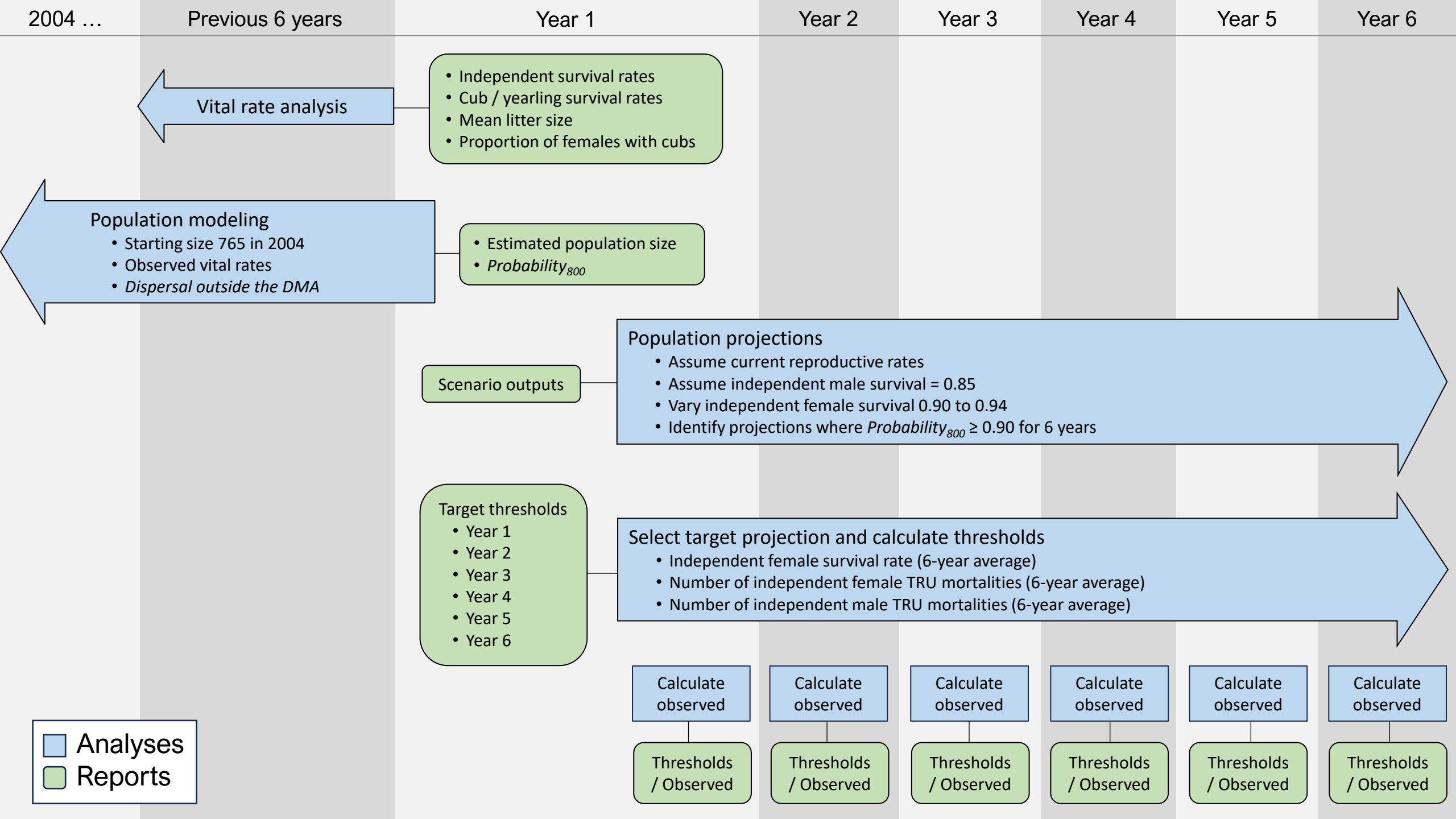
NCDE Demographic Monitoring
A Schematic

Objective 2: Manage mortalities from all sources to support an estimated probability of at least 90% that the grizzly bear population within the DMA remains above 800 bears, considering the uncertainty associated with all of the demographic parameters.


2004 …
Previous 6 years
Year 1
Year 2
Year 3
Year 4
Year 5
Year 6
Vital rate analysis
• Independent survival rates
• Cub / yearling survival rates
• Mean litter size
• Proportion of females with cubs
Population modeling
• Starting size 765 in 2004
• Observed vital rates
• Dispersal outside the DMA
• Estimated population size
• Probability800
Scenario outputs
Population projections
• Assume current reproductive rates
• Assume independent male survival = 0.85
• Vary independent female survival 0.90 to 0.94
• Identify projections where Probability800 ≥ 0.90 for 6 years
Target thresholds
• Year 1
• Year 2
• Year 3
• Year 4
• Year 5
• Year 6
Select target projection and calculate thresholds
• Independent female survival rate (6-year average)
• Number of independent female TRU mortalities (6-year average)
• Number of independent male TRU mortalities (6-year average)
Calculate observed
Thresholds / Observed
Calculate observed
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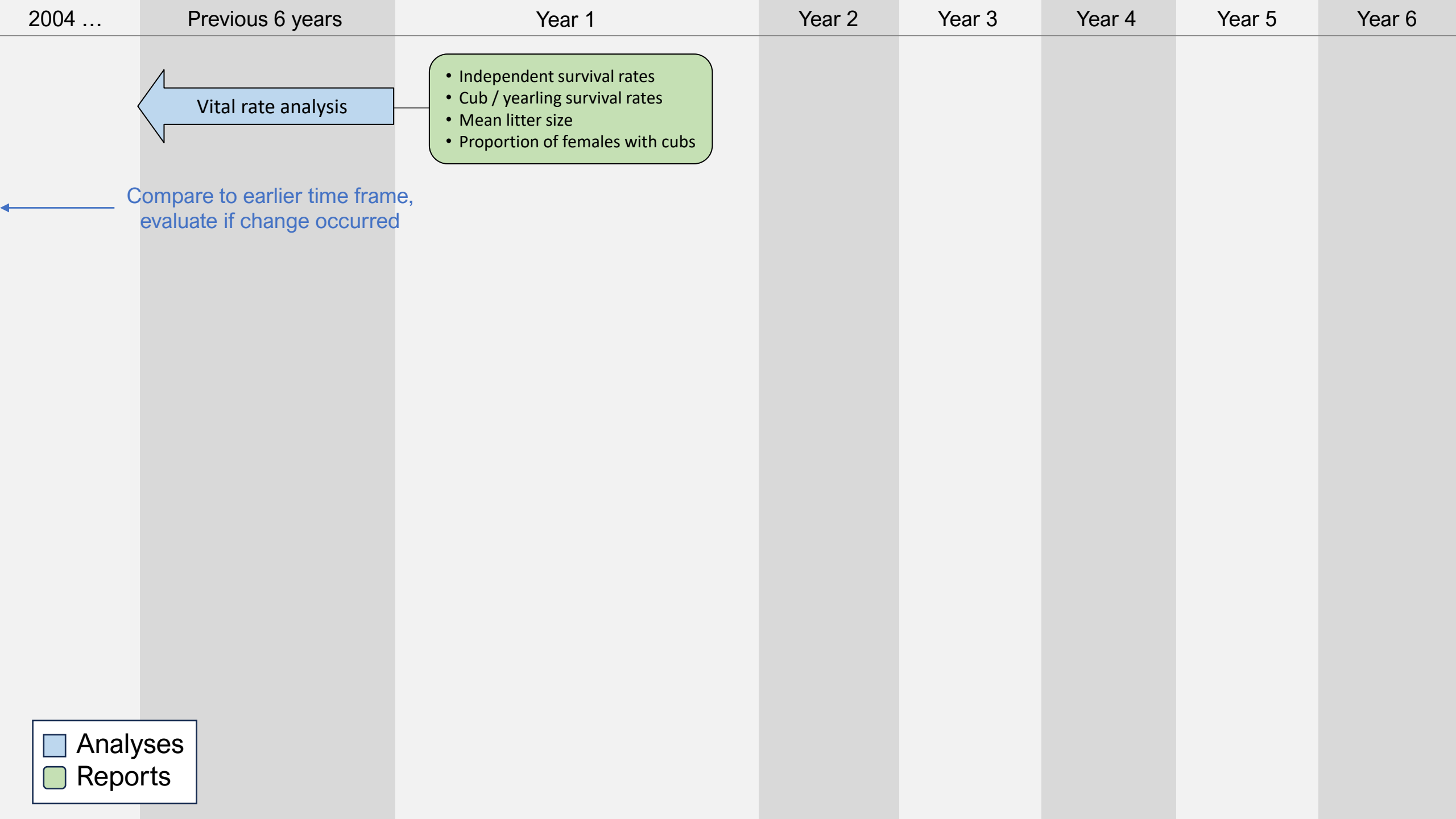

