Quantification questions. For each of these we will need both the number ( 0 to 1) and the literature or data that we are citing to back up the number. Alternatively, it would be marked as unknown and given a value of ‘1’. For incidence, 0 = 0% certainty of occurrence, 1 = 100% certainty of occurrence. For probability of failure, 0 = 0% chance of failing, 1 = 100% chance. These are for current conditions. The same questions below can also be asked of future scenarios, where feasible.

* Critical event: What is the target frequency for tolerating Boreal Caribou λ persistently <1 in the study areas?
* Threat 1: What is the frequency of predation (absent any barriers) contributing to λ persistently < 1 in the study areas?
  + Barrier 1: What is the probability that daily movement to evade predators will functionally fail?
  + Barrier 2: What is the probability that current efforts to restore seismic traces will functionally fail to prevent predation (both functionally and numerically) in the study areas?
  + Barrier 3: What is the probability that current regular trapping and hunting of wolves will fail to prevent predation in the study areas?
  + Barrier 4: What is the probability that current management of early seral stage forests (forest harvesting, fire) will functionally fail to prevent predation in the study areas?
  + Barrier 5: What is the probability that current bans on caribou hunting will fail to prevent human predation on caribou in the study areas?
  + Barrier 6: What is the probability that current hunting of alternative prey will fail to prevent numeric increases in predator populations and resulting predation in the study areas?
* Threat 2: At what frequency does current permanent habitat appropriation (deforestation) and resulting exclusion of caribou from habitat (absent any barriers) contribute to λ persistently < 1 in the study areas? This is a two-step question: 1) How much current deforestation is there in the study areas? 2) What are the impacts of that level of habitat exclusion on the caribou?
  + Barrier 1: What is the probability that current habitat set-asides (Parks and Resource Review Areas = RRAs) will fail to prevent habitat appropriation (deforestation, forest harvesting) and resulting functional exclusion of caribou in the study areas?
  + Barrier 2: What is the probability that current habitat recovery and restoration efforts will fail to prevent functional and numeric recovery of caribou from loss of habitat in the study areas?
  + Barrier 3: What is the probability that current levels of afforestation in the study areas will fail to prevent functional and numeric recovery of caribou from loss of habitat in the study areas?
* Threat 3: At what frequency does the occurrence of stresses reducing caribou fitness and health currently contribute to λ persistently < 1 in the study areas?
  + Barrier 1: What is the probability that current management of forests to encourage food-providing habitat will fail to prevent nutritional stress in the study areas?
  + Barrier 2: What is the current probability that daily selection of high quality habitat by caribou will fail to limit nutritional and physical stresses in the study areas?
  + Barrier 3: What is the current probability of stable epidemiology failing to prevent disease or parasite outbreaks reducing the fitness and health of caribou in the study areas?
  + Barrier 4: What is the current probability that endemic disease/parasite resistance will fail to prevent disease or parasite outbreaks reducing the fitness and health of caribou in the study areas?
  + Barrier 5: What is the current probability that measures against harassment will prevent humans from causing physical stress to caribou in the study areas?
* Threat 4: What is the frequency of disturbances and disease outbreaks that significantly and currently affect numeric predator/prey balance, contributing to λ persistently < 1 in the study areas
  + Barrier 1: What is the probability that current resistance to starvation caused by extreme weather events will fail to prevent mortality and numeric increase in the predator/prey balance in the study areas?
  + Barrier 2: What is the probability that current resistance to epizootic diseases and parasites fail to prevent mortality and numeric increase in the predator/prey balance in the study areas?
* Outcome 1: Given that the critical event occurs, what is the current target frequency for tolerating the projected collapse of Boreal Caribou populations in the study areas?
  + Mitigation barrier 1: What is probability that current wolf culls will fail to mitigate collapse of Boreal Caribou populations in the study areas?
  + Mitigation barrier 2: What is the probability that natural density-dependant limits to current predation levels will currently fail to mitigate collapse of Boreal Caribou populations in the study areas?
  + Mitigation barrier 3: What is the probability that current efforts for intensive in situ conservation (maternal penning, enclosures/exclosures) will fail to mitigate collapse of Boreal Caribou populations in the study areas?

FRANCES ADDITIONS

Note: if any of the barrier values are changed, I will need to recalculate several values. Please let me know if barrier values are changed based on my below comments, and I can give you the updated values for the final draft.

