Harvesting theory: relevance to non-detriment findings

Non-detriment Finding Workshop, Mexico
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Terms of reference

Workshop organizing committee request:

- background on general harvesting theory
- including both plant and animal aspects

Given practical consideration that most harvests not subject to monitoring:

- talk focuses both on theory and basic needs
- not for experts in harvesting theory and those with masses of data, able to construct complex models
- background (sorry!): animals>plants

Background

NDF pivotal to achieving aims of CITES :

- overall success of CITES depends on ensuring species not transferred from Appendix II to I
- requires effective NDFs to ensure species not uplifted from position where international commercial trade effectively regulated to one where banned (Wijnstekers 2003)
- key for Scientific Authorities to understand theory and basic needs for making NDF's (Resolution Conf 10.3)

Use that is sustainable

Convention on Biological Diversity: Article 2

- "Use *in a way* and *at a rate* that does not lead to long-term decline of biodiversity, thereby maintaining its potential to meet needs and aspirations of future generations"

- focus of sustainable use movement on configurations of social and economic factors that impinge on biological sustainability

- theory for this talk mainly focuses on biological factors underpinning extractive use

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Aims of talk

To consider

- approaches to harvesting
- simple harvesting models
- defining over-use for well monitored species
- basic data needs for poorly monitored species, and
- establishing adaptive framework to make NDFs

Approaches to harvesting

Routes to sustainable use

Two main approaches to harvesting:

- individual remains in wild population; and,
- individual is removed from wild population

Important distinction:

- each approach underlain by different theoretical and practical implications

Harvest without removing

Eider down

Brazil nuts

Vicuna wool

Multi-stemmed palm hearts

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Harvest without removing

Little theory involved:

- rotation times between harvests
- generally, highest sustainable productivity when populations AT maximum carrying capacity
- possible impacts to population, eg, capture or disturbance of animals, or loss of reproductive potential in plants
- political decision when to harvest
- for animals, relatively easy NDF

Non-removal grading into removal

Functionally, harvest by non-removal can grade into harvest by removal with:

- excessive removal of plant parts, eg roots, bark or leaves, eg ginseng, *Prunus*
- excessive disturbance in nesting or breeding season, eg swiftlet nests,
- such that harvested plant or animal dies or cannot breed
- making NDFs harder

Harvest by removing

Whaling

Mahogony

Finches

Functionally, live capture/collection = killing

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Harvest by removing

Strong theoretical basis

- generally, highest sustainable productivity when populations BELOW carrying capacity
- biologically optimal harvesting strategy to lower density and remove at rate of maximum rebound
- such harvesting ALWAYS reduces density
- initial decline does NOT mean that population over-utilised

Simple harvesting models

Key parameter = R_m

r-selected, fast

0.6

0.06

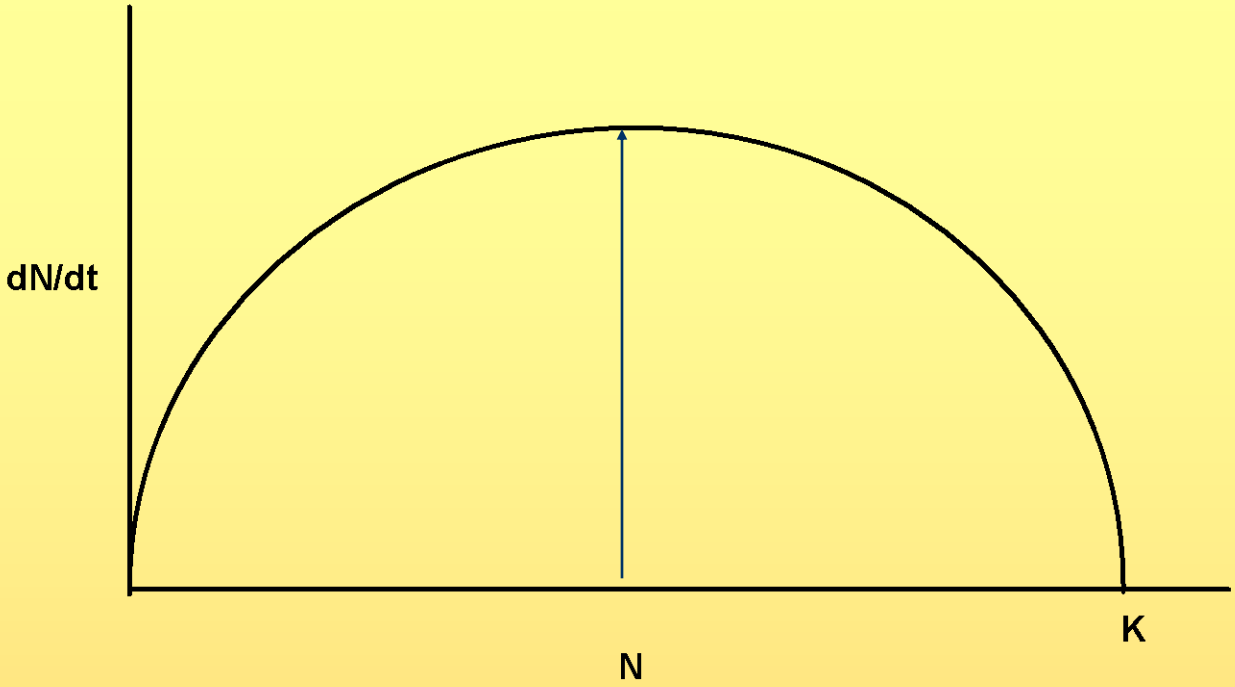
K-selected, slow

Different life-history

r