerable in terms of possible impact by the tropical fire ants who might attack and kill the chicks. Disturbance to adults during the laying period also might represent a potential factor impacting the breeding success.

3.4.10 Crested tern (*Sterna bergii*)

Distribution

The crested tern is almost a cosmopolitan species and it is widely distributed around the coastline of Australia, especially in the southern States, and on small islands off the coast (Pringle 1987, Higgins & Davies 1996, Gochfeld & Burger 1996). The crested tern has been recorded breeding at Ashmore on East and West Island (ANPWS 1989, Milton 1999a&b, Swann 2001). The crested tern colony at Ashmore is the largest in Western Australia and similar in size to the third largest colony recorded elsewhere in Australia (Higgins & Davies 1996). The movements are poorly known, and the species, throughout its range, is considered resident, dispersive and partly migratory (Urban et al 1986).

Conservation status

The crested tern is **not globally threatened.** Although not globally threatened, locally, the species might be vulnerable owing to its propensity for nesting in few, large, dense colonies (Gochfeld & Burger 1996).

Potential threat by tropical fire ant

The crested tern nest is usually placed on bare ground, in shallow recesses in rock, depressions among coral or rock fragments, or scrapes in shallow soil, sand, grass, saltbush (Figure 12).

Sometimes nests are fringed with small shells and other material. Both sexes build the nest, and the clutch size is composed of one or two eggs (Higgins & Davies 1996, Hulsmann 1977a). Both members of the pair engage in incubation, and both brood, feed and defend chicks. The hatching process generally takes more than a day. Young chicks spend more than 80% of their time inactive, usually crouched in the nest or in nearby shelter (Gochfeld & Burger 1996). The chicks of this species remain dependent on the adults for a long time. This dependency may be necessary to give the young birds time to perfect the difficult skills of diving for fish (Pringle 1987). The impact of ants of the genera *Solenopsis* on the nesting success of terns has been previously documented (Lockley 1995, Drees 1994). It is likely that the ants at Ashmore might pose a serious threat during the hatching stage and when chicks of the crested tern are very young.

Figure 12 Crested tern colony breeding at Middle Island

3.4.11 Lesser crested tern (*Sterna bengalensis*)

Distribution

The lesser crested tern is a species of tern confined to tropical waters. It occurs across the tropical Indian Ocean from the Red Sea to Indonesia and New Guinea. In Australia it is widespread along the north coast, from Shark Bay (WA) to about the latitude of Gladstone in Queensland (Pringle 1987, Higgins & Davies 1996). Estimates of 500 pairs of lesser crested tern have been reported for Ashmore Reef (ANPWS 1989). In Australia the species is rather sedentary and does not migrate far from its breeding ground, although lesser crested terns are migratory elsewhere in the Indian Ocean (Pringle 1987).

Conservation status

The lesser crested tern is **not globally threatened**. The world population has been estimated at 225 000 pairs, more than half of which are in Australia (Gochfeld & Burger 1996).

Potential threat by tropical fire ant

The breeding season is from October to December on the Great Barrier Reef, and from April to June in the tropical north-west. The breeding biology has not been well studied. Clutch size is generally one, rarely two. The young are precocial and semi-nidifugous and both parents feed the young till at least fledging (Hulsman 1977a&b). As for the other species of terns, it is likely that the tropical fire ants at Ashmore might represent a potential threat to the lesser crested tern during the hatching stage and when chicks are very young.

3.4.12 Roseate tern (*Sterna dougallii*)

Distribution

The roseate tern is almost a cosmopolitan species. It has a wide but scattered breeding range in the temperate and tropical waters on both sides of the equator (Pringle 1987, Higgins & Davies 1996). The roseate tern has been recorded breeding at Ashmore (ANPWS 1989). In Australia it breeds annually on small islands off the coast of Western Australia, especially in the Abrolhos group, and few coral islands off the north coast of Queensland (Serventy & White 1951, Fuller & Burbidge 1992, ANPWS 1989). Thirty-eight roseate tern breeding colonies were confirmed during aerial and ground surveys of the coast of the Top End of Australia. The breeding colonies of roseate terns around the Northern Territory coast varied in size from a few pairs in association with larger black-naped tern colonies, to sites with many thousands of roseate terns nesting alone (Chatto 2001).

Conservation status

The roseate tern is **not globally threatened**. The world population has been estimated at approx 50 000 pairs. Nevertheless, some populations show drastic declines; egging is a continual threat and significant cause of mortality in the Carribean and E Africa. Netting, baited hooks or snaring may account for population declines in South America and West Africa (Gochfeld & Burger 1996).

Potential threat by tropical fire ant

The breeding season is extremely variable. In general, it breeds during the local summer above the equator and during the local winter below it (Pringle 1986). In Western Australia there seem to be two quite distinct breeding periods, with peak months for laying appearing to be April and November (Higgins & Davies 1996). A peak of 306 estimated breeding pairs have been recorded for Ashmore reef in May (ANPWS 1989). Breeding pairs locate the nest on bare ground, in shallow recesses in rock, depressions among coral or rock fragments, or scrapes in shallow soil, sand, grass or saltbush (Higgins & Davies 1996). One to two eggs are laid (Hulsman 1977a) and incubation is shared by both sexes (Warham 1956). Young are precocial and semi nidifugous, but very few studies of information is available on growth or development. In general the species seems to be quite vulnerable to any sort of disturbance during the breeding seasons, and disturbed birds are most likely to abandon the nest (Gochfeld & Burger 1996). On Long Island, New York, there was records of ants entering pipping eggs and killing hatchlings (Gochfeld & Burger 1996). Tick infestation sometimes cause abandonment in the Seychelles and East Africa (Gochfeld & Burger 1996). Therefore, it is likely that the tropical fire ants at Ashmore might be a potential threat to the breeding success of this species, especially during the hatching stage and when chicks are very young.

