The natural occurrence of northern quolls *Dasyurus hallucatus* on islands of the Northern Territory: assessment of refuges from the threat posed by cane toads *Bufo marinus*.

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Picture above and front cover:
Northern quoll on Jagged Head Island, off Groote Eylandt
(photo Mani Berghout)

Picture right: Part of the Bromby islands chain, off north-eastern Arnhem Land.
(photo: Kym Brennan)

Summary

Recently, the northern quoll *Dasyurus hallucatus* has suffered widespread and rapid decline across its mainland range because of its susceptibility to poisoning by the invading cane toad *Bufo marinus*. Island populations may now offer the greatest long-term security for the northern quoll. Here, we collate all available information on the occurrence of northern quolls on Northern Territory islands, and report on two surveys to previously-unsampled sets of islands.

We list 233 islands >20 ha in the Northern Territory. Northern quolls are known to occur naturally on 10 of these islands, known to be absent from 58 islands, and probably absent (on the basis of lack of reports from inhabited or visited islands) from a further 35 islands. This set of islands is an unrepresentative sample of the total island pool, with larger more rugged islands more likely to have been sampled.

The pattern of occurrence of quolls on Northern Territory islands was examined with generalised linear modelling, with one model including only definite present and absent records, and the other model also including probable absences. The two models were similar, explained a high proportion of the deviance (55% and 61% respectively), and correctly predicted a high proportion of known presences and absences (concordance = 88% and 93% respectively). Quolls were more likely to occur on islands that were more rugged, larger, further from the mainland and with lower rainfall. The model predicts that quolls will occur on seven islands that have not yet been sampled.

Recently, quolls have been translocated to two islands. The model predicts that suitability of these islands is only moderate (likelihood of natural occurrence 0.02 – 0.1). Potentially more suitable islands are indicated.

The distributional model was tested on an island data base sourced from a different region (Kimberley, Western Australia), and found to be far less effective (concordance = 53%), in part because that data set included values of variables outside the range used in deriving the model, and in part because some components of the Northern Territory model are idiosyncratic.

Contents

Introduction

The northern quoll *Dasyurus hallucatus* has suffered a catastrophic decline across its north Australian range over the last 50 or so years, due to the rapid expansion of the exotic cane toad *Bufo marinus* (Burnett 1997; Oakwood 2004; Taylor and Edwards 2005; Woinarski *et al*. 2007). While there is evidence that some populations of northern quolls have persisted in toad-invaded areas in pockets of their former range (Pollock 1999), the mechanisms allowing this persistence remain uncertain and (hence) the long-term endurance of these surviving populations is questionable. These now isolated mainland populations may also be under continuing threat from a range of factors (including predation by feral cats and vegetation change through fire and/or pastoralism) that are presumed or known to have contributed to a general decline in the quoll's status even before toad invasion.

In contrast to the fragile fate of remnant mainland populations, populations of quolls on islands may have a more secure future. In northern Australia, most islands have been isolated from the mainland by rising sea levels between about 12,000 and 8,000 years ago (Abbott 1980; Abbott and Burbidge 1995; Woinarski *et* al. 1999), so, where quolls are still present on these islands, it suggests a demonstrated long-term viability. At least some threatening processes are absent, restricted or moderated on islands: most islands have been exposed to relatively little development, livestock are restricted to only a very few islands, and feral cats are known to be present on only a small proportion of islands.

In general, cane toads are far more likely to expand their ranges comprehensively throughout mainland northern Australia than to colonise offshore islands. This is not to say that islands are inviolable, and there may be four main mechanisms for the colonisation of islands by toads.

1. As their specific name suggests, cane toads have a perhaps unusually robust tolerance of salt water (Lever 2001), and may disperse through mangroves and on low tides to islands close to the mainland and/or with intermittent connection.

2. Particularly associated with annual or exceptional wet season flood events, toads may drift on debris or on freshwater plumes well out to sea. This will particularly jeopardise the security of islands in line with river mouths. The colonisation by toads of the main islands in the Sir Edward Pellew group has been linked to toads floating on freshwater plumes from the McArthur River in a single flood event in 2001-02 (Taylor *et al*. 2004). In some cases this is an over-sea distance of at least 30 km.

3. Inadvertent assisted package associated with human transport.

4. Deliberate human-assisted transport. Given the high and negative public profile of toads, this is an unlikely mechanism, but there is at least anecdotal evidence that one or more toads were taken as pets to Elcho Island (R. Taylor *pers. comm.*).

These mechanisms suggests that the most likely safe refuges from toads will be islands that are remote from the mainland (and/or nearby toad-colonised islands), not in the pathway of river debouchments, and with least human visitation. Further, islands with no permanent freshwater sources may be least likely to be successfully colonised by toads; and larger islands may be more likely to support more viable quoll populations. With adequate surveillance, larger islands may also allow more time for toad eradication before quoll local extinction, but conversely it may be far easier to eradicate toads from smaller islands.

This study aimed to document the natural occurrence of northern quolls on islands of the Northern Territory, in order to assess the contribution of these islands to the long-term conservation security of the Territory's quoll population. This assessment fulfils a high priority recommendation for research by the National Cane Toad Taskforce (Taylor and Edwards 2005). More specifically, we sought to:

(i) assess whether the occurrence of quolls on some but not all islands could be related to any environmental, locational or other factors;

(ii) provide an estimate of the population size of quolls on their inhabited islands;

(iii) provide a basic risk analysis that may help identify the island populations that may be most important and/or offer greatest long-term security; and

(iv) identify islands that may best serve as hosts for any subsequent translocated populations.

This study is based on a collation of existing information, supplemented by new inventory data derived from surveys carried out specifically for this study.

The Northern Territory has very many islands, and includes – after Tasmania - Australia's second (Melville, with a land area of 5809 km^2), third (Groote Eylandt, 2277 km^2) and fifth (Bathurst, 1699 km^2) largest islands. In the Northern Territory, most islands are remote from main population centres and most are Aboriginal lands. These factors mean that comprehensive surveys may be logistically challenging and expensive, and may require considerable lead time for adequate consultations and access permission. Over the course of this study, we undertook two main focused surveys – on Groote Eylandt and some of its satellite islands, and on Maria Island. Both of these surveys were undertaken in participation with Indigenous ranger groups.

Methods

Northern Territory islands

We initially considered all Northern Territory islands larger than 20 ha. There are 233 such islands in the Northern Territory (based on a previous collation of islands for records of feral animals: Rankmore 2005). These are listed (noting that many have no gazetted names) in Table 1 (with numbering ordered latitudinally, from the most northern), and mapped in Fig. 1. Some of these listed islands are marginal – connected to the mainland (or larger islands) at low tides (with the tidal range in northern Australia typically being 6-8 m), part of diffuse mangrove networks, or barely above sea level. If islands less than 250 m from the mainland and/or with maximum elevation less than 2.5 m are excluded, the island set falls to 173.

Biodiversity data

The amount of biodiversity information available for Northern Territory islands is very variable, and much of the information is not published. In a review of all then known records of Northern Territory mammals, Parker (1973) included only one island (Groote Eylandt) in the quoll's known distribution. A broad review of the distribution of mammal species across all Australian islands (Abbott and Burbidge 1995) lists the following Northern Territory islands for northern quoll: Bathurst, Groote Eylandt, Marchinbar, Melville and Vanderlin.

Here we compile from primary sources all known records of quolls on Northern Territory islands, and all information on probable absences of quolls from islands.

surveys

Presence records of quolls are generally definitive, but there may be less certainty attached to absence records. In general, quolls, if present, are likely to be detected by trapping in standard wildlife surveys and/or by the presence of their distinctive tracks (which may especially be evident on sandy beaches of islands). In the compilation here, we assume that quolls are absent from an island if the island had been subject to wildlife survey but no quolls were recorded.

The two main islands of the Tiwi group (Bathurst and Melville Islands) have been very substantially sampled, with collation of all records presented in Woinarski *et al*. (2000, 2003) and information on the occurrence of mammals reported in Firth *et al*. (2006). Quolls are not known from either Bathurst or Melville Islands, notwithstanding some generalised literature reports (Strahan 1995) that have resonated through subsequent literature (Abbott and Burbidge 1995).

Five islands to the south-west of Cobourg Peninsula in the Van Diemen Gulf (Mologut, Morse, Greenhill, Wunmiyi and Wangoindjung) were sampled by K. Brennan and others (NRETA; unpublished) in October 2005. No quolls were recorded.

Croker Island near Cobourg Peninsula was surveyed by mammals by Firth and Panton (2006) over the period 23-27/4/2001. No quolls were recorded.

Two islands (Field and Barron) near the mouth of the South Alligator River in Kakadu National Park were sampled in August 2001 (M. Armstrong, NRETA file notes), and Field Island was subsequently re-sampled in 2007 (J. Green, NRETA file notes). No quolls were reported.

A general wildlife survey of North and South Peron Islands was undertaken by B. L. Bolton and others from the Department of the Northern Territory over the period 19/10/1974 to 2/11/1974, and results reported in a file note. Mammals were trapped over a 10-day period on North Peron Island, but only a day visit was made to South Peron Island. No quolls were recorded.

A wildlife survey (including mammal trapping) of Indian Island was undertaken by R.J. Begg and others of the Department of the Northern Territory over the period 14-20/9/1976, and results reported in a file note. No quolls were recorded. The island was re-surveyed in August 1997 (Wilkins *et al*. 1999), and again no quolls were recorded.

Islands of the Wessel and English Company (including Bromby) groups were systematically and comprehensively sampled over the periods 5/7/1993 to 9/8/1993, 6/10/1993 to 16/10/1993, 7/8/1994 to 7/10/1994 and 4/2/1995 to 27/2/1995 (Wessel islands: Woinarski and Fisher 1996) and 11/8/1996 to 7/10/1996 (English Company islands: Woinarski 1998). The reports of these trips (Woinarski and Fisher 1996; Woinarski 1998) also collate the previous very limited sampling of these islands, notably including a survey by D. Howe, D.

Lindner and P. Latz of Marchinbar Island between 16/9/1972 and 22/10/1972 (unpublished Parks and Wildlife file note). A total of 49 islands were sampled for mammals during these surveys (Woinarski *et al*. 1999), including all 26 islands in these chains >20 ha (note that 23 islands < 20 ha were also sampled, but are not considered in the present report). Northern quolls were reported from only two islands, Marchinbar and Inglis.

Howard Island was surveyed by M. Armstrong in September 2005 (NRETA file notes), and no quolls were recorded.

A number of brief wildlife surveys (including mammal trapping) have been conducted on Groote Eylandt. Northern quolls have been known from this island since Wilkin's collection in 1925, and have been recognised as a distinct subspecies *Dasyurus hallucatus nesaeus* (Thomas 1926). Donald Thomson (in Dixon and Huxley 1985) listed several records of northern quoll from Groote Eylandt during his explorations of the 1930s and 1940s, and Johnson (1964) also collected the species from Groote during the visit of the American-Australian Scientific Expedition to Arnhem Land in 1948. In a file note, R.J. Begg of the Department of the Northern Territory reported on a survey from 19-26/7/1976, including capture of northern quolls. Webb (1992) reported that quolls were common, during sampling of the western portion of Groote Eylandt in 1991 and 1992.

Five islands (North, Centre, South-West, West and Black Craggy) of the Sir Edward Pellew group were sampled by Calaby (1976) and Keith (1968) in the period July 1966 to December 1967, and February and June 1976. Johnson and Kerle (1991) sampled eight islands (all of the preceding as well as Vanderlin, Skull, and Watson). Northern quolls were not recorded in the earlier surveys and were recorded in the latter only on Vanderlin Island. In 2004 and 2005, West, South-West, North, Centre and Vanderlin Islands were re-sampled, with quolls being reported only from Vanderlin Island (Taylor *et al*. 2004; S. Ward NRETA file notes).

In 2003, a total of 65 quolls from the Northern Territory mainland were translocated to two previously quoll-absent islands, Astell and Pobasso. These translocated populations are not included in the modelling.

Quolls have also been reported from Channel Island in Darwin Harbour (R. Taylor *pers. comm.*), however as this island is connected to the mainland by bridge, this record is not included in analyses here.

