9. Estimates of MVPs and MHAs

Estimates of minimum viable population size are very scale dependent, and tend to increase approximately linearly with projection time (number of years a population must remain viable), but non-linearly as the definition of the acceptable risk level (probability of extinction) becomes more conservative. The MVP-Risk-Time surface is illustrated in Figure 1 for the northern sand goanna, *Varanus panoptes*, and very similar relationships were evident for the other 11 candidate species (Table 1). The general result is that larger population sizes will reduce the likelihood of extinction, especially if the absolute risk is quite low, and larger population sizes are also required to buffer against long-term population fluctuations, where chance events such as a succession of poor years may cause extinction even when "average" conditions are not expected to drive an overall population decline (see Shaffer 1981, for a sobering example of this, the Heath Hen).

The results of the MVP evaluations for a range of risk/time definitions for the 12 candidate species are presented in Table 1, ranked from lowest to highest MVP. The differences amongst the different species in their MVP tend to arise because of contrasting modes of reproduction and patterns of survival (e.g., a strategy of producing many offspring with low survival rates [reptiles] versus few, well nurtured offspring [mammals]), generation length, body size, environmental variability etc. (Gilpin and Soule 1986; Reed et al. 2003). MVPs vary by almost an order of magnitude across the 12 species, with the general result being that we should be thinking in terms of several thousands of individuals if our goal to maintain viable populations of these vertebrates.

Two of the definitions used in Table 1 have been applied in Table 2 to address the more practical management question of how much habitat area would be required to support these MVPs. The definition of a 20% risk of extinction over 20 years and a 10% risk over 100 years encompasses short- and long-term perspectives on viability, and are of practical conservation relevance because they represent the risk-time thresholds used to define a species on the borderline between IUCN's (2000) (IUCN) definition of *Endangered* and *Vulnerable* (20% in 20 yr), and *Vulnerable* and *Lower Risk* [not threatened] (10% in 10 yr).

Species with small home range requirements or high average densities tend to require relatively small areas to maintain viable populations. For example, a viable frill-neck lizard (*Chlamydosaurus kingii*) population would require and area of 15.5 km^2, equivalent to a square enclosure with a boundary fence of only 3.9 km length on each side (see Table 2),