3.4.13 Common noddy (*Anous stolidus*)

Distribution

The common noddy is widespread in tropical and subtropical areas, found on both sides of the equator in the Indian, Pacific and Atlantic Oceans. In Australia it breeds on small off-shore islands and coral cays around the north coast from the Abrolhos Islands, in Western Australia, to the Capricorn group in the Great Barrier Reef. Common Noddies have been recorded breeding on all three islands at Ashmore Reef (ANPWS 1989, Higgins & Davies 1996) (Figure 13). The total estimated number of breeding pairs varied between 13 000 to 35 000 during the 1983–1988 surveys conducted by ANPWS (1989). Milton (1999b) estimated 14 000 birds on East Island during a survey in October 1998. The same estimate (15 000 birds) was recorded during this survey in November 2004 These estimates make the Ashmore Reef common noddy colony the second largest in Australia, after the Abrolhos Islands populations (Milton 1999b).

Conservation status

The common noddy is **not globally threatened.** The world population has been estimated to be around 300 000–500 000 pairs, 100 000 of which are in Australian waters. The main threats to the species are invasive species such as cats and rats (Gochfeld & Burger 1996).

Figure 13 Common noddy at East Island, November 2004

Potential threat by tropical fire ant

The breeding season is erratic and varies greatly. At some sites they can breed annually; at others they breed twice a year, in spring to early summer and in autumn; on some islands they breed at all times of the year (King et al 1992, Higgins & Davies 1996). At Ashmore the peak breeding season has been recorded between September and December (Higgins & Davies 1996, Dunlop & Goldberg 1999). Nesting colonies are impressive, though rarely as large as those of the sooty terns. At Ashmore they nest on the bare ground, while at other locations nests can be placed on trees, small bushes or bare rocks. Clutch size varies between one and two, but usually one egg only is laid (Hogan 1925, Hindwood 1940, Gibson-Hill 1949, King 1985). Both members of the pair engage in incubation, the shifts are normally short and the eggs are seldom unattended for long periods. The young are semi-precocial and hatch in down. As for the other ground nesting species of seabirds the tropical fire ants may pose a potential threats to the breeding success of this species during hatching and when hatchlings are very young. There is evidence that if eggs are removed this species will re-lay up to three times (Gibson-Hill 1947). Therefore, despite the potential threat that tropical fire ants may represent, this species may respond better than other species to the ant's impact.

3.4.14 Black noddy (*Anous minutus*)

Distribution

The black noddy is mainly distributed in the central and south-west Pacific Ocean. Breeding populations are sparsely scattered elsewhere in the tropical and subtropical Atlantic Ocean, Caribbean Sea, Philippines and Indonesia. In Australian waters it breeds on small islands and coral cays along the Great Barrier Reef from Darnley Island in Torres Strait to the Capricorn Group in Queensland (Pringle 1987, Higgins & Davies 1996). Estimated numbers of 50–100 breeding pairs were recorded at Ashmore Reef during the surveys conducted by ANPWS between 1983–1988 (Milton 1999a).

Conservation status

The black noddy is **not globally threatened.** The black noddy's world population is estimated at over 200 000 pairs. Many local populations, however, are threatened by habitat destruction. Cyclones occasionally interfere with parental feeding, causing chick starvation (Gochfeld & Burger 1996).

Potential threat by tropical fire ant

The black noddy nests on trees or shrubs. At Ashmore Reef it has been recorded nesting in *Sesbania cannibina* bushes (Stokes & Hinchey 1990). One egg is laid, usually in November and the first chicks hatch in December. Both parents share in incubating the egg and feeding the young. The young are semi-precocial and remain in the nest until fledging (Pringle 1987, Higgins & Davies 1996). No evidence of direct impact of ants of the genera *Solenopsis* on the black noddy has been found in the literature. Nevertheless, as for the other species of seabirds described above, the stages of pipping eggs/hatching and the first days of life of the young are when they might be vulnerable to attack by tropical fire ant.

3.4.15 Lesser noddy (*Anous tenuirostris melanops*)

Distribution

The nominate subspecies, *Anous t. tenuirostris*, of the lesser noddy is mainly confined to the Indian Ocean, where it breeds in the Seychelles, Mascarene Islands and probably Maldives (Gochfeld & Burger 1996). In Australia, the subspecies *melanops* is rare and breeds on the Houtman Abrohols off the coast of Western Australia. The subspecific status of birds recorded at Ashmore is still under debate (Stokes & Hinchey 1990).

Conservation status

The species is **not globally threatened.** Although not globally threatened few colonies have been discovered to date (Gochfeld & Burger 1996). In Western Australia there has been an apparent decline from 1989 to 1993, but the population fluctuates and is still larger than earlier in the century (Fuller et al 1994, Burbidge & Fuller 1996). In Australia, the subspecies *melanops* breeds in a small area that could be badly affected by catastrophes, such as cyclones or pollution from oil spills, consequently the species is listed on the Action Plan for Australian Birds as **Vulnerable** (Burbidge & Fuller 1991, Garnett & Crowley 2000).

Potential threat by tropical fire ant

If breeding occurs at Ashmore this species may be similarly under threat as described for the black and common noddy.