2004 …
Previous 6 years
Year 1
Year 2
Year 3
Year 4
Year 5
Year 6
Vital rate analysis
• Independent survival rates
• Cub / yearling survival rates
• Mean litter size
• Proportion of females with cubs
Compare to earlier time frame, evaluate if change occurred
Analyses
Reports

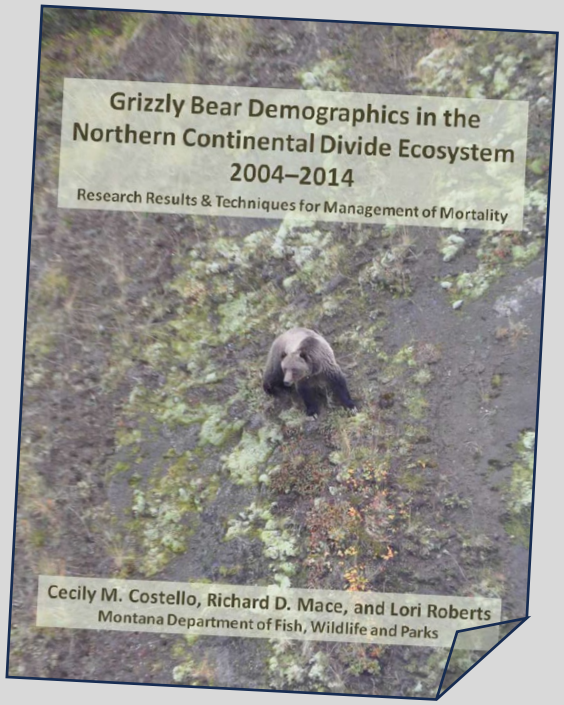
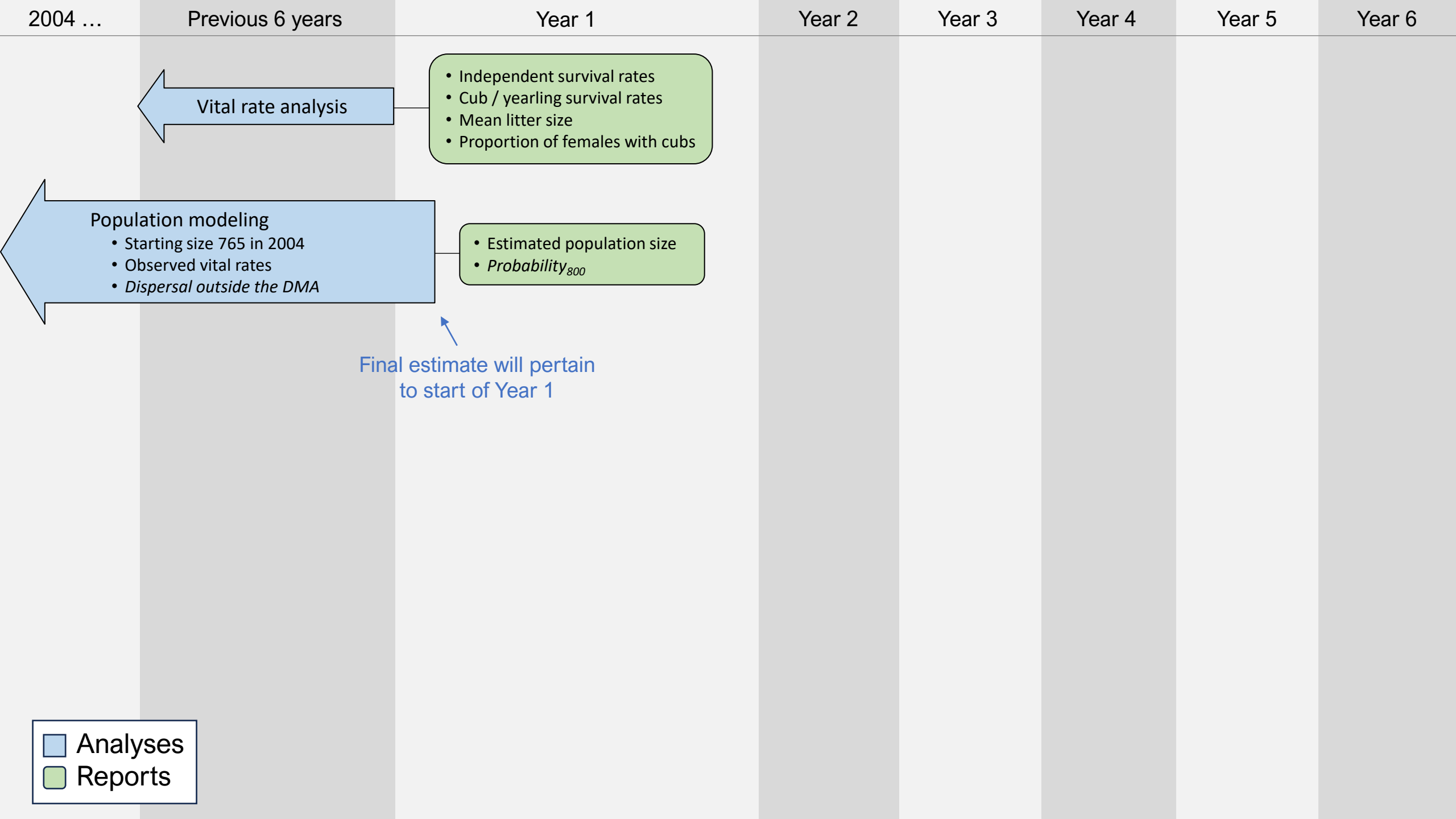


Table 4.8.1. Input parameter estimates used for stochastic modeling of NCDE grizzly bear populations with RISKMAN software.

