

## Proposed Hunting Influences GYE Grizzly Bear Population Structure

RAMAS Metapop 6.0© population dynamics modeling software was used to explore the potential impact of proposed levels of harvest of the Greater Yellowstone Ecosystem population of grizzly bears (*Ursus arctos horribilis*). The model was parameterized using published data from the Interagency Grizzly Bear Study Team (Harris 2012; Schwartz et al 2006) and a study of grizzly bears in southern British Columbia by Proctor et al (2012) for dispersal parameters. In general, when a choice was made between differing parameter values in various studies the parameter favoring higher grizzly bear population persistence was chosen. The updated 2002-2011 mortality rates for cubs and yearlings was used instead of the more favorable 1983-2001 survival rates reported by Schwartz et al (2006).

Two major populations were defined within the Greater Yellowstone Ecosystem metapopulation to reflect the differing management of grizzlies within Yellowstone National Park and Grand Teton National Park and outside of those parks. One population (Parks) was not hunted and its initial population size set at 225 individuals with a stable age distribution assumed. This initial abundance was set based on the estimate of 150 grizzlies at with home ranges totally or partially within YNP and a statement by GTNP staff that the population in that park was likely 65-75 bears within the park at least partially. These numbers reflect higher than expected densities and may include some duplications between the parks, but were used following the basic premise to favor grizzly population persistence when grizzly home range data was not available. The population outside of the parks (Hunted) was then set to add to 750 total bears (525 in the Hunted population) in the metapopulation as that fell within the confidence interval for GYE population numbers. The Hunted population was subjected to annual harvest that allowed a maximum of 26 male grizzly adults to be taken each year for 20 years. This figure is based on the overall 20% allowable mortality for independent adult grizzlies when the metapopulation is between 674 and 747 individuals minus the estimated 5.2% annual mortality from causes other than hunting reported in Harris (2012). Independent adult females also can be harvested under the plan, and harvest of females was reflected in the use of 7.6% as the adult female mortality rate in the model.

Dispersal from the protected Park population to the Hunted population could be an important influence on that population's demography. No published material directly reported grizzly dispersal rates in the GYE. Therefore I used estimates derived from the study by Proctor et al (2012) documenting movement between British Columbia and Alberta in southern Canada. The overall estimate of movement in that case is 2.4% per annum with a standard deviation of 1.8. In order to account for uncertainty a value of 4% was used for dispersal of 4 year old and adult male grizzlies from the Park population to the Hunted population. Some emigration from Hunted to Park might occur as well and that rate was set at 1% per annum given that the Park population might be expected to be more of a source population and density there might be higher perhaps deterring dispersal into that habitat.

Environmental stochasticity, demographic stochasticity and catastrophes can all influence population dynamics and demography. Only environmental stochasticity was included here with a lognormal distribution of probability per the standard RAMAS Metapop 6.0 protocol. Catastrophes could include the magnitude of effect expected with a whitebark pine nut crop failure, but ran counter to the principle

of favoring grizzly bear population persistence and are challenging to accurately parameterize so catastrophes were not modeled.

Density dependence was modeled as a simple ceiling where survival rates declined once that carrying capacity was exceeded. The Parks population carrying capacity was set at 300 given the likely high habitat occupancy for the initial population size. The Hunted population ceiling was set at 1000 individuals allowing near doubling of the outside of the park population from its initial size and to reduce the imposition of density dependent effects

The model was run for 20 years for 1000 iterations. All reported probabilities and statistics are based on those 1000 iterations. Quasi-extinction was defined in the model as falling below a total metapopulation of 600 grizzly bears given the differing management that is triggered by that population count. Note that this is threshold defined based on the total population derived from summing all age classes in both populations, not an  $F_{coy}$  based estimate.

Two alternatives of hunting mortality management were modeled. In one, the hunting mortality of adult males in the Hunted population continued regardless of actual population size to investigate what might occur if a decline to 674 individuals was not detected within 20 years. In the other, the hunting of adult males ceased entirely if the metapopulation declined to 674 individuals as an actual count.

## Results

The results of the model runs are attached to this comment (Attachments A and B). The first model (no threshold for harvest decrease in the Hunted population) showed an increase in metapopulation size followed by a decline to an average of 598 individuals across all simulation iterations (see Attachment A for all model results). Moreover, this model showed a 61.9% chance (95% confidence interval 59.1-64.7) that the population would decline to 500 individuals, the relisting threshold, a 73% likelihood (70.2-75.8) of decline to 600 individuals, the decline of Hunted population adult males to 6 or 7 individuals on average across the 1000 iterations from an initial abundance of 131 adult males in that population.

Declines of this nature might be expected to be detected much earlier and management revised to avoid such declines. However, the number of cubs and adult females in the metapopulation increases initially and then declines to a level higher than the initial abundance set in the model. This calls into question whether a females with cubs of the year ( $F_{coy}$ ) method of population estimation will be adequate to detect the decline in time to avoid these consequences.

The second model with a cessation of adult male harvest outside of the parks once the population reaches 674 individuals is more promising. After an initial increase the metapopulation declines to 764 individuals total, close to the original size of 750 individuals. The number of males in the Hunted population declines in this model as well, however, to 55 individuals on average. Likelihood of decline to 500 individuals falls to zero, but there still remains a 12.5% chance of the population declining to 600 individuals and a 45% chance of the population declining to 674 individuals. Thus, there remains substantial risk of declines below management adaptation trigger levels. The number of cubs in each

year is increased over the first model and therefore declines are even less likely to be detected by a  $F_{coy}$  method of population estimation.

Further examination of permissible male mortality as specified by the proposed MOA with the states would be prudent in view of these results. Likewise, development of an alternative method to assess adult male mortality and population status appears necessary based on these results.