New surveys

For this project, we undertook two surveys of previously-unsampled Northern Territory islands. These comprised an assessment of 12 islands around the north of Groote Eylandt in August-September 2006 and a survey of Maria Island in November 2007 (for more details and results see Appendix 1,2).

Anecdotal records

Paul Josif (then of the Northern Land Council) reported that on a brief trip to North-East island (off Groote Eylandt) one to two decades ago, a northern quoll was captured by visiting Aboriginal owners, and eaten. Note that quolls were not recorded from this island during surveys by A. Fisher and others in 2007 (NRETA, see Appendix 1).

A former long-time resident of Elcho Island, the naturalist Ian Morris reported that northern quolls do not occur on Elcho Island.

Indigenous knowledge

In a broad ethnobiological compilation for the Pellew Islands area, Bradley *et al*. (2006) reported that older Yanyuwa people noted that:

> "quolls were common on the islands and that old people sometimes ate them. An elderly woman then sang a short song that dealt with the hunting of these animals. She could not remember the composer of the song but remembered it being sung and acted out when she was a child in the early part of last century:
>
> > "*Quiet you two.*
> > *There is the quoll.*
> > *I will strike it on the head!"*
>
> Subsequent investigations revealed that most people of middle age and below were not familiar with the species or the term applied to this species."

This record is not incorporated in the current data base because of its imprecision, but notably suggests that quolls were formerly present on more of the Pellew islands than the single island (Vanderlin) on which they are now known to persist.

A comprehensive ethnobiological account of the Tiwi Islands (Purantatameri *et al*. 2001) did not include the northern quoll. In contrast, Waddy's (1988) ethnobiological review for Groote Eylandt reported that the northern quoll was well known on Groote.

Probable absences

Many Northern Territory islands have been visited by biologists targeting other animal groups (notably breeding marine turtles and seabird rookeries: Chatto 2001, 2003; Chatto and Baker in press), in some cases frequently and intensively enough for the occurrence of quolls to have been noted if they were present. Here we categorise such islands as "probable" absences. This set also includes some islands that are permanently inhabited (e.g. Millingimbi), and the recent high profile of quolls amongst these island communities suggests to us that quolls, if present, would have been reported.

Environmental and locational data

We used GIS to determine island size, distance to the mainland, maximum elevation and topographic ruggedness. Topographic ruggedness was calculated following Riley *et al*. (1999) to express the amount of elevation difference between adjacent cells of a digital elevation grid. The process essentially calculates the difference in elevation values from a centre cell and the eight cells immediately surrounding it. Then it squares each of the eight elevation difference values to make them all positive and averages the squares. The topographic ruggedness index is then derived by taking the square root of this average, and corresponds to average elevation change between any point on a grid and its surrounding area.

Annual rainfall was calculated from the program ANUCLIM. Broad island habitat was determined from the coarse-scale (1:1,000,000) vegetation map of the Northern Territory (Wilson *et al*. 1990), as either (i) predominantly mangroves, (ii) predominantly open saline grasslands and saltflats or (iii) predominantly woodland and/or heathland. The predominant geology of islands was assessed from finer-scale (1:250,000 or better) geological mapping as either (i) sandstone, (ii) laterite, (iii) Quaternary sand or mud deposits, or (iv) other.

Note that there are some caveats in the interpretation of these variables. Our measure of isolation (distance to mainland) doesn't encompass consideration of islands that may be very close to another larger island, but still distant from the mainland. The ruggedness measure used assesses the topographic variation across a series of points on an island, but would provide a high score for a small island with a smooth-sided high hill and low for a dissected and boulder-strewn island with small elevational range, but the latter probably offers more refuges and high quality habitat for quolls than the former.

The relatively small sample size (and particularly so for number of islands with quoll presence) substantially constrains the number of explanatory variables that can be used for modelling, so there is limited scope for further refinement in the variable set.

Analysis

From the total matrix of Northern Territory islands >20 ha, we related the presence/absence of northern quolls to the continuous variables distance to mainland, logarithm of island size, ruggedness, maximum altitude and annual rainfall, using generalised linear modelling (with binomial distribution, logit link function and backward stepwise elimination of variables). The analysis was replicated with and without records of "probable" absences.

We attempted to also include two categorical variables (geology and vegetation) in the modelling, but the distribution of sampled islands was unrepresentative of the variation in these two parameters to such an extent that the models were fatally compromised. Instead, we simply tabulate the occurrence of quolls on islands with different geologies and vegetation.

We applied the derived models to predict the likelihood of quoll occurrence on all (sampled and unsampled) islands, and from this calculated the *sensitivity* (correct prediction of presences), *specificity* (correct prediction of absences) and *concordance* (the overall percentage correctly predicted) of the models. Prediction was based on the logit transformation

$p=e^{model} / (1+e^{model})$.

We also attempted to test the resultant models on an entirely separate dataset (that was not used in the derivation of the model), that of 30 Kimberley islands sampled mostly by Burbidge and McKenzie (1978).

Results

The collation of records here (and the new surveys undertaken for this project) resulted in reports of northern quolls from a total of 10 Northern Territory islands (Table 1). Surveys failed to report quolls from 58 islands (quolls absent), and we have no records from a further 35 islands that are reasonably well known (probable absences).

This collation substantially upgrades and refines the data base given in Abbott and Burbidge (1985), that included northern quoll records from only five islands, of which two were erroneous.

The sampling of islands is unrepresentative, in that there has been a marked tendency to sample larger and more rugged islands, those with sandstone geology and those with woodland vegetation (Table 2). Inclusion of islands with "probable" quoll absences substantially redressed some of the sampling imbalance for geology and vegetation.

The results for the generalised linear modelling are summarised in Table 3. Note that maximum elevation did not appear in the final models, at least in part because it was highly correlated with the better predictor of topographic ruggedness ($r=0.57$, $p<0.001$) and with island size ($r=0.63$, $p<0.001$). No other variables were intercorrelated at $r>0.25$.

The models predict that quolls are more likely to be present on larger, more remote, more rugged and lower rainfall islands. The location of islands with quoll presence and absence is illustrated in Fig. 2, relative to two highly significant island explanatory variables. The two models (with and without "probable" quoll absences) are similar, but the model including "probable" quoll absences is more significant, presumably because it includes many more islands with characteristics that are unlikely to be suitable to quolls. Both models explained a very high proportion of the deviance.

The predicted occurrence of quolls on islands, based on these models, is summarised in Table 4. The two models produced very similar predictions. Both models correctly predicted the presence of quolls on six of the ten islands known to support quolls, with reasonable likelihood (0.1-0.4) predicted for the four other islands known to be occupied. Model 1 incorrectly predicted presence of quolls on four islands (North, Cotton, Maria and island 145), and model 2 incorrectly predicted presence of quolls on three of these islands (with likelihood of occurrence on Maria marginally less than the threshold of 0.5). The overall performance of the models was: sensitivity (model 1, 2 = 60%), specificity (model 1= 93%; model 2=97%), concordance (model 1=88%; model 2=93%).

Both models predicted very low likelihood of quolls on most Northern Territory islands (likelihood of <0.01 for 181 islands and 182 islands for models 1 and 2 respectively; likelihood of >0.1 for only 38 and 37 islands respectively).

Note that the two islands to which quolls have been translocated had only moderate suitability for quolls (likelihood of occurrence of quolls of 0.11 for Pobasso and 0.02 for Astell). The model predicts that more suitable, but currently unoccupied, islands include Cotton, Maria and North (although the latter has now been colonised by cane toads, and hence is unsuitable).

The model predicted quolls were likely to be present on seven islands that have not yet been sampled (all in the Groote Eylandt archipelago). Beyond this archipelago, Gwakura and Probable Islands (in Arnhem Bay) may also merit survey, given their very rugged nature (Fig. 2).

The Northern Territory islands model performed far less well at predicting the occurrence of quolls on Kimberley islands (Table 5), with a sensitivity (i.e. correctly predicting presence) of 67%, selectivity of 44% and concordance of 53%, little better than random.

Discussion

The collation reported here expands substantially from the previous documentation of the occurrence of quolls on Northern Territory islands (Abbott and Burbidge 1995) and notably includes records of 14 previously unsurveyed islands, with quolls being recorded from five of these. Notwithstanding these new records, the total number of Northern Territory islands on which quolls naturally occur is limited: we know now of 10 such islands, and the modelling suggests that there may be a further seven. This small minority of quoll-populated islands (a confirmed 4% and a probable 7% of all Northern Territory islands) suggests that this is a very finite conservation resource, and every island population may have a conservation management significance. The Northern Territory tally is substantially greater than that reported for quoll presence on islands in Queensland (one island only - Magnetic – although it appears to have disappeared from here since soon after the arrival of cane toads on it in the late 1960s: R. Taylor *pers. comm.*), but somewhat less than that reported for quoll presence on islands in Western Australia (14 islands: Augustus, Bigge, Boongaree, (Burrup), Caffarelli, Capstan, Carlia, Dolphin, Hidden, Koolan, Purrungku, Sir Frederick, Uwins, Wollaston: Burbidge and McKenzie 1978; Abbott and Burbidge 1995; McKenzie *et al*. 1995; J. Holmes *pers. comm.*.).

The environmental factors associated with quoll occurrence on islands reported here parallel results reported by Burbidge *et* al. (1997) for northern Australian islands more generally. Amongst relationships defined for mammal species richness and a range of individual mammal species, they found that the occurrence of northern quolls on islands was significantly positively related to island size and maximum elevation (they did not consider a parameter of topographic ruggedness, but did consider rainfall, distance to mainland, channel depth and presence of competing species, none of which were found to be significant). Their analysis included 11 islands where quolls were present and 252 where they were absent (with most data from the Kimberley).

Our analysis contrasts with that of Burbidge *et al*. (1997) in also including as significant terms rainfall (negatively) and distance to mainland (positively). The inverse relationship with annual rainfall appears perverse, as, on the mainland, quolls appear to have declined particularly in the lower rainfall fringe of their range (Braithwaite and Griffiths 1994). We consider that the observed negative relationship with rainfall is an idiosyncratic linkage with the spatial occurrence of the most geologically and topographically complex Northern Territory islands in relatively low rainfall areas around the west and south-west of the Gulf of Carpentaria. Further, the absence of northern quolls on two of the three very large Northern Territory islands (Bathurst and Melville, both at the highest rainfall extreme) means that, across the Northern Territory island set, modelling will really only include a positive relationship with island size if it also includes a negative relationship with rainfall.

The inclusion in our modelling of a positive response to isolation is less obviously explainable, but again is probably an idiosyncratic consequence of the quirk that many larger rocky islands (and island groups – notably Groote Eylandt and its satellites) populated by quolls happen to be relative distant from the mainland, whereas many of the more inshore islands are relatively low-lying and featureless, a contrast to the Kimberley, where narrow sea disjunctions often sever otherwise continuous escarpments and rugged rocky ranges extending from the mainland. Further, we suspect that our isolation variable is unhelpfully coarse. Many of the quoll-populated satellite islands around Groote are rated here as substantially isolated (because distant from the mainland), but are extremely close to (a potential source population on) Groote. We have frequently observed island quolls to forage on beaches and in the inter-tidal zone, and they may be readily able to move between nearby islands on very low tides and/or in periods when sea levels may have fallen even marginally.

The idiosyncracies underlying the Northern Territory modelling of quolls explain its substantially weakened performance when predicting quoll occurrence on Kimberley islands.

Consistent with, but refining, the finding of Burbidge *et al*. (1997), we found that the occurrence of quolls on islands was highly related to the island's topographic complexity. Previous studies on the mainland (e.g. Begg 1981; Schmitt *et al*. 1989; Woinarski *et al*. 1992; Braithwaite and Griffiths 1994; Oakwood 2000, 2002) have indicated that rugged rocky areas are the core habitat and refuge for northern quolls. These are likely to be prime habitat because they provide a greater diversity of environments (Freeland *et al*. 1988), they offer many sites for shelter and protection from predators and weather (Burbidge and Manly 2002), and they provide both immediate refuge from fire and more likelihood of retaining patchiness post-fire. Historically, on the mainland, quolls may have spread out from these cores during relatively favourable periods but contracted back to them during less favourable periods. The current absence of quolls from the vast Bathurst and Melville Islands suggests that the separation of these islands from the mainland some 8-12,000 years ago probably coincided with a period when quolls were largely absent from the lowlands, that is when the climate was probably relatively drier (Nix and Kalma 1972).