Input parameter	Estimate	SE	Notes
Probability with 1 offspring	0.160		Held constant among models
Probability with 2 offspring	0.590		Held constant among models
Probability with 3 offspring	0.250		Held constant among models
Mean litter size	2.100	0.050	Held constant among models
Proportion with litters	0.287	0.031	Held constant among models
Male survival age 0	0.553	0.070	Held constant among models
Male survival age 1	0.639	0.080	Held constant among models
Male survival ages 2–28	0.895	0.054	Base rate, but varied for investigations
Female survival age 0	0.553	0.070	Held constant among models
Female survival age 1	0.639	0.080	Held constant among models
Female survival ages 2–28	0.947	0.014	Base rate, but varied for investigations
Initial population size	765	29.27	Base rate, but varied for investigations

Rates	Years	Vital rates to estimate population in 2018
Survival	2004-2013	No evidence of change during 2014-2017 (only 4 yrs of additional data)
Reproduction	2004-2014	No evidence of change during 2015-2017 (only 3 yrs of additional data)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Final estimate will pertain to start of Year 1
Analyses
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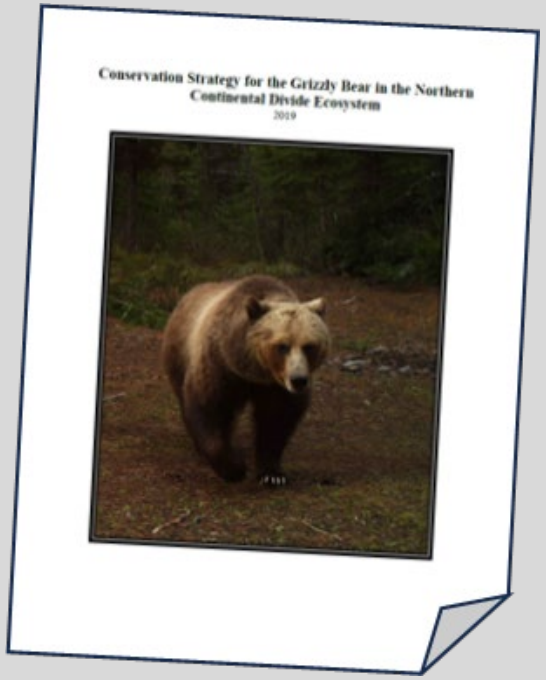


Population modeling, based on vital rates from Costello et al. (2016), indicates that the estimated probability that the population was above 800 grizzly bears increased from only 21% in 2004 to 90% in 2010, and has been ≥99% since 2012 (Figure 4). Median population estimates for those years when Objective 2 was met ranged from 885 bears in 2010 to 1,047 bears in 2018. Thus, given our current rates and levels of uncertainty, managing for a population with an estimated probability of at least 90% being above 800 bears necessitates maintaining an estimated population size of approximately 950–1,000 grizzly bears. Additionally, larger estimated population sizes would be needed if the level of uncertainty increases.

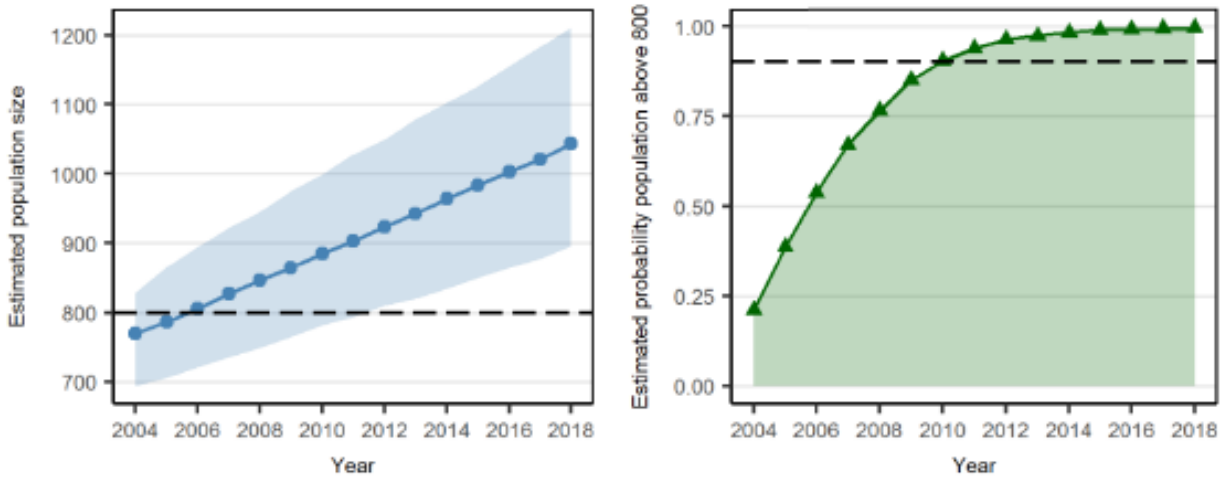
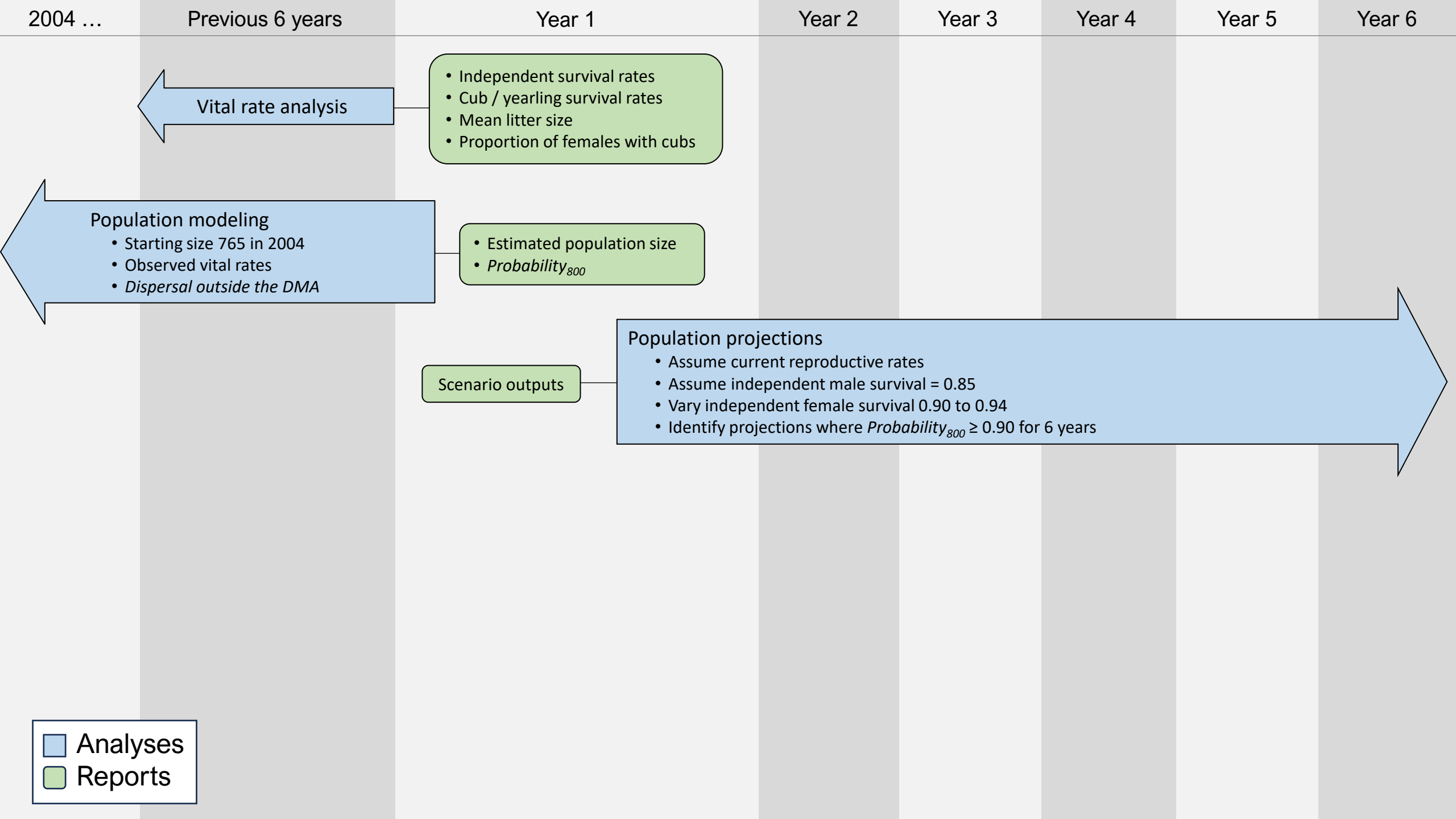


