

# Guidelines for Determining Sustainable Harvest of Mountain Goats



Ian Hatter

Ungulate Specialist

Biodiversity Branch, MWLAP

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# Harvest Considerations

- Mountain Goats are sensitive to overharvest as:
  1. reproductive rates (age of first reproduction, litter size) are low and compensatory responses are poorly developed.
  2. they occupy open habitat, are white in colour, and thus highly visible.
  3. they display low wariness to hunters.
  4. local populations are relatively isolated, with low dispersal rates.
  5. females are harvested (nanny-kid groups are especially vulnerable to hunting).
- There is uncertainty about sustainable harvest rates
- Mountain goats are infrequently surveyed.

# What do we Know?

- Sustainable harvest rates are substantially greater in introduced populations with good range conditions and without predators (Cote and Festa-Bianchet in press).
- Hunting appears to lead to additive mortality in native populations (Hebert and Turnbull 1977, Kuck 1977, Smith 1986).
- Harvest rates <10% were unsustainable in Alberta (Smith 1988).
- Recruitment and productivity declined as harvest rates increased in native mountain goat populations in Idaho and British Columbia (Kuck 1977, Hebert 1978).
- The Caw Ridge herd of about 102 goats recruited ~ two 4-year-old males/year, suggesting a sustainable adult male harvest of 1/year, or 1% of the population (Gonzalez-Voyer et al. in press).
- Most studies report no effect of population size on reproductive success or evidence of compensatory reproduction in native populations (Cote and Festa-Bianchet in press).

# Harvest Management Guidelines from Literature

- Hall 1977:
  - In Alberta (1973-1985), some herds were managed by harvesting up to 5% of the number seen during aerial surveys.
- Hebert and Turnbull 1977:
  - The harvest of coastal herds in British Columbia should not exceed 4% of the total population
- Kuck 1977:
  - An average harvest of 4% was allowed in Idaho.
- Cote and Festa-Bianchet (in press):
  - The best management strategy for native populations of mountain goats would combine a 2-3% yearly harvest with a strong encouragement to harvest adult males.
  - Hunting quotas must be set on a herd-specific basis.
  - A “tracking harvest strategy” should be employed.

# Harvest Management Guidelines from Literature (con't):

- Gonzales-Voyer et al. *in press*.
  - A more practical management strategy would be to establish ‘total’ and ‘female’ quotas for each population.
  - If the female harvest one year exceeded the “female” quota, hunting could be closed for the following season(s).
  - A similar “double-quota” system is used in Alberta to manage cougar harvests.

# Population Modeling Approaches for Determining Sustainable Harvest

- An alternative approach is to use demographic data from published studies to build herd-specific harvest models to investigate effects of population size, proportion of females in harvest, and survey frequency
- *RISKMAN* provides a flexible RISK MANagement decision tool to assess harvest impacts on mountain goat populations (Taylor et al. 2002).
  - Incorporates environmental and demographic stochasticity.
  - Incorporates hunter selectivity and age-class vulnerability to harvest (herd specific).
  - Allows calculation of the sustainable harvest level, based as a proportion of the survey population estimate (herd specific).

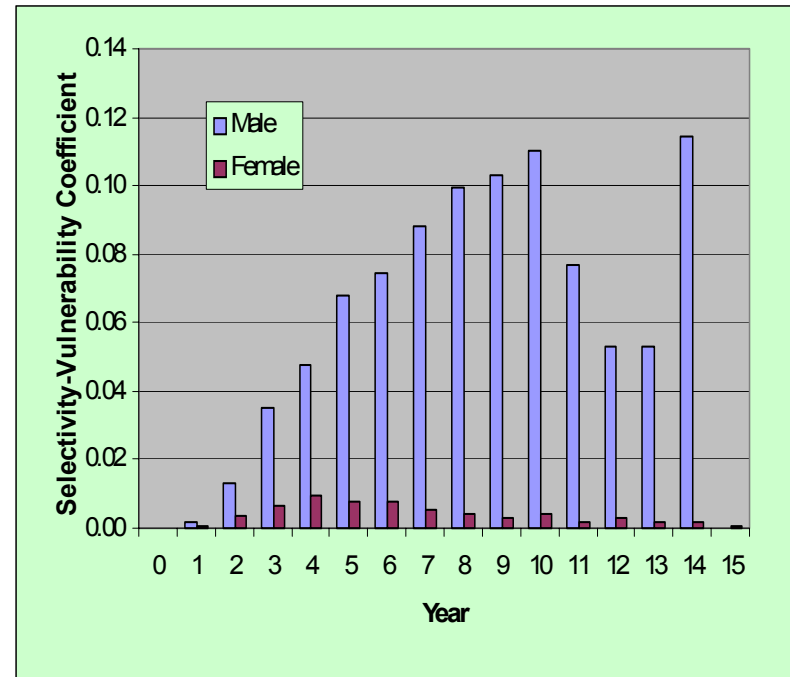
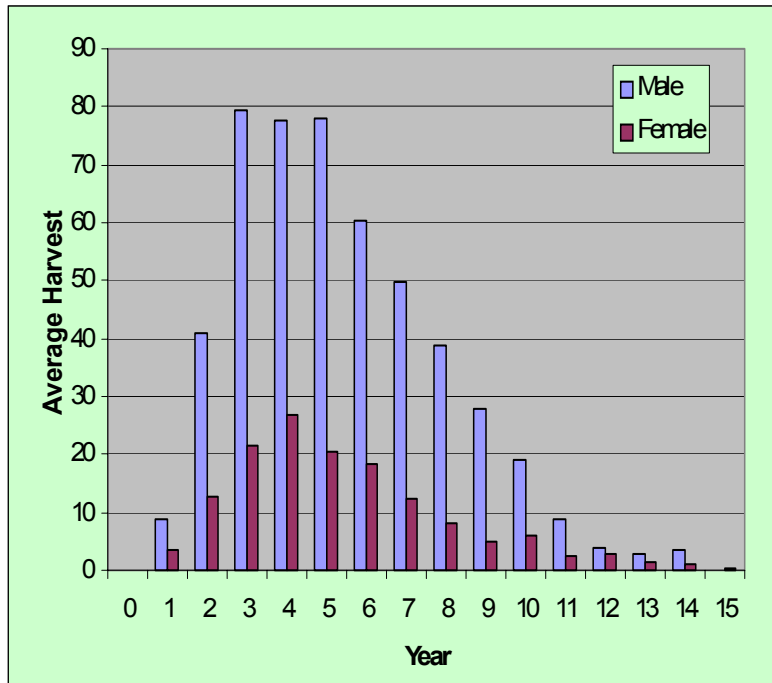
# Mountain Goat Demographics used for RISKMAN model