Respectfully submitted,

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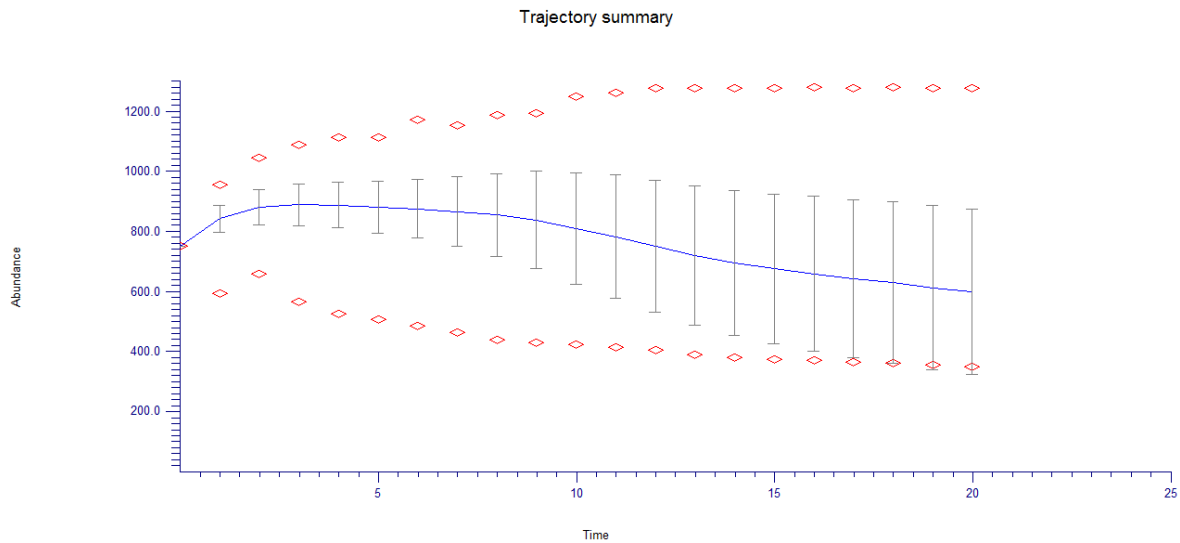
#### **Literature Cited**

Harris, R 2012. Updating and evaluating approaches to estimate population size and sustainable mortality limits for grizzly bears in the Greater Yellowstone Ecosystem. Interagency Grizzly Bear Study Team.

Protor, M. et al 2012. Population fragmentation and inter-ecosystem movements of grizzly bears in western Canada and the northern United States. Wildlife Monographs 180:1-46.

Schwartz, C et al 2006. Temporal, spatial and environmental influences on the demographics of grizzly bears in the Greater Yellowstone Ecosystem. Wildlife Monographs 161: 1-68

Attachment A



2 populations (2 included in summation)

1000 replications; Duration = 20

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Trajectory summary (Metapopulation)

Time	Abundance				
	Minimum	-1 S.D.	Average	+1 S.D.	Maximum
0	750.00	750.00	750.00	750.00	750.00
1	592.00	797.82	841.66	885.49	953.00
2	658.00	822.24	880.63	939.02	1044.00
3	564.00	819.70	887.89	956.08	1088.00
4	525.00	811.49	887.23	962.97	1112.00
5	505.00	795.05	880.13	965.21	1113.00
6	484.00	776.63	874.54	972.45	1170.00
7	462.00	749.66	865.95	982.23	1151.00
8	440.00	717.69	854.50	991.32	1187.00
9	430.00	674.82	837.03	999.25	1192.00
10	424.00	624.16	809.47	994.78	1247.00
11	415.00	578.45	782.53	986.60	1261.00
12	403.00	532.44	750.85	969.26	1275.00
13	389.00	489.34	720.92	952.50	1276.00
14	380.00	454.90	695.80	936.70	1274.00
15	375.00	427.08	675.45	923.81	1275.00
16	370.00	402.01	659.17	916.33	1277.00

17	365.00	379.02	642.62	906.22	1276.00
18	362.00	359.96	628.66	897.35	1278.00
19	354.00	340.61	612.66	884.70	1276.00
20	348.00	324.77	599.53	874.29	1276.00

Percentiles of final total abundance

	5th	25th	50th	75th	95th
20	380.00	420.00	463.50	653.00	1191.05

Trajectory summary (Population 1: Parks)

Time	Abundance				
	Minimum	-1 S.D.	Average	+1 S.D.	Maximum
0	225.00	225.00	225.00	225.00	225.00
1	259.00	259.00	259.00	259.00	259.00
2	277.00	277.00	277.00	277.00	277.00
3	286.00	286.00	286.00	286.00	286.00
4	292.00	292.00	292.00	292.00	292.00
5	297.00	297.00	297.00	297.00	297.00
6	302.00	302.00	302.00	302.00	302.00
7	302.00	302.00	302.00	302.00	302.00
8	302.00	302.00	302.00	302.00	302.00
9	302.00	302.00	302.00	302.00	302.00
10	300.00	300.00	300.00	300.00	300.00
11	302.00	302.00	302.00	302.00	302.00
12	302.00	302.00	302.00	302.00	302.00
13	301.00	301.00	301.00	301.00	301.00
14	300.00	300.00	300.00	300.00	300.00
15	300.00	300.00	300.00	300.00	300.00
16	300.00	300.00	300.00	300.00	300.00
17	300.00	300.00	300.00	300.00	300.00
18	302.00	302.00	302.00	302.00	302.00
19	300.00	300.00	300.00	300.00	300.00
20	300.00	300.00	300.00	300.00	300.00

Trajectory summary (Population 2: Hunted)

Time	Abundance				
	Minimum	-1 S.D.	Average	+1 S.D.	Maximum
0	525.00	525.00	525.00	525.00	525.00
1	333.00	538.83	582.66	626.48	694.00
2	381.00	545.25	603.63	662.02	767.00

3	278.00	533.70	601.89	670.08	802.00
4	233.00	519.50	595.23	670.96	820.00
5	208.00	498.05	583.13	668.20	816.00
6	182.00	474.63	572.54	670.45	868.00
7	160.00	447.66	563.95	680.23	849.00
8	138.00	415.69	552.50	689.31	885.00
9	128.00	372.82	535.03	697.24	890.00
10	124.00	324.16	509.47	694.78	947.00
11	113.00	276.45	480.53	684.60	959.00
12	101.00	230.44	448.85	667.26	973.00
13	88.00	188.34	419.92	651.50	975.00
14	80.00	154.90	395.80	636.70	974.00
15	75.00	127.08	375.45	623.81	975.00
16	70.00	102.01	359.17	616.33	977.00
17	65.00	79.03	342.62	606.21	976.00
18	60.00	57.96	326.66	595.35	976.00
19	54.00	40.61	312.65	584.70	976.00
20	48.00	24.77	299.53	574.29	976.00