Figure 4. Estimated population size (median and 90th percentile; left) and estimated probability that the population was above 800 grizzly bears (right) during 2004–2018, based on current observed vital rates (Costello et al. 2016).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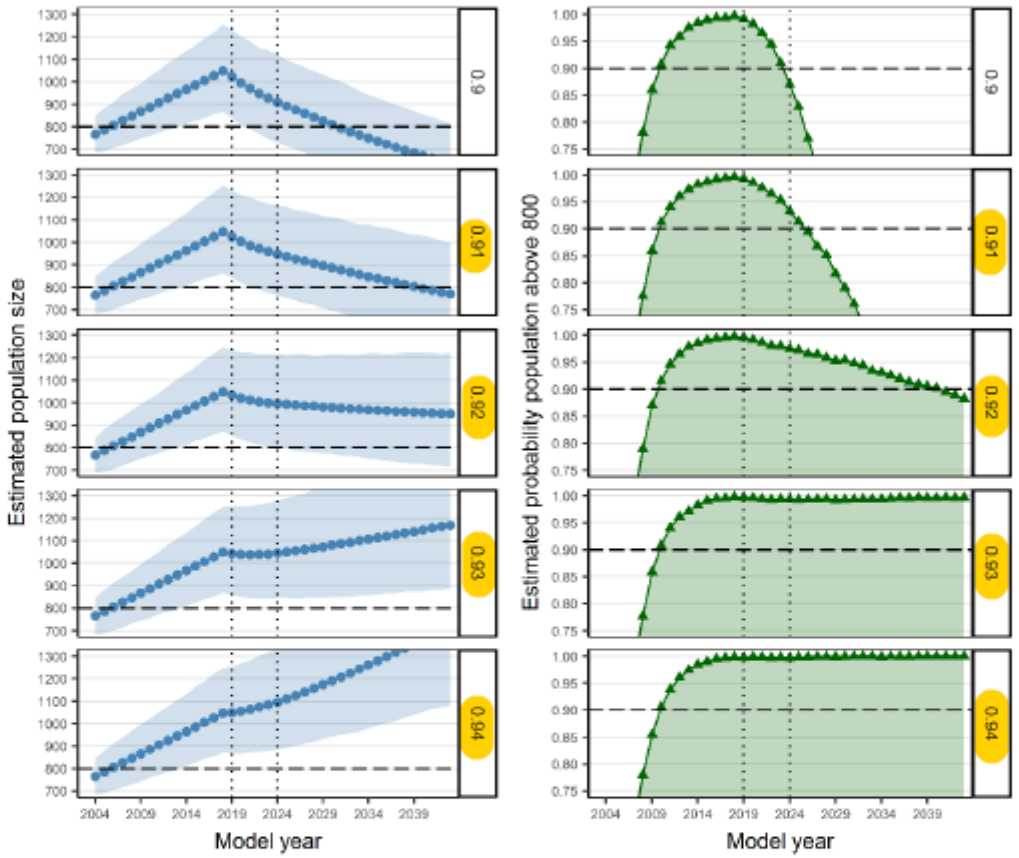


Figure 2. Projected population size (median and 95th percentile; right) and probability that the population is above 800 bears (left) for independent varying female survival rates under a scenario of an estimated population size of approximately 1000 bears.

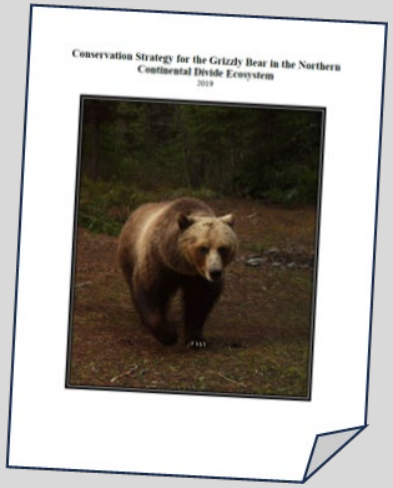
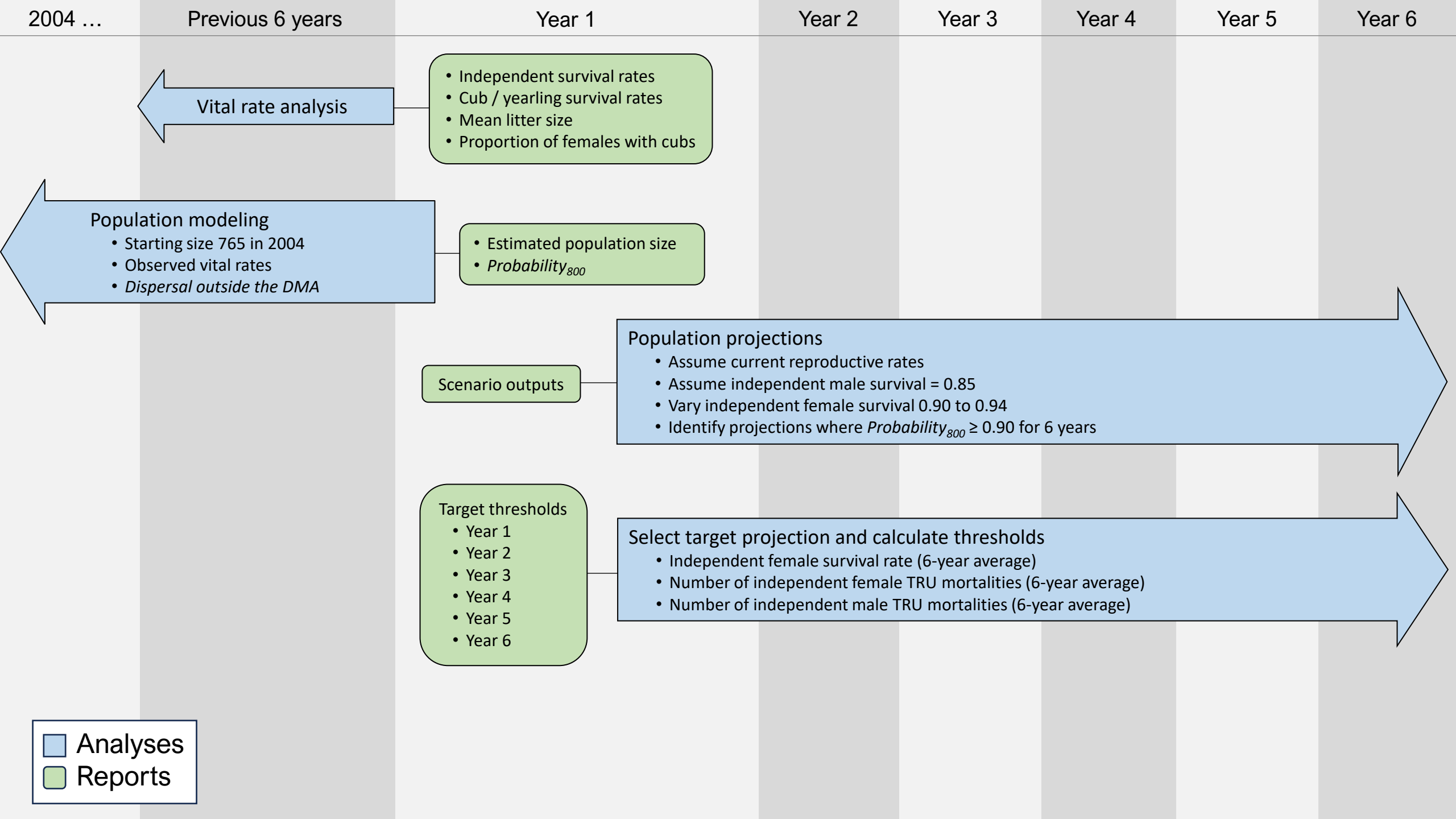


Table 2. Modeling results used to establish thresholds for independent female survival and mortality for the NCDE population under a scenario of an estimated population size of approximately 1000 bears.