Age (years)	Male Survival	Standard Error	Female Survival	Standard Error	Recruit. (0.3 yrs)	Standard Error
0.3	0.770	0.116	0.770	0.116		
1.3	0.730	0.073	0.820	0.082		
2.3	0.780	0.078	0.940	0.047		
3.3	0.780	0.078	0.940	0.047	0.032	0.006
4.3						0.079
5.3						0.117
6.3						0.133
7.3						0.133
8.3						0.133
9.3	0.710	0.071	0.840	0.084	0.664	0.133
≥ 10.3	0.710	0.071	0.840	0.084	0.577	0.115

•Estimates of survival and recruitment are from studies by Festa-Bianchet and Cotè in Alberta (primarily Caw Ridge). SE's assumed.

•Females in the Caw Ridge population do not reproduce until 4 or 5 years old, and only about 50% of yearling females survive to 4 years (Festa-Bianchet et al. 1994)

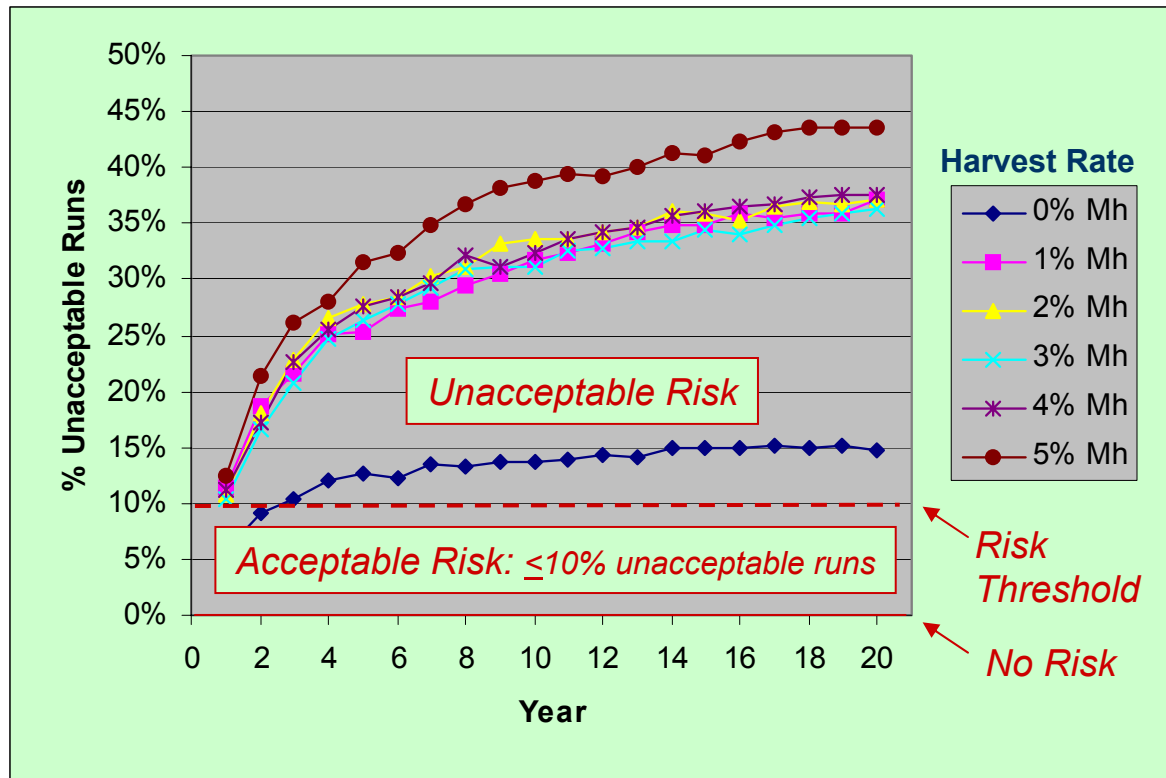
# BC Provincial Harvest Structure and RISKMAN estimate of Selectivity/Vuln.