#### Harvest summary

Time	Total Harvest				
	Minimum	-1 S.D.	Average	+1 S.D.	Maximum
0	0.00	0.00	0.00	0.00	0.00
1	26.00	26.00	26.00	26.00	26.00
2	9.00	25.45	25.98	26.52	26.00
3	5.00	25.25	25.97	26.68	26.00
4	4.00	24.23	25.83	27.43	26.00
5	6.00	23.94	25.71	27.48	26.00
6	3.00	22.94	25.41	27.87	26.00
7	0.00	21.87	25.01	28.15	26.00
8	0.00	20.29	24.25	28.21	26.00
9	0.00	17.81	23.06	28.32	26.00
10	0.00	15.73	22.00	28.26	26.00
11	0.00	13.29	20.72	28.15	26.00
12	0.00	10.84	19.36	27.87	26.00
13	0.00	7.22	17.38	27.54	26.00
14	0.00	4.18	15.30	26.42	26.00
15	0.00	1.41	13.24	25.08	26.00
16	0.00	-0.87	11.13	23.13	26.00
17	0.00	-2.50	9.40	21.30	26.00
18	0.00	-3.18	8.55	20.27	26.00

19	0.00	-3.66	7.88	19.43	26.00
20	0.00	-4.07	7.35	18.76	26.00

TOTAL: 78.00 272.51 379.52 486.53 520.00

Average abundance of stage 10 (Adult ma) in population 1 (Parks)

Time Stage abundance

0.00	56.0000
1.00	58.0000
2.00	61.0000
3.00	61.0000
4.00	61.0000
5.00	67.0000
6.00	72.0000
7.00	75.0000
8.00	78.0000
9.00	81.0000
10.00	83.0000
11.00	86.0000
12.00	89.0000
13.00	91.0000
14.00	93.0000
15.00	95.0000
16.00	97.0000
17.00	98.0000
18.00	100.0000
19.00	101.0000
20.00	102.0000

Average abundance of stage 10 (Adult ma) in population 2 (Hunted)

Time Stage abundance

0.00	131.0000
1.00	109.4770
2.00	89.6820
3.00	66.1350
4.00	44.0580
5.00	36.9370
6.00	30.6940
7.00	25.3440
8.00	20.4250

9.00	16.0110
10.00	12.4630
11.00	10.0300
12.00	8.5240
13.00	7.6610
14.00	7.0700
15.00	6.6010
16.00	6.3660
17.00	6.4370
18.00	6.4480
19.00	6.4800
20.00	6.6190

Average abundance of stage 5 (Adult fema) in population 2 (Hunted)

Time	Stage abundance
0.00	231.0000
1.00	232.6890
2.00	235.2630
3.00	228.7580
4.00	219.3640
5.00	223.1500
6.00	226.4100
7.00	229.8330
8.00	232.3370
9.00	233.8310
10.00	234.2820
11.00	234.6600
12.00	234.4130
13.00	233.2120
14.00	230.2510
15.00	225.4320
16.00	219.3400
17.00	212.2880
18.00	204.6680
19.00	197.3200
20.00	189.6690

Average abundance of stage 5 (Adult fema) in population 1 (Parks)

Time	Stage abundance
0.00	99.0000



1.00	99.0000
2.00	99.0000
3.00	96.0000
4.00	93.0000
5.00	94.0000
6.00	94.0000
7.00	93.0000
8.00	92.0000
9.00	91.0000
10.00	89.0000
11.00	88.0000
12.00	87.0000
13.00	86.0000
14.00	85.0000
15.00	85.0000
16.00	85.0000
17.00	84.0000
18.00	84.0000
19.00	83.0000
20.00	82.0000

Average abundance of stage 1 (female cub) in population 1 (Parks)

Time Stage abundance	
0.00	13.0000
1.00	33.0000
2.00	33.0000
3.00	33.0000
4.00	32.0000
5.00	31.0000
6.00	32.0000
7.00	31.0000
8.00	30.0000
9.00	30.0000
10.00	30.0000
11.00	29.0000
12.00	29.0000
13.00	28.0000
14.00	28.0000
15.00	28.0000
16.00	28.0000
17.00	28.0000

18.00	28.0000
19.00	27.0000
20.00	27.0000

Average abundance of stage 1 (female cub) in population 2 (Hunted)

Time	Stage abundance
0.00	30.0000
1.00	77.4630
2.00	78.3540
3.00	79.0100
4.00	76.8810
5.00	73.1230
6.00	72.1460
7.00	71.0730
8.00	68.5390
9.00	63.0510
10.00	56.1560
11.00	48.9120
12.00	41.5590
13.00	36.0700
14.00	33.0120
15.00	30.9280
16.00	29.4460
17.00	26.9480
18.00	25.3370
19.00	24.1290
20.00	23.3370

Average abundance of stage 6 (male cub) in population 2 (Hunted)

Time	Stage abundance
0.00	26.0000
1.00	77.4630
2.00	78.3540
3.00	79.0100
4.00	76.8810
5.00	73.1230
6.00	72.1460
7.00	71.0730
8.00	68.5390
9.00	63.0510

10.00	56.1560
11.00	48.9120
12.00	41.5590
13.00	36.0700
14.00	33.0120
15.00	30.9280
16.00	29.4460
17.00	26.9480
18.00	25.3370
19.00	24.1290
20.00	23.3370

Average abundance of stage 6 (male cub) in population 1 (Parks)