3.4.16 Sooty tern (*Sterna fuscata*)

Distribution

The sooty tern is a pelagic species of tern distributed across the tropical and subtropical waters and islands of the Indian, Pacific and Atlantic Oceans. In Australia, the sooty tern has been recorded on islands of the north-west, including the Abrolhos group in Western Australia, and on the north-east coast along the Great Barrier Reef. Breeding colonies of up to 1 000 000 pairs have been recorded on Lord Howe Island and offshore islets, and up to 70 000 pairs at Norfolk Island and its offshore islets (Higgins & Davies 1996, Pringle 1987). The APWS estimated 10 000–50 000 breeding pairs at Ashmore Reef during their surveys between 1983–1988 (ANPWS 1989). These estimates make Ashmore Reef the largest breeding colony of sooty terns in Western Australia. Recently, Milton estimated 6000

breeding pairs during his survey in 1998 (Milton 1999). Counts and estimates vary considerably between years and observers. Milton (1999a&b) reported that this variability could be due to: count underestimation, a decline in the breeding populations or, more likely, represent interannual variation similar to that found in the Great Barrier Reef colonies (Higgins & Davies 1996, Milton 1999a&b) (Figure 14).

Figure 14 Adult of sooty tern at Middle Island, November 2004

Conservation status

The sooty tern is **not globally threatened**. The sooty tern is probably one of the most abundant of seabirds, with a total world population exceeding 25 000 000 pairs. The main threats are represented by predation of eggs by humans, predation of eggs and chicks by cats and rats and infestation of colonies by virus-infected ticks (Feare 1976, Gochfeld & Burger 1996).

Potential threat by tropical fire ant

The sooty tern nest is placed on the ground, usually in a depression or a scrape in the sand or grass. In grassy areas the grass is pressed down to make a hollow, and no additional material is used (Reithmuller 1931, Hindwood 1940, Serventy 1959). Often one egg is laid and laying is usually synchronised within groups or sub-colonies in the colony. Incubation is shared by both sexes. The youngs chicks are precocial and semi-nidifugous, but they mature slowly and are fed by their parents for some time after they have fledged (Pringle 1986). The time of breeding vary with sites, and so does the breeding cycle. Some populations breed every twelve months, some every nine and a half months or even six months. Although the frequency of breeding is quite high, sooty terns do not breed until they are at least four years old and more usually not until an age of six to eight years. Therefore, the recruitment is very important in this species. As for the other ground nesting species, this is a species at high risk of a possible impact of tropical fire ants. The stages of pipping eggs/hatching and the first days of life of the young may be the most vulnerable in terms of possible impact by the tropical fire ants who might attack and kill the chicks.

3.4.17 Eastern reef egret (*Egretta sacra*)

Distribution

The eastern reef egret has almost a continuous distribution around the mainland coast of Australia and islands as far out as Ashmore Reef and the islands of Torres Strait. It is also widespread in the south western Pacific (Japan and South Korea to Bangladesh) and New Guinea (Marchant & Higgins 1990, Draffan et al 1983). Intertidal areas of estuarine mudflats, mangrove lined shores, rocky shorelines of maritime littoral, tidal reaches of rivers and creeks and coral cays and reef are the preferred habitat (Figure 15). At Ashmore Reef the Eastern Reef Egret is present on all the three islands, with West Island having the highest number of breeding birds.

Figure 15 Eastern reef egret – dark morph

Conservation status

The eastern reef egret is **not globally threatened.** The eastern reef egret is relatively common and abundant in all south east Asia, Australia included, but has declined in the last 30–40 years due to transformation of habitat.

Potential threat by tropical fire ant

The species nests singly or in small colonies, sometimes in mixed colonies with other species. The nest is placed on the ground, cliff edges, bushes or trees, up to 3 m in height. The nest is usually difficult to see as it is well concealed. The nest consists of a large flattish pile or platform of sticks and dead stalks. The clutch size varies from two to three, occasionally four, and rarely five. The young are altricial and nidicolous. As for the other species of birds described above, the impact of tropical fire ants on this species has never been quantified but it may affect the early stages of pipping and hatchlings. However, on Ashmore the species has been recorded to put the nest in the bushes of *Argusia* and *Scevola*, and often well above the ground. As such, the birds should be at a lower risk than ground nesting birds from a potential attack by ants.

3.5 Current status of breeding seabird at Ashmore

3.5.1 Methods

Seabirds

A thorough assessment of the reproductive success of a species involves estimating: the density of active nests; mean clutch size (number of eggs/nest); mean hatching success (number of chicks/nest); and fledgling success. Mean mortality and recruitment rates of the colony for that breeding season can therefore be estimated without resort to longitudinal data that requires mark-recapture of individuals. However, because access and research activities at Ashmore Reef are restricted by Parks Australia, it was not possible to conduct the type of life history population study outlined above. Furthermore, field time was limited by budget constraints and, hence, three different indirect survey methods were used to obtain as much relevant information on seasonal recruitment of each species as possible within a one-off visit.

The three techniques employed were:

- mapping the extent of nesting colonies;
- mapping the distribution and abundance of nests with eggs and/or chicks;
- mapping the distribution and abundance of dead chicks across a grid system encompassing the colony.

Mapping the extent of nesting colonies

This method was employed for the lesser frigatebird, both at Middle and East Island, and for the red-footed booby and the crested tern that were only nesting at East Island.

A non-intrusive sampling technique was employed because of potential impact from human disturbance. Concerns that stress or disturbance could occur were due to the following reasons:

- Many juveniles of the lesser frigatebird were at a pre-flight stage of development and injury may result from premature flight.
- Regurgitation of food by juvenile lesser frigatebirds sitting on nest when disturbed. This was seen on Middle Island when we walked within about 20 m of a juvenile bird and it regurgitated about six fresh fish 120 mm long. Regurgitated fish was found on both islands, hence birds may not re-eat such fish.
- Nesting adult red-footed boobies and crested terns displayed clear signs of distress (upright position of the body, quick side head movements, display of alarm calls) when approached and, hence, a ‘safe’ distance when mapping their colonies was maintained.