Based on 2000-2002 age-class reports from SSDB. SV coefficients should be herd-specific if possible, otherwise based Game Management Zone's.

# Effect of Harvest Rate on Herd Viability

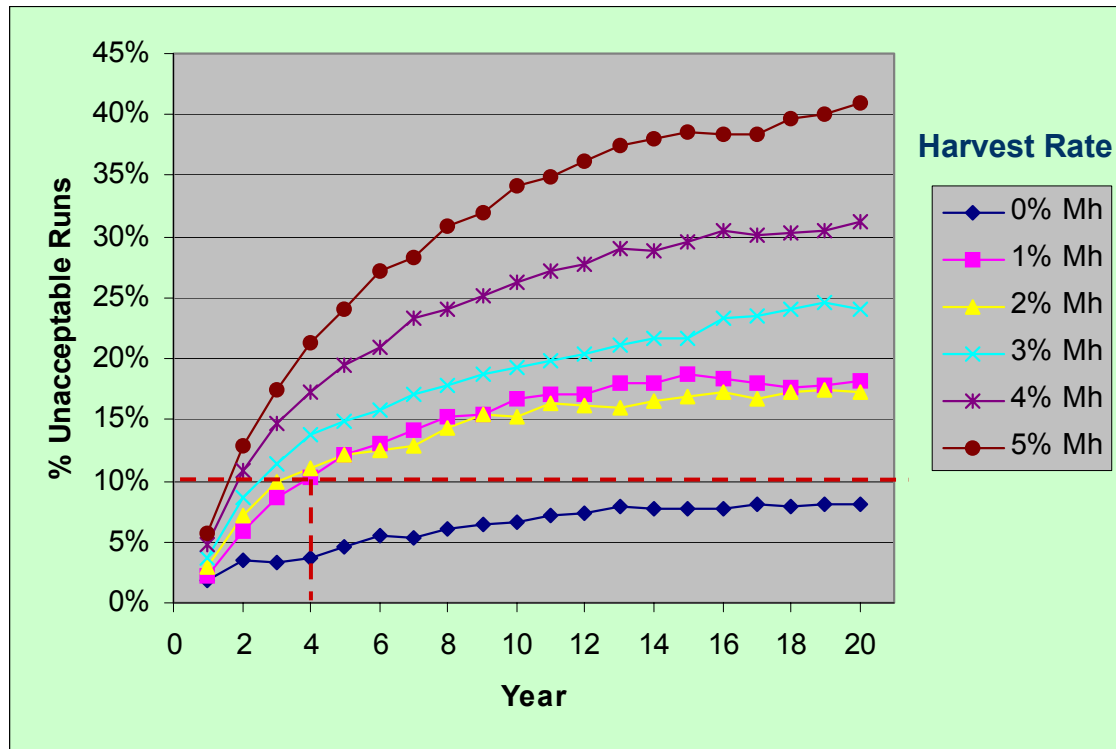
$N_{init} = 25$ ,  $SE = 6.25$ ,  $\lambda = 1.032$



% Unacceptable Runs = % of 2000 runs where the population drops below 0.856 of initial population size (i.e. level that requires 5 yrs for recovery without harvest)

