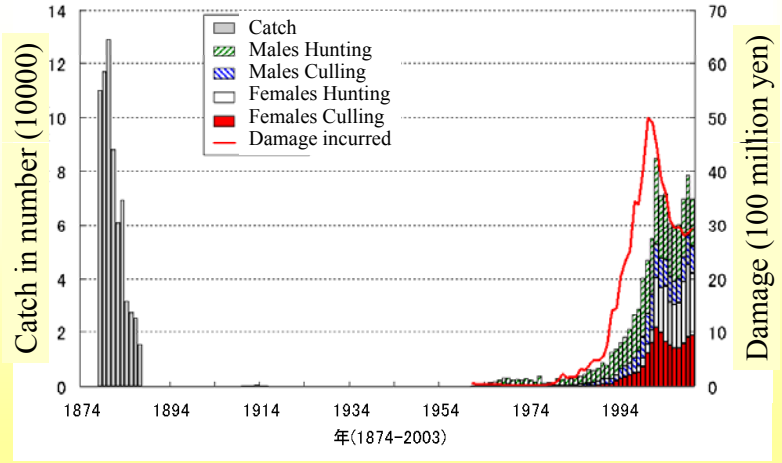
sika deer: history of overexploitation and ban-on-hunting



Damage by sika deer (釧路支庁web site)

http://www.marimo.or.jp/Kushiro_shichou/ezosika/cover.html

2

http://risk.kan.ynu.ac.jp/matsuda/2004/CMPSDEH98.pdf

Aims of deer management

to promote coexistence between sika deer as a common natural resource and humans... stable deer population is maintained, avoiding the extinction of sika deer as well as minimising the conflicts between human activities and sika deer.

3

http://risk.kan.ynu.ac.jp/matsuda/2004/CMPSDEH98.pdf

Conservation and Management Plan for Sika Deer (*Cervus nippon*) in Hokkaido **1997/Dec/1**

the "Feedback management" is used to maintain stable deer population not to be extinction and to keep moderate sustained yield in the eastern district.

if heavy snow occurs for 2 years running, the least population of 1000 deer is kept under this management standard.

4

Stage-Structured Model

$$\begin{pmatrix} N_c(t+1) \\ N_f(t+1) \\ N_m(t+1) \end{pmatrix} = \begin{pmatrix} 0 & 2r(t)L_{ff}(t) & 0 \\ L_{fc}(t)/2 & L_{ff}(t) & 0 \\ L_{mc}(t)/2 & 0 & L_{mm}(t) \end{pmatrix} \begin{pmatrix} N_c(t) \\ N_f(t) \\ N_m(t) \end{pmatrix}$$

$L_{fc}(t) = L_{mc}(t) = \exp[-Q(t)H_c(t)]\exp[-M_c(t)]\exp[-R_c(t+1)]$,

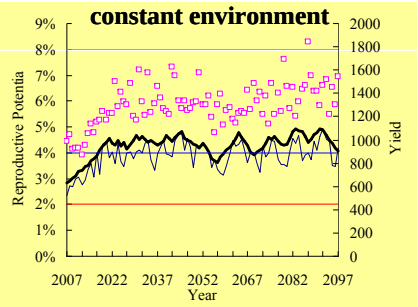
$L_{ff}(t) = \exp[-Q(t)H_f(t)]\exp[-M_f(t)]\exp[-R_f(t+1)]$,

$L_{mm}(t) = \exp[-Q(t)H_m(t)]\exp[-M_m(t)]\exp[-R_m(t+1)]$,

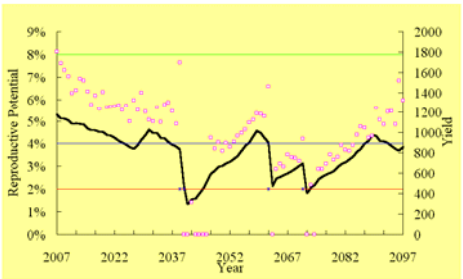
Deer Management Plan

Irruption Threshold (>50% of 1993 level)	Emergency Culling within 2 years
>Target level (25%)	Graduate Population Reduction (catch of females)
<Target level (25%)	Graduate Population Increase (catch of males)
Critical Threshold or a year after heavy snow,	Hunting Bans

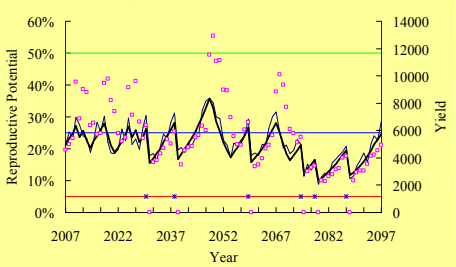
1) Know life history parameters and constant environment