On East Island the colonies were mapped at sunrise on 11 November 2004. A position was taken up some distance from a colony so that an imaginary straight line through the centre of the colony to the point of sunrise at the horizon was drawn. A GPS reading was taken at this point and the approximate distance to the centre of the colony was estimated (Appendix 1). The width of the colony and the number of birds in the colony were recorded. Adjacent colonies were mapped by estimating the distance from the first colony and the distance from the original GPS point. The time of sunrise was calculated from the Australian Government Geoscience website, and hence an azimuth to the point of sunrise at the horizon. Hence, the location of all other GPS points were estimated from recorded elapse times. The time of sunrise was 06:42 (Austrailian Central Standard Time) and the azimuth bearing was 108

degrees 3 minutes and 24 seconds. Points were then rectified (rotated 18 degrees) in AutoCAD and a reasonably accurate map of the colonies was drawn. The map obtained was then converted from AutoCAD format into ARCGIS (see section 'results' for maps).

A slightly different method was employed for mapping the colonies at Middle Island on 12 November. A position was taken up some distance from a colony so that from that point an imaginary straight line through the centre of the colony to an imaginary point in the middle of West Island (≈ 6 km away) was drawn. A GPS reading was taken at this point and the approximate distance to the centre of the colony was estimated (Appendix 2). The width of the colony was recorded as well as the number of birds in the colony. Close adjacent colonies were mapped by estimating the distance from the first colony and the distance from the GPS point. The GPS point and coordinate of the centre of West Island were inserted into AutoCAD and the extension and position of the colonies were drawn. The map obtained was then converted from AutoCAD format into ARCGIS (see section 'Results' for maps).

Mapping the distribution and abundance of nests with eggs and/or chicks

This method was employed for the eastern reef egret and for the red-tailed tropicbird that were found nesting on West Island. West Island was surveyed on 9 November.

The perimeter of the island was walked and all bushes of *Argusia argentea*, *Guettarda speciosa* and *Scaevola taccada* inspected, looking for nests evidence. A GPS reading was taken nearby the bush, or clump of bushes where the nests were found (Appendix 3). Despite the fact that the nests of the eastern reef egret were usually well concealed, it was possible to count the number of eggs and/or chicks present while minimising disturbance. The number of eggs and the stage of development of chicks were recorded in each eastern reef egret nest mapped at West Island (Appendix 3).

The following codes were used for different stages of chick development:

- *stage 1*: just hatched – less than 5 cm and covered in dark grey down;
- *stage 2:* hatched – bigger than 5cm and covered in dark grey down;
- *stage 3:* starting to show growing primaries and rectrices;
- *stage 4:* almost ready to fledge but still sitting on the nest;
- *stage 5:* fledged, walking around in the vicinity of the nest.

Mapping the distribution and abundance of dead chicks across a grid system encompassing the colony

This method was employed for the common noddy and the brown booby. Dead common noddy and brown booby chicks were found on Middle and East islands, and a systematic sample grid was used to map their distribution and abundance. The sample grid was obtained in the following way: the two islands were subdivided into a series of square grids obtained by marking six transects running east-west across the islands. A GPS waypoint was taken at the center of each grid, so that the two centers of adjacent grids were placed approximately (± 5–10 m) 50 m apart on Middle Island, 60 m on East Island, for a total sampling area for each grid of 0.25 ha at Middle Island and 0.36 ha at East Island. The varying distance interval between waypoints was based on 10% of the total length of the greatest width of the island. The number of common noddy and brown booby dead chicks found within a 10 m radius from the centre of each sample grid cell and an estimate of percentage vegetation cover were recorded.

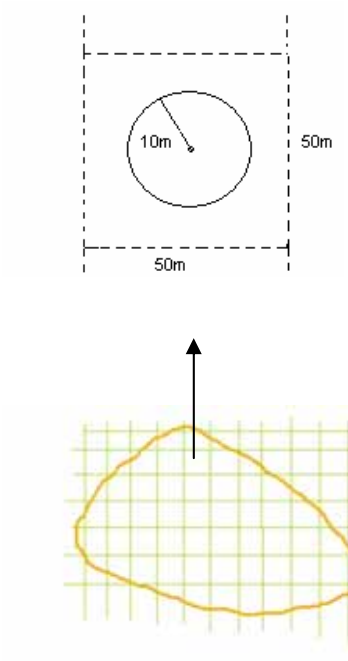

Figure 16 Method used to sample the number of dead chicks of the common noddy and brown booby in each grid cell

Dead common noddy chicks were classified into the following four size classes or developmental stages (Figures 17 & 18):

- Class 1: < 11 cm
- Class 2: > or = 11 and < 15 cm
- Class 3: > = 15 cm and not a fully grown juvenile
- Class 4: a fully grown juvenile

Figure 17 Common noddy dead chick Class 1 (left) and Class 2 (right)

Figure 18 Common noddy dead chick Class 3 (left) and Class 4 (right)

Seabirds, shorebirds and other species count estimates

During the visits on East Island and Middle Island estimates of the number of individuals of all the species of seabirds, occurring at the time of the survey, were made (Appendix 4). During the visit of 9 November 2004 several other species of shorebirds and non-shorebirds were recorded on the island (Appendix 5).

Turtles

On November 17 a visit to West Island was made in order to map the fresh tracks of green turtle nesting on the island, and to look for evidence of ant activity around turtle nests.

The perimeter of the island was walked and the number of fresh turtles tracks was counted between fixed GPS positions (Appendix 6).