# Effect of Harvest Rate on Herd Viability

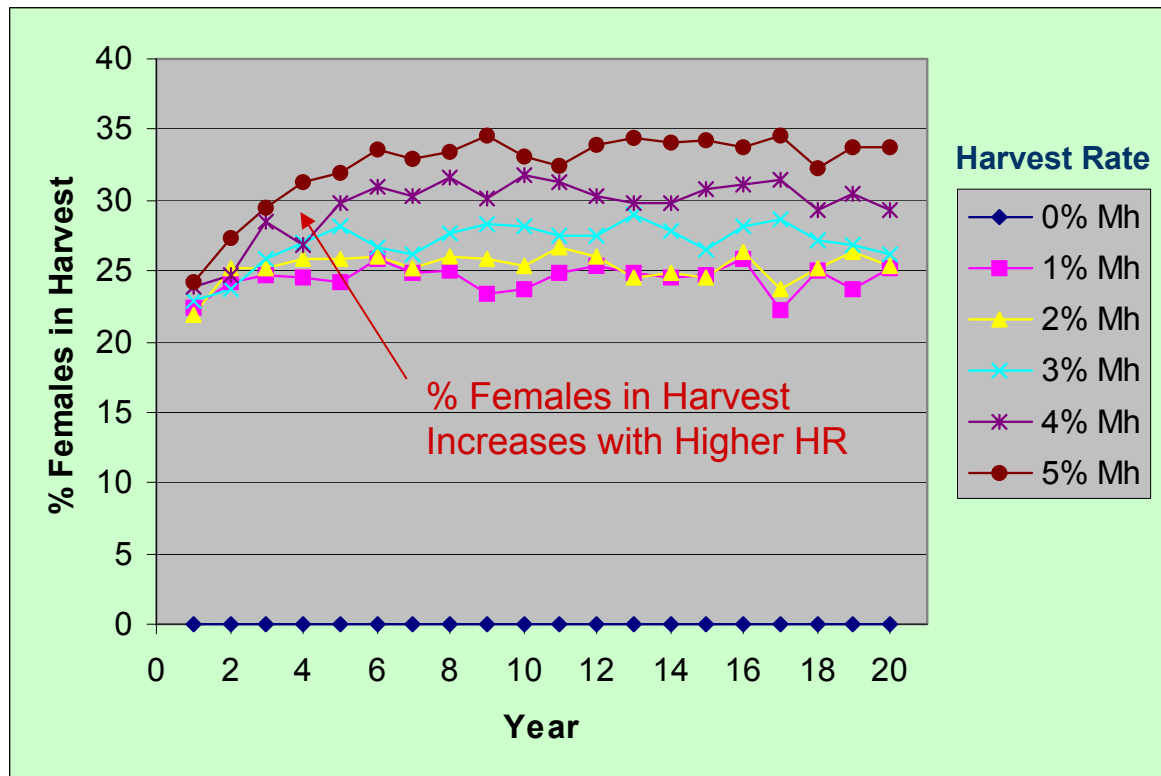
$N_{init} = 50$ ,  $SE = 12.5$ ,  $\lambda = 1.032$



HR = 1 to 2% has acceptable risk, if surveys conducted every 4 yrs

# Effect of Harvest Rate on % HarvFemls

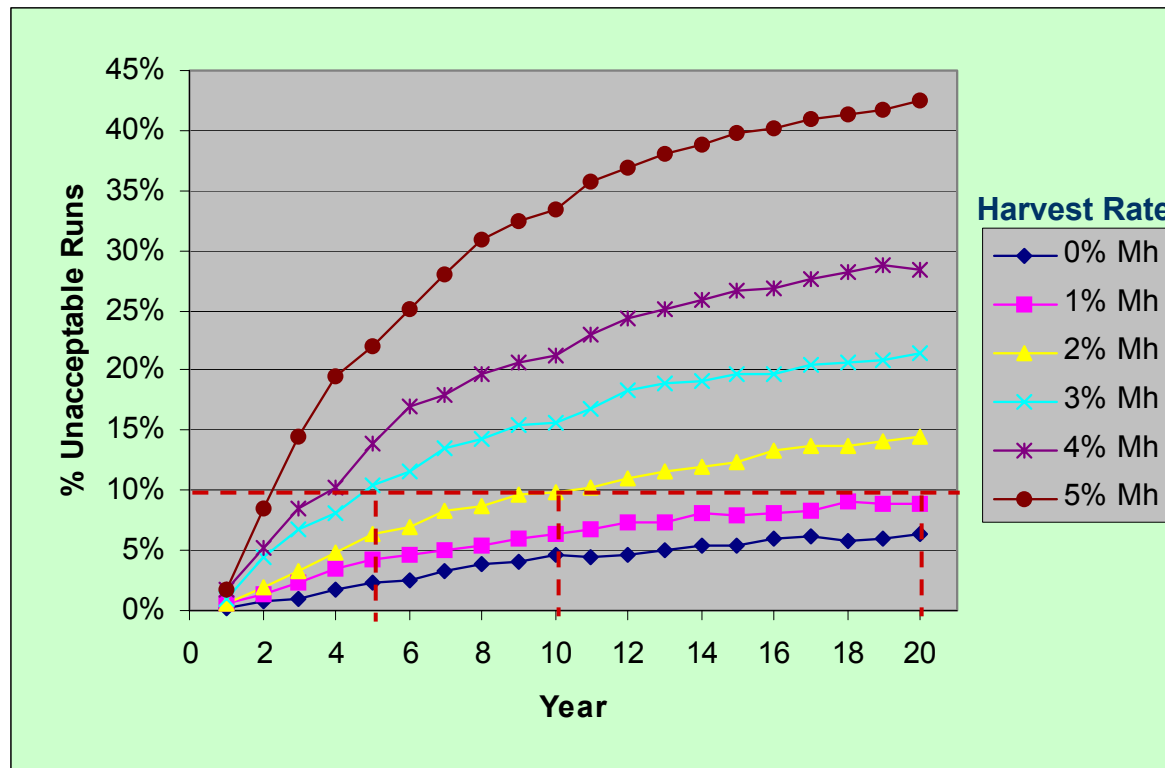
$N_{init} = 50$ ,  $SE = 12.5$ ,  $\lambda = 1.032$