Model input		Model output			Independent mortality thresholds (2019–2024)	
Independent survival during 2019–2043		Probability population >800 in 2024	No. years before <90% probability population >800	Median λ (2019-2024)		
Female	Male				Female	Male
0.90	0.85	0.87	5	0.98	32	31
0.91	0.85	0.93	9	0.99	29	31
0.92	0.85	0.98	20	1.00	27	31
0.93	0.85	0.99	>25	1.00	24	32
0.94	0.85	>0.99	>25	1.01	22	32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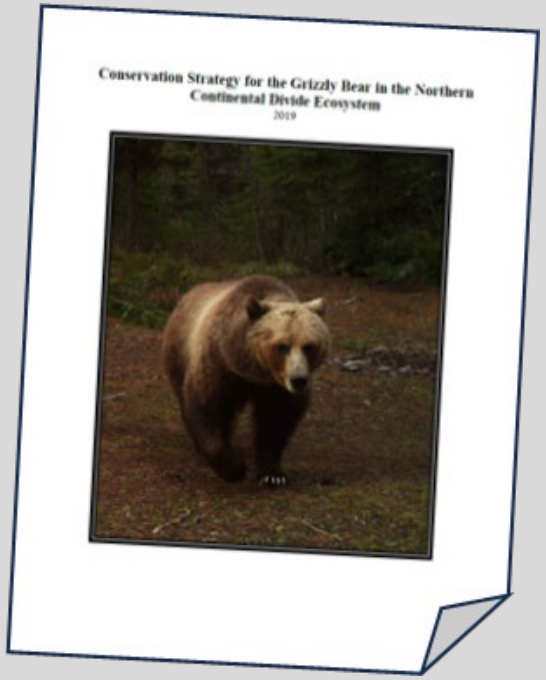
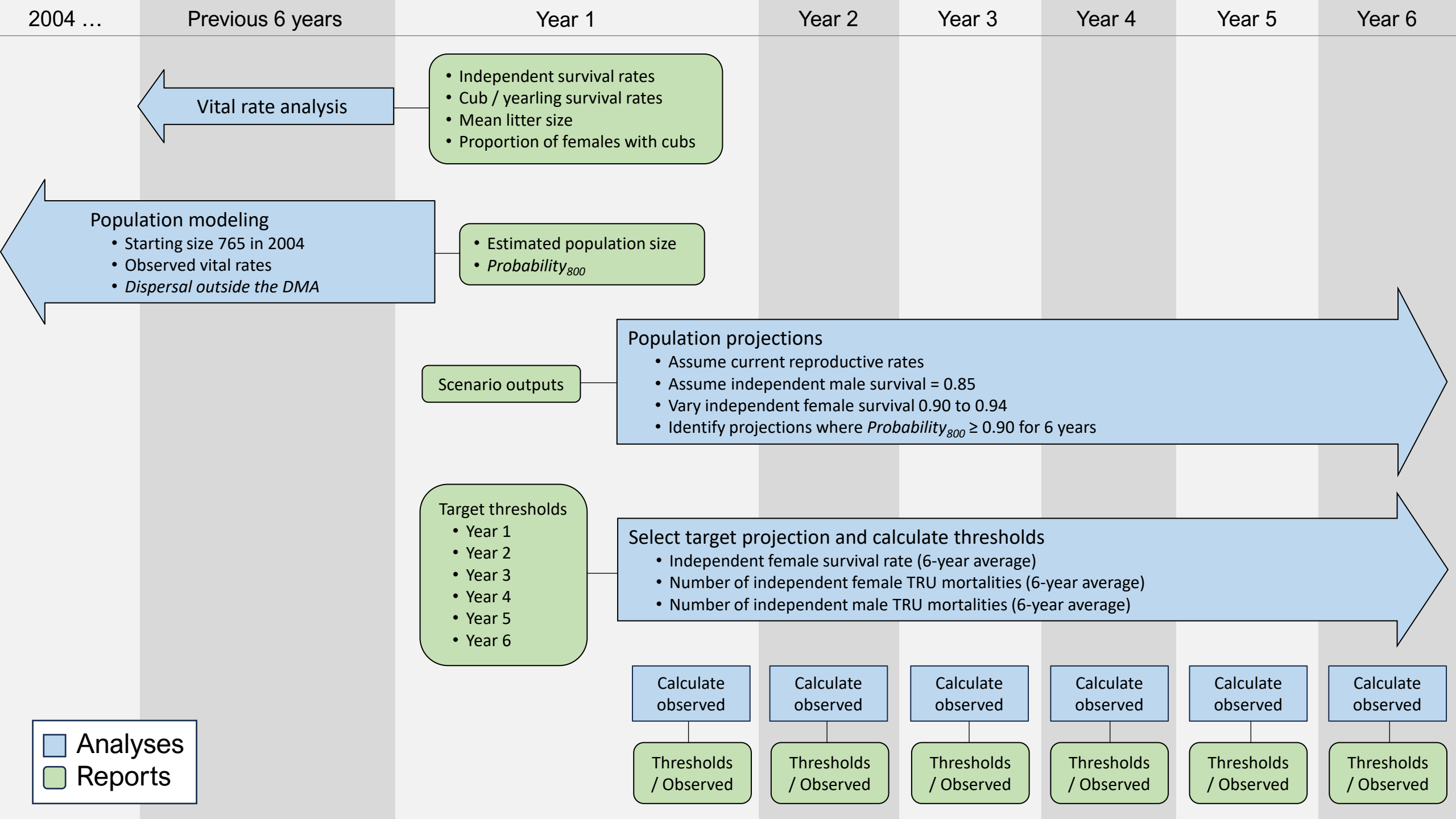


Table 3. Example of assignment and evaluation of annual thresholds for two hypothetical management periods beginning in 2013, including observed parameters for the years 2013–2017.