3.5.2 Results

Map of colonies/nests of breeding birds at Ashmore

West Island

Two species were found breeding at West Island during the survey on 9 November 2004, the eastern reef egret and the red-tailed tropicbird (Table 3). The three nests of the red-tailed tropicbird were well concealed at the base of three bushes of *Argusia argentea*, and the chicks were in an advanced stage of development showing a juvenile plumage (chick age approx between 6–11 weeks) (Figure 19). During a subsequent visit on 16 November, two adult red-tailed tropicbirds were seen displaying in flight over the island.

Table 3 Coordinates of red-tailed tropicbird nests found at West Island on 9 November 2004

Waypoint	Comments	Lat	Long
N 45	Juv. Stage 4 – 7 metres from N45	-12.24335000	122.97011000
N 46	Juv. Stage 4	-12.24366000	122.97033000
N 55	Juv. Stage 4	-12.24453000	122.96987000

Figure 19 West island. A juvenile red-tailed tropicbird on a nest

Fifty-seven active nests of the eastern reef egret were recorded during the visit of 9 November 2004 (Appendix 3). Whilst 73 nests were classified as non-active, these were most likely

relics from the previous breeding season and/or nests of chicks that had recently fledged and abandoned the nest. Most nests were found in the bushes of *Argusia argentea*, and only two nests were found in a bush of *Guettarda speciosa*. The nests were placed from a few centimetres from the ground to a height of 1.0–2.5 m (Figure 20).

Figure 20 West Island. A nest of the eastern reef egret in a bush of *Argusia argentea*

The breeding biology of the eastern reef egret is poorly known (Marchant & Higgins 1990a). Their clutch size has been reported to average between two and three eggs, with occasionally four or five eggs (Edgard 1978). The results of our surveys agree with information found in the literature, whereby 65% of active nests had three eggs and the remainder (35%) had one or two eggs in the same proportion. Only one nest had five eggs (Figures 21 & 22).

Fifty two percent of nests with hatchlings contained only one chick, 42% two chicks and 8% three chicks. These results are similar to that reported in the literature (one or two brood on average for each nest, Guthrie 1972).

A general observation of this bird survey was that the breeding success of the eastern reef egret on West Island was not adversely impacted on by tropical fire ants, despite the fact that they were observed climbing bushes of *Argusia* during the ant survey. High densities of ant activity were recorded, in the previous ant survey, in areas where high numbers of eastern reef egret nests were found. Similarly, the ground nesting red-tailed tropicbird, a species at greater risk from tropical fire ants, appeared to breed normally.

West Island – turtles

Sixty-four fresh tracks were found between two fixed GPS positions (Appendix 6). No evidence of ant activity was observed near green turtle nests. However, because the turtle track survey was conducted doing the hottest part of the day due to tide constraints, the lack of ant activity may have been an artefact of high temperature. Nevertheless, the highest numbers of turtle nests were found on the south-eastern and north-western corners of the Island, where higher densities of tropical fire ant activity were recorded. Hence, the fact that tropical fire ants may pose a potential risk to successful turtle nesting cannot be ruled out.

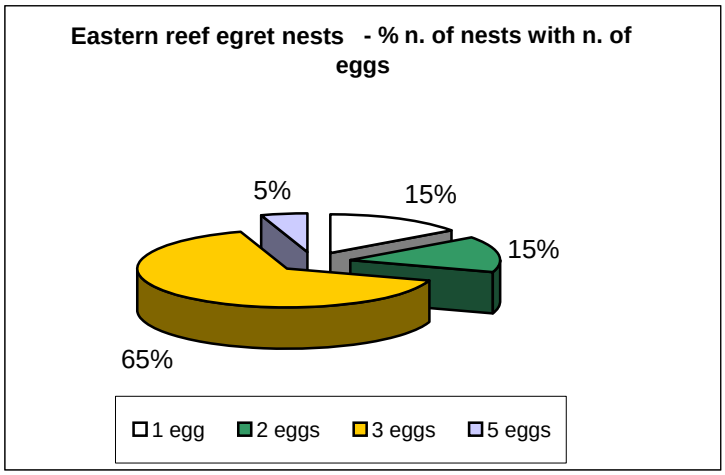

Figure 21 Eastern reef egret. Percentage of nests with 1, 2, 3 and 5 eggs

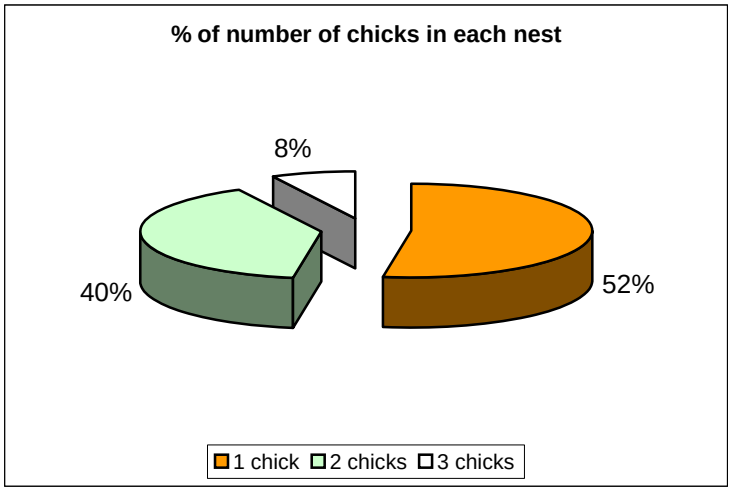

Figure 22 Eastern reef egret . Percentage of nests with 1, 2 and 3 chicks

East Island

During the two visits made to East Island, the lesser frigatebird, the brown booby and the masked booby were found to be breeding. The colonies of lesser frigatebirds were located mainly around the eastern and south-western side of the island (Figure 23), whereas the nests of the brown booby and masked booby were scattered along the perimeter of the island. The common noddy and sooty tern were also present but not breeding. Although the sooty tern had gathered in huge flocks on the island, very few had started to lay eggs. In contrast, the common noddy had already completed their breeding cycle and, hence, fully grown juveniles and adults were both present on the island.

