Survey protocol for masked owls in the NT *Tyto novaehollandiae* (north Australian mainland subspecies *T. n. kimberli* and Tiwi subspecies *T. n. melvillensis*)

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Purpose

This short note is aimed at land managers, developers, consultants and biologists in the NT to assist in the detection of masked owls, covering two listed threatened subspecies requiring a high level of conservation management.

Introduction

The masked owl *Tyto novaehollandiae* is a large owl (males *ca.* 600 g, females *ca.* 1 kg.), dark on the back, light underneath, with a prominent heart-shaped facial disc. It is most likely to be confused with the barn owl *Tyto alba*, which is noticeably smaller, paler and more lightly built. Four subspecies of masked owls are currently recognised in Australia and all are separately listed as threatened species. Two subspecies occur in the NT: the Tiwi subspecies *T. n. melvillensis* is restricted to the Tiwi Islands, immediately to the north of Darwin, and the north Australian mainland subspecies *T. n. kimberli* is shared with northern WA and northern Queensland. Both these subspecies are appreciably smaller than masked owls from south-eastern and south-western Australia The Tiwi subspecies is listed as "Endangered" under national and NT legislation and the northern Australian mainland subspecies is listed as "Vulnerable" in the NT, Queensland and nationally (http://www.nt.gov.au/nreta/wildlife/animals/threatened/pdf/birds/masked_owl_kimberli_vu.pdf).

The Tiwi subspecies *T. n. melvillensis* is restricted to Bathurst Island and Melville Island, two closely associated islands (separated by the Apsley Strait, which in places is less than 800 m wide) which together form the Tiwi Islands. The islands are dominated by eucalypt tall open forests and woodlands (especially Darwin woollybutt *Eucalyptus miniata*, Darwin stringybark *E. tetrodonta* and Melville Island bloodwood *Corymbia nesophila*), with patches of monsoon rainforests and treeless plains and grasslands. Much of the coast line supports mangrove forests. Tiwi masked owls occur mainly in the forests and woodlands (Fig. 1a), but may roost in monsoon forests or mangroves and may forage over the treeless plains and grasslands. Preferred roosts are in large hollows in standing trees and such hollows are required for nesting (Figs 1b&c). The major threats to the Tiwi masked owl are a small population size (probably less than 2500 individuals, confined to only two closely-associated islands) and the clearing of large areas of optimum habitat for plantations of exotic trees.

The distribution of the north Australian mainland subspecies *T. n. kimberli* is less clearly defined. There are three major parts to its distribution: two in northern Queensland and the third, and largest, across the north of the NT

and Western Australia (Woinarski 2004). Within the NT, most records come from the western Top End from the Cobourg Peninsula down to about Katherine, with other records from the Victoria River District, McArthur River area, the Barkly Tablelands and one from the Tanami (the latter two possibly distributional isolates from the broader range in the NT). As for the Tiwi subspecies, north Australian mainland masked owls mainly inhabit eucalypt tall open forests and woodlands (especially Darwin woollybutt and Darwin stringybark), but also use patches of monsoon rainforests and grasslands. Comparison of the numbers recorded in surveys in 1977–81 and 1998 – 2002 indicated a decline across the subspecies' range (Barrett *et al.* 2003), including in the NT. Given the broad scale across which the decline appears to be occurring, it is difficult to define threatening processes for the subspecies but two landscape-scale processes are most often considered possible reasons. Firstly, over the last 50 or so years the frequency, intensity and scale of fires has increased, probably resulting in declines in the number of the largest eucalypt trees, especially those providing nesting and roosting hollows. Secondly, the major food supply of masked owls is native small and medium-sized mammals and these have declined across much of northern Australia over the last century.