			Period thresholds involved in 6-year running average										
Parameter	Period	Period year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Female survival	2013–2018	1	0.93	0.93	0.93	0.93	0.93	0.93					
		2		0.93	0.93	0.93	0.93	0.93	0.93				
		3			0.93	0.93	0.93	0.93	0.93	0.93			
		4				0.93	0.93	0.93	0.93	0.93	0.93		
		5					0.93	0.93	0.93	0.93	0.93	0.93	
		6						0.93	0.93	0.93	0.93	0.93	0.93
	2019–2023	1							0.92	0.92	0.92	0.92	0.92
		2								0.92	0.92	0.92	0.92
		3									0.92	0.92	0.92
		4										0.92	0.92
		5											0.92
6-year-average threshold			0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.92	0.92
6-year-average observed			0.95	0.95	0.96	0.95	0.95						
At or above threshold			Yes	Yes	Yes	Yes	Yes						
Female TRU	2013–2018	1	22	22	22	22	22	22					
		2		22	22	22	22	22	22				
		3			22	22	22	22	22	22			
		4				22	22	22	22	22	22		
		5					22	22	22	22	22	22	
		6						22	22	22	22	22	22
	2019–2023	1							27	27	27	27	27
		2								27	27	27	27
		3									27	27	27
		4										27	27
		5											26
6-year-average threshold			22	22	22	22	22	22	23	24	25	25	26
6-year-average observed			10	15	15	16	15						
At or below threshold			Yes	Yes	Yes	Yes	Yes						
Male TRU	2013–2018	1	28	28	28	28	28	28					
		2		28	28	28	28	28	28				
		3			28	28	28	28	28	28			
		4				28	28	28	28	28	28		
		5					28	28	28	28	28	28	
		6						28	28	28	28	28	28
	2019–2023	1							31	31	31	31	31
		2								31	31	31	31
		3									31	31	31
		4										31	31
		5											
6-year-average threshold			28	28	28	28	28	28	29	29	30	30	31
6-year-average observed			16	16	17	16	19						
At or below threshold			Yes	Yes	Yes	Yes	Yes						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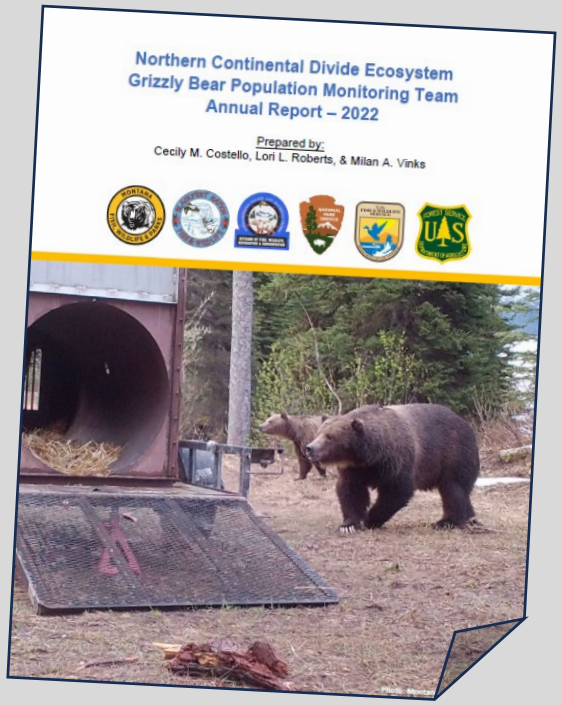
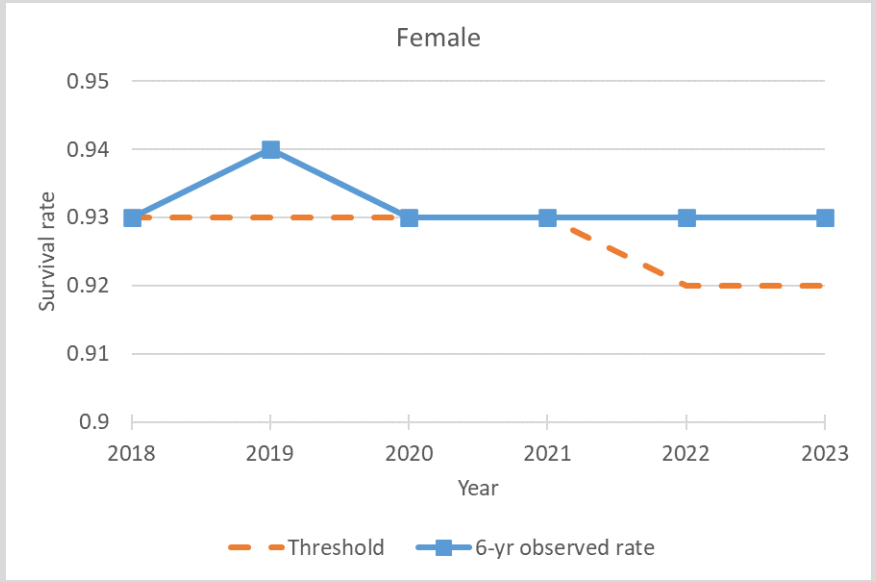
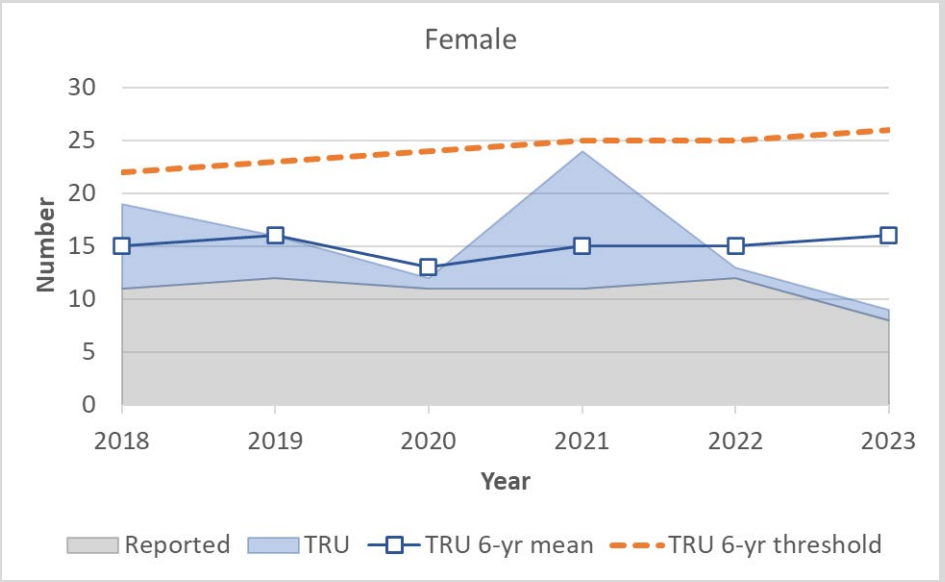
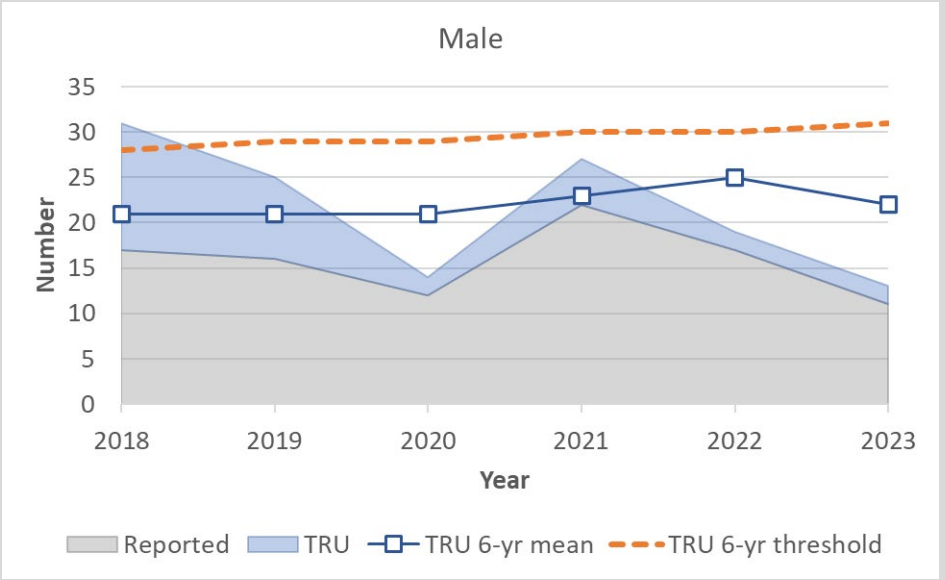