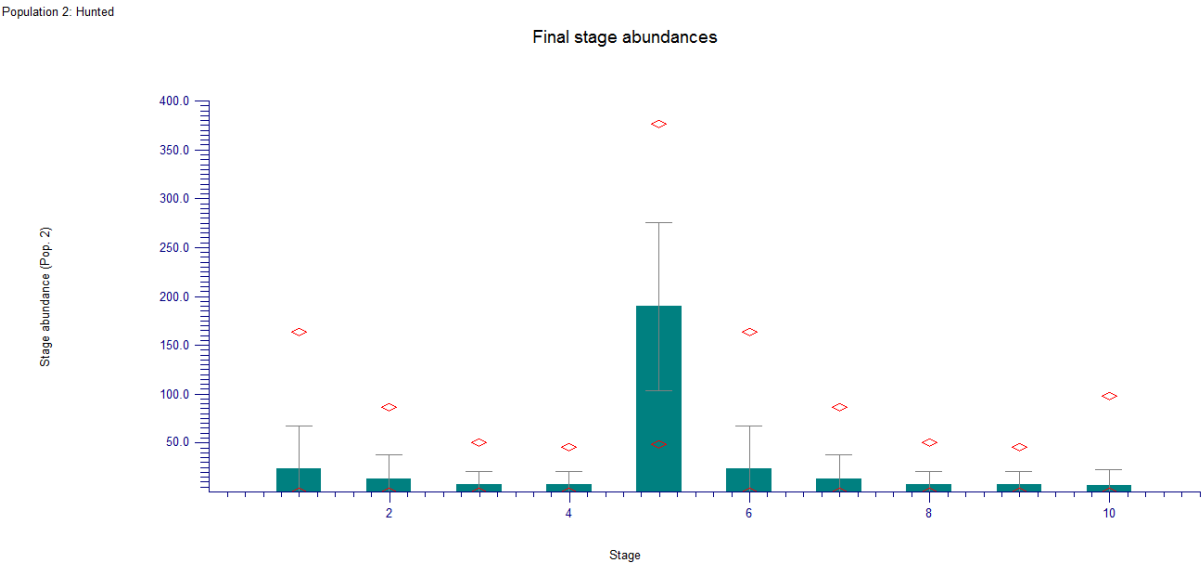
Time Stage abundance

0.00	11.0000
1.00	33.0000
2.00	33.0000
3.00	33.0000
4.00	32.0000
5.00	31.0000
6.00	32.0000
7.00	31.0000
8.00	30.0000
9.00	30.0000
10.00	30.0000
11.00	29.0000
12.00	29.0000
13.00	28.0000
14.00	28.0000
15.00	28.0000
16.00	28.0000
17.00	28.0000
18.00	28.0000
19.00	27.0000
20.00	27.0000

Final stage abundances

Stage	Stage abundance (Pop. 2)				
	Minimum	-1 S.D.	Average	+1 S.D.	Maximum
1	0.00	-21.15	23.34	67.82	163.00
2	0.00	-11.55	13.24	38.03	86.00

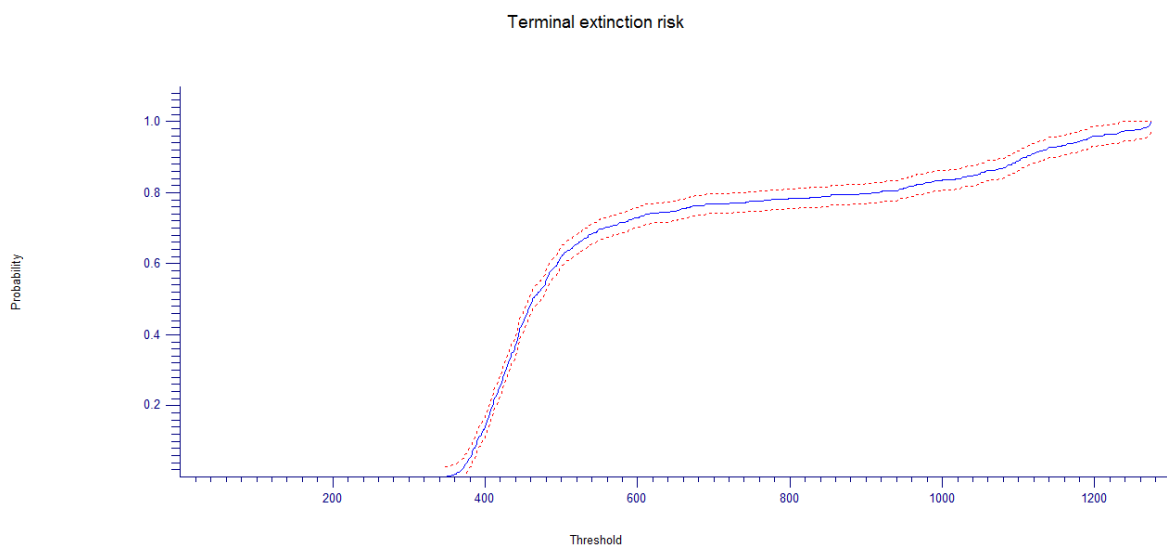
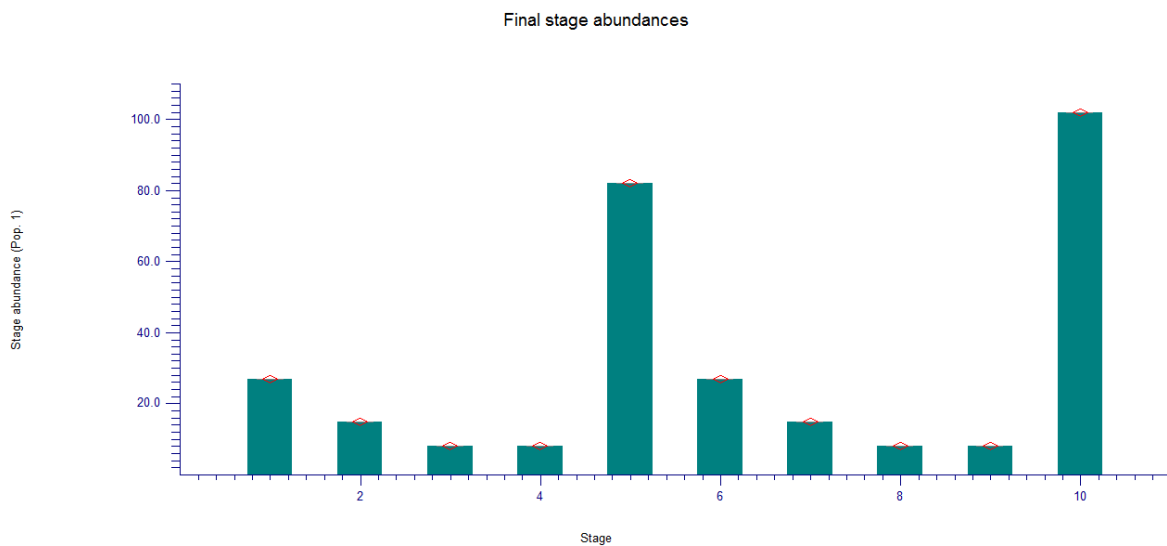
3	0.00	-6.03	7.48	20.99	50.00
4	0.00	-5.38	7.56	20.49	46.00
5	48.00	103.56	189.67	275.78	376.00
6	0.00	-21.15	23.34	67.82	163.00
7	0.00	-11.55	13.24	38.03	86.00
8	0.00	-6.03	7.48	20.99	50.00
9	0.00	-5.41	7.56	20.52	46.00
10	0.00	-9.67	6.62	22.91	98.00