Middle Island

Five species were found nesting on Middle Island when it was surveyed on 12 and 13 November 2004: the lesser frigatebird; the brown booby; the masked booby; the red-footed booby; and the crested tern. Lesser frigatebird nesting colonies were located mainly along the eastern part of the island, whereas brown booby nests were scattered along the perimeter of the island. Red-footed booby nests were mainly found in dead bushes that fringed the southern and south-western part of the island hosted (Figure 24). These dead bushes were also

used as roosting sites by brown boobies and the lesser frigatebirds. Two small colonies of crested terns were located on the north-western and south-eastern parts of the island.

Common noddies and sooty terns were present on the island but were not breeding at the time of survey. Common noddies had completed nesting and both fully grown juveniles and adults were still present on the island. In contrast, sooty terns were gathering in huge flocks on the island and some had just started to lay eggs.

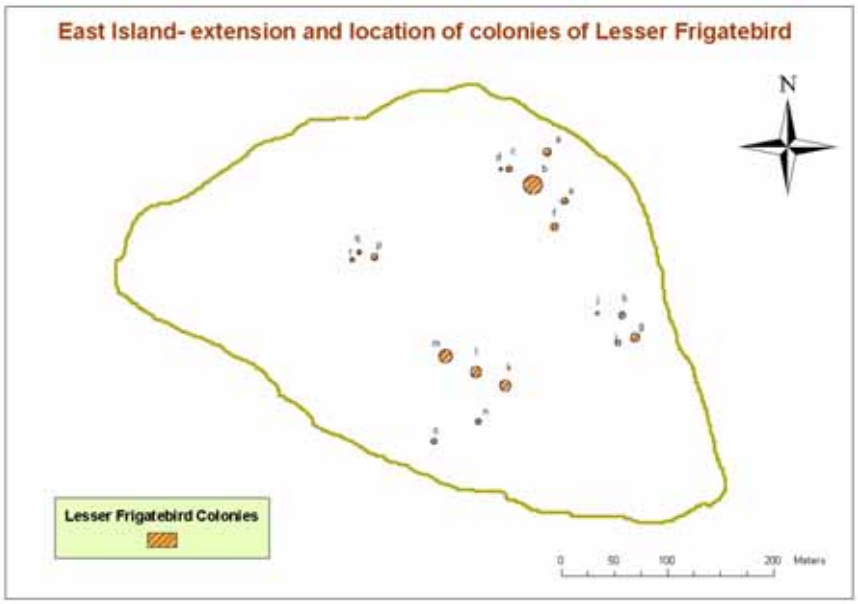

Figure 23 East Island. Location and extent of Lesser Frigatebird nesting colonies

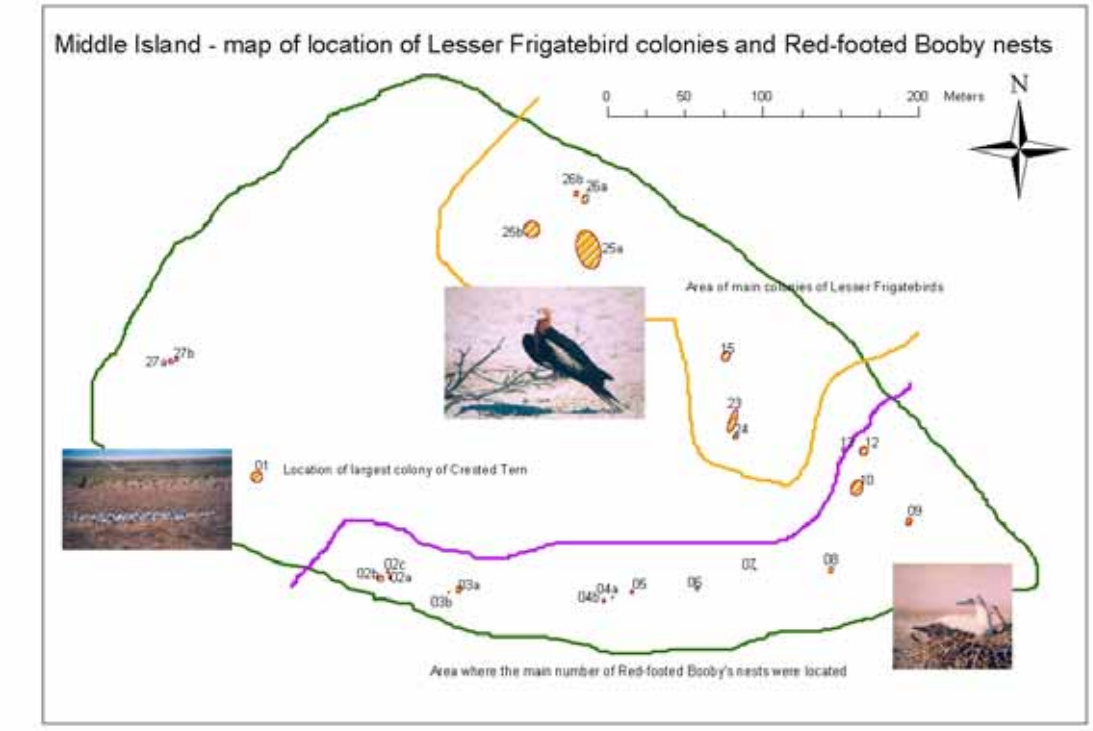

Figure 24 Middle Island. Location of nesting colonies of lesser frigatebirds, crested terns and red-footed boobies, November 2004

The relationship between chick mortality and tropical fire ants

Middle Island – common noddy

Dead chicks of the common noddy were found on 25 (56%) sample areas within 45 grid cells sampled (Figure 25). A total of 130 dead chicks were found, or a mean of 2.8 dead chicks per sample area (0.03 ha^{-1}).