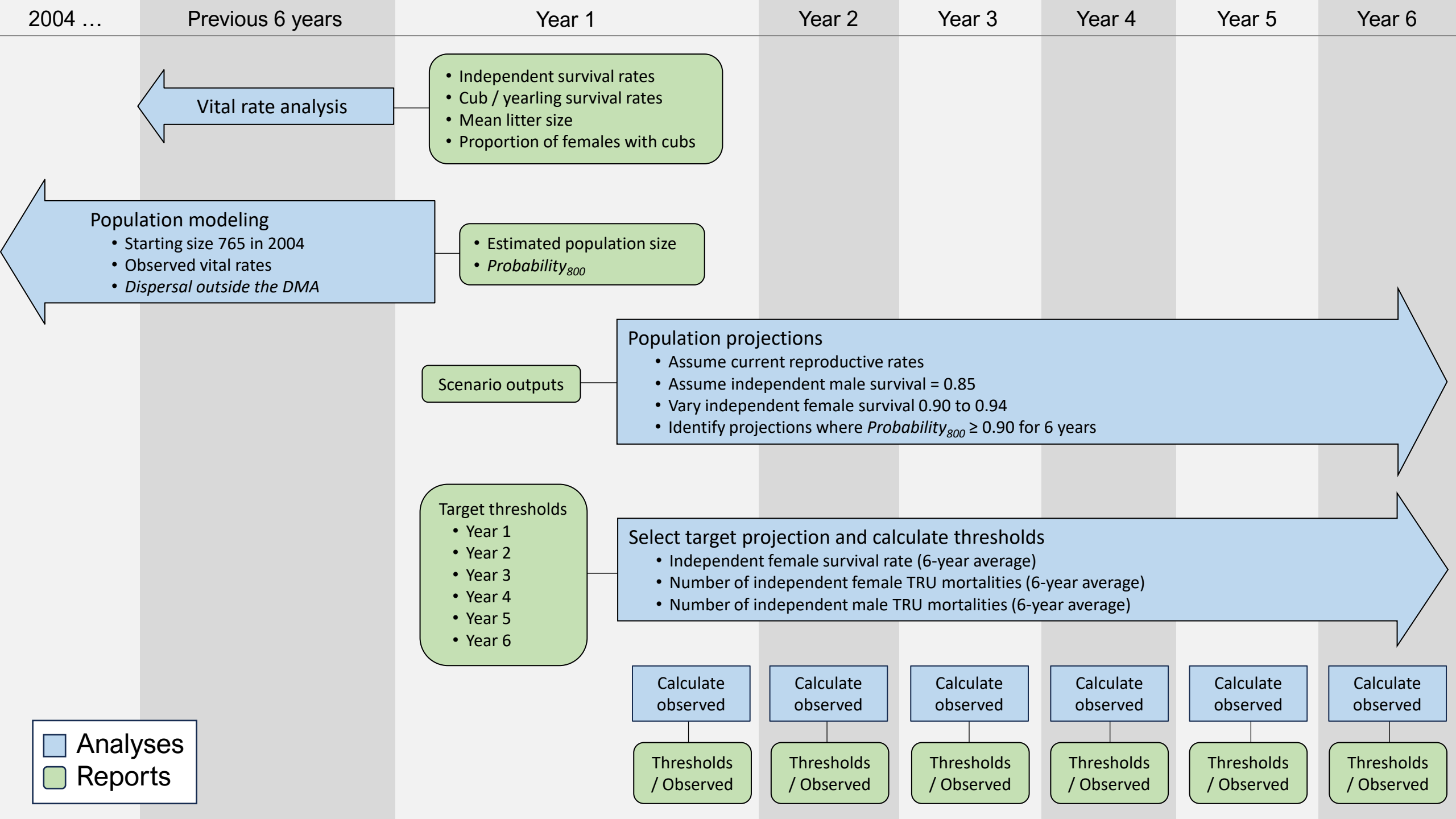
Appendix E. Thresholds and observed estimates for demographic objectives described in the 2019 Conservation Strategy, 2017–2022. Parameters include occupancy of females with offspring within 23 Bear Management Units (BMUs) in the Primary Conservation Area (PCA) and 7 Occupancy Units (OUs) in Zone 1, tallied over the last 6 years; survival rate of independent females within the Demographic Monitoring Area (DMA) averaged over the last 6 years; and numbers of total reported and unreported (TRU) mortalities of independent female and male grizzly bears within the DMA averaged over the last 6 years.

Parameter	Area or Sex	Threshold/ observed	Year					
			2017	2018	2019	2020	2021	2022
Occupancy	PCA (BMUs)	Minimum	21	21	21	21	21	21
		Observed	23	22	22	23	23	23
	Zone 1 (OUs)	Minimum	6	6	6	6	6	6
		Observed	7	7	7	7	7	7
Survival rate	Female	Minimum	0.93	0.93	0.93	0.93	0.93	0.92
		Observed	0.95	0.93	0.94	0.93	0.93	0.93
TRU mortalities	Female	Maximum	22	22	23	24	25	25
		Observed	14	15	16	13	15	15
	Male	Maximum	28	28	29	29	30	30
		Observed	19	21	21	21	23	25


Female
0.95
0.94
0.93
0.92
0.91
0.9
Survival rate
2018
2019
2020
2021
2022
2023
Year
Threshold
6-yr observed rate


Female
30
25
20
15
10
5
0
Number
2018
2019
2020
2021
2022
2023
Year
Reported
TRU
TRU 6-yr mean
TRU 6-yr threshold


Male
35
30
25
20
15
10
5
0
Number
2018
2019
2020
2021
2022
2023
Year
Reported
TRU
TRU 6-yr mean
TRU 6-yr threshold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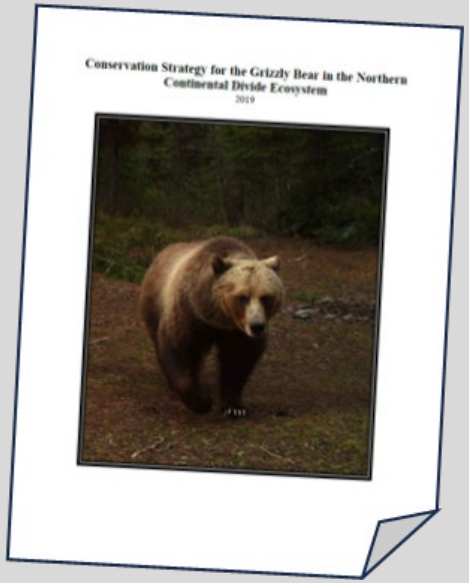
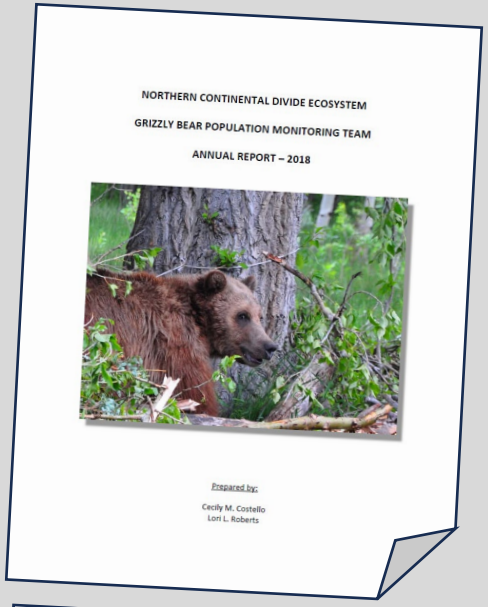
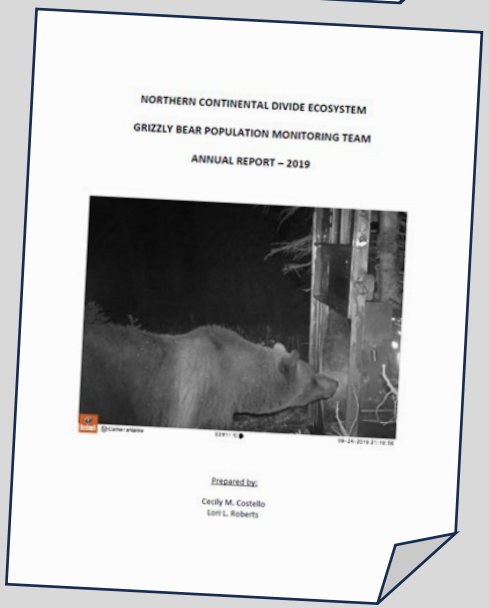
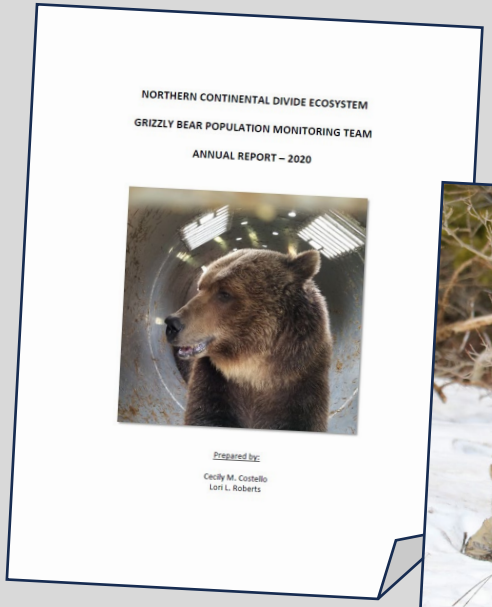