Masked owls are nocturnal hunters and most of the diet comprises small mammals (up to the size of possums). The major threatening process for the Tiwi masked owl is the loss to habitat through the clearing of tall forests and woodlands for plantation forestry. For the mainland Australian subspecies, broad-scale decline of small native mammals across northern Australia, combined with habitat alteration caused by changed fire regimes (particularly the loss of old large hollow-bearing trees) are the most likely threatening processes. A multi-species recovery plan for woodland birds in the NT covers both subspecies (Woinarski 2004).

Pairs of masked owls occupy large exclusive home ranges (estimated at 5-10 km^2 in south-eastern Australia). In the lead-up to nesting (typically the early dry-season) they communicate within the pair and to advertise their territories using a range of screeches, screams, hisses and chatter calls. Once nesting commences masked owls are less vocal. Surveys for masked owls typically combine playback of calls and listening for calls at multiple sites (typically along a road) at night, and are likely to be most successful in the lead-up to nesting (i.e. build-up and wet-season).

Prior to the intensification of plantation forestry on the Tiwi Islands, a comprehensive fauna survey there carried out surveys for masked owls (Woinarski et al 2003). The forestry company subsequently commissioned consultants to study the breeding and ranging behaviour of the subspecies as forestry operations progressed. Regional fauna and flora surveys of the Cobourg Peninsula in 2004-06 did targeted surveys for north Australian masked owls (K. Brennan pers. comm.), and an Australian Government-funded project in 2009-10 did surveys for the subspecies on Cobourg Peninsula, Cox Peninsula and in Kakadu National Park. The protocol outlined below is refined from the methods used in these surveys, plus advice from James Smith (EWL Consulting) and Kym Brennan (NRETAS).
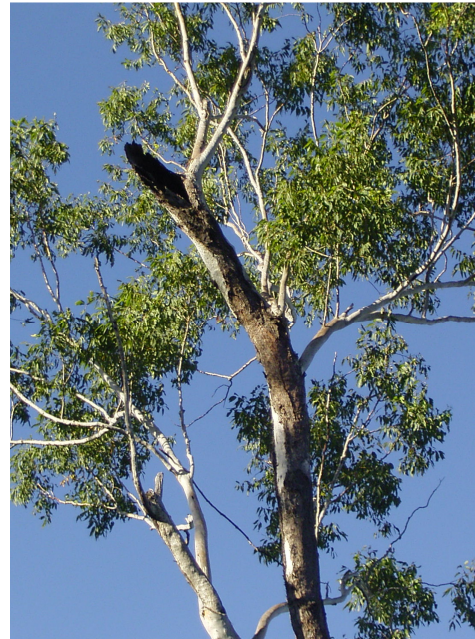
a.

b.

c.

Figure 1. Habitat and hollows used by masked owls in the NT.
a. Tall open eucalypt woodland on the Cobourg Peninsula (Jan. 2010).
b. A large *Eucalyptus miniata* tree with a hollow used for nesting by masked owls on Melville Island (photo: James Smith, EWL Consulting). c. Close-up of the hollow in b. (photo: James Smith, EWL Consulting).

The Protocol

Survey design
Broadcast surveys for masked owls are done at night along roads through suitable habitat at sites 1-2 km or more apart. At each site:
  i.   broadcast the call of the masked owl (see details below).
  ii. For the first 5 minutes of the broadcast, listen for calls of masked owls and watch for silhouettes of birds flying in to the area around the speaker (i.e. don't use a spotlight).
  iii. In the second 5 minutes, keep listening for owl calls but use a spotlight to look for owls in the trees around the site.
  iv. When spotlighting, do an initial scan of all the nearby trees, then spend the rest of the 5 minutes doing a more-careful search of the trees for owls and small mammals (potential prey).
The three most common responses from masked owls to the broadcast are:
  • make a territorial call and fly into to a tree close to the speaker. The bird may continue to call or may be quiet. In the 2010 surveys of Cobourg, Kakadu and Cox Peninsula, this occurred in 5 of 7 cases where masked owls were detected.
  • make a territorial call and continue previous activity (i.e. be heard but not seen). In the 2010 surveys of Cobourg, Kakadu and Cox Peninsula, this occurred in 2 of 7 cases where masked owls were detected.
  • ignore the broadcast (in which case they will not be detected – false negative). In the 2010 surveys, this occurred an unknown number of times.
Given the very large size of territories, it is very possible that a broadcast within an occupied territory will not be heard by resident birds, in which case they will not be detected (false negative). Hence multiple sites within an area must be surveyed. If the site of interest is small, it may cover only part of a territory, and surveys over multiple nights may be more appropriate.