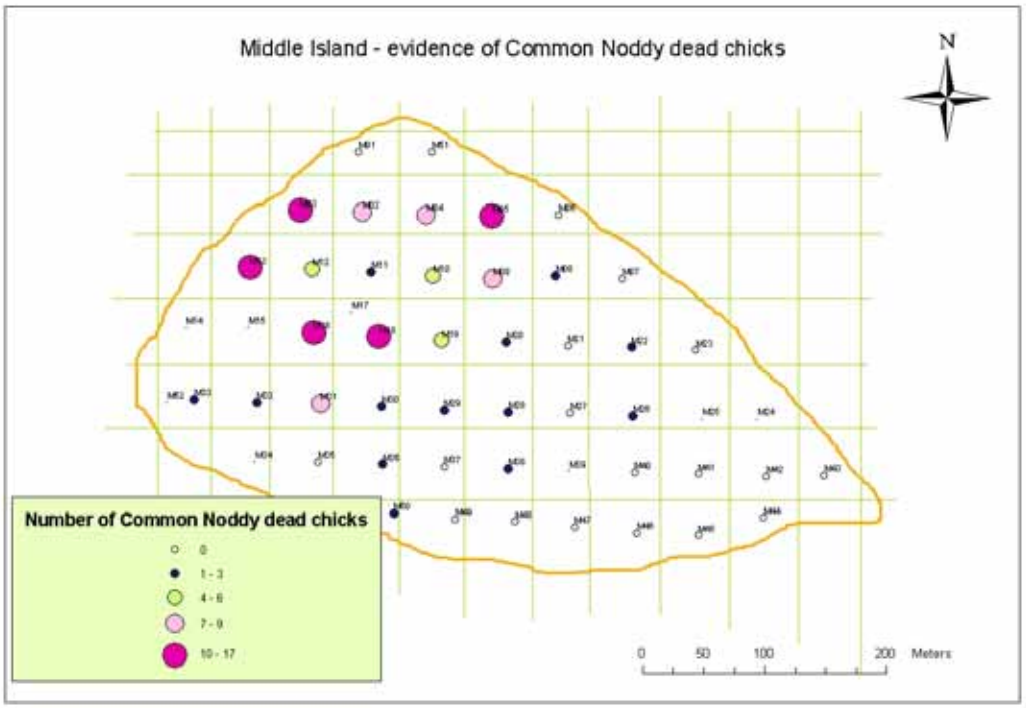

Figure 25 Common Noddy distribution of total number of dead chicks in each sampling grid, Middle Island

As expected, 72% of the total number of dead chicks belonged to the smaller size class (Class 1 and 2, Figure 26).

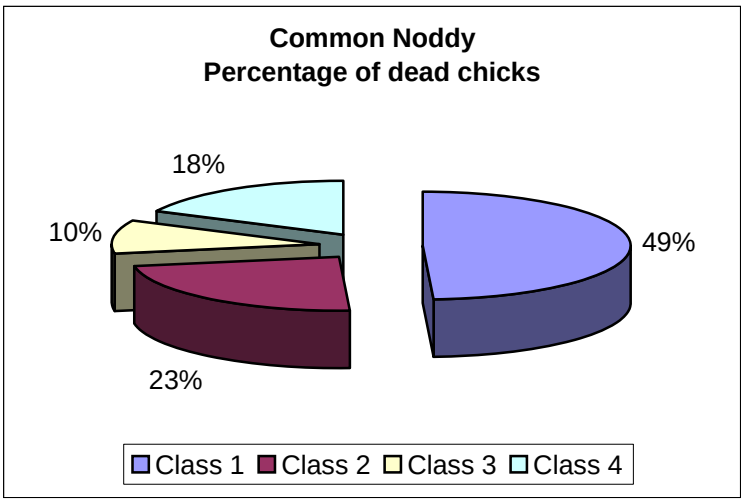

Figure 26 Common noddy. Percentage of dead chicks in each of four size classes, Middle Island

East Island – common noddy

Dead chicks of the common noddy were found on 24 sample areas (77%) within 31 grid cells sampled (Figure 27). A total of 129 dead chicks were found, or a mean of 4.2 dead chicks per sample area (0.02 ha^{-1}).

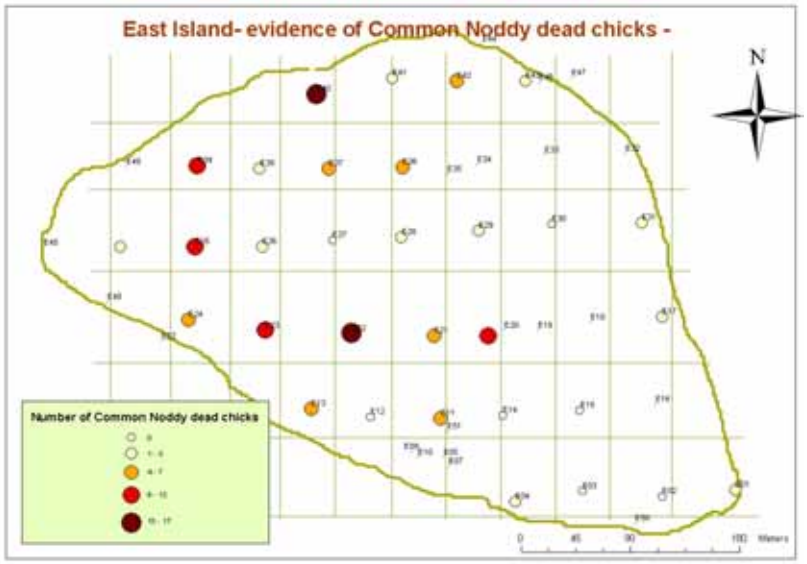

Figure 27 Common noddy distribution of total number of dead chicks in each sampling grid, East Island

The 60% of the total number of dead chicks belonged to the smaller size class (Class 1 and 2, Figure 28). Except for the smallest class of dead chicks (class one), the deaths were almost equally distributed across the other classes (Figure 28).