Final stage abundances

Stage	Stage abundance (Pop. 1)				
	Minimum	-1 S.D.	Average	+1 S.D.	Maximum
1	27.00	27.00	27.00	27.00	27.00
2	15.00	15.00	15.00	15.00	15.00
3	8.00	8.00	8.00	8.00	8.00
4	8.00	8.00	8.00	8.00	8.00
5	82.00	82.00	82.00	82.00	82.00
6	27.00	27.00	27.00	27.00	27.00
7	15.00	15.00	15.00	15.00	15.00
8	8.00	8.00	8.00	8.00	8.00
9	8.00	8.00	8.00	8.00	8.00
10	102.00	102.00	102.00	102.00	102.00

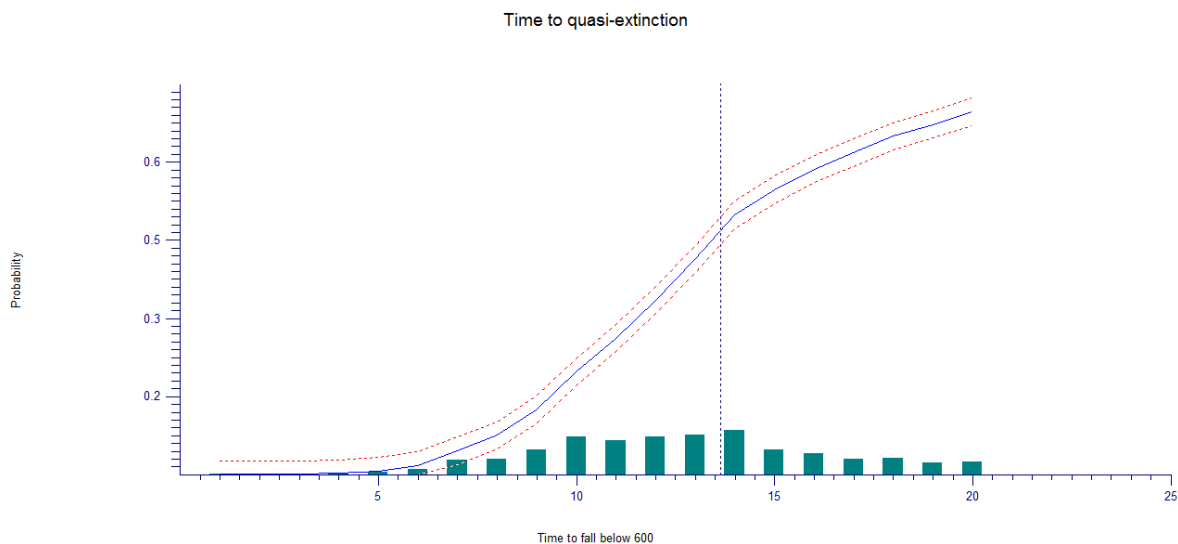
Population 1: Parks



### Terminal extinction risk

Threshold	Probability	95% confidence interval	
500	0.6190	0.5910	0.6470
600	0.7300	0.7020	0.7580
674	0.7620	0.7340	0.7900
700	0.7690	0.7410	0.7970

Median ~ 13.7



Time to quasi-extinction (Threshold level = 600.0)

Median time = 13.7 timestep(s)

Time	Probability	Cumulative Probability	95% confidence interval	
1	0.0010	0.0010	0.0000	0.0290
2	0.0000	0.0010	0.0000	0.0290
3	0.0000	0.0010	0.0000	0.0290
4	0.0020	0.0030	0.0000	0.0310
5	0.0050	0.0080	0.0000	0.0360
6	0.0110	0.0190	0.0000	0.0470
7	0.0300	0.0490	0.0210	0.0770
8	0.0320	0.0810	0.0530	0.1090
9	0.0520	0.1330	0.1050	0.1610
10	0.0770	0.2100	0.1820	0.2380
11	0.0700	0.2800	0.2520	0.3080
12	0.0780	0.3580	0.3300	0.3860
13	0.0820	0.4400	0.4120	0.4680
14	0.0920	0.5320	0.5040	0.5600
15	0.0510	0.5830	0.5550	0.6110
16	0.0430	0.6260	0.5980	0.6540
17	0.0330	0.6590	0.6310	0.6870
18	0.0340	0.6930	0.6650	0.7210
19	0.0240	0.7170	0.6890	0.7450
20	0.0260	0.7430	0.7150	0.7710