Masked owl calls and broadcasting equipment
The 2010 surveys of Cobourg, Kakadu, Cox Peninsula and the Katherine Region used a playback recording consisting of a series of calls recorded of Tiwi masked owls by James Smith. The 10 minute playback included 5 % screeches, 4 % hisses and 4 % chattering – the remaining 87% was silence, during which the surveyor listened for calls of resident owls. The playback recording was stitched together using free-ware audio editing software called 'Audacity' and was loaded onto an MP3 player. The calls were broadcast through a 10 watt speaker with a 12 watt amplifier powered by a 12 volt rechargeable battery.

Timing of surveys
Masked owls are most vocal, and therefore most amenable to playback-based survey techniques, in the lead-up to the nesting season. On the Tiwi Islands, James Smith (pers. com.) found that nesting started soon after the end of the wet season, that calling was most evident during the build-up and that calling continued through the wet season. Hence the best times of year for surveys of masked owls in the NT are the build-up (October-December) and the wet

season (approximately January-March). Unfortunately this is also the most uncomfortable time of year for observers, and access to many areas become difficult in the wet season. Masked owls may respond to broadcast surveys at other times of year, but their detectability will be lower, so more false negatives should be expected.

As for all owl species, surveys should be carried out at night. Rain or windy weather makes it difficult to detect the birds and surveys should not occur under such conditions.

Detectability and survey effort
Past surveys in the NT for masked owls include those by NRETAS on the Tiwi Islands, Cobourg Peninsula (2004/05 and 2010), Kakadu National Park (2010) and the Cox Peninsula (2010). These areas support different woodland/forest types, but the Tiwis and Cobourg Peninsula both fall into the same Bioregion and have the wettest, densest and tallest forests in the NT. The results of each survey give an indication of the relative densities of masked owls in different parts of the NT. Numbers of survey points varied between surveys and the earlier surveys employed different recordings and lengths of broadcasts, but all employed playback surveys along roads at night. Table 1 gives a summary of the results of each survey and the locations of all points surveyed in the 2010 surveys are listed in Appendix 1.

The clearest conclusions that can be drawn from these survey results are that the highest densities of mainland masked owls in the NT are on Cobourg Peninsula, and that relatively high population densities also occur on the Tiwi Islands. Comparison of the 2004/05 and 2010 results from Cobourg Peninsula is difficult because the total number of sites where playback surveys were carried out in 2004/05 is not clear, and these surveys occurred at a variety of times of year. However, the detection rate does appear to have been much higher in the earlier survey, suggesting that there has been a decline in the population. Tropical Cyclone Ingrid passed directly over Cobourg Peninsula in March 2005, and caused extensive defoliation and tree damage to a broad area. Presumably this caused direct damage to owl nesting trees and Kym Brennan (pers. com.) reported that it resulted in local crashes in small mammal populations. Kym also assisted in the 2010 owl surveys and considered the strike rate to be much lower than he remembered in 2004/05, prior to the cyclone.

Detection rates in Kakadu National Park, the Cox Peninsula and in the Katherine area were very low or zero. This probably reflects both lower densities and smaller areas of preferred habitat for masked owls in these areas. Under these conditions, roads often do not pass through large areas of preferred habitat, so choosing sites at fixed distances along roads probably results in a majority of surveys occurring at inappropriate sites. So at mainland sites, away from the Cobourg Peninsula, more careful stratification of habitat types and concentration of surveys in areas of tall eucalypt woodland are recommended. The recording and playback conditions remain appropriate.