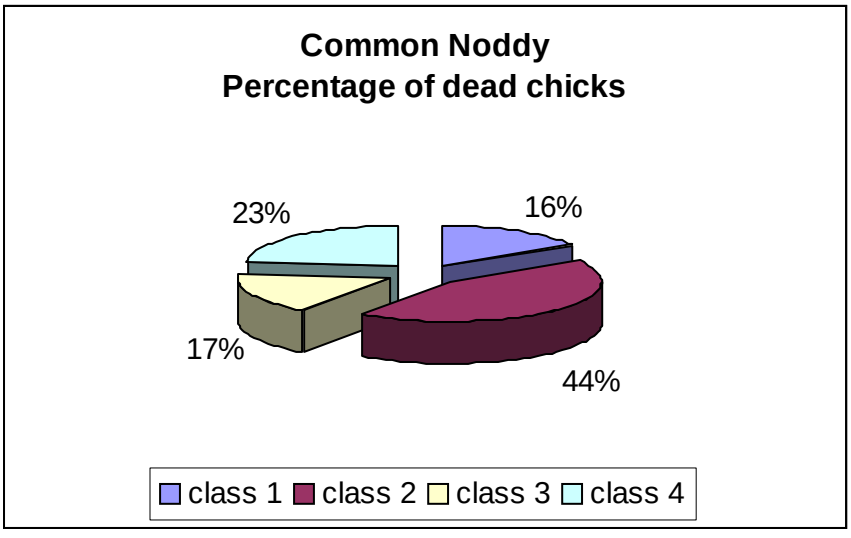

Figure 28 Common noddy distribution of total number of dead chicks in each sampling grid, East Island

Middle Island – brown booby

Brown booby nests on Middle Island were located mainly along the periphery of the island. Dead chicks of the brown booby were found on 9 sample areas (20%) within 45 grid cells sampled (Figure 29).

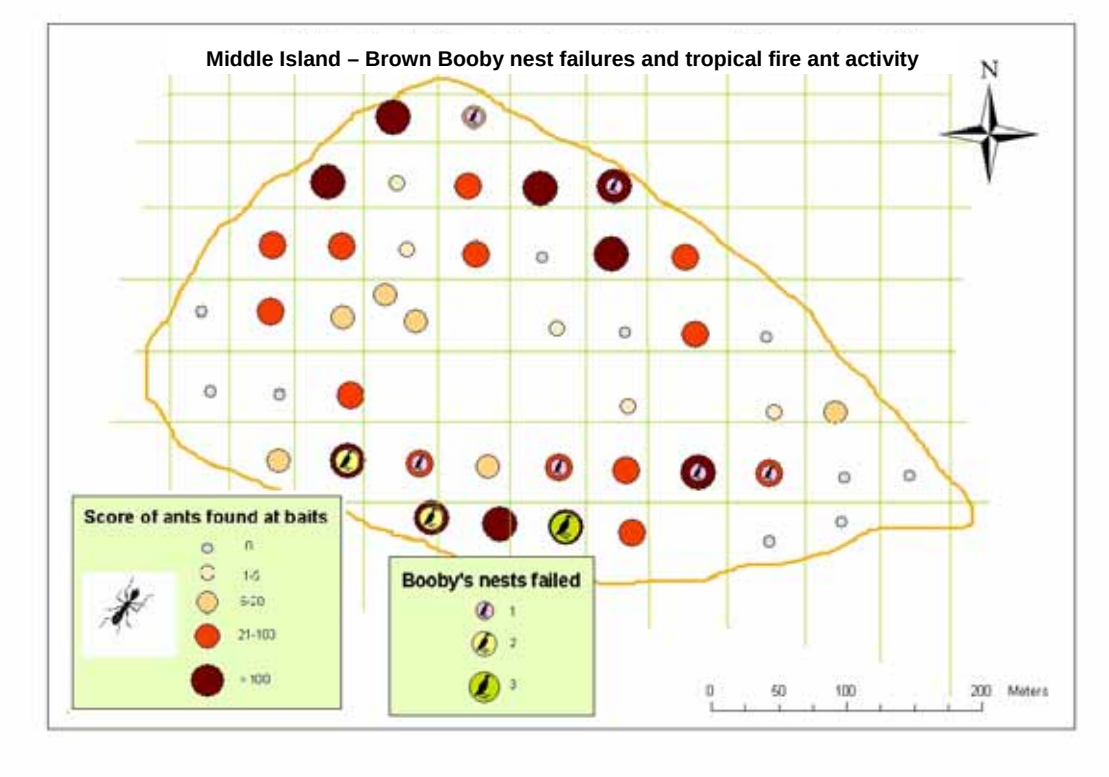

Figure 29 Brown booby distribution of total number of dead chicks in each sampling grid, Middle Island

East Island – brown booby

Brown booby nests on East Island were scattered across all the island but mainly along the periphery of the island. Dead chicks of the brown booby chicks were found on 2 (6%) sample areas within the 31 grid cells sampled.