From CaribouCalculations.R file

**STUDY AREA 1**

Using ECCC 2011 data for Chinchaga herd.

N = 250

SadF = 0.87

recr = 0.13

Values to add to the BRAT framework – as of January 21, 2019:

We know total adult female mortality is 1-SadF = 0.13 (ECCC value)

But this amount needs to be split up between the causes of mortality (ie threats). I’ve assigned 90% to predation, 5% to habitat appropriation, and 5% to disease. The multipliers are in blue font.

**HAZARDS**

* Target Frequency: 1.07 (units are lambda) – ie. We are aiming for a 1.02 lambda to ensure population variation is consistently above 1, given a small sd for the population (sd = 0.1).
* Current total top event frequency: 0.69 (units are in lambda)
* Current consequence frequency: 1.38 (units are in lambda)
  + i.e. Chinchaga caribou population growth rate is definitely persistently below the Target Frequency (Hazard lopa crit not met).
  + After mitigation strategies, lopa crit met.

**THREATS AND BARRIERS**

* General predation
  + Initial Freq: 0.117 ( 1 – SadF)\*0.9
  + Current top event frequency: 0.22 – this was calculated in the R code, given the current barriers to the threat

**Current top event frequency = (1 – ECCC Value)\* %ofECCC value due to this threat**

* Predation specific to juvenile caribou
  + Initial frequency = 0.37 (once you account for pregnancy rates, adult female survival, and death within the first 24 hrs of life, so only 63% of females actually produce a calf one year later.

**Initial Frequency = PregnancyRate\*SadF\*SurvivalTo1Day**

* + Current top event frequency = 0.82. 90% of animals that will die due to predation, and animals that will die due to other factors pre30days. ECCC mortality (0.87) – InitialFrequency (0.37) is 0.5. Therefore 90% of this value is 0.45 (ie. Only 5% is due to deaths in the pen). 0.45 plus 0.37 is the current top event frequency (mortality due to predation, and mortality due to other causes prior to 30 days).

**Current top event frequency = survivalTo30Days\*(ECCC Value-InitialFrequency) + Initial Frequency**

* + - The effect of predator avoidance is therefore: 0.82/0.37 = 2.19

5% of juvenile mortality are due to deaths in a maternity pen. Therefore, I’ve added **0.025** to each of the following threats as they encompass both adult female and juvenile data.

**DeathsInPen = (ECCCValue – InitialFreq(i.e. NaturalDeaths))\*SurvivalTo30Days**

* **Threat 3:** Permanent habitat appropriation that excludes caribou from their natural range
  + Initial Frequency: 0.029 (calculated given the threat values)
  + Current top event frequency: (1-SadF)\*0.05 +0.025 = 0.0315
* **Threat 4:** Stresses reducing caribou fitness and health
  + Initial Frequency: 0.025 (calculated given the threat values)
  + Current top event frequency: (1-SadF)\*0.05 + 0.025 = 0.0315
    - These values only work if we change the ‘Management of forests for habitat providing food’ to 1
    - Daily selection of high quality habitat: 0.8

**Study Area 2**

Made up data

N = 600

Recr = 0.30

SadF = 0.85

**HAZARDS**

* Target Frequency: 1.07 (units are lambda) – ie. We are aiming for a 1.02 lambda to ensure population variation is consistently above 1, given a small sd for the population (sd = 0.1).
* Current total top event frequency: 0.59 (units are in lambda)
* Current consequence frequency: 1.33 (units are in lambda)
  + i.e. Caribou population growth rate is definitely persistently below the Target Frequency (Hazard lopa crit not met).
  + After mitigation strategies, lopa crit met.

Threats and Barriers are the same as above scenario.

**Study Area 3**

ECCC 2011 data for Snake-Sahtahneh herd

N = 360

Recr = 0.072

SadF = 0.94

* Target Frequency: 1.07 (units are lambda) – ie. We are aiming for a 1.02 lambda to ensure population variation is consistently above 1, given a small sd for the population (sd = 0.1).
* Current total top event frequency: 1.04 (units are in lambda)
* Current consequence frequency: 1.55 (units are in lambda)
  + i.e. Caribou population growth rate is definitely persistently below the Target Frequency (Hazard lopa crit not met).
  + After mitigation strategies, lopa crit met.