2) if heavy snow comes, this management fails



We are ready for 10 fold fluctuation (5%-50%)



Population Indices

Catch (Sighting) per unit effort

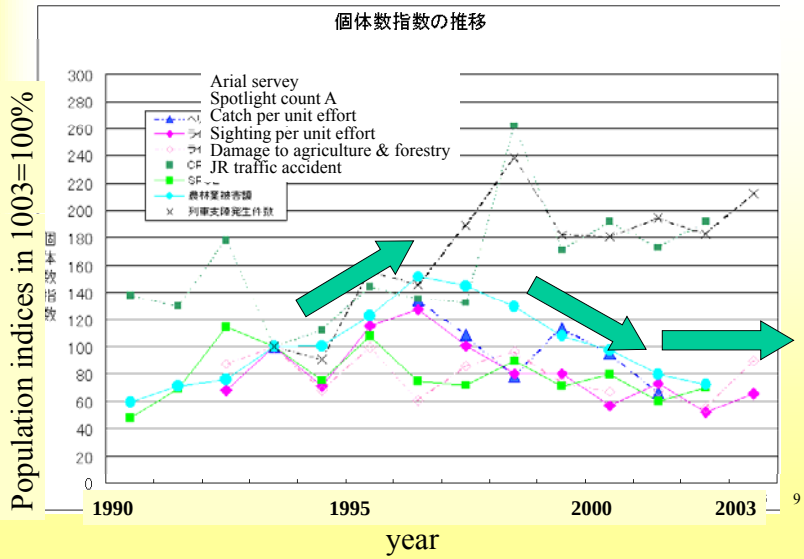
Spotlight (& helicopter) census

Train-deer accidents

Damage of agriculture & forest

uncertain in absolute population size

Trends in Population indices



Risk of deer management

Minimum Viable Populatoin = 1000

Minimum threshold for hunting P^- =5% MVP

Population usually fluctuate 2 fold. Heavy snow decreases half a year, 2 year heavy snow is possible: target level $P^*= 5\ P^-$

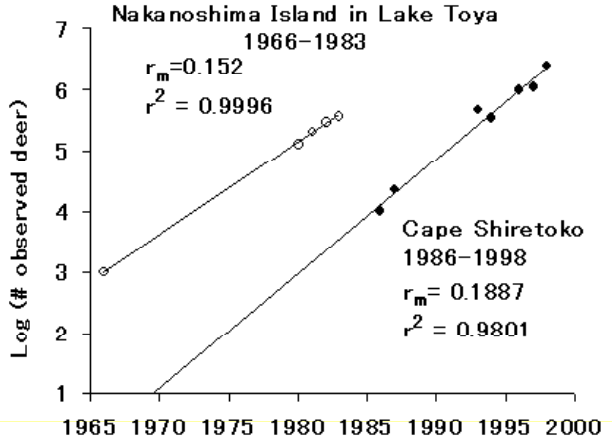
Irruption level $P^+ = 2P^*$

Absolute population = ca.160,000 in 1993

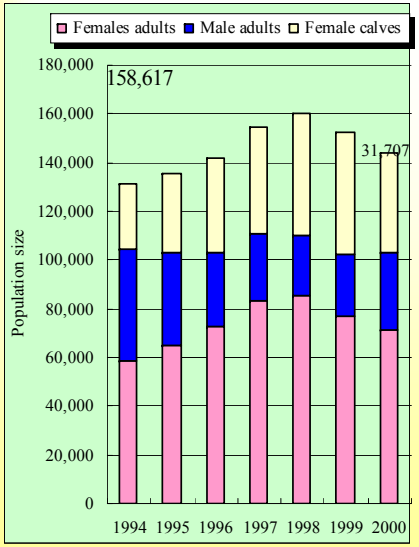
Take into account of uncertainty, we assume...

- Rate of natural population increase $\lambda = 15\% \sim 20\%$
- Survival % of immature $L_{fc} = 46\% \sim 54\%$
- Survival % of female $L_{ff} = 90\% \sim 99\%$
- Reproduction rate $2rL_{ff} = 2\lambda(\lambda - L_{ff})/ L_{fc}$
- Annual variation < 10% in each parameter
- Measurement error in population index < 20%

Deer increases by 15-20%/yr



Males disappeared in simulations!!