Table 1. Summary of the results of playback surveys for masked owls in the NT.

Survey	Number of sites surveyed	Number of locations of masked owls	Time of year	Reference
Melville Is. (Tiwi Islands) 2002	202	13	May (dry season)	Woinarski et al 2003
Cobourg Peninsula 2004/05	(approximately 150)	28	Wet and dry seasons	Brennan pers. com.
Cobourg Peninsula 2010	112	6	15-22 January (wet season)	Ward unpub.
Kakadu National Park 2010	68	1	15-19 February (wet season)	Ward unpub.
Katherine Region 2010	8	0	29 March (wet season)	Ward unpub.
Cox Peninsula 2010	44	0	30 March & 8 April (wet season)	Ward unpub.

Conclusions:

The Tiwi Islands continue to support populations of the Tiwi subspecies of masked owls. The Cobourg Peninsula has the largest population of mainland masked owls in the NT, due to its large area of tall open eucalypt forests and woodlands (preferred habitat). However, this population may have declined following destruction of habitat and collapses of small mammal prey populations caused by Cyclone Ingrid in 2005. In other parts of the Top End masked owl populations are sparse and probably patchily distributed. Since masked owls are specialist predators on small mammals, recent dramatic declines in small-medium-sized mammals across northern Australia (Woinarski et al 2010) are likely to have caused a decline in masked owl populations.

Initial surveys in a region should concentrate surveys in areas of the preferred habitat (see introduction). More-detailed surveys, such as pre-development or clearing surveys within the known distribution, should be more intensive, at about 1 km intervals along tracks or roads. These should also occur over multiple nights, since resident masked owls may be out of hearing range on any one given night. Low hit-rates are to be expected.

References

Barrett, G., Silcocks, A., Barry, S., Cunningham, R. and Poulter, R. (2003). *The New Atlas of Australian Birds*. (Birds Australia: Hawthorn East.)

Woinarski, J.C.Z. (2004). *National multi-species Recovery Plan for the Partridge pigeon [eastern subspecies]* Geophaps smithii smithii*; crested shrike-tit [northern (sub)species]* Falcunculus (frontatus) whitei*; masked owl [north Australian mainland subspecies]* Tyto novaehollandiae kimberlii*; and masked owl [Tiwi Islands subspecies]* Tyto novaehollandiae melvillensis*, 2004-2008*. (NT Department of Infrastructure Planning and Environment: Darwin.) http://www.environment.gov.au/biodiversity/threatened/publications/recovery/smithii-whitei-kimberli-melvillensis/index.html

Woinarski, J., Brennan, K. Hempel, C., Armstrong, M., Milne, D. and Chatto, R. (2003). *Biodiversity conservation on the Tiwi Islands, Northern Territory: Part 2. Fauna.* (NT Department of Infrastructure Planning and Environment: Darwin.)

Woinarski, J.C.Z., Armstrong, M., Brennan, K., Fisher, A., Griffiths, A.D., Hill, B. Milne, D.J., Palmer, C., Ward, S., Watson, M., Winderlich, S. and Young S. (2010). Monitoring indicates rapid and severe decline of native small mammals in Kakadu National Park, northern Australia. *Wildlife Research* **37,** 116-126.

Appendix 1 Locations of masked owl survey points, 2010.

Table A1. Locations of all playback survey sites in the NRETAS 2010 surveys of Cobourg Peninsula (Garig Gunak Barlu National Park), Kakadu National Park, Cox Peninsula, Katherine Region. Locations where masked owls were recorded are shown in bold. All locations are in GDA.