Quolls have persisted on at least 10 Northern Territory islands over a period of about 8,000 years. With due care to some caveats, this persistence can provide some perspective on the minimum viable population size for medium to long term conservation. The smallest Northern Territory islands that were found to support quolls were Finch (76 ha), island 149 (111 ha), island 158 (121 ha), North Point island (148 ha), Angarmbulluma Island (170 ha) and North-east Island (423 ha) (all satellite islands around Groote). These islands seem very small relative to the average home range (and hence population carrying capacity) previously reported for mainland quolls: Schmitt *et al*. (1989) report average home range of 2.3 ha for females in rocky areas of the Kimberley; Oakwood (2002) estimated the average home range size for female northern quolls in the Kakadu lowlands was 35 ha, and appreciably larger for males; and King (1989) reported movements of > 3 km for individual quolls in the Pilbara. Quoll home ranges are probably appreciably smaller in more resource-rich rocky areas and there may be substantial spatial overlap amongst individuals (perhaps an average of 2-5 quolls with overlapping range at any point): such presumptions would suggest a total population size of about only 47-1000 individuals on these islands (if home range is assumed to be 2.3 ha), extraordinarily low numbers to allow for population persistence in an annual species over a 8000 year period. As argued above, we suggest that this apparently anomalous finding may be attributable in part to the quolls on the satellite islands around Groote effectively operating as a long-term meta-population, with occasional movements between islands. Such a proposition could be tested through genetic analysis of these island populations.

Other than the Groote satellite islands, the smallest indisputably isolated Northern Territory island with quolls is Inglis Island (8181 ha). Using the presumptive estimates above, this island may support around 7-18,000 northern quolls, more feasibly sufficient to buffer against environmental perturbations and genetic constraints over an 8000 year period. These genetic constraints may be substantial: Cardoso *et al*. (ms) have detected greatly reduced genetic variability in the quoll populations of Marchinbar (20,966 ha) and Groote (227,656 ha) compared to mainland populations.

Brook *et al*. (2004) modelled the minimum area required to maintain a viable population of northern quolls (where viability was defined as <10% extinction over 100 years of a minimum viable population of 19,100 individuals (with MVP based on body weight, ecological flexibility and demographics) as 21,965 ha. Eight of the 10 islands reported here to be occupied by northern quolls are smaller than this threshold, but presumably (with the caveat about possible re-colonisations among the Groote satellite islands) have persisted for at least 8,000 years.

In interpreting the pattern of contemporary occurrence of quolls on Northern Territory islands, the success stories (quoll persistence) may be less revealing than the failures (presumed extinctions). It is plausible that all the rocky islands held quoll populations when rising sea levels isolated them. Hence, local extinction has been a far more likely eventuality than persistence. Islands that appear suitable for quolls but do not now support them include such moderately-sized rugged islands as North (5540 ha), Cotton (2120 ha) and Maria (3893 ha). Only four islands that still support quolls are larger than these (Groote, Marchinbar, Inglis and Vanderlin). It is impossible to date the local extinctions of quolls from some now-unoccupied islands. The oral history given by Bradley (above) for the Pellew Islands suggests that quolls may have disappeared from some of the Pellew Islands over the last (human) generation. In this case, this disappearance may be coincident with the spread of feral cats to almost all islands in this group. Since then, cane toads have also spread to most of these islands, including Vanderlin, where quolls had persisted. The management and monitoring of this population in the face of such threats should be a high priority.

Seven of the 10 quoll-occupied islands are part of the Groote Eylandt archipelago, and all may be readily accessible to toads should toads arrive on any one island (which is most likely to be Groote, given its size and the amount of traffic to it). Hence, the most substantial risk to the conservation status of Northern Territory island quolls is probably associated with such a colonisation event. A range of quarantining measures are in place on Groote to minimise the chances of toad invasion.

Conversely, the island quolls are probably likely to be little affected directly by climate change and consequential sea level rise, because all occupied islands are of relatively high relief.

One major active management response to the threat of toads was the translocation of quolls to Pobasso and Inglis Islands. While these two new island populations add significantly to the relatively small pool of naturally-occupied islands, the analysis here suggests that these islands are only moderately suitable for the long-term persistence of these populations, and identifies additional islands with higher suitability. However, the factors affecting island choice for translocation are far broader than simply suitability for quolls, notably also including the occurrence of other species on the islands (for Northern Territory islands including many potential prey species, such as nesting seabirds and marine turtles), likelihood of toad colonisation, and the attitude of the Aboriginal owners.

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Table 1. Listing of all Northern Territory islands >20ha. Numbering system (no.) is ordered latitudinally, from north to south (see also Fig. 1). Note that some islands have no established (European) names. *area* is in ha; *dist*. (distance to mainland) in km; *elev* is maximum elevation (m); *rugged* is topographic ruggedness; *rainf* is mean annual rainfall in mm; *geol*. = dominant geological substrate as either 1=sandstone, 2=laterite, 3=Quaternary sands and muds, 4=other; *veg* = dominant vegetation, as either 1=mangroves, 2=nil, or saline grasslands or saltbush, 3=woodland or heathland; *quolls* 1=present, 0=absent, (0)= probably absent.

no.	*name*	*area*	*dist.*	*elev*	*rugged*	*rainf*	*geol*	*veg*	*quolls*
2	NEW YEAR ISLAND	78	48.0	3	0.23	1320	3	3	(0)
3	OXLEY ISLAND	195	37.1	13	1.56	1315	3	2	(0)
4	CROKER ISLAND	32589	2.5	61	1.89	1314	1	3	0
5		136	34.4	12	1.73	1311	3	2	
6	RIMBIJA ISLAND	246	97.0	22	3.47	1449	1	3	0
7	MCCLUER ISLAND	806	28.3	21	1.65	1303	1	3	(0)
8	LAWSON ISLAND	328	29.8	17	1.75	1309	3	3	(0)
9	MARCHINBAR ISLAND	20966	46.6	73	4.35	1428	1	3	1
10		46	27.2	2	0.05	1304	3	2	
11		23	91.1	24	7.58	1443	1	3	0
12		42	89.8	21	7.26	1445	1	3	0
13		55	136.2	3	0.33	1681	3	2	(0)
14	GRANT ISLAND	1281	17.6	31	2.19	1300	1	3	
15		71	82.9	15	4.60	1436	1	3	0
16	DARCH ISLAND	600	16.4	22	2.31	1306	3	3	
17	MELVILLE ISLAND	580903	24.1	144	2.01	1547	1	3	0
18	TEMPLER ISLAND	116	15.4	10	1.60	1296	3	1	
19		490	60.1	2	0.00	1492	3	2	
20	KARSLAKE ISLAND	80	99.2	11	2.23	1632	1	2	(0)
21	BATHURST ISLAND	169933	56.8	101	2.09	1667	1	3	0
22		38	119.8	2	0.07	1700	3	1	
23	VALENCIA ISLAND	291	2.7	25	3.15	1289	1	3	
24		27	77.0	2	0.17	1533	3	1	
25		37	51.7	10	4.10	1397	1	3	0
26	NORTH GOULBURN ISLAND	3993	16.9	28	1.07	1239	1	3	0
27	BURFORD ISLAND	213	6.3	2	0.01	1325	3	1	
28	GULUWURU ISLAND	4114	39.3	48	4.18	1386	1	3	0
29		60	45.2	17	4.87	1388	1	3	0
30	WUNMIYI ISLAND	133	6.4	15	2.93	1301	3	1	0
31		21	43.7	12	3.97	1382	1	3	0
32	STEVENS ISLAND	289	47.8	27	3.78	1366	2	3	
33	WANGOINDJUNG ISLAND	31	4.7	1	0.00	1310	3	1	
34	MORSE ISLAND	781	10.9	13	0.46	1305	3	3	0
35	GREENHILL ISLAND	1766	2.8	25	1.02	1316	3	3	0
36		28	42.7	13	5.24	1374	1	3	0
37	RARAGALA ISLAND	9399	36.6	58	4.44	1372	1	3	0
38	WARLDAGAWAJI ISLAND	66	7.0	2	0.02	1310	3	1	0
39	SOUTH GOULBURN ISLAND	6229	3.0	21	0.84	1225	1	3	

no.	name	area	dist.	elev	rugged	rainf	geol	veg	quolls
40	BURGUNNGURA ISLAND	264	42.6	11	1.29	1361	2	3	
41	MOGOGOUT ISLAND	106	8.9	5	0.38	1300	3	1	0
42	DJEERGAREE ISLAND	319	41.8	25	4.18	1362	1	3	0
43	ENDYALGOUT ISLAND	11942	0.3	31	0.50	1301	3	3	
44	YARGARA ISLAND	158	37.5	11	0.93	1350	2	3	
45	DRYSDALE ISLAND	5014	27.3	22	0.82	1344	2	3	(0)
46		224	0.0	3	0.05	1293	3	2	
47	SIMS ISLAND	51	3.2	22	7.30	1235	1	2	
48	TRUANT ISLAND	306	35.0	26	4.52	1393	2	3	0
49	NORTH WEST CROCODILE ISLAND	286	50.4	14	2.43	1272	3	2	(0)
50	JIRRGARI ISLAND	747	34.7	36	4.31	1352	1	3	0
51	GRAHAM ISLAND	926	20.9	9	0.57	1335	2	3	(0)
52	BUMAGA ISLAND	376	26.7	26	4.29	1341	1	3	0
53	WIGRAM ISLAND	2285	9.2	66	7.40	1368	1	3	0
54	ELCHO ISLAND	28315	0.7	47	1.33	1306	2	3	0
55	WARNAWI ISLAND	242	20.1	18	3.20	1334	1	3	0
56	COTTON ISLAND	2120	4.1	92	13.33	1353	1	3	0
57	BUCHANAN ISLAND	118	53.3	3	0.07	1566	3	1	(0)
58		282	9.5	40	8.05	1367	1	3	0
59		46	10.2	31	9.83	1354	1	3	0
60	ALGER ISLAND	848	6.5	24	2.70	1324	2	3	0
61	ASTELL ISLAND	1268	5.4	74	9.54	1351	1	3	0
62		62	1.2	29	8.51	1356	1	3	0
63		65	33.2	13	2.92	1244	3	3	
64	POBASSOO ISLAND	392	2.3	78	13.78	1351	1	3	0
65	MOOROONGGA ISLAND	2074	24.4	16	1.24	1232	3	3	(0)
66	IRRITITU ISLAND	160	24.1	6	0.60	1538	3	1	(0)
67	ENTRANCE ISLAND	126	3.5	8	1.42	1185	3	3	
68	BOSANQUET ISLAND	155	6.5	64	14.56	1328	1	3	0
69		58	10.8	35	8.65	1330	1	3	0
70		55	6.6	43	11.02	1326	1	3	0
71	INGLIS ISLAND	8181	2.6	115	8.56	1324	1	3	1
72	CROCODILE ISLAND	920	2.3	8	0.24	1191	3	2	(0)
73	DARBADA ISLAND	592	0.7	4	0.11	1188	3	2	(0)
74	YABOOMA ISLAND	2503	7.8	17	0.44	1201	3	3	(0)
75		75	0.1	8	0.53	1332	3	1	
76		21	9.9	19	6.27	1313	1	3	0
77	NORTH WEST VERNON ISLAND	1384	9.5	3	0.00	1535	3	1	(0)
78	MILINGIMBI ISLAND	4958	0.4	17	0.23	1188	3	3	(0)
79		52	0.2	2	0.02	1185	3	2	
80	BOOJIRAGI ISLAND	159	8.1	5	0.36	1192	3	2	
81		21	0.6	2	0.34	1185	3	2	
82	EAST VERNON ISLAND	1254	8.2	2	0.00	1527	3	1	(0)
83		218	1.0	3	0.16	1183	3	2	
84	HOWARD ISLAND	27372	0.0	46	0.88	1249	2	3	0
85	GANANGGARNGUR ISLAND	494	7.2	13	0.96	1200	3	3	(0)

