Conservation of the fairy tern (*Sternula nereis* spp.) via subspecies level management

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How does one manage a species of concern when their distribution crosses geographic and political boundaries (i.e. countries)? The laws and legislations of each country govern different levels of national management priorities, therefore resulting in unequal outcomes regarding the status of species' conservation efforts. In most cases the general strategy, especially for widely distributed species, focuses on management at a population level. This is particularly true for species comprised of several subspecies distributed between different countries.

The fairy tern (*Sternula neries*) is an example of a wide geographically ranging species, and it is distributed between Australia, New Zealand, and New Caledonia (Figure 1). The species' phenotypic differences as well as genetic and geographical distances between three regions have resulted in the classification of three subspecies (Hitchcock 1959; Hitchcock 1967; Higgins and Davis 1996; Chambers and Coddington 1998; Baling and Brunton 2005). The fairy tern has just recently been uplisted to '*Vulnerable C1*' (from '*Least Concern*') under the IUCN Red List (Birdlife International 2008), however the population status of each subspecies differs due to variations in their local abundance (Table 1). Therefore, the priority status of this species varies across the countries where it occurs.

The New Zealand (NZ) fairy tern (*S. n. daviase*) has the smallest popula-

Figure 1:
Distribution of the fairy tern species (in grey) in the world. (Map modified from Higgins & Davis 1996 p. 726).

	Australian fairy tern *S. n. neresis*	New Caledonia fairy tern *S. n. exsul*	New Zealand fairy tern *S. n. davisae*
National Status[1]	Least Concern	Threatened	Acutely Threatened - Nationally Critical
Breeding pairs	2,000-3,000	c. 100	c. 10
Breeding adult morphology[2]	Posterior loral patches; yellow beak sometimes with black tip.	Larger posterior loral patches than nominate subspecies but smaller than *S. n. davisae*; larger black on tip of bill than nominate; shortest wing length.	Adults have largest posterior loral patches (round to square); black cap extends from lower hindneck to cap; whole bill yellow; longest wing length; darker dorsally.
Distribution[3]	Western Australia, and south-east Australia (South Australia, Victoria, Tasmania and New South Wales).	Islands or islets around Grande Terre, Loyalty Islands, and other islands in the Pacific Ocean. Possible population at Herald Island, Great Barrier Reef.	North Island, only four known breeding sites (Waipu, Mangawhai, Papakanui, and Pakiri).
Migratory behaviour[4]	Sedentary in Victoria and South Australia, Migratory within Western Australia and Tasmania.	Migratory between islands in the Pacific, and possibly northeastern part of Australian Territory.	Within New Zealand
Breeding season[5]	September to March	June to October	October to February
Nesting behaviour[6]	Colonies between several to hundreds of pairs. Nesting area from sand to rocky substrate, both on the mainland and islands. Aggressive behaviour seen in smaller colonies; flushing behaviour observed in larger colonies; aggression seen at aerial predators. Aggression seen toward mixed pairs (little and fairy terns).	Colonies of several pairs, on dead coral banks or islands. Aggressive behaviour observed in pairs iwth chicks. Flushing behaviour seen in the rest of the colonies with eggs.	No obvious 'colonies,' nests are between 8 m to several kilometres. Nesting area in sandspits. Aggression ('territorial') behaviour observed towards conspecifics and others in the vicinity.
Recovery plan?	No	No	Yes
Threats[7]	Human disturbance (including industrial pollution), mammalian and avian predators, interbreeding with little tern (*Sternula albifrons sinensis*).[8]	Human disturbance (especially recreational activities), mammal and avian predators, weather.	Human disturbance (especially urban development), mammalian and avian predators, weather.

Table 1:
Subspecific comparison of the biology, ecology and management of the fairy tern (*Sternula nereis* spp.).

Conservation management[9]	No direct management (benefits via little tern conservation management), metal banded according to general shore-and seabird banding scheme.	No active management. No banding scheme. Status and conservation efforts initiated by Societe Caledonienne d'Ornithologie. A rodent eradication project on several islands in the New Caledonia territory is underway, and will also benefit the fairy tern.	Colour banding scheme, nest areas and nesting pair protection from human access, pest and weather. Flock counts and distribution by New Zealand Department of Conservation and public volunteers for long-term database collection. Public education and participation. NZ Fairy Tern Charitable Trust formed in 2008.

