POPULATION VIABILITY ANALYSES FOR THE CHUDITCH (Dasyurus geoffroii) IN NORTHERN JARRAH FORESTS

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We are estimating the probability of chuditch (Dasyurus geoffroii) population persistence, predicted time to extinction, average population size, and average genetic loss caused by inbreeding in the northern jarrah (Eucalyptus marginata) forest, using a spatially explicit population viability model. We are following a 5-step process to predict the response of chuditches to management over the area: 1. map habitat availability over the northern jarrah forest; 2. produce one map for each year during a 15-year prescribed burn cycle, with corresponding estimates of habitat suitability based on time since the burn and consideration of loss of den log habitat following bauxite mining; 3. regrid the map into cells that correspond to chuditch home ranges (approximately 400-ha core area for a female, Morris, unpubl. data), 4. estimate the chuditch demographic and movement parameters corresponding to each stage in recovery of the post-burn habitat; and 5. predict the probability of extinction, time until extinction, population trends for chuditch, and genetic loss over 100 years over the region.

Mapping Available Habitat

The Forest Management Information System (FMIS) Geographic Information System (GIS) was used to map habitat over the northern jarrah forest region. FMIS is a raster-based system with 2-ha pixel size and encompasses the managed jarrah forest.

Chuditch use of habitat seems to be associated with the jarrah and wandoo (E. wandoo) forests having sufficient hollow logs and/or burrows for den sites. We estimated hollow log availability as den sites for chuditch from ground inventory data collected throughout the jarrah forest region (Spencer 1992). Because wood quality of logs was assessed on over 2800 0.12-ha ground plots throughout the

region, we were able to make a conservative estimate of den log availability by considering only those logs with the following characteristics: (1) hollow in the center of the log only, (2) entrance size > 7 cm in diameter, (3) extent of the hollow > 80 cm deep into the hollow. Both average number of potential den logs per ha and the percent of plots that contained potential den logs were used as indices to habitat quality for chuditch. We considered these estimates conservative, because only hollows in boles of logs were included in the inventory (hollows in limbs were not included). We considered only strata with > 0.12 potential den logs per ha as suitable habitat (K. Morris has found chuditch use about 1 den log per 8 ha of habitat within their home ranges). The exception was low quality mature jarrah stands, known to contain chuditch (K. Morris, unpubl. data) despite the predicted absence of den logs. Jarrah forest mined for bauxite was predicted to lack den logs based on these data.

Mapping Burn Cycles

Survival rates of chuditchs seem to be effected by burning, with survival and reproduction stabilising once stands have recovered > 1 years from a burn). Consequently it was necessary to impose a fire mosaic over the suitable habitat on the map for each year of a burn cycle. Nearly all patches are prescribed burned in the region for protection from wildfires. Based on burn records and burning themes in FMIS, and consultation with the Fire Protection Branch, CALM, most stands in the northern jarrah forest are currently burned on a 15-year cycle and that cycle is likely to persist into the future. Using burn records, we assigned each stand in the region a time of burning based on the timing of burns that occurred in the past 15 years. Consequently 15 maps of the area were produced, one for each year in the burn cycle reflecting the disturbances caused by burning and the stage of recovery (<1 and >1 year after the burn). Areas known to have been mined over the past 15 years were included in the first series of maps, but future mine sites need to be predicted and included in new maps that project habitat change into the future. Pat Collins and Paul Biggs are currently developing a technique to accomplish this.

Regridding Habitat Maps

The average core home range size for female chuditchs is about 400 ha. Consequently, habitat maps were regridded to 400-ha cells by assigning the cell to a stage in habitat recovery following a burn based on the stage present at the center of the 400-ha grid cell. Such regridding has the potential to alter the habitat mosaic (Schulz and Joyce 1992), so we will compare the area in each stage of recovery following fire between original maps and regridded maps using a paired t-test to determine if the average

difference between maps over a burn cycle departed significantly from zero. Pattern of all original and regridded maps also will be inspected visually to identify any gross errors made during regridding.

Estimates of Demographic and Movement Parameters

Estimates of the mean movement, and mean and variance of reproductive and survival rates in each of 3 chuditch age classes in each of the 2 burn stages were made by Keith Morris based on past work, unpublished data, and experience (Table 2). The estimates in table 2 were used to predict persistence, population trends, extinction time, and genetic loss in the absence of fox baiting and with a 15-year burn cycle.