With HR = 2%, about 25% of harvest is comprised of females

# Effect of Harvest Rate on Herd Viability

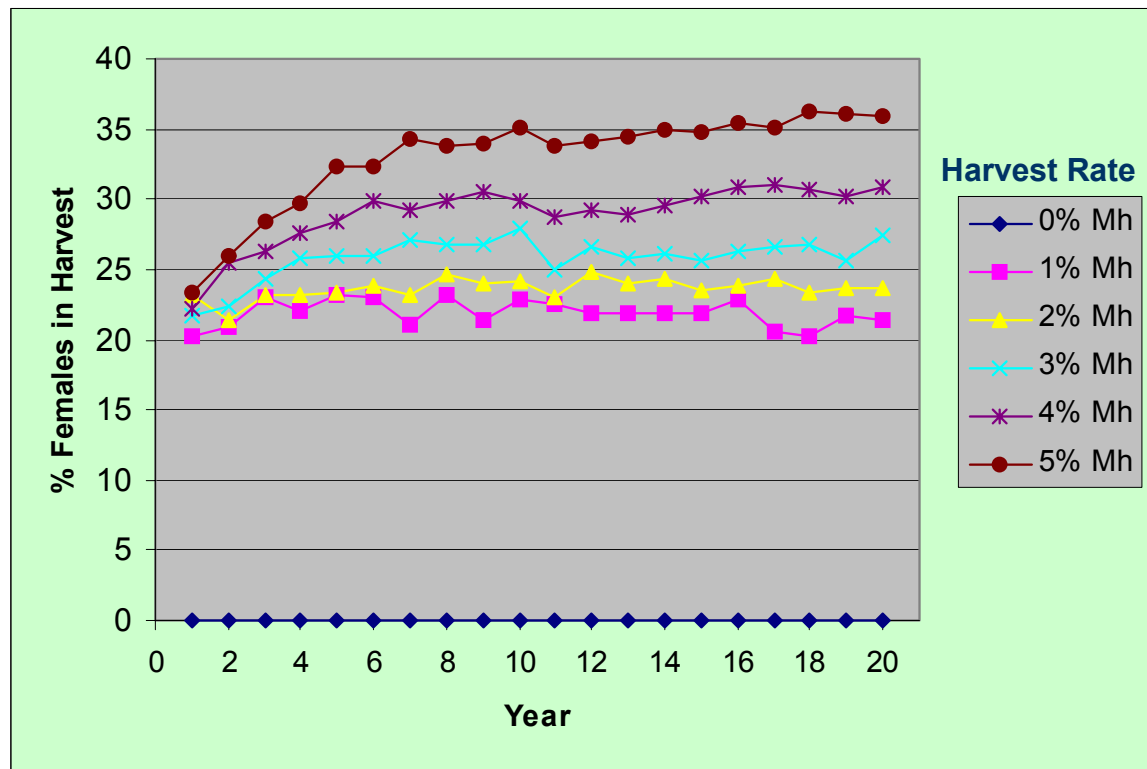
$N_{init} = 100$ ,  $SE = 25$ ,  $\lambda = 1.032$



HR = 3% has acceptable risk if surveys conducted every 5 yrs,  
2% if conducted every 10 yrs, 1% if conducted every 20 yrs.

# Effect of Harvest Rate on %HarvFemls

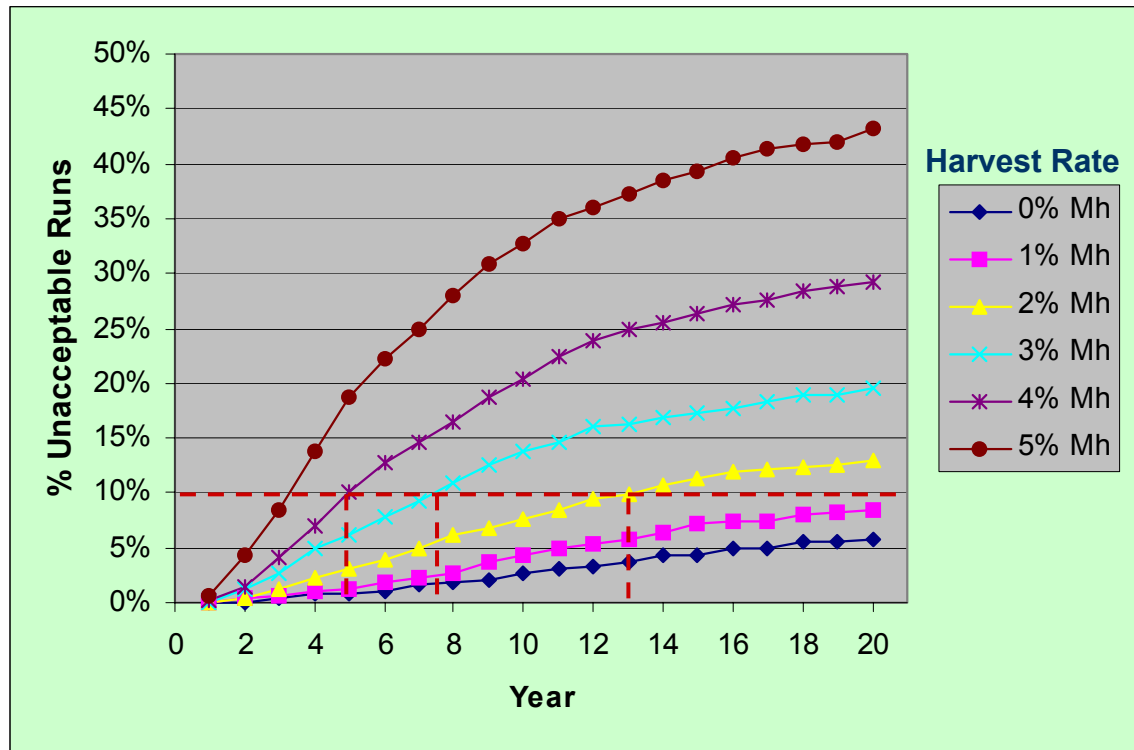
Ninit = 100, SE = 25,  $\lambda = 1.032$