| **Cobourg Peninsula**					
CBP001	S11.39169 E132.28981	CBP045	S11.39163 E132.51105	CBP096	S11.22026 E132.22080
CBP002	S11.37402 E132.28763	CBP046	S11.39735 E132.49397	CBP097	S11.20991 E132.21035
CBP003	S11.35876 E132.28560	CBP047	S11.41317 E132.48630	**CBP098**	**S11.19450 E132.20619**
CBP004	S11.34932 E132.27287	CBP048	S11.41452 E132.46937	CBP099	S11.17797 E132.18056
CBP005	S11.33452 E132.27210	CBP049	S11.40137 E132.45188	**CBP100**	**S11.16461 E132.16909**
CBP006	S11.32031 E132.26373	CBP050	S11.40632 E132.44143	CBP101	S11.15397 E132.15392
CBP007	**S11.30998 E132.24964**	CBP051	S11.41309 E132.42573	CBP102	S11.13667 E132.14971
CBP008	S11.29527 E132.24857	**CBP052**	**S11.40742 E132.40797**	CBP103	S11.19570 E131.88136
CBP009	S11.27942 E132.25409	CBP053	S11.39357 E132.39546	CBP104	S11.20839 E131.89454
CBP010	S11.26699 E132.24177	CBP054	S11.38335 E132.38151	CBP105	S11.22536 E131.89674
CBP011	S11.25053 E132.23985	CBP055	S11.38039 E132.36614	CBP106	S11.23955 E131.90680
CBP012	S11.24048 E132.22976	CBP056	S11.38999 E132.35104	CBP107	S11.25447 E131.90990
CBP013	S11.22864 E132.22170	CBP057	S11.40179 E132.33712	CBP108	S11.28460 E131.89833
CBP014	S11.21732 E132.21338	CBP058	S11.40586 E132.32186	CBP109	S11.28461 E131.89832
CBP015	S11.20099 E132.20806	CBP059	S11.39873 E132.30442	**CBP110**	**S11.28829 E131.91593**
CBP016	S11.18757 E132.19812	CBP060	S11.15563 E132.34178	CBP111	S11.29717 E131.93181
CBP017	S11.18319 E132.18094	CBP061	S11.17315 E132.33915	CBP112	S11.30319 E131.94783
CBP018	S11.16997 E132.17432	CBP062	S11.19150 E132.33923	CBP113	S11.29897 E131.96481
CBP019	S11.15818 E132.16073	CBP063	S11.20630 E132.33600	CBP114	S11.31469 E131.97559
CBP020	S11.34158 E132.04814	CBP064	S11.22176 E132.33747	CBP115	S11.32942 E131.98630
CBP021	S11.35178 E132.06424	CBP065	S11.23166 E132.33254	CBP116	S11.33638 E132.00329
CBP022	S11.36748 E132.07428	CBP066	S11.24076 E132.32522	CBP117	S11.33585 E132.01772
CBP023	S11.37872 E132.08874	CBP067	S11.25686 E132.31914	**CBP118**	**S11.33364 E132.03339**
CBP024	S11.39578 E132.09488	CBP068	S11.27056 E132.33002	**Kakadu National Park**	
CBP025	S11.41068 E132.10542	CBP069	S11.28725 E132.33737	KAK122	S12.86667 E132.81138
CBP026	S11.42674 E132.11220	CBP070	S11.30413 E132.33222	KAK123	S12.85583 E132.79678
CBP027	S11.45655 E132.12409	CBP071	S11.31927 E132.33979	KAK124	S12.84177 E132.80058
CBP028	S11.44307 E132.11118	CBP072	S11.33373 E132.35018	KAK125	S12.82464 E132.79838
CBP029	S11.46406 E132.13488	CBP073	S11.35132 E132.35143	KAK126	S12.81751 E132.78088
CBP030	S11.46286 E132.14989	CBP074	S11.36951 E132.35699	KAK127	S12.81074 E132.76446
CBP031	S11.45843 E132.16638	CBP075	S11.12996 E132.14776	KAK128	S12.80660 E132.74798
CBP032	S11.45683 E132.18275	CBP076	S11.12996 E132.14776	KAK129	S12.82696 E132.73174
CBP033	S11.44955 E132.19895	CBP077	S11.14711 E132.15070	KAK130	S12.84603 E132.73422
CBP034	S11.44674 E132.21646	CBP084	S11.38255 E132.28902	KAK131	S12.86287 E132.72956
CBP035	S11.44150 E132.23457	CBP085	S11.36686 E132.28206	KAK132	S12.86087 E132.71182
CBP036	S11.43180 E132.24598	CBP086	S11.35088 E132.28237	KAK133	S12.86003 E132.69283
CBP037	S11.41534 E132.24982	CBP087	S11.34124 E132.27024	KAK134	S12.86887 E132.67650
CBP038	S11.40274 E132.25602	CBP088	S11.32631 E132.27053	KAK135	S12.88063 E132.66182
CBP039	S11.39341 E132.27143	CBP089	S11.31605 E132.25563	KAK136	S12.89126 E132.64646
CBP040	S11.43070 E132.55998	CBP090	S11.30246 E132.25031	KAK137	S12.90253 E132.63020
CBP041	S11.41672 E132.55610	CBP091	S11.28845 E132.25423	KAK138	S12.90501 E132.60415
CBP042	S11.41800 E132.54301	CBP092	S11.27464 E132.24680	KAK139	S12.90899 E132.56935
CBP043	S11.41034 E132.52825	CBP093	S11.25886 E132.24050	**KAK140**	**S12.91497 E132.55100**
CBP044	S11.40163 E132.52026	CBP094	S11.24324 E132.23602	KAK141	S12.92957 E132.54139
		CBP095	S11.23255 E132.22960	KAK142	S12.68338 E132.46938