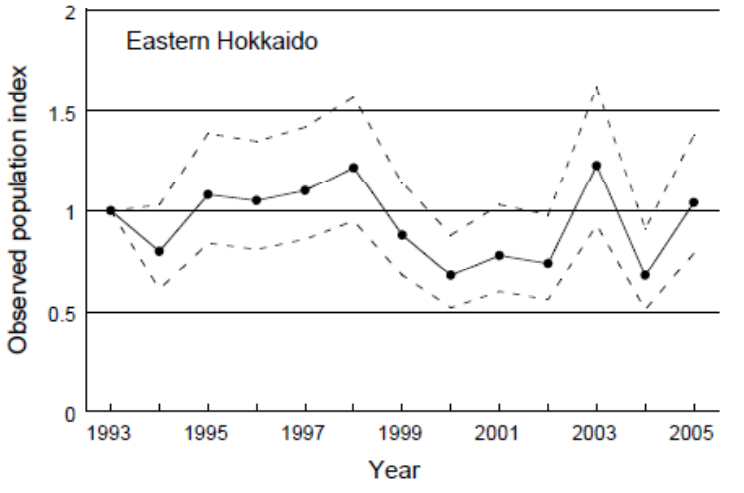
120,000 deer are not enough!

- 80-160,000×15%/yr＝12-24,000 deer increase every year
- Male adults must be 20-40,000 in 1993
- >20,000 male deer were caught for >5 years
- If all these are true, males must disappear

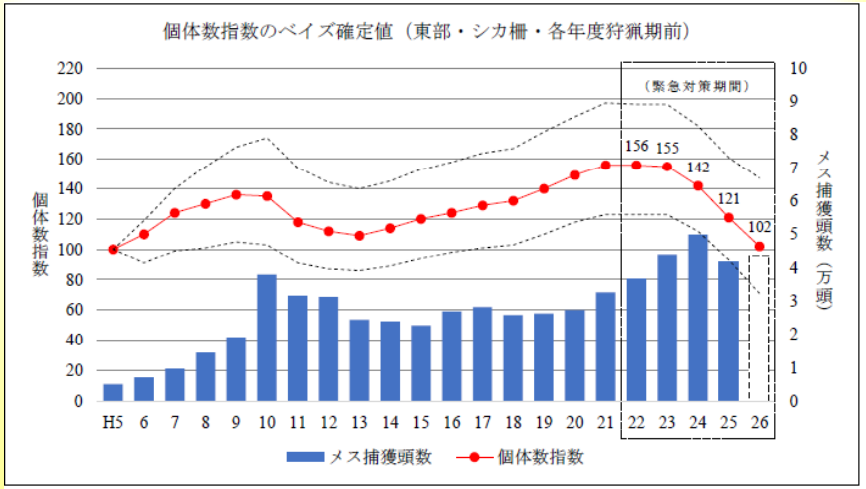
Revision of deer management plan (Hokkaido Gov. 2000)

- **If deer population in FY1993 was 120,000, 180,000 deer, 15% of population, were caught since 1994, the population must decrease, ..., we must conclude underestimation...**
- **Unusual accountability in Japan**
- **Matsuda et al. (2002) revised the absolute population size.**

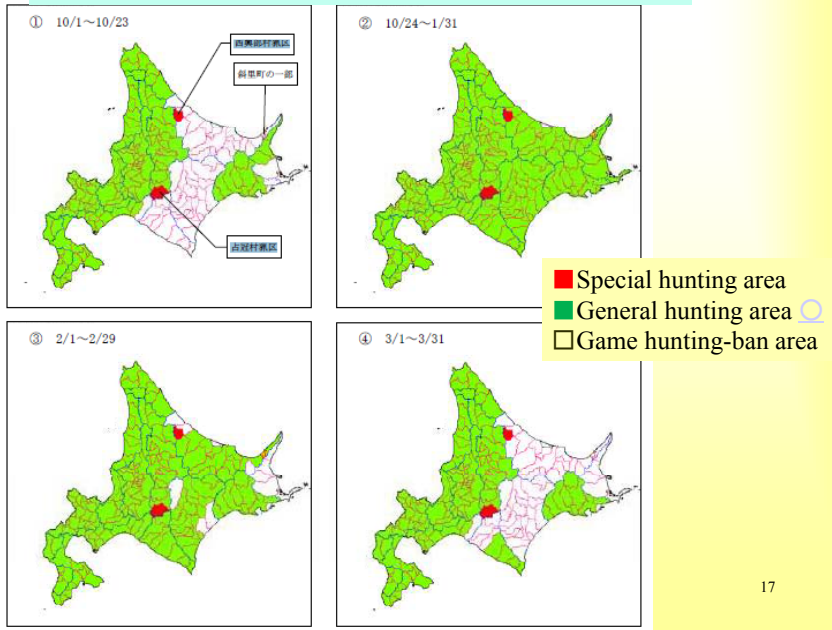
Maximum likelihood of population index (Yamamura et al. 2008, Pop Ecol)



State-space model by Bayesian estimation



Seasonal hunting area by municipality



Trends in deer population estimated by Bayesian estimation