## Attachment B

GYE grizzly bear RAMAS Metapop 6.0<sup>®</sup> simulations

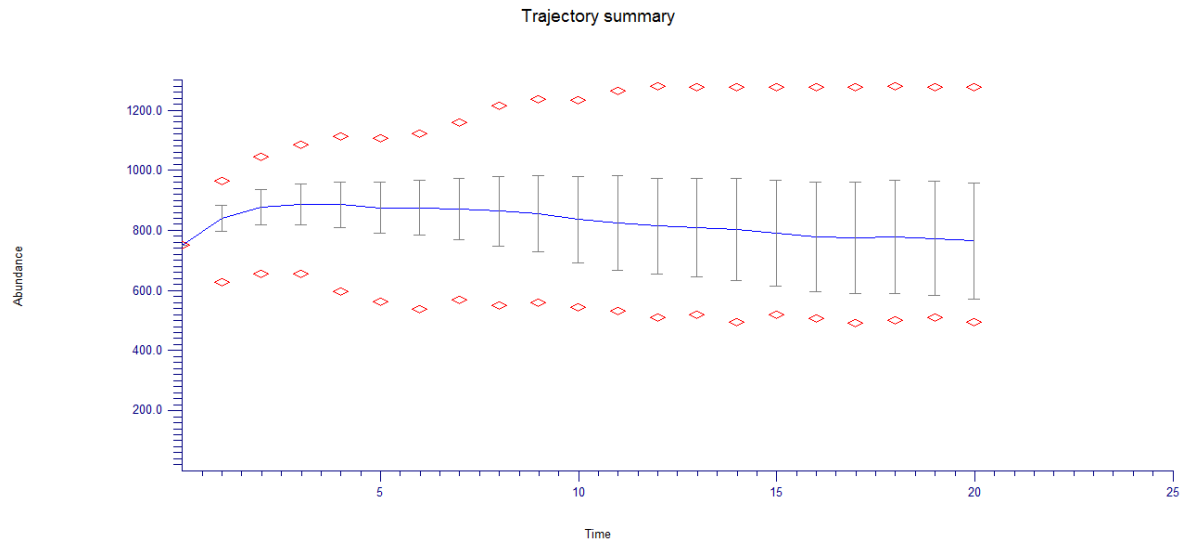
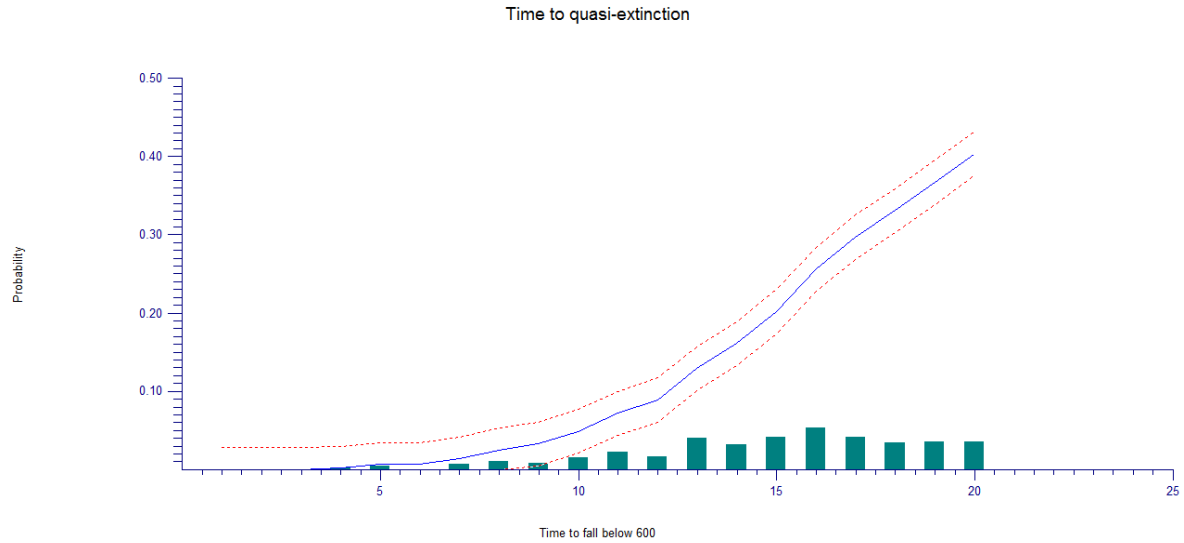
Hunted populations up to 26 males removed until metapopulation declines to 674- then no hunting

20 years 1000 iterations

**Time to quasi-extinction** (Threshold level = 600.0)

Median time > 20 timesteps

Time	Probability	Cumulative Probability	95% confidence interval	
1	0.0000	0.0000	0.0000	0.0280
2	0.0000	0.0000	0.0000	0.0280
3	0.0000	0.0000	0.0000	0.0280
4	0.0020	0.0020	0.0000	0.0300
5	0.0050	0.0070	0.0000	0.0350
6	0.0000	0.0070	0.0000	0.0350
7	0.0070	0.0140	0.0000	0.0420
8	0.0110	0.0250	0.0000	0.0530
9	0.0080	0.0330	0.0050	0.0610
10	0.0160	0.0490	0.0210	0.0770
11	0.0230	0.0720	0.0440	0.1000
12	0.0170	0.0890	0.0610	0.1170
13	0.0400	0.1290	0.1010	0.1570
14	0.0320	0.1610	0.1330	0.1890
15	0.0410	0.2020	0.1740	0.2300
16	0.0540	0.2560	0.2280	0.2840
17	0.0410	0.2970	0.2690	0.3250
18	0.0340	0.3310	0.3030	0.3590
19	0.0360	0.3670	0.3390	0.3950
20	0.0360	0.4030	0.3750	0.4310



### Trajectory summary (Metapopulation)

Time	Abundance				
	Minimum	-1 S.D.	Average	+1 S.D.	Maximum
0	750.00	750.00	750.00	750.00	750.00
1	628.00	795.94	838.84	881.75	962.00
2	656.00	817.44	877.27	937.10	1045.00
3	655.00	816.99	885.73	954.48	1083.00
4	597.00	809.76	884.91	960.07	1112.00
5	562.00	791.32	875.28	959.24	1105.00
6	538.00	784.94	875.39	965.84	1121.00
7	569.00	769.46	870.99	972.52	1158.00



8	549.00	748.55	863.67	978.79	1215.00
9	558.00	727.87	854.20	980.52	1235.00
10	544.00	691.49	835.87	980.25	1231.00
11	532.00	666.05	823.28	980.50	1263.00
12	510.00	654.66	813.85	973.04	1279.00
13	519.00	645.35	809.76	974.17	1275.00
14	495.00	632.95	802.42	971.89	1275.00
15	518.00	614.54	790.47	966.40	1274.00
16	507.00	596.06	778.07	960.09	1274.00
17	490.00	590.20	774.50	958.80	1276.00
18	500.00	589.39	777.78	966.17	1278.00
19	510.00	584.00	773.10	962.20	1276.00
20	493.00	572.42	764.68	956.94	1276.00