no.	name	area	dist.	elev	rugged	rainf	geol	veg	quolls
86	FIELD ISLAND (KARDANGARL)	4438	3.2	11	0.10	1326	3	3	0
87	MARDANAINGURA ISLAND	332	5.6	8	0.47	1191	3	1	(0)
88		300	0.8	4	0.18	1179	3	2	(0)
89	BAT ISLAND	377	0.2	3	0.01	1170	3	1	(0)
90		87	0.1	2	0.07	1180	3	2	(0)
91	BREMER ISLAND	1682	3.5	29	1.80	1346	2	3	
92	RUBY ISLAND (ABAGIN)	180	2.8	4	0.18	1473	3	1	
93	PROBABLE ISLAND	738	0.4	65	12.47	1299	1	3	
94	SOUTH WEST VERNON ISLAND	839	1.8	4	0.03	1541	3	1	(0)
95		64	0.8	2	0.05	1177	3	2	(0)
96		23	0.0	2	0.28	1276	3	2	
97		57	0.0	1	0.00	1272	3	2	
98		29	0.2	2	0.03	1176	3	2	(0)
99	BARRON ISLAND (DJIDBORDU)	451	1.1	7	0.63	1329	3	3	0
100		40	0.4	6	0.88	1545	3	1	(0)
101		65	0.3	3	0.29	1549	3	1	(0)
102	GWAKURA ISLAND	87	4.2	40	15.48	1291	1	3	
103	MALLISON ISLAND	1249	1.4	72	6.10	1286	1	3	
104		69	0.8	3	0.08	1235	3	1	
105		58	0.2	2	0.02	1329	3	1	
106		300	0.3	41	3.16	1323	2	3	
107	BANYAN ISLAND	4950	0.0	21	0.53	1206	2	3	
108		216	0.0	3	0.04	1211	3	2	
109		35	0.2	19	5.19	1322	2	3	
110	HARDY ISLAND	380	1.4	8	0.71	1264	2	3	
111	LOW ISLAND	23	7.2	6	1.58	1259	3	2	
112	GANUMBALI ISLAND	48	0.4	4	0.61	1231	3	2	
113	QUAIL (DOOENDA) ISLAND	70	12.1	14	3.23	1584	3	1	(0)
114	CHANNEL ISLAND	117	0.4	24	4.11	1565	4	3	(1)
115	INDIAN ISLAND	2702	0.3	15	0.97	1574	3	3	0
116	GROSE (BUTTYERAHIT) ISLAND	645	5.1	4	0.01	1581	3	1	(0)
117		442	4.7	3	0.02	1583	3	1	(0)
118	BEER-EETAR ISLAND	231	3.8	3	0.01	1581	3	1	(0)
119		109	0.1	2	0.03	1550	3	1	
120	DUM IN MIRRIE ISLAND	738	2.3	5	0.04	1581	3	3	(0)
121		29	2.7	2	0.00	1580	3	2	
122	TURTLE ISLAND	40	0.2	11	2.75	1578	3	3	(0)
123		75	0.5	2	0.02	1579	3	1	
124	CROCODILE ISLAND	46	0.3	1	0.00	1563	3	1	
125	MCNAMARA ISLAND	105	1.7	19	3.96	1207	4	3	
126	BRIDGLAND ISLAND	46	6.1	33	9.90	1208	4	3	
127	DUDLY ISLAND	33	11.7	17	5.15	1214	4	3	
128	PERON ISLAND	1914	4.5	19	0.74	1512	3	3	0

no.	*name*	*area*	*dist.*	*elev*	*rugged*	*rainf*	*geol*	*veg*	*quolls*
	NORTH								
129	PERON ISLAND SOUTH	537	3.4	9	0.48	1504	3	2	0
130	ROUND HILL ISLAND	270	2.6	61	3.86	1101	4	3	
131	GOONINNAH ISLAND	94	1.2	14	2.90	1113	1	3	
132	FOWLER ISLAND	163	2.8	16	2.65	1082	2	3	
133	PALMERSTON ISLAND	425	0.4	4	0.15	1470	3	2	
134	ISLE WOODAH	6421	7.2	36	1.87	1080	2	3	
135	NICOL ISLAND	467	15.2	37	3.39	1086	1	3	
136	COOL YAL YOU MA ISLAND	25	16.8	10	3.00	1085	2	3	
137	MARRINAN ISLAND	31	14.9	5	1.02	1076	3	3	
138	MORGAN ISLAND	703	12.1	81	9.12	1087	1	3	
139	BURNEY ISLAND	476	16.5	31	4.79	1067	1	3	0
140	WEDGE ROCK	24	26.3	29	8.00	1080	1	3	
141		37	21.1	7	1.47	1070	1	3	
142	HAWKNEST ISLAND	259	33.2	7	0.49	1076	2	3	0
143	NORTH POINT ISLAND	148	47.8	36	9.52	1080	1	3	1
144	NORTH EAST ISLES	422	65.9	56	5.52	1093	1	3	1
145		102	48.2	37	8.80	1078	1	3	0
146		28	51.7	14	4.55	1081	1	3	
147	CHASM ISLAND	299	44.7	76	11.22	1091	1	3	
148	GROOTE EYLANDT	227657	40.0	192	3.58	1057	1	3	1
149		111	48.7	32	8.35	1080	1	3	1
150		470	49.5	25	3.54	1076	1	3	
151	BICKERTON ISLAND	22521	7.2	77	2.59	1048	2	3	
152	ANGARMBULUMARDJA ISLAND	169	48.3	30	5.93	1076	1	3	1
153		27	46.6	11	3.18	1076	1	3	
154		37	48.0	12	4.71	1074	1	3	
155	HAWK ISLAND	226	65.4	22	2.22	1082	1	3	0
156	LANE ISLAND	55	67.4	11	2.71	1086	1	3	
157		58	44.8	20	5.09	1076	1	3	
158		121	56.4	31	9.18	1069	1	3	1
159	BUSTARD ISLAND	254	32.4	30	2.97	1068	1	3	0
160	WINCHELSEA ISLAND	4697	42.3	51	2.16	1072	1	3	
161		36	32.4	7	2.67	1066	3	3	0
162	FINCH ISLAND	76	50.3	53	11.99	1080	1	3	1
163	YARRANYA ISLAND	84	54.3	6	0.80	1065	3	3	
164	CONNEXION ISLAND	1046	33.3	36	3.00	1062	1	3	0
165		20	0.0	0	2.84	1365	3	1	
166	DORCHERTY ISLAND	3171	0.2	14	0.21	1340	3	1	
167		30	88.6	16	5.40	1043	3	3	
168		33	0.4	2	0.29	1339	3	2	
169		57	110.2	12	2.81	1050	3	3	
170		31	111.7	11	3.03	1049	3	3	
171		57	113.2	13	4.04	1050	3	3	
172	NUNGKANANGKA ISLAND	44	0.2	2	0.05	885	3	2	
173		43	113.0	13	4.55	1047	3	3	
174		23	99.6	14	3.16	1031	3	3	

no.	*name*	*area*	*dist.*	*elev*	*rugged*	*rainf*	*geol*	*veg*	*quolls*
175		44	111.9	12	3.57	1042	3	3	
176	EDWARD ISLAND	627	1.2	13	1.02	852	1	3	
177		8480	0.4	8	0.04	1152	3	2	
178		30	0.1	2	0.13	1111	3	2	
179		1091	0.9	6	0.07	1086	3	2	
180	QUOIN ISLAND	5646	2.6	6	0.02	1071	3	2	
181	CLUMP ISLAND	2829	0.9	8	0.03	1078	3	2	
182	MARIA ISLAND	3893	15.9	62	3.43	823	1	3	0
183		2304	0.2	5	0.02	1055	3	2	
184	DRIFTWOOD ISLAND	813	0.8	2	0.00	1051	3	2	
185		29	0.4	2	0.32	1051	3	2	
186		45	0.3	2	0.02	1053	3	2	
187		23	0.2	2	0.45	1047	3	2	
188		107	0.2	2	0.00	1045	3	2	
189		22	0.3	2	0.11	1041	3	2	
190		62	0.0	3	0.00	1030	3	2	
191		694	2.8	3	0.07	1011	3	1	
192		26	0.1	2	0.08	1009	3	2	
193		25	0.1	2	0.50	1007	3	2	
194		250	0.4	1	0.00	1002	3	1	
195		49	0.4	3	0.43	990	3	2	
196	BEATRICE ISLAND	93	3.2	8	1.49	804	3	3	
197		52	0.3	4	0.54	982	3	2	
198	ENTRANCE ISLAND	1523	0.2	121	8.33	961	1	3	
199		111	0.2	0	0.00	966	3	1	
200		26	0.0	2	0.07	972	3	2	
201		35	0.1	2	0.00	945	3	2	
202	URQUHART ISLET	24	40.7	2	0.14	1008	3	2	
203	NORTH ISLAND	5540	24.7	74	4.35	990	1	3	0
204	WEST ISLAND	12895	3.6	52	0.89	912	3	3	0
205		32	14.5	4	0.75	901	3	2	
206	WATSON ISLAND	1413	26.1	45	3.14	978	1	3	0
207	GILBERT ISLAND	28	19.2	2	0.04	934	3	2	
208	VANDERLIN ISLAND	26248	5.7	82	2.94	1023	1	3	1
209	BLACK ISLET	462	17.2	48	4.87	936	1	3	0
210	SKULL ISLAND	673	23.4	46	3.33	973	1	3	0
211	WHEATLEY ISLET	42	29.1	24	6.55	1014	1	3	
212	OBSERVATION ISLAND	36	29.0	20	5.19	997	1	3	
213	CENTRE ISLAND	8439	7.6	89	4.35	959	1	3	0
214	RED ISLET	35	16.3	24	5.05	947	1	3	
215	SOUTH WEST ISLAND	9134	0.6	90	2.62	932	1	3	0
216		1126	0.0	3	0.02	903	3	2	
217		21	2.7	2	0.00	902	3	1	
218		23	3.4	5	0.67	909	3	2	
219		259	0.3	4	0.08	898	3	1	
220	STEEPCUT ROCK	22	19.3	6	1.66	1033	4	3	
221		400	14.7	29	3.82	965	1	3	
222	HOBLER ISLAND	521	0.0	7	0.08	906	3	2	
223		31	0.7	2	0.00	898	3	1	
224		124	0.0	4	0.00	909	3	2	

no.	*name*	*area*	*dist.*	*elev*	*rugged*	*rainf*	*geol*	*veg*	*quolls*
225	LABU ISLET	42	6.1	8	1.39	936	3	3	
226	JOLLY ISLET	101	10.7	10	1.65	1001	1	3	
227		47	0.0	2	0.02	910	3	2	
228		75	0.8	4	0.35	913	3	2	
229		183	0.2	4	0.21	912	3	2	
230		626	0.1	4	0.04	999	3	1	
231	LITTLE VANDERLIN ISLAND	48	5.6	2	0.05	1020	4	2	
232		33	0.0	1	0.00	971	3	2	
233		110	0.0	2	0.04	983	3	2	

Table 2. Characteristics of islands with quoll presence, absence and not sampled. Note that this tabulation is based only on the data set containing “definite” absences. Values in body of table are mean (median), with (s.e.; range) below. For the two categorical variables, the value shown is the number of islands, with in brackets the number of islands including “probable” quoll absences.

variable	**class**	**quolls present**	**quolls absent**	**island not sampled**
Island area (km^2)		258.5 (2.9)	159.4 (4.6)	7.9 (1.0)
		(203.8; 0.8 – 2277)	(103.6; 0.2 – 5809)	(1.8; 0.2 – 225)
Distance to mainland (km)		37.7 (48.1)	24.0 (16.2)	17.3 (2.9)
		(6.9; 2.6 – 65.9)	(3.2; 0 – 97)	(2.3; 0 – 136)
Maximum elevation (m)		65.9 (53.2)	37.8 (29.5)	12.6 (6.0)
		(15.1; 25 – 192)	(3.7; 2 – 144)	(1.4; 0 – 121)
Topographic ruggedness		6.64 (5.93)	4.46 (3.72)	1.67 (0.50)
		(0.92; 2.94 – 11.99)	(0.46; 0.02 – 14.56)	(0.20; 0 – 15.48)
Annual rainfall (mm)		1145 (1080)	1277 (1329)	1191 (1180)
		(41; 1023 – 1428)	(24; 823 – 1667)	(16; 804 – 1700)
geology	sandstone	11 (11)	41 (44)	28 (25)
	laterite	0 (0)	5 (7)	14 (12)
	mud & sand	0 (0)	12 (42)	114 (84)
	other	0 (0)	0 (0)	7 (7)
vegetation	woodlands	11 (11)	54 (66)	69 (57)
	mangroves	0 (0)	3 (16)	34 (21)
	saltflats	0 (0)	1 (11)	60 (50)

Table 3. Summary of results of generalised linear modelling of quoll occurrence. Table 3a reports results for the data set containing islands with quoll presence and “definite” absence; Table 3b reports results for the data set containing islands with quoll presence and “definite” and “probable” absence.