KAK143	S12.69430 E132.45354	CXP006	S12.44355 E130.70885
KAK144	S12.70180 E132.43622	CXP007	S12.44189 E130.69961
KAK145	S12.71127 E132.41978	CXP008	S12.44036 E130.69114
KAK146	S12.71579 E132.40152	CXP009	S12.43858 E130.68133
KAK147	S12.69145 E132.38338	CXP010	S12.43708 E130.67279
KAK148	S12.69147 E132.38332	CXP011	S12.43524 E130.66339
KAK149	S12.72285 E132.38299	CXP012	S12.43210 E130.65490
KAK150	S12.73243 E132.36511	CXP013	S12.42878 E130.64613
KAK151	S12.73731 E132.34868	CXP014	S12.45720 E130.74086
KAK152	S12.73670 E132.32955	CXP015	S12.46635 E130.73981
KAK153	S12.74095 E132.31150	CXP016	S12.47362 E130.73397
KAK154	S12.74986 E132.29537	CXP017	S12.48312 E130.73216
KAK155	S12.76124 E132.27970	CXP018	S12.49255 E130.73208
KAK156	S12.76715 E132.25916	CXP019	S12.50099 E130.72719
KAK157	S12.77011 E132.24374	CXP020	S12.50792 E130.72214
KAK158	S12.77940 E132.22649	CXP021	S12.51596 E130.71682
KAK159	S12.78842 E132.19997	CXP022	S12.57271 E130.68991
KAK160	S12.83121 E131.88614	CXP023	S12.58234 E130.68823
KAK161	S12.83332 E131.90587	CXP024	S12.59069 E130.69248
KAK162	S12.83448 E131.92792	CXP026	S12.61526 E130.70019
KAK163	S12.83276 E131.94223	CXP027	S12.62586 E130.69692
KAK164	S12.82512 E131.96001	CXP028	S12.63344 E130.70200
KAK165	S12.82084 E131.97872	CXP029	S12.64338 E130.69351
KAK166	S12.82313 E131.99717	CXP030	S12.65282 E130.68977
KAK167	S12.83152 E132.05844	CXP031	S12.65933 E130.68343
KAK168	S12.82804 E132.07793	CXP032	S12.66410 E130.67300