With HR = 3%, about 25 - 30% of harvest is comprised of females

# Effect of Harvest Rate on Herd Viability

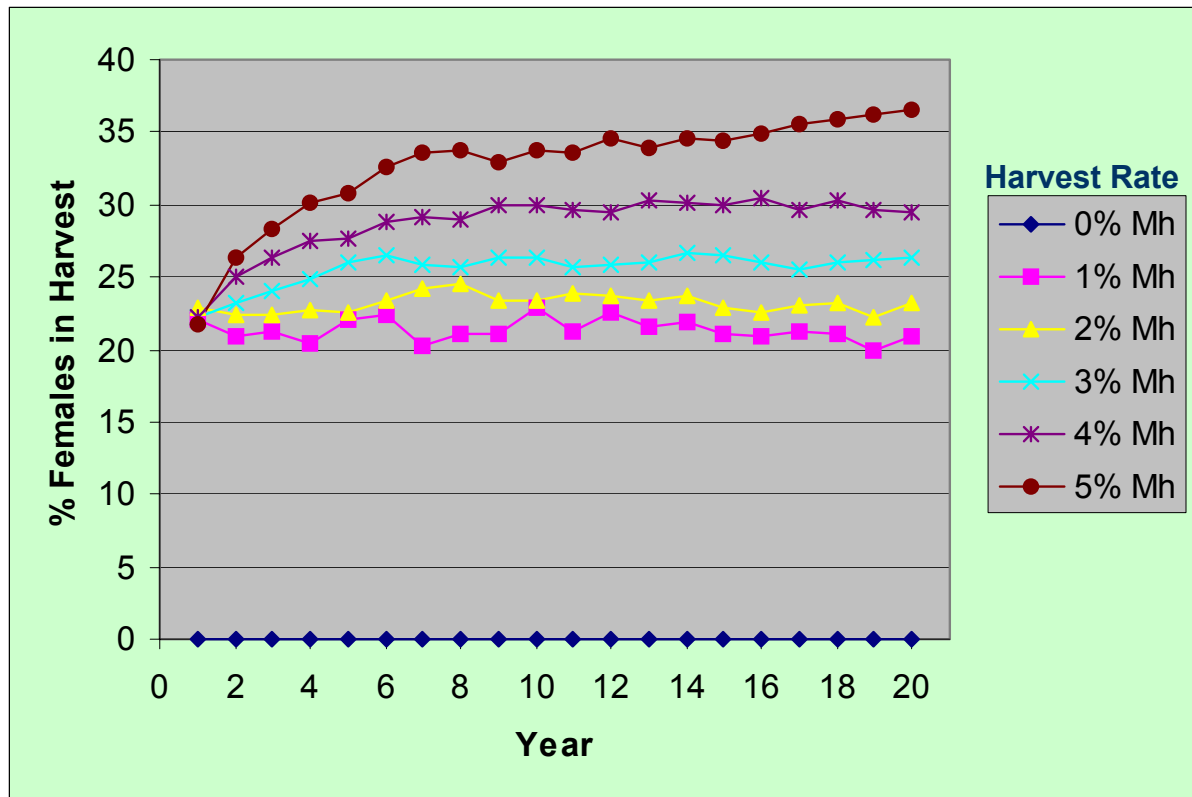
$N_{init} = 200$ ,  $SE = 50$ ,  $\lambda = 1.032$



HR = 4% has acceptable risk if surveys conducted every 5 yrs,  
3% if conducted every 7-8 yrs and 2% if conducted every 13 yrs.