[1]Garnett and Crowley 2000a; Hitchmough *et al.* 2007.
[2]Hitchcock 1959; Higgins and Davis 1996.
[3]Napier 1972; Rancurel 1976; de Naurois and Rancurel 1978; Lane 1981; Willig 1982; Rounsevell 1983; Higgins and Davis 1996; Burbidge and Fuller 2000; Garnett, and Crowley 2000c; Tarburton 2001; Benoit and Bretagnolle 2002; Baling *et al.* 2008; Birdlife International 2008.
[4]Storr 1960; Hill *et al.* 1988; Parrish and Pulham 1995b; Carter and Mustoe 2007.
[5]Parrish and Pulham 1995b; Paton and Paltridge 2001; Baling *et al.* 2009.
[6]Lane 1984; Hill *et al.* 1988. Parrish and Pulham 1995a; Baling *et al.* 2009; pers. obs.
[7]Lane 1981; Hill *et al.* 1988.
[8]Cox, and Close 1977; Benoit and Bretagnolle 2002; Taylor *et al.* 2004.
[9]NSW National Parks and Wildlife Service 2003; Ferreira *et al.* 2005; Cranwell 2009.

tion size in the species (c. 10 breeding pairs), with their lowest record of c. 3 breeding pairs in 1983. This population is regarded as one of the rarest and most threatened bird populations in the country (Hitchmough *et al.* 2007). The other small population, the New Caledonian (NC) fairy tern (S. *n. exsul*) has a slightly higher number of estimated breeding pairs than NZ (c. 100, (Wetlands International 2002)), and is also considered to be nationally threatened. Despite the low densities of fairy terns in these areas, the overall species status on the IUCN Red List is less severe than expected due to the overwhelming c. 2,000 – 3,000 breeding pairs in Australia (Birdlife International 2000; Wetlands International 2002), which have a national listing of '*Least Concern*' (Garnett and Crowley 2000a).

However, the overall population trend, including Australia, is seen to be decreasing (Birdlife International 2008), and many of the previously recorded nesting areas (Higgins and Davis 1996) are absent of the nominate subspecies. For example, my 2004 survey for nesting Australian fairy terns (*S. n. nereis*) in the state of Victoria, resulted in the location of only two nesting colonies out of 12 previously recorded areas, listed by Higgins & Davis (1996). In addition, the absence of nesting colonies in a well-known breeding area in NC between 1991 and 1996, followed by their appearance again in 1997 until present, may indicate extreme fluctuations in population numbers (Benoit and Bretagnolle 2002; Baling and Brunton 2008). The current population size and status of this subspecies is being re-assessed (N. Barré, unpub. data). The NZ fairy tern population size has varied between 20 - 40 individuals over the last 15 years (Ferreira *et al.* 2005; Hansen 2006). These current information justifies the uplisting of the fairy tern in the IUCN Red List, however also highlights the issue of why these populations are

decreasing or in constantly in low densities.

All subspecies are threatened at the breeding stage, where increasing human disturbance (direct and indirect), mammalian and avian predators, and unpredictable weather events are identified as key factors affecting breeding success (Hill *et al.* 1988; Benoit and Bretagnolle 2002; Hansen 2006; Baling *et al.* 2009). It is unfortunate that breeding areas selected by fairy terns are also preferred sites for urban development and human recreational activities. These activities also indirectly introduce potential predators, such as domestic pets (e.g dogs and cats). Other introduced mammalian pests (e.g. hedgehogs, *Erinaceus europaeus*, in NZ; or foxes, *Vulpes vulpes*, in Australia) and birds (e.g. silver gull, *Larus novaehollandiae*, and kelp gull, *L. dominicanus*) are also threats to eggs and chicks (Hulsman 1977; Secomb 1994; Rose 2001); pers. obs). Large storm events are unavoidable threats for these low-lying nest areas where eggs or chicks are exposed to strong winds and high tides.

So how do conservation efforts for each subspecies differ between countries? There is little species management in Australia and NC. In Australia, the majority of the efforts have been indirectly influenced by management of eastern little tern (*S. albifrons sinensis*), a sympatric species breeding in the south-eastern region of the country (Vincent 1983; Hill *et al.* 1988). The little tern is listed as '*Endangered*' in two states (Queensland and New South Wales), '*Threatened*' in Victoria, and '*Vulnerable*' in South Australia (Garnett and Crowley 2000b; NSW National Parks and Wildlife Service 2003; Department of Environment Water Heritage and the Arts 2007). Protection of the little terns' nesting habitat by fencing off nesting colonies from public access, predator-control, and removal of encroaching vegetation to nesting areas have also benefited other shorebird and seabird species nesting in the same area, including the fairy tern (Vincent 1983; NSW National Parks and Wildlife Service 2003).

The priority for conservation of NC fairy tern has been expressed in previous surveys showing low local population abundance, and increasing threats to breeding colonies (Benoit and Bretagnolle 2002; Spaggiari et al. 2007a; Baling *et al.* 2009). However a governmental-based management plan for this species has yet to be established. The recent publication of Important Bird Areas (IBA) for New Caledonia (Spaggiari *et al.* 2007b) has identified several areas that are significant for colonial seabirds, which includes breeding populations of bobbies, frigatebirds, tropicbirds, and terns. The recognition of these areas was considered an initial but important step for applying conservation actions in the field and acquiring community support for New Caledonian birds (Spaggiari 2007). Two of these identified 'important areas' are known fairy tern breeding sites, therefore any conservation efforts directed at those sites will be beneficial to the species.