KAK169	S12.82397 E132.09727	CXP033	S12.66503 E130.66396
KAK170	S12.81469 E132.11207	CXP034	S12.66172 E130.65369
KAK171	S12.80110 E132.12840	CXP035	S12.65951 E130.64504
KAK172	S12.79316 E132.14520	CXP036	S12.65997 E130.63523
KAK173	S12.79063 E132.16498	CXP037	S12.65501 E130.62718
KAK175	S13.63616 E132.17297	CXP038	S12.64811 E130.62127
KAK176	S13.60199 E132.21875	CXP039	S12.65286 E130.61199
KAK177	S13.58283 E132.25686	CXP040	S12.66066 E130.60774
KAK178	S13.57488 E132.25471	CXP041	S12.66355 E130.59956
KAK179	S13.56661 E132.26336	CXP042	S12.66629 E130.59018
KAK180	S13.55953 E132.27017	CXP043	S12.64235 E130.70398
KAK181	S13.54825 E132.27919	CXP044	S12.64923 E130.71102
KAK182	S13.48510 E132.24902	CXP045	S12.65448 E130.71875
KAK183	S13.49283 E132.25043	CXP046	S12.65660 E130.72804
KAK184	S13.50276 E132.25758	CXP047	S12.67823 E130.79244
KAK185	S13.51704 E132.26906	**Katherine Region**	
KAK186	S13.52872 E132.28233	KAT228	S14.31415 E132.42302
KAK187	S13.54627 E132.29339	KAT229	S14.32352 E132.42328
KAK188	S13.54157 E132.31631	KAT230	S14.33263 E132.42286
KAK189	S13.53668 E132.33376	KAT231	S14.34644 E132.43297
KAK190	S13.52558 E132.34727	KAT232	S14.38168 E132.41468
Cox Peninsula		KAT233	S14.49070 E132.24982
CXP003	S12.44700 E130.73589	KAT234	S14.43336 E132.27937
CXP004	S12.44597 E130.72679	KAT235	S14.31300 E132.42289
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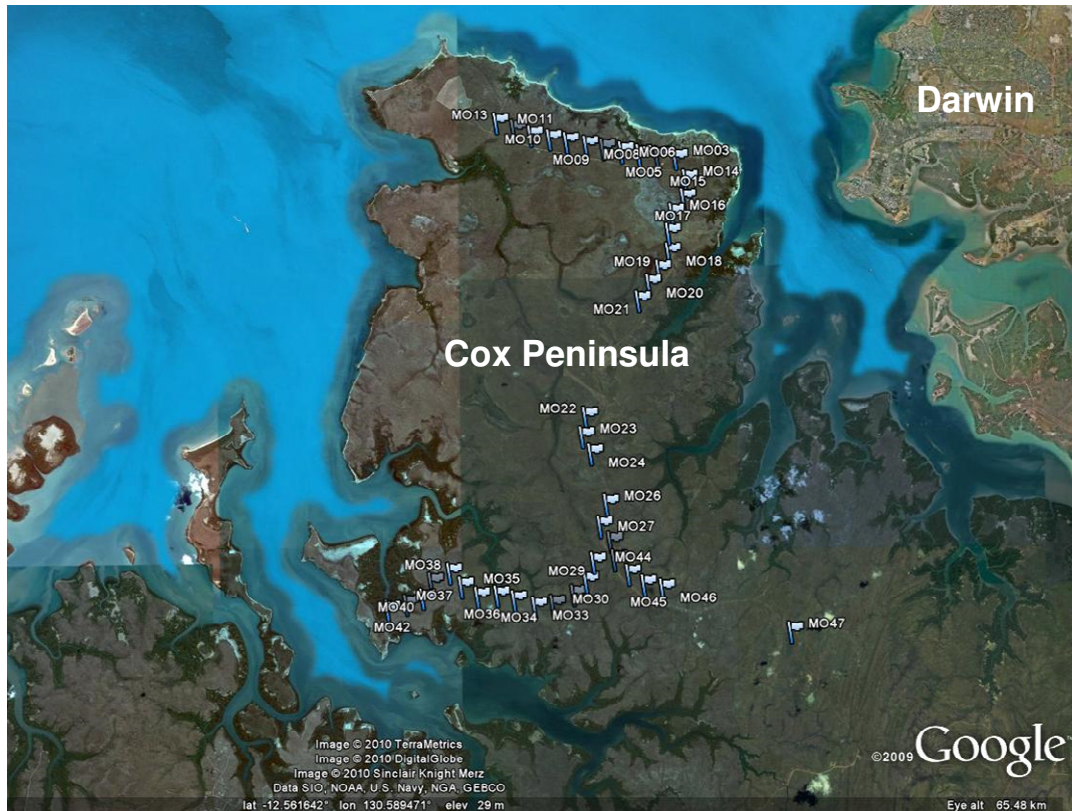**Cobourg Peninsula**