Table 3a. With “definite” absences.

parameter	**estimate**	**Wald statistic**	**p**
intercept	-7.0823	2.88	0.09
log (Area)	3.3569	6.37	0.012
mainland distance	0.1214	7.00	0.0082
ruggedness	0.8933	7.47	0.0063
rainfall	-0.01214	7.53	0.0061

Deviance explained = 54.7% (4 df)

Table 3b. Including also islands with “probable” quoll absences

parameter	**estimate**	**Wald statistic**	**p**
intercept	-7.1441	2.94	0.09
log (Area)	3.3899	6.66	0.0099
mainland distance	0.1222	7.17	0.0074
ruggedness	0.9019	7.84	0.0051
rainfall	-0.01225	7.87	0.0050

Deviance explained = 60.7% (4 df)

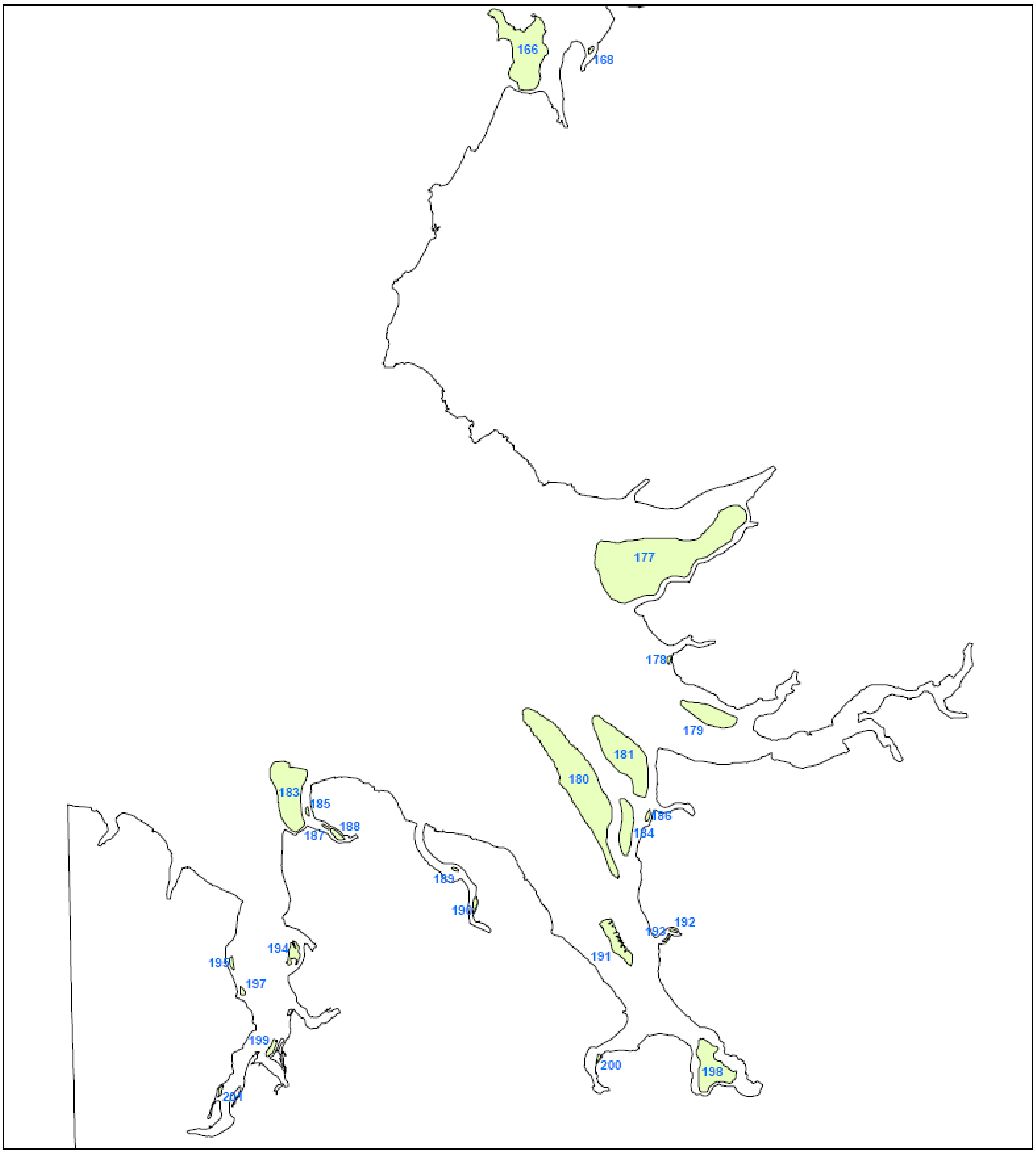
Table 4. Modelled likelihood of occurrence of northern quolls, shown for all islands with likelihood >0.5, and for all islands known to contain quolls but with likelihood of occurrence of <0.5. Note that islands are arranged in descending order of likelihood of quoll presence (based on model 1 predictions). Model 1 includes only “definite” absences; model 2 also includes “probable” absences.

island	**quoll occurrence**	**prediction (model 1)**	**prediction (model 2)**
Groote	present	0.998	0.998
island 173	not sampled	0.971	0.970
Chasm	not sampled	0.970	0.970
island 171	not sampled	0.970	0.968
Finch	present	0.951	0.951
island 175	not sampled	0.930	0.927
island 158	present	0.883	0.880
island 169	not sampled	0.880	0.874
island 170	not sampled	0.819	0.811
North point	present	0.809	0.804
North east	present	0.808	0.802
island 167	not sampled	0.703	0.692
North	absent	0.598	0.591
island 145	absent	0.581	0.571
Cotton	absent	0.531	0.521
island 149	present	0.521	0.510
Maria	absent	0.502	0.496
Marchinbar	present	0.423	0.409
Vanderlin	present	0.213	0.207
Angarmbuluma	present	0.189	0.180
Inglis	present	0.119	0.113
Pobasso	(translocated)	0.106	0.101
Astell	(translocated)	0.021	0.020

Table 5. Occurrence of northern quolls on some islands of the Kimberley, Western Australia.

no.	name	area (km^2)	dist	elev	rugged	rainfall	quoll	prediction
2	SIR GRAHAM MOORE ISLAND	28.3	4.5	61	2.74	982	0	0.012
3	BROWSE ISLAND	0.2	175	7	1	1086	0	0.997
4	BORDA ISLAND	6.8	3.8	108	11.56	1012	0	0.723
5	EAST MONTALIVET ISLAND	3.5	27	90	10.97	1082	0	0.807
6	MIDDLE OSBORNE ISLAND	23.6	2.8	220	15.67	1038	0	0.998
7	SOUTH WEST OSBORNE ISLAND	12.7	4.9	132	11.71	1006	0	0.901
8	CARLIA	4.4	1.8	123	12.53	1007	1	0.731
9	KATERS ISLAND	16.7	4	92	7.49	1070	0	0.111
10	SOUTH MARET	3.7	29	48	5.27	1102	0	0.025
11	BIGGE ISLAND	174.1	5	140	4.63	1104	1	0.181
12	WOLLASTON ISLAND	8.7	3	175	18.81	1108	1	0.999
13	CAPSTAN ISLAND	3.8	0.3	64	6.63	1099	1	0.003
14	PURRUNGKU ISLAND	13.3	0.3	80	7.37	1113	1	0.029
15	CORONATION ISLAND	39.5	7	144	12.70	1155	0	0.961
16	BOONGAREE ISLAND	46.3	0.3	228	13.35	1163	1	0.957
17	BAT ISLAND	0.1	0.2	28	2	1144	0	0.000
18	UWINS ISLAND	33.0	0.7	136	7.40	1167	1	0.060
19	AUGUSTUS ISLAND	190.6	4.6	180	8.50	1169	1	0.781
20	DARCY ISLAND	48.5	27	95	6.66	1147	0	0.646
21	CHAMPAGNY ISLAND	13.9	30	55	4.50	1124	0	0.073
22	HEYWOOD ISLAND	7.2	23	52	5.70	1135	0	0.032
23	SAINT ANDREW ISLAND	15.4	2.8	278	21.20	1170	0	1.000
24	BYAM MARTIN ISLAND	8.0	15	70	6.07	1147	0	0.017
25	ADELE ISLAND	2.7	75	10	1.12	928	0	0.470
26	CAFFARELLI ISLAND	2.7	30	63	13.11	861	1	0.998
27	KINGFISHER ISLAND	10.6	17	80	9.37	933	0	0.901
28	KOOLAN ISLAND	25.5	1	172	19.11	897	1	1.000
29	SIR FREDERICK ISLAND	4.0	15	79	12.85	861	1	0.989
30	MELOMYS ISLAND	7.2	10	75	12.08	922	0	0.967
31	HIDDEN ISLAND	20.0	4	118	10.95	845	1	0.983