Simulating Population Responses

To initiate each simulation, 632 adults were distributed systematically on the map. Based on Keith Morris's knowledge of chuditch abundance, this distribution and number of individuals simulated seemed reasonable. Five response variables will be used to assess the future of chuditches in the region and allow future comparisons among management options: the probability of extinction during 100 years, the predicted time until extinction (based on the $\underline{x}$ intercept using a linear regression of populations over time), the probability of the adult population achieving an arbitrary goal of > 5,000 adults within the area of assessment, average total populations over the region, and the average percent genetic loss as a function of inbreeding.

RESULTS

To date, preliminary maps have been prepared and demographic rules have been tested with these maps. Additional work is needed to include future bauxite mine sites on maps representing future conditions in the region. Also, future research is needed to more accurately estimate demographic parameters.

Table 1. Estimates of chuditch den log availability based on jarrah ground inventory plots, northern and central jarrah forest region (N = number of 0.12-ha ground plots sampled).

		Logs per hectare			Percent plots with		Total
	N	Mean	Std Dev	Range	logs	ha	logs
Swan Region							
Wandoo	81	0.294	1.512	0-8	3.7	44575	13105
Mining sites	19	0.000	0.000		0.0	9546	0
Very high and high quality jarrah							
mature	34	0.702	2.291	0-8	8.8	24041	16877
regeneration	237	1.209	3.682	0-24	11.4	132684	160415
Medium quality jarrah							
mature	50	1.273	3.357	0-16	14.0	26346	33538
regeneration	79	0.403	1.756	0-8	5.1	40979	16515
Low quality jarrah							
mature	30	0.000	0.000		0.0	20740	0
regeneration	59	0.270	1.452	0-8	3.4	24306	6563
Woodlands	45	0.175	1.186	0-8	2.2	31416	551
Other species	46	0.517	1.989	0-8	6.5	87175	45069
Central Region							
Wandoo	12	0.661	2.300	0-8	8.3	9138	6040
Mining sites	5	0.000	0.000		0.0	3227	0
Very high and high quality jarrah							
mature	54	0.147	1.083	0-8	1.9	31147	4579
mature-regrowth mix	29	0.549	2.052	0-8	6.9	17794	9769
regeneration	218	0.475	2.037	0-16	5.5	104412	49596
Medium quality jarrah							
mature	126	0.316	1.560	0-8	4.0	62444	19732
mature-regrowth mix	59	0.540	2.501	0-16	5.1	27817	15021
regeneration	190	0.921	3.033	0-24	10.0	87255	80362
Low quality jarrah							
mature	41	0.000	0.000		0.0	21863	0
regeneration	85	0.374	1.695	0-8	4.7	56111	20986
Eastern mature	49	0.325	1.591	0-8	4.1	26254	8533
East. woodlands	114	0.558	2.041	0-8	7.0	52301	29184
Sunklands	97	1.395	3.811	0-24	14.4	52839	73710
Dieback unclass.	18	0.446	1.878	0-8	5.1	11394	5082
Other species	63	0.501	1.958	0-8	5.8	84886	42528

Table 2. Demographic and movement parameters estimated for chuditch by habitat type.

	Unsuitable	Pine plantations and Jarrah & wandoo Burned < 1 year	Jarrah and Wandoo Burned > 1 year
SURVIVAL PROBABILITIES			
Age 0-1 year	0.05 (0.01)	0.12 (0.05)	0.25 (0.05)
range	0-0.10	0.10-0.30	0.10 - 0.45
Age 1-2 years	0.05 (0.01)	0.26 (0.05)	0.52 (0.05)
range	0.00-0.10	0.10-0.45	0.40 - 0.70
Age 2-3 years	0.05 (0.01)	0.26 (0.05)	0.52 (0.05)
range	0.00-0.10	0.10-0.45	0.40-0.70
PROBABILITY OF PRODUCING YOUNG			
Age 0-1 year	0.00	0.80 (0.04)	0.80 (0.04)
range		0.70-0.90	0.70-0.90
Age 1-2 years	0.00	0.80 (0.04)	0.80 (0.04)
range		0.70-0.90	0.70-0.90
Age 2-3 years	0.00	0.80 (0.04)	0.80 (0.04)
range		0.70-0.90	0.70-0.90
OK for reproducing	no	yes	yes
Aversion to crossing	0.90	0.50	0.50
Probability of continuing	0.90	0.50	0.50
Young per adult female	6		
Probability of male young	0.50		
Probability of male finding a female	0.99		
Probability of a male avoiding another male's territory	0.20		
Number of movements per year	10		
Total number of runs	20		
Total run length	100 Years		

Preliminary results for the northern jarrah forest:

Mean population size : 114.14
Percent extinctions : 100.00
Mean time to extinction : 14.85
Projected extinction time : 68.79
Minimum population level : 0