# Effect of Harvest Rate on % HarvFemls

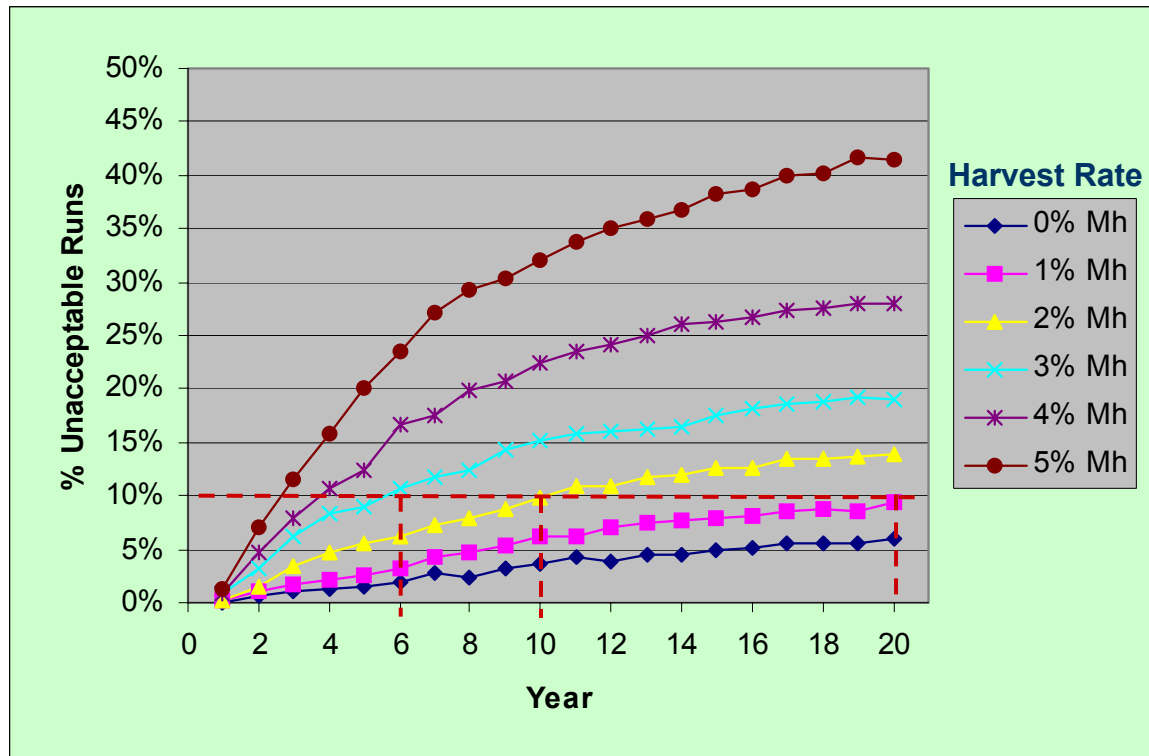
Ninit = 200, SE = 50,  $\lambda = 1.032$



With HR = 4%, about 30% of harvest is comprised of females

# Effect of Survey Error on Harvest Rate

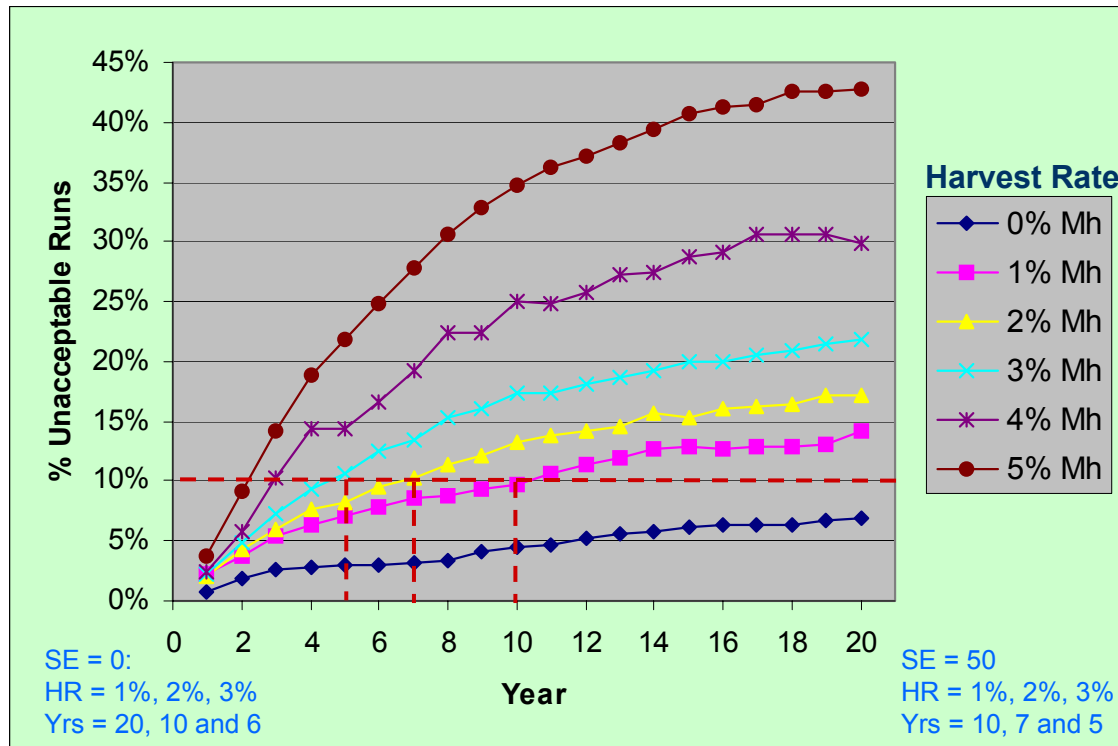
$N_{init} = 100$ ,  $SE = 0$ ,  $\lambda = 1.032$



Increasing survey precision (CV = 25% to 0%) has small effect on risk, due to stochastic effects on recruitment and survival rates.