Fig. 1. Maps showing Northern Territory islands, with numbering system as used in this report. Following the map of the entire Northern Territory coastline, subsequent maps show sections, arranged from the western border to the eastern border. For island names, refer to numbers in Table 1.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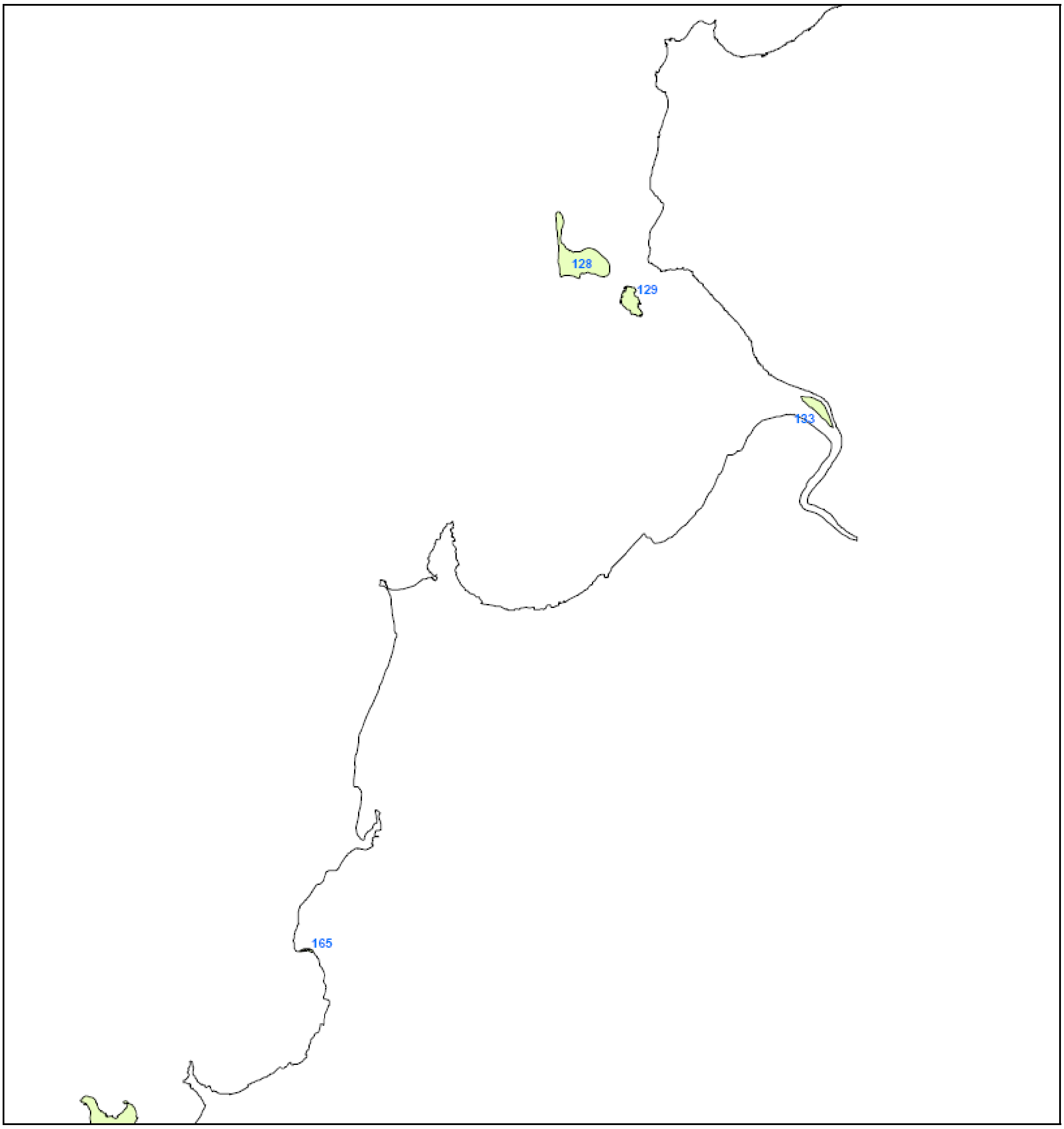
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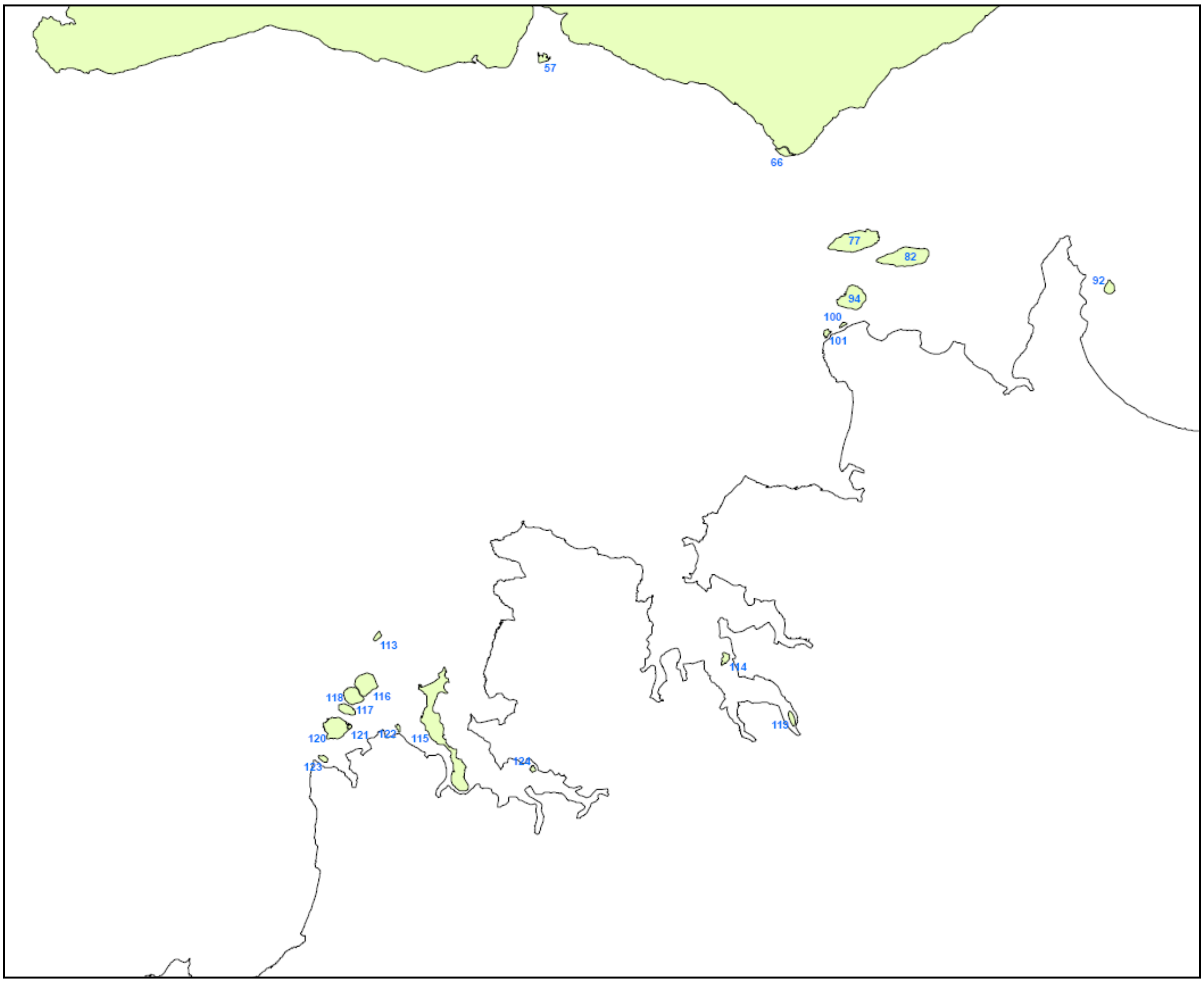
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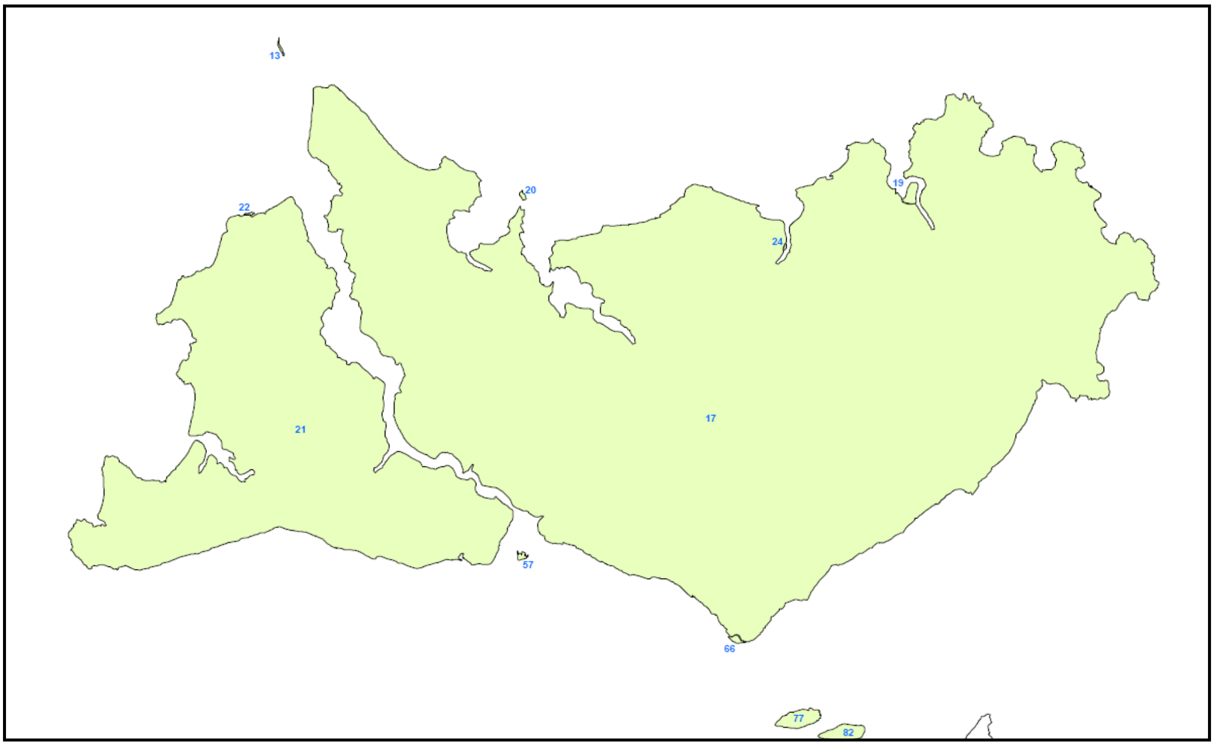