Percentiles of final total abundance

	5th	25th	50th	75th	95th
20	563.90	639.00	690.50	819.00	1203.00

**Harvest summary**

Time	Total Harvest				
	Minimum	-1 S.D.	Average	+1 S.D.	Maximum
0	0.00	0.00	0.00	0.00	0.00
1	0.00	24.79	25.95	27.11	26.00
2	0.00	24.50	25.92	27.34	26.00
3	11.00	25.46	25.98	26.49	26.00
4	0.00	23.39	25.73	28.06	26.00
5	0.00	22.29	25.53	28.76	26.00
6	0.00	21.23	25.22	29.22	26.00
7	0.00	19.48	24.63	29.78	26.00
8	0.00	16.44	23.46	30.48	26.00
9	0.00	15.04	22.60	30.15	26.00
10	0.00	11.61	20.77	29.93	26.00
11	0.00	9.64	19.67	29.71	26.00
12	0.00	8.37	18.88	29.39	26.00
13	0.00	7.59	18.38	29.16	26.00
14	0.00	5.65	17.00	28.35	26.00
15	0.00	3.42	15.34	27.25	26.00
16	0.00	2.18	14.25	26.33	26.00
17	0.00	1.76	13.99	26.23	26.00
18	0.00	3.04	15.08	27.13	26.00

19	0.00	1.98	14.04	26.10	26.00
20	0.00	0.52	12.78	25.05	26.00

TOTAL: 155.00 322.94 405.21 487.48 520.00

**Average abundance of stage 1 (female cub) in population 1 (Parks)**

Time Stage abundance

0.00	13.0000
1.00	33.0000
2.00	33.0000
3.00	33.0000
4.00	32.0000
5.00	31.0000
6.00	32.0000
7.00	31.0000
8.00	30.0000
9.00	30.0000
10.00	30.0000
11.00	29.0000
12.00	29.0000
13.00	28.0000
14.00	28.0000
15.00	28.0000
16.00	28.0000
17.00	28.0000
18.00	28.0000
19.00	27.0000
20.00	27.0000

**Average abundance of stage 6 (male cub) in population 1 (Parks)**

Time Stage abundance

0.00	11.0000
1.00	33.0000
2.00	33.0000
3.00	33.0000
4.00	32.0000
5.00	31.0000
6.00	32.0000
7.00	31.0000
8.00	30.0000

9.00	30.0000
10.00	30.0000
11.00	29.0000
12.00	29.0000
13.00	28.0000
14.00	28.0000
15.00	28.0000
16.00	28.0000
17.00	28.0000
18.00	28.0000
19.00	27.0000
20.00	27.0000

**Average abundance of stage 10 (Adult ma) in population 1 (Parks)**

Time	Stage abundance
0.00	56.0000
1.00	58.0000
2.00	61.0000
3.00	61.0000
4.00	61.0000
5.00	67.0000
6.00	72.0000
7.00	75.0000
8.00	78.0000
9.00	81.0000
10.00	83.0000
11.00	86.0000
12.00	89.0000
13.00	91.0000
14.00	93.0000
15.00	95.0000
16.00	97.0000
17.00	98.0000
18.00	100.0000
19.00	101.0000
20.00	102.0000

**Average abundance of stage 1 (female cub) in population 2 (Hunted)**

Time	Stage abundance
0.00	30.0000
1.00	76.6100
2.00	77.9190
3.00	79.0950
4.00	76.6050
5.00	72.2540
6.00	73.6790
7.00	73.3030
8.00	71.4680
9.00	69.3260
10.00	63.0340
11.00	60.0980
12.00	59.6490
13.00	61.0060
14.00	59.3230
15.00	54.9550
16.00	52.0590
17.00	53.3210
18.00	56.3590
19.00	55.4930
20.00	52.2280

**Average abundance of stage 6 (male cub) in population 2 (Hunted)**

Time	Stage abundance
0.00	26.0000
1.00	76.6100
2.00	77.9190
3.00	79.0950
4.00	76.6050
5.00	72.2540
6.00	73.6790
7.00	73.3030
8.00	71.4680
9.00	69.3260
10.00	63.0340
11.00	60.0980
12.00	59.6490
13.00	61.0060

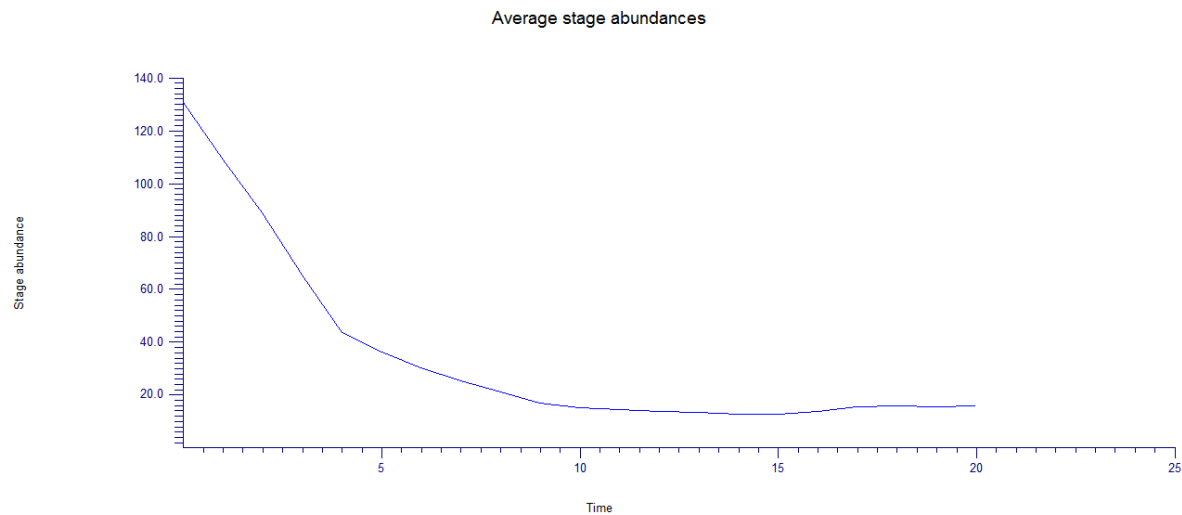
14.00	59.3230
15.00	54.9550
16.00	52.0590
17.00	53.3210
18.00	56.3590
19.00	55.4930
20.00	52.2280