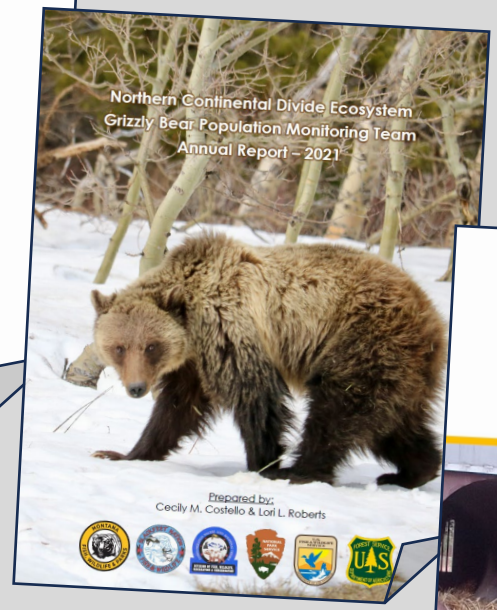
Median population estimate in 2018
1,047 bears
Probability$_{800}$ >99%





No annual estimate reported





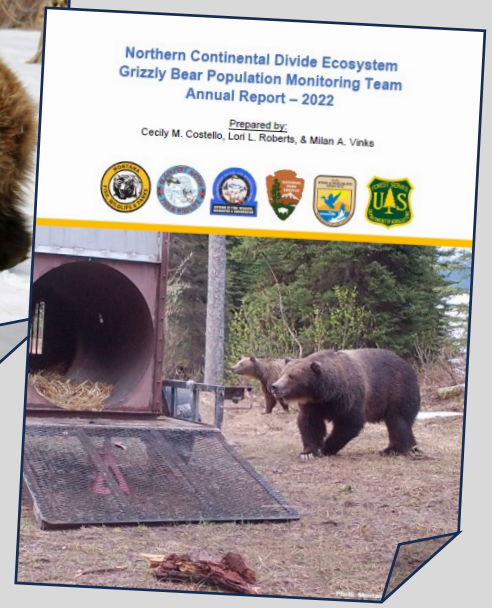
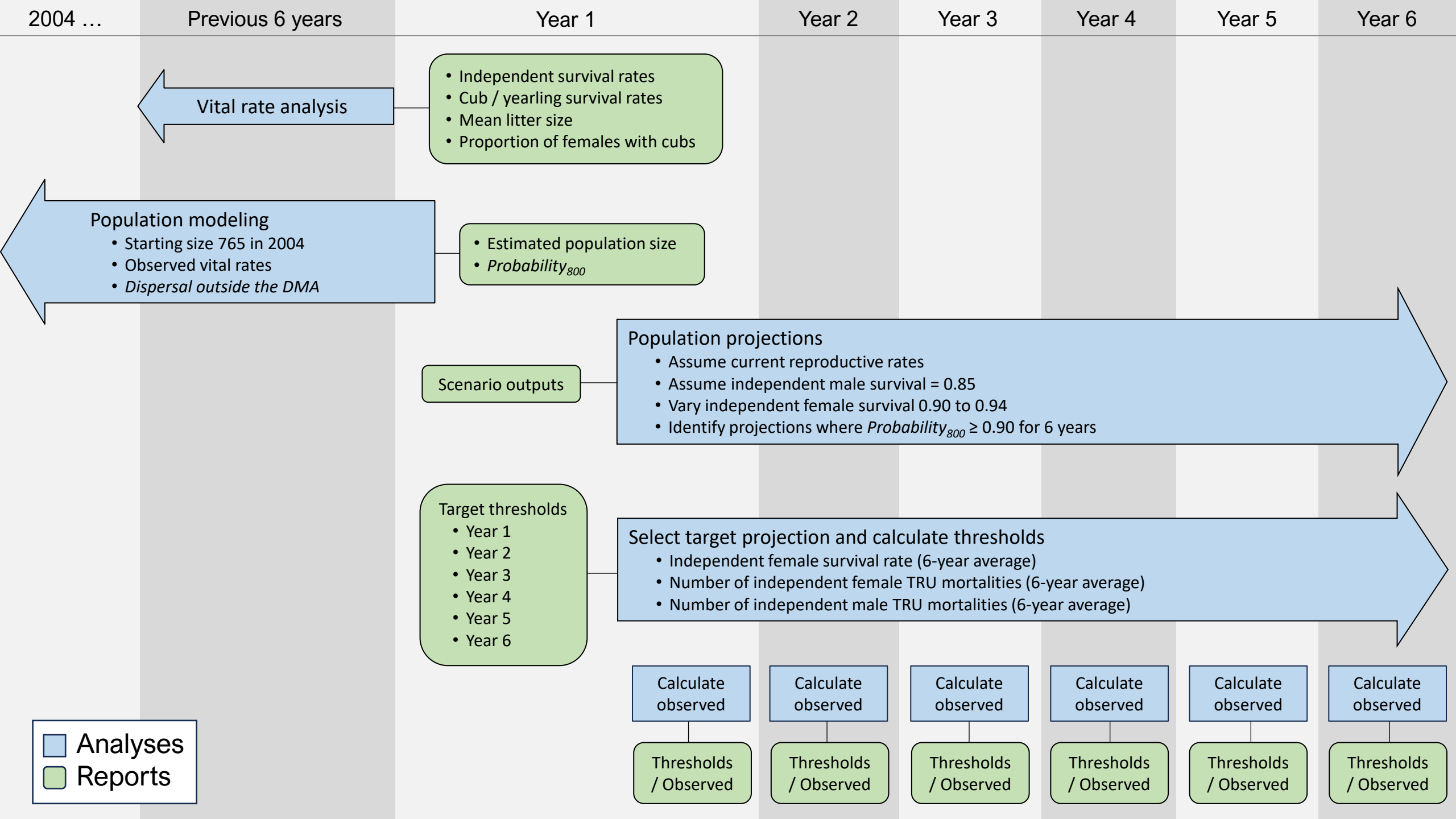


Table 6. Projected population size of grizzly bears in the NCDE for the management period 2019–2023, assuming previously observed vital rates (Costello et al. 2016).

	Year				
Estimate	2019	2020	2021	2022	2023
Population size	1,068	1,092	1,114	1,138	1,163
95th percentile	906–1,243	923–1,276	938–1,305	958–1,335	971–1,366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