# Effect of Survey Error on Harvest Rate

$N_{init} = 100$ ,  $SE = 50$ ,  $\lambda = 1.032$



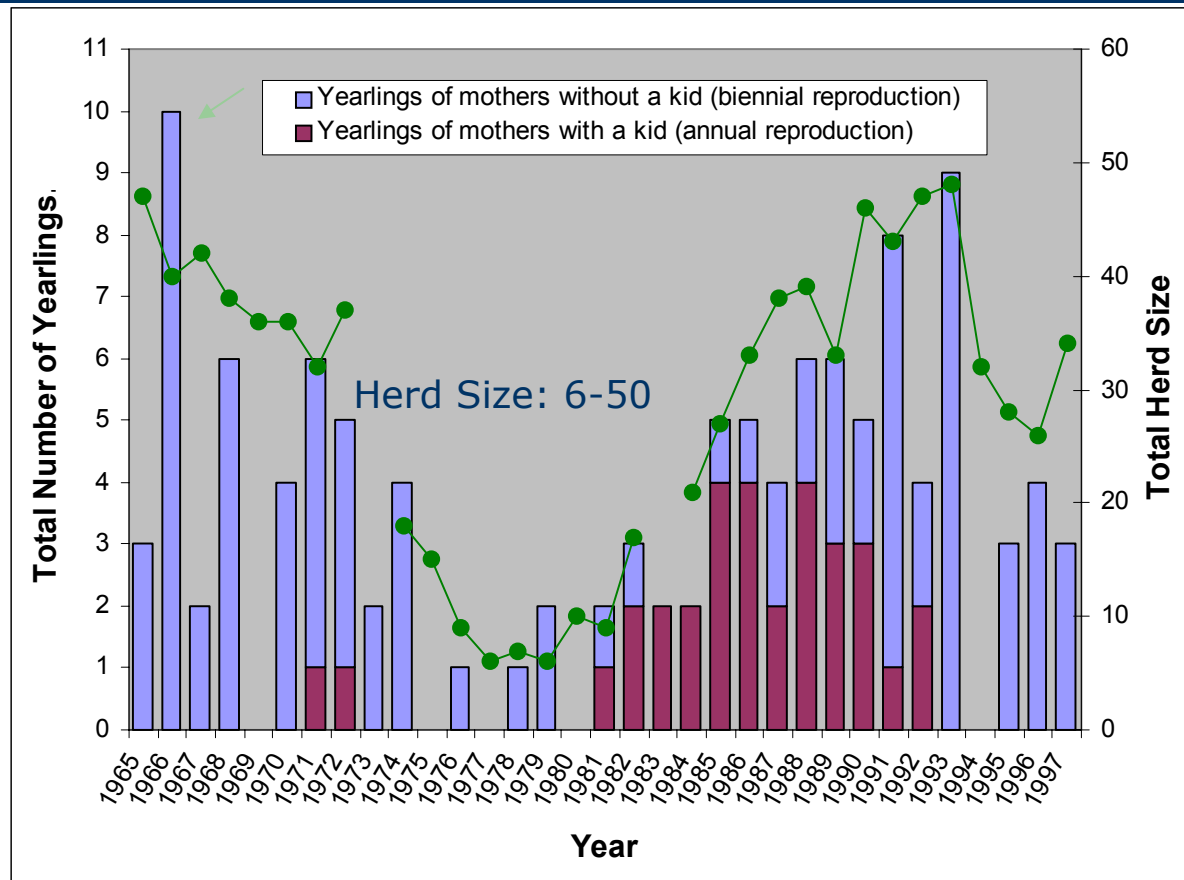
Herd estimates with poor ( $CV = 50\%$ ) precision, however, require more frequent surveys, because of error in estimating the AAH from initial survey.

# Recommendations for Sustainable Harvests of Mountain Goats in BC

- There is no single correct harvest rate to apply to Mountain Goat populations. Because information is uncertain, each harvest level poses a different level of risk to the population.
- *Maximum Acceptable Harvest Rates\** and % Females in Harvest
  - < 50 goats, HR = 0%, i.e. no sustainable harvest
  - $\geq 50$  to < 100 goats, HR = 2%, % HarvFemls  $\leq 25\%$
  - $\geq 100$  to < 200 goats, HR = 3%, % HarvFemls = 25 – 30%
  - $\geq 200$  goats, HR = 4%, % HarvFemls =  $\leq 30\%$
- Where possible, apply demographic model to individual herds to determine max. harvest rate based on herd-specific recruitment rates, SV's (SSDB), and pop estimates (survey SE, frequency).

*\* Applies to surveys conducted every 5 yrs.*

# 30 year Mtn Goat Study in BC



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