Kakadu National Park
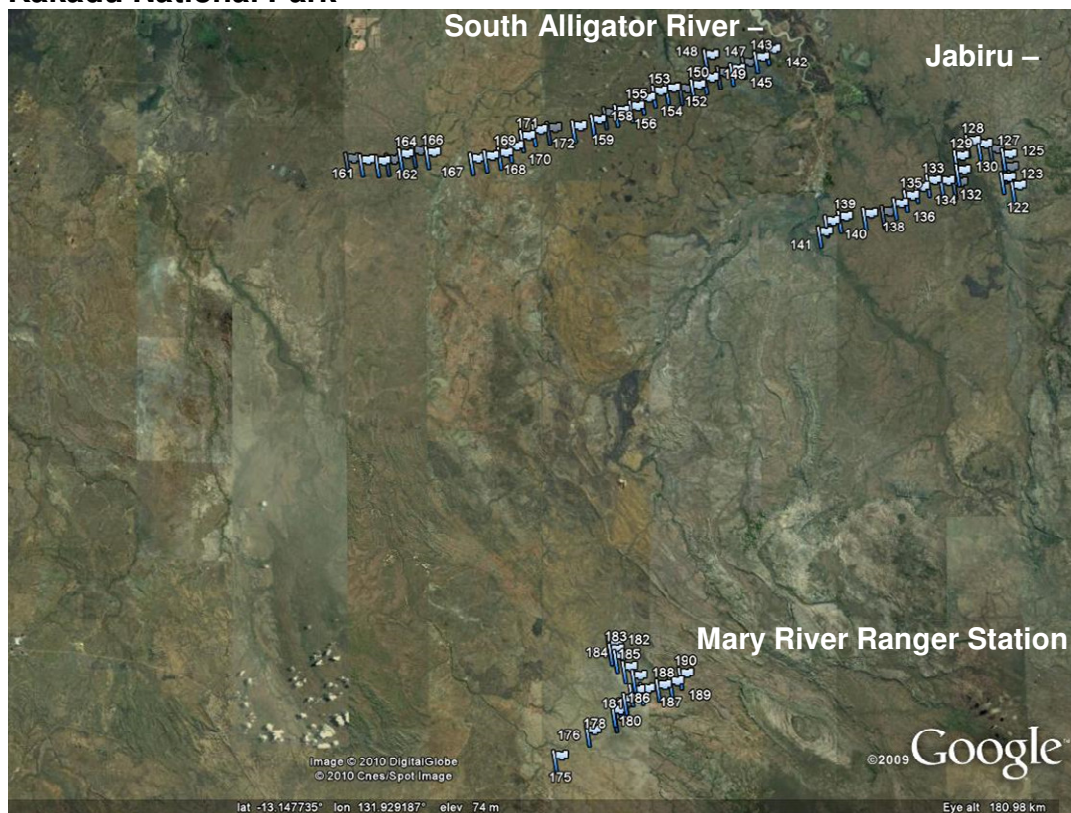
Figure A1a. Google images of locations of masked owl playback survey sites

Cox Peninsula

Katherine region

Figure A1b. Google images of locations of masked owl playback survey sites