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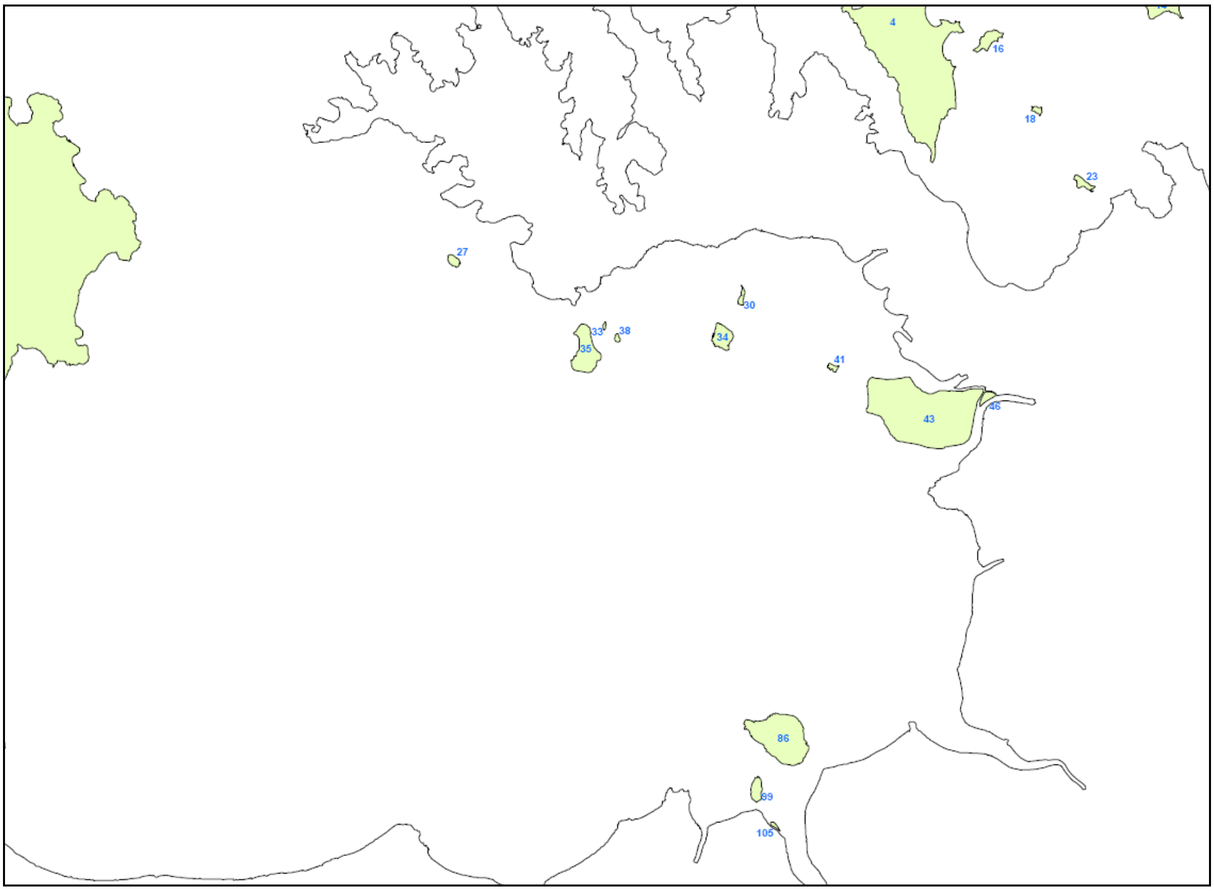
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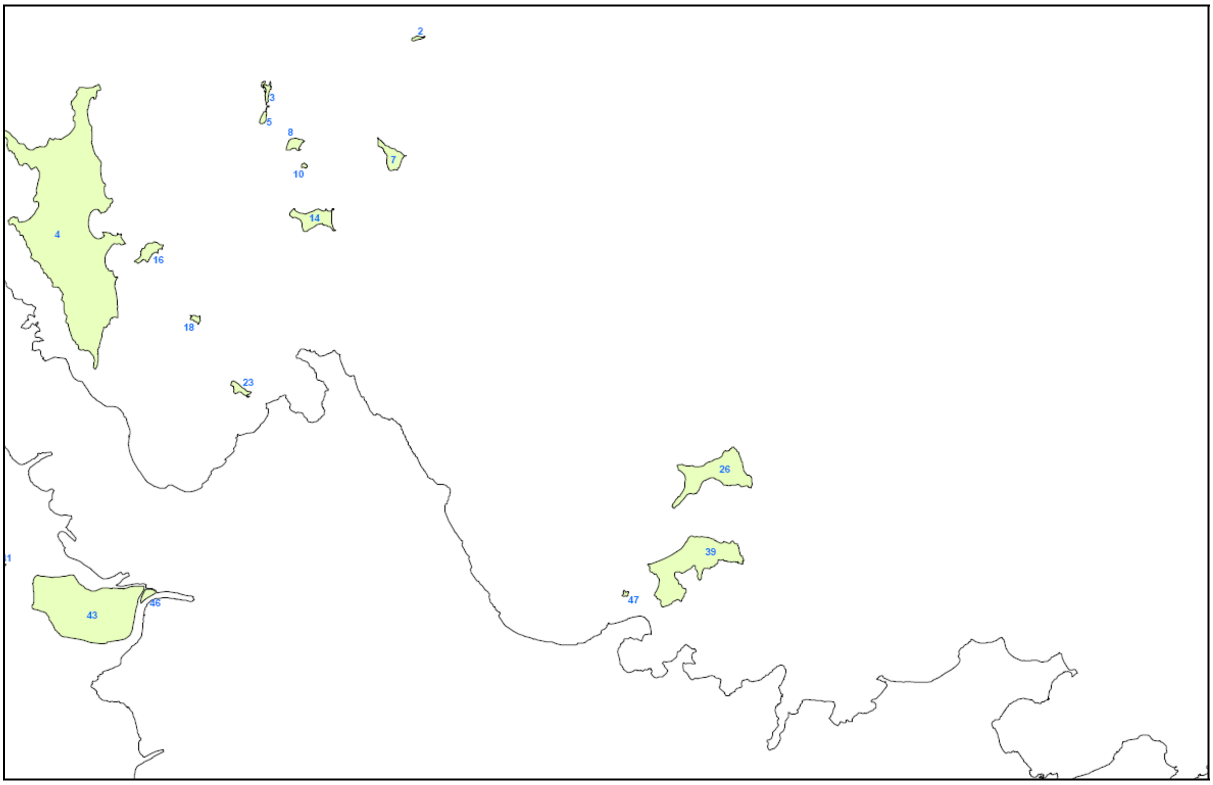
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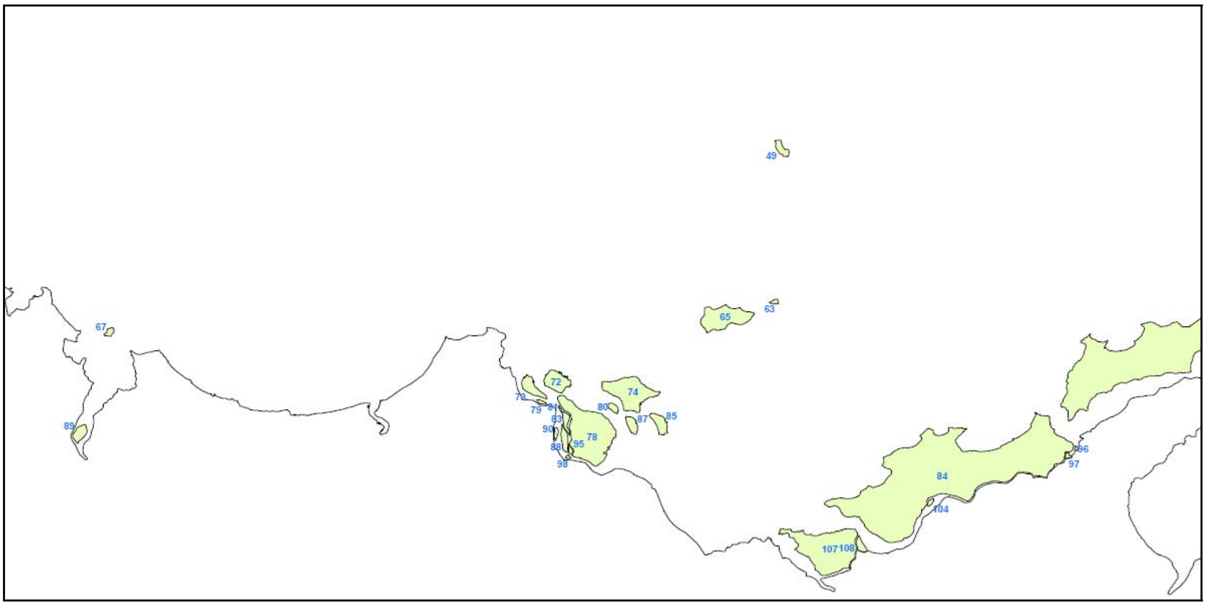
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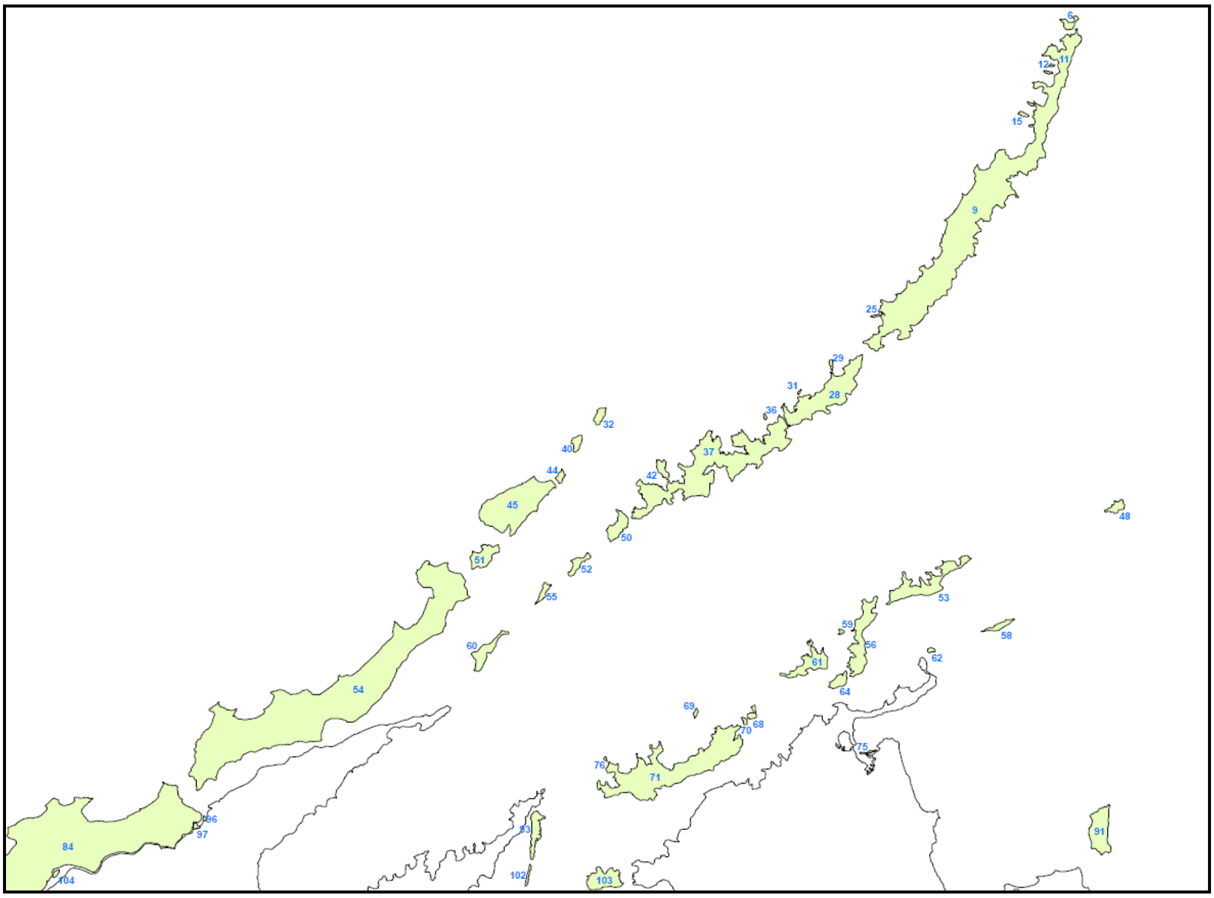
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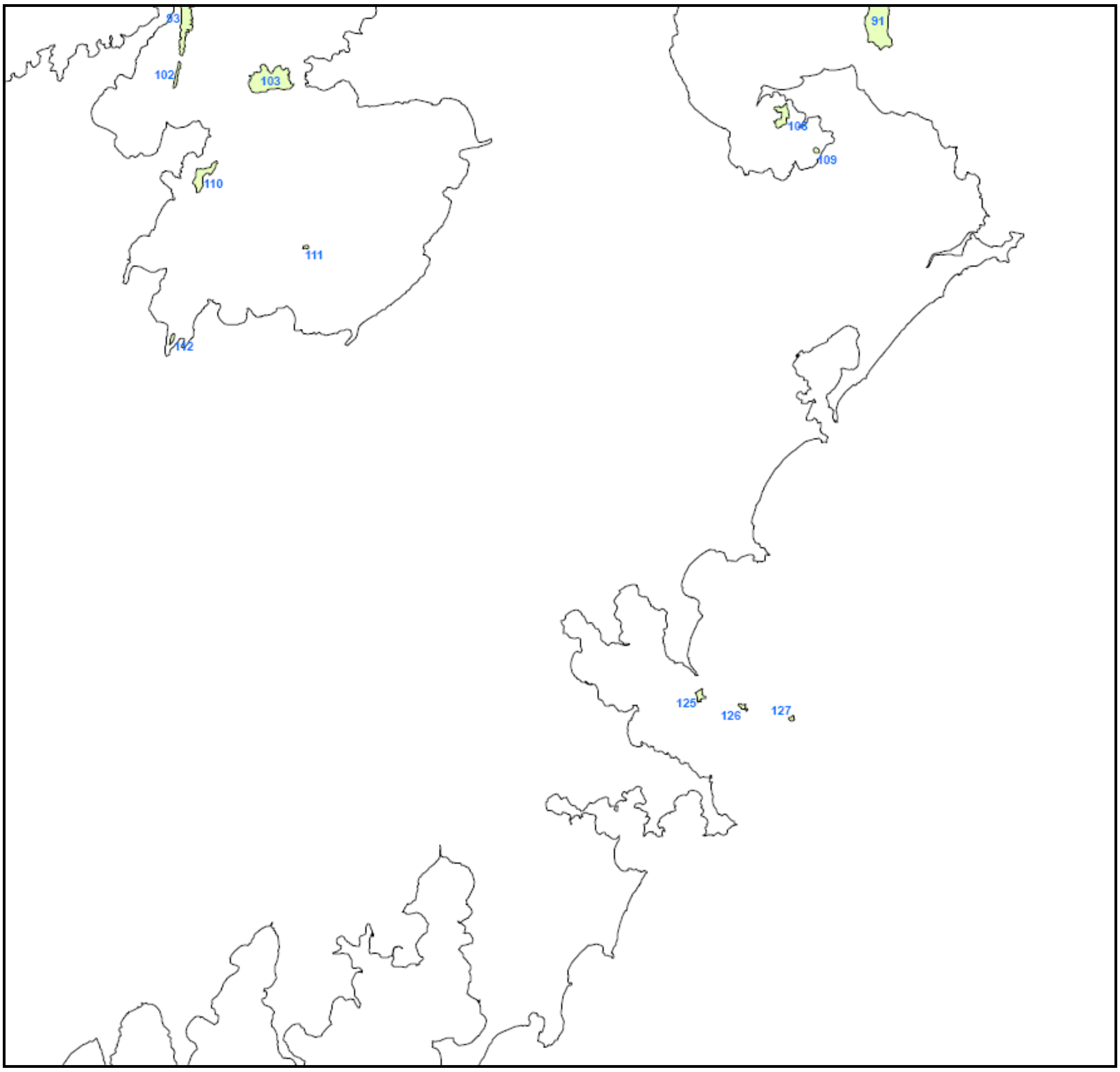
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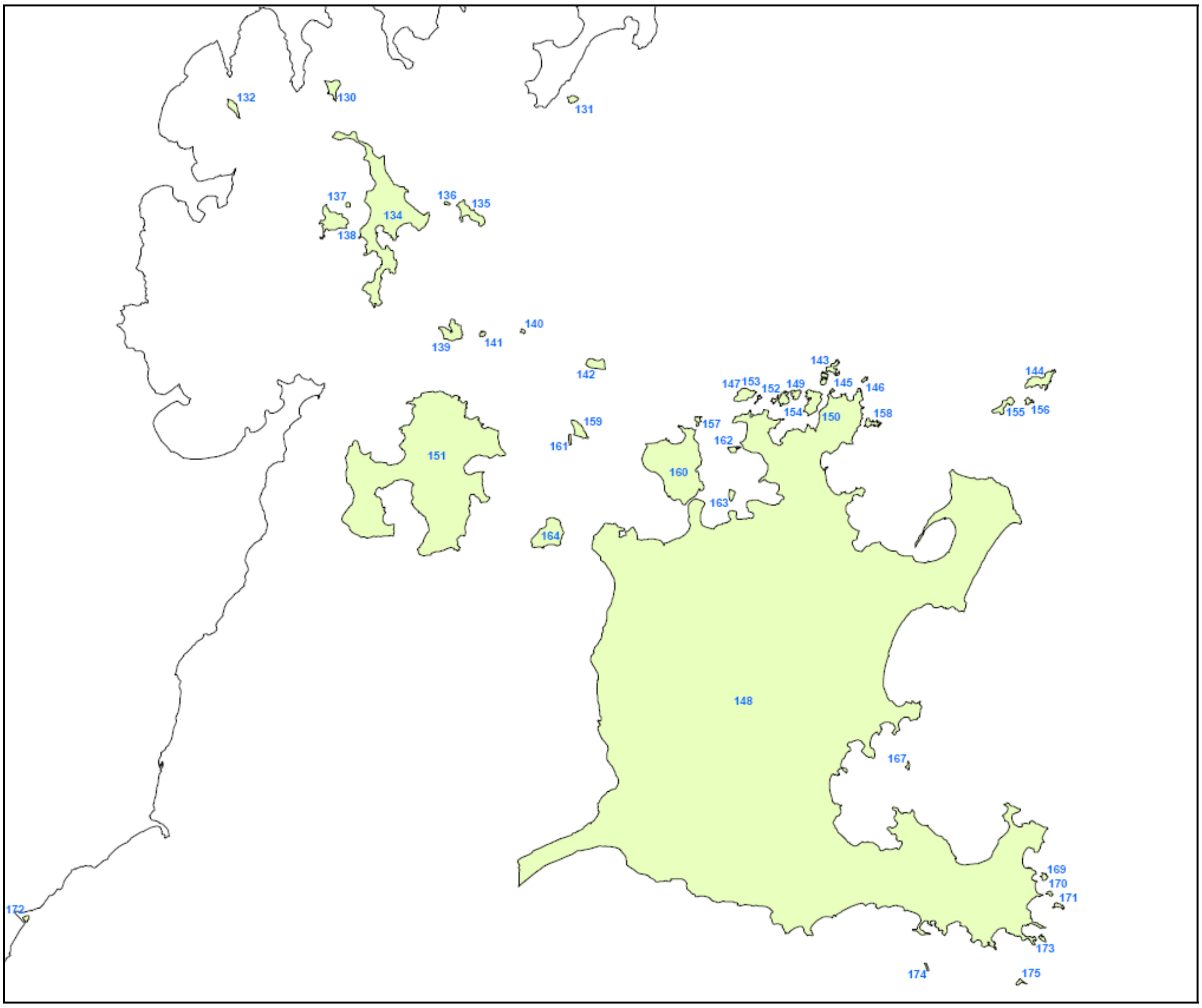