**Average abundance of stage 10 (Adult ma) in population 2 (Hunted)**

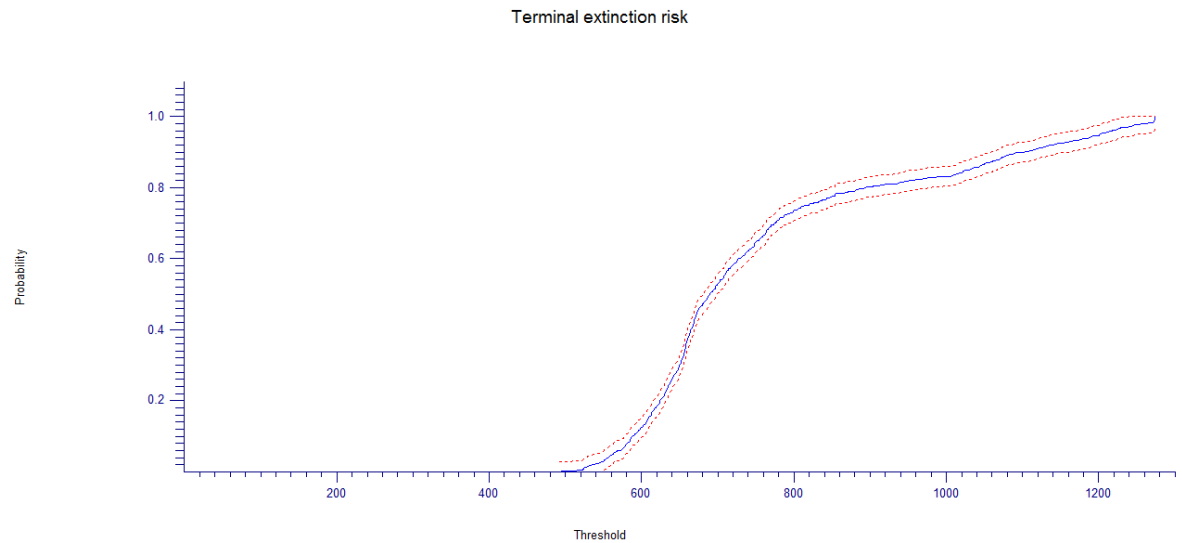
Time	Stage abundance
0.00	131.0000
1.00	109.2000
2.00	89.1660
3.00	65.5170
4.00	43.5590
5.00	36.2390
6.00	30.2080
7.00	25.2620
8.00	21.1440
9.00	16.8510
10.00	15.0620
11.00	14.2710
12.00	13.7370
13.00	13.2870
14.00	12.5570
15.00	12.7240
16.00	13.8910
17.00	15.5690
18.00	15.6810
19.00	15.5810
20.00	15.8730

Adult Male Stage Abundance Hunted Population

Population 2: Hunted

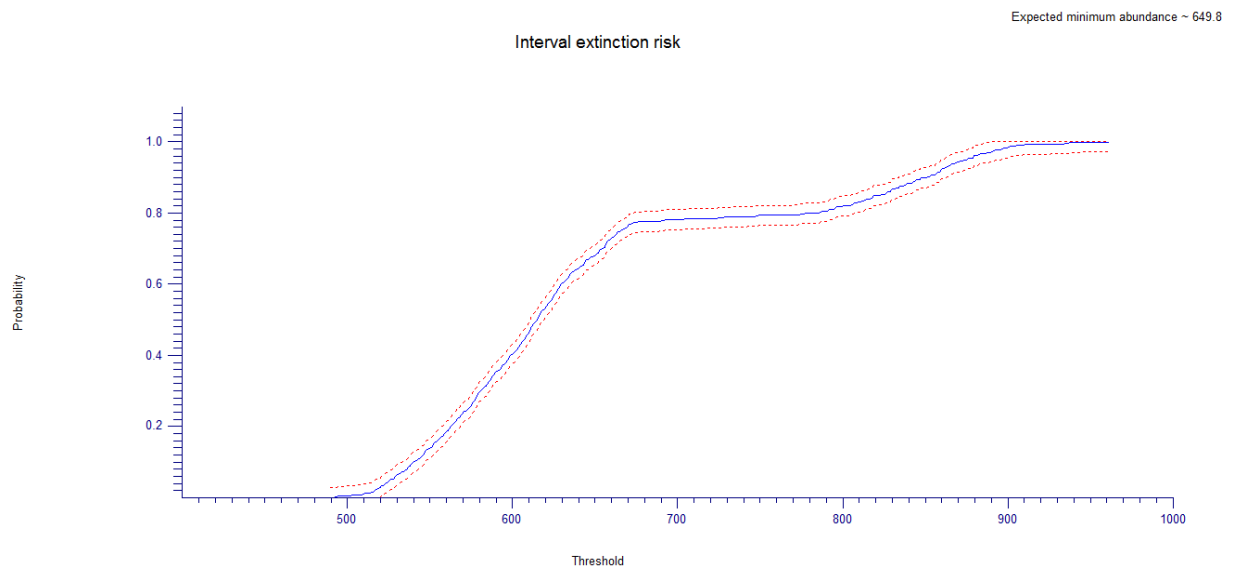


Terminal extinction risk



Terminal extinction risk

Threshold	Probability	95% confidence interval	
500	0.0020	0.0000	0.0300
600	0.1250	0.0970	0.1530
674	0.4540	0.4260	0.4820
700	0.5260	0.4980	0.5540



### Interval extinction risk

Expected minimum abundance = 649.8

Threshold	Probability	95% confidence interval	
500	0.0050	0.0000	0.0330
600	0.4030	0.3750	0.4310
674	0.7730	0.7450	0.8010
700	0.7810	0.7530	0.8090