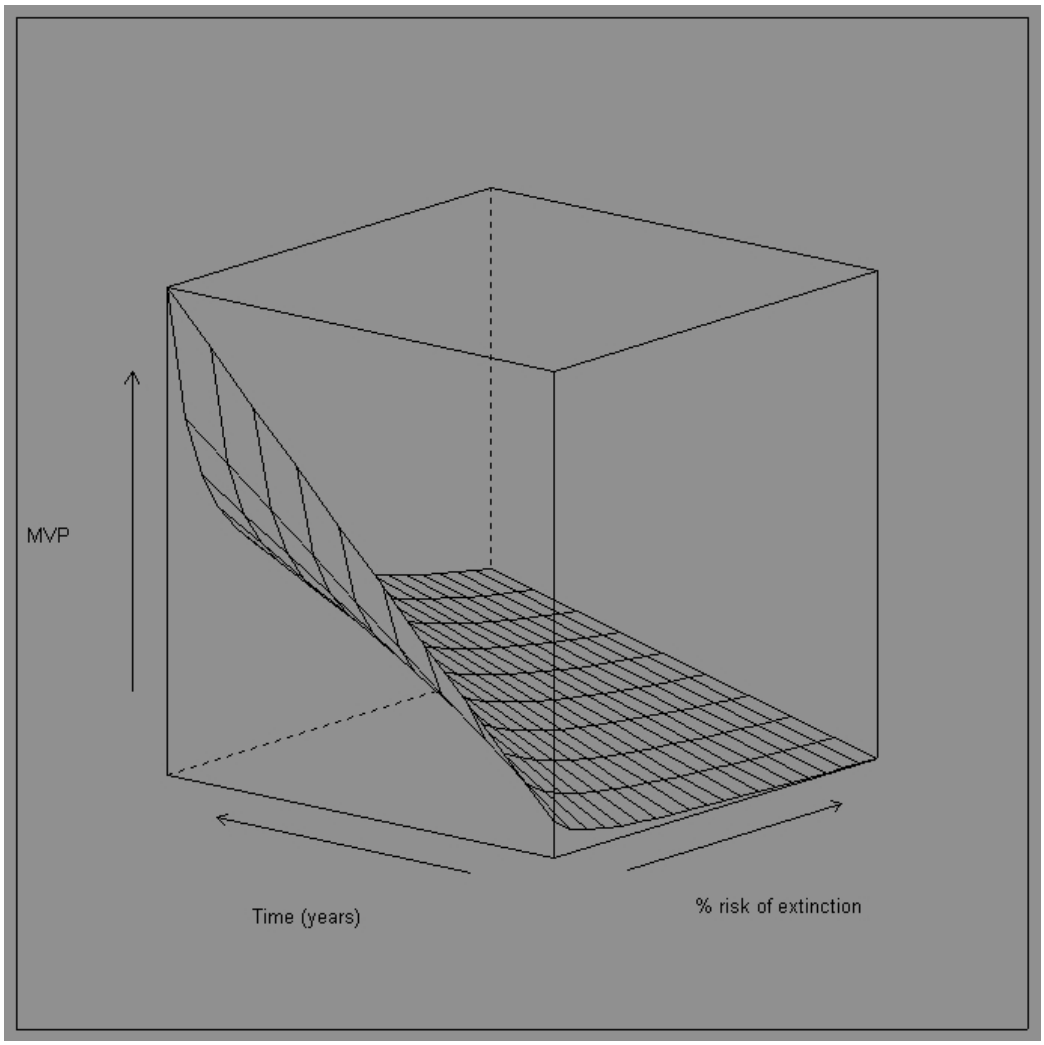

Figure 1. Relationship between MVP, risk level (expressed as the probability of extinction, ranging from 0 to 20 %) and projection time (ranging from 1 to 100 years) for the northern sand goanna, *Varanus panoptes*. MVP ranges here from 150 – 12 150 individuals.

Table 1. Estimates of minimum viable population size (MVP) for 12 candidate species which are suspected to be vulnerable to cane toad impacts, ranked from smallest to largest, using five different risk/time definitions (e.g. 10%/100 yr is the population size required for a less than 10% risk of extinction over a 100 year period).

Species	20%/20yr	10%/100yr	1%/50yr	1%/100yr	1%/1000yr
Wedge tailed eagle	500	2,200	4,700	13,500	193,800
Dingo	500	2,300	4,800	13,700	196,600
Black necked stork	700	3,200	6,900	19,600	281,300
Australian Bustard	800	3,600	7,700	21,800	313,800
Northern Sand Goanna	900	4,000	8,500	24,300	349,800
Black headed python	1,100	5,000	10,600	30,100	432,800
Black bittern	1,200	5,400	11,500	32,700	470,200
Mangrove monitor	1,200	5,400	11,500	32,700	470,100
Blue winged Kookaburra	1,400	6,200	13,200	37,500	539,300
Frill necked lizard	1,400	6,400	13,600	38,600	555,400
Northern Death Adder	1,700	7,500	15,900	45,500	653,200
Northern Quoll	4,300	19,100	40,600	115,600	1,661,800

based on an MVP of 6,400 individuals (Table 1) and a home range size of 0.7 ha.

Conversely, wide ranging and sparsely distributed species (e.g. top avian predators such as the wedge-tailed eagle) have huge area requirements that could not be feasibly enclosed by any boundary exclusion (Table 2). Moreover, from a practical standpoint, species with very high dispersal capabilities via flight are unlikely to confine their movements to enclosures. In this case, it is more a question of providing sufficient natural prey, such as small mammals and reptiles, in toad free areas.

To provide some perspective of scale to the habitat area requirements cited in Table 2, the entire extent of Kakadu National Park is 19,804 km^2, and the Cobourg Peninsula is 2 207 km^2 (Garig Gunak Barlu National Park), which could be conceivably isolated from cane toads by means of a relatively short boundary fence along its narrowest point of connection to Arnhem Land – see next section). Thus the relatively cost effective fencing of the Cobourg would likely support viable population of a host of small mammal and reptile species (and presumably most amphibians and insects, which have considerably smaller home range requirements again), but would fail to capture fully the areas for some of the largest free-ranging species. Worryingly, however, recent field observations suggest that toads may have already penetrated the south-eastern fringes of Garig (information related to Dr. Donald Franklin by one of the Park's senior rangers, John Williams, 30 September 2004), suggesting that it may be too late to isolate this particular region.

Table 2. Minimum habitat area (MHA in km^2) estimates for the 12 candidate species which are suspected to be vulnerable to cane toad impacts and using two different risk/time definitions. MHA was calculated using the MVP estimates given in Table 1 multiplied by the home range estimate (HR) for the species. Perim = length (km) of the total perimeter of a rectangular fenced enclosure required to encompass the MHA for each species.

		20% in 20 yr		**10% in 100 yr**	
Species	**HR km^2**	**MHA**	**Perim**	**MHA**	**Perim**
Wedge tailed eagle	35	8,750	374	38,500	785
Dingo	39	9,750	395	44,850	847
Black necked stork	10	3,500	237	16,000	506
Australian Bustard	25	10,000	400	45,000	849
Northern Sand Goanna*	0.143	43	26	191	55
Black headed python	0.32	176	53	800	113
Black bittern	5	3,000	219	13,500	465
Mangrove monitor*	0.009	3.6	7.6	16	16
Blue winged Kookaburra	0.4	280	67	1,240	141
Frill necked lizard*	0.007	3.3	7.2	15	16
Northern Death Adder	0.25	213	58	938	123
Northern Quoll	0.023	50	28	220	59

* 2:1 female to male sex ratio in a given territory is assumed