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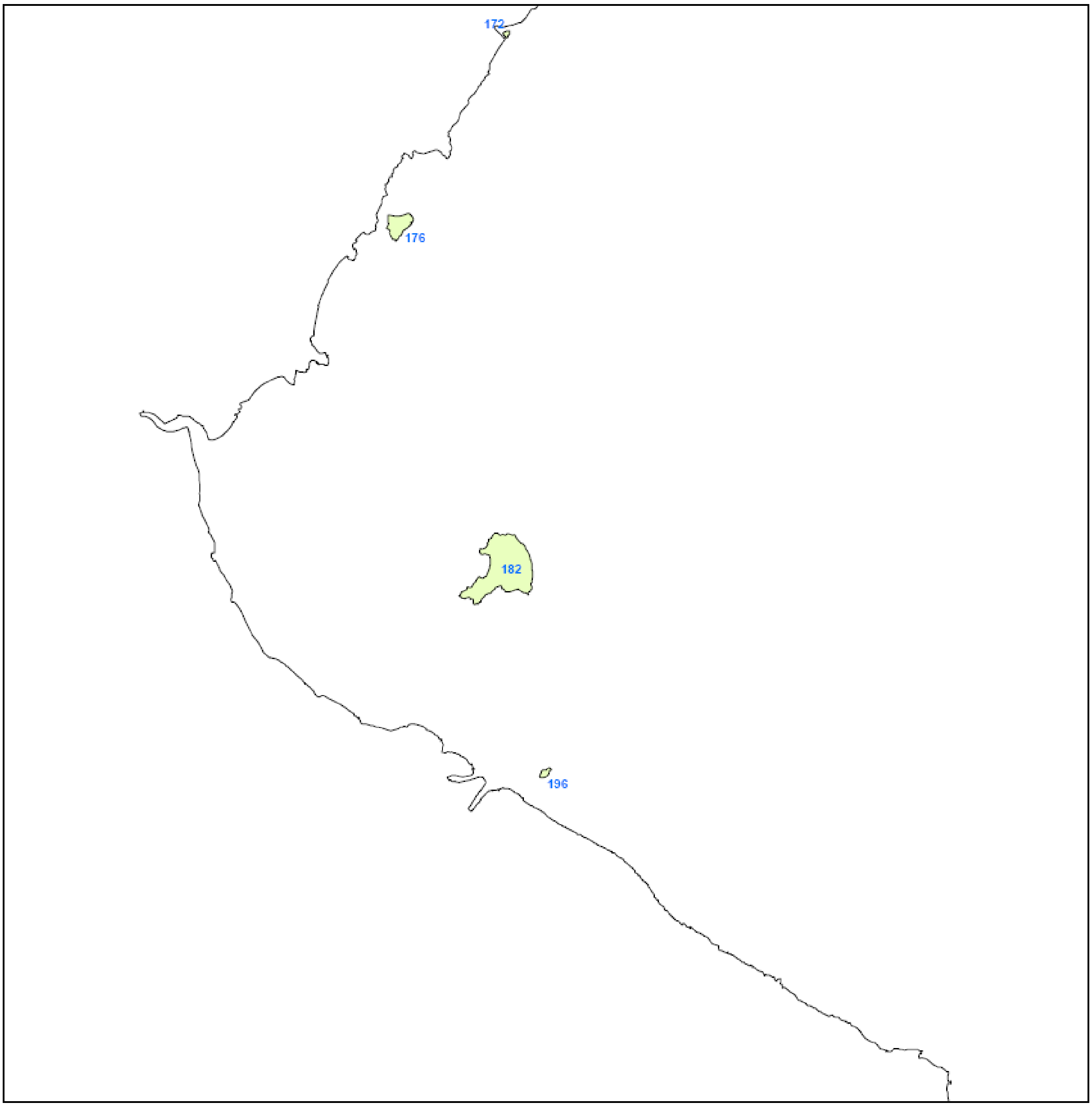
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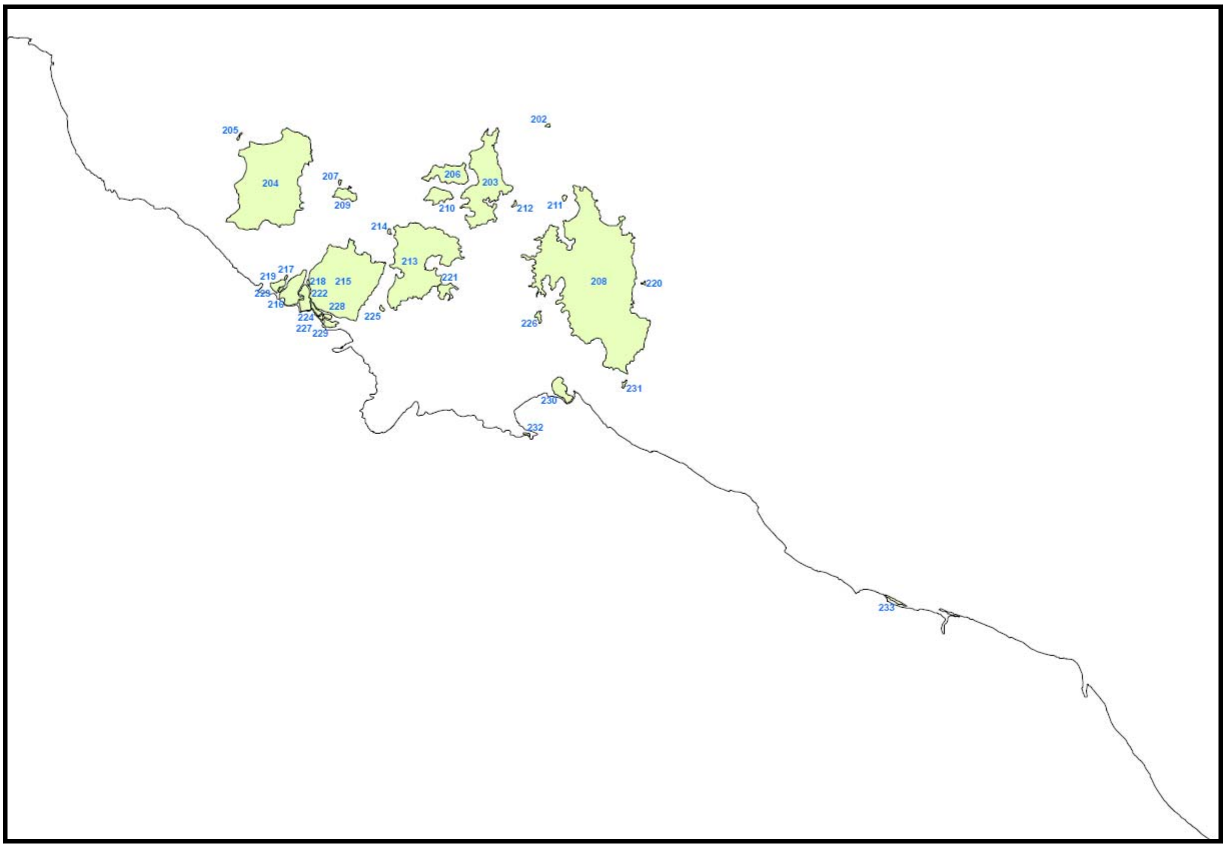
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Fig. 2. Scatterplot of Northern Territory islands, by island size (logAREA (in ha)) and topographic ruggedness. Red filled circles indicate islands where quolls are known to be present; green open squares are islands where quolls are absent; blue crosses are islands not yet surveyed. Some islands named in the text are indicated: Ast=Astell, Pob=Pobasso (both islands now containing translocated quoll populations); Cott=Cotton, Bos=Bosanquet, Prob=Probable, Gwak=Gwakura.