A rodent eradication project started in 2003 on several important breeding seabird islands located north-west of NC (Cranwell 2009), will also assist in securing the breeding success of the fairy terns. This rodent eradication project, led by the *Société Calédonienne d'Ornithologie* (SCO) and BirdLife International (supported by the Packard Foundation), aims to protect and restore selected islands of ecological significance to seabirds. This ongoing project included several stages of process: ecological island surveys and selection; eradication planning, training and application; and finally monitoring for full eradication confirmation.

Between the three countries, only

New Zealand fairy tern. Photo credit: Sioux Plowman.

New Zealand has produced a recovery plan for the fairy tern (Parrish and Honnor 1997; Hansen 2006), with goals to increase population size by active management, public relations, and research. Since 1983, the population has undergone colour banding for identification, DNA-sexing, nest and nesting pair protection, predator-control, and database collection via flock-counting and other sightings (Taylor *et al.* 2004). Additionally, the NZ Fairy Tern Charitable Trust was formed in 2008 to encourage public participation in tern advocacy and monitoring, alongside NZ Department of Conservation (DOC). Public awareness and support are very important for minimising and preventing the growing urban development around nesting sites. Long-term monitoring and research revealed detailed life history, behaviour, and distribution information on the NZ fairy tern (Parrish and Pulham 1995b; Parrish and Pulham 1995a; Jeffries 2000; Treadgold 2000; Jeffries and Brunton 2001; Ferreira *et al.* 2005; Preddey 2008). This information has been used to review the progress of current management and guide future management decisions (Taylor *et al.* 2004).

Despite intensivemanagement assisted in fledgling success, two significant issues were identified; overall hatching rate (38%) and breeding attempts by adults (43%) were still low (Ferreira *et al.* 2005). The hatching rate in NZ is similar to the rates for fairy terns (34%) at unmanaged sites in New Caledonia (Baling *et al.* 2009). This suggests that influences other than external factors (e.g. human, predator and weather disturbance) may be affecting the low hatching rates. Hatching rate is generally considered as a measure of reproductive fitness; when population fitness decreases along with low abundance, inbreeding depression is said to be occurring (Frankham *et al.* 2002; Jamieson *et al.* 2006). High failures in hatching rates have also been associated to high levels of severity in population genetic bottleneck (Briskie and Mackintosh 2004). Therefore, the very low number of breeding pairs in 1983 (i.e. high genetic bottleneck) and the recorded infertility in several eggs (i.e. high hatching failure) may indicate inbreeding depression within the NZ fairy tern

population (Parrish and Honnor 1997; Ferreira *et al.* 2005). Although conservation efforts have been primarily focused on minimising the ecological risks (e.g. predator-control), issues regarding the effects of inbreeding depression in the long-term should not be neglected; and consequently investigation of the population's genetic structure is suggested to monitor this potential additional factor.

The low number of NZ fairy terns attempting to breed is also of concern, despite increasing fledgling success rate in the 16 years of management. An average of only 43% of all identified adults attempt to breed each season which raises concerns that limitations to breeding site access and habitat quality may exist (Ferreira *et al.* 2005). The lack of recruitment in breeding adults is also noted. This includes several occurrences of NZ fairy tern fledglings or adults disappearing from the known breeding sites for several years, after which they would appear again and breed successfully thereafter (Ferreira *et al.* 2005). It is unknown where these individuals go during these periods, and the possibility of movement or migration out of the country is raised. However, due to the lack of, or very little, banding and monitoring schemes for fairy terns in NC and Australia, the probability of detecting colour-banded NZ fairy terns is very low. There is currently a call for NZ public to record sightings of fairy tern foraging to determine seasonal movement and foraging patterns.

Can New Caledonia learn from the conservation efforts of New Zealand? The logistics of accurate estimation of population abundance and trends is limited by frequency of access to some of the more remote small coral islets, islands and atolls. This frequency is highly dependent on weather, labour and financial aspects (Cranwell 2009; pers. obs.). Once their conservation status has been reviewed and more funding approved, the NC fairy tern population may initially benefit by enforcing similar management protocols as NZ. In particular, the implementation of colour-banding schemes to accurately monitor local (or potential international) movements and individual breeding stages (e.g. first or second clutches), public access restrictions during breeding period, and pest-controls on targeted breeding areas. These direct management efforts will be capable of reducing or even eliminating some of external factors that negatively influence the fairy tern's breeding success.

New Zealand's fairy tern conservation efforts are also highly dependent on local community volunteer and support. The large number of hours spent by many unpaid volunteers - reporting sightings, behavioural observations, and advocating for fairy tern conservation has provided valuable information for the DOC database. This may also be considered for the NC fairy tern management plan: to invest in local education, promote interest, participation and adherence to island restrictions during the seabird breeding season. The constant communication between researchers, NGO's, governmental departments, and the public will also provide long-term benefits for fairy tern conservation.

Finally, the importance of communication and collaboration between countries will also be crucial for the species' conservation as a whole. Greater sharing of information on sightings, breeding biology, and conservation techniques should be encouraged between the three countries. Lessons learned from one case, may prove to be invaluable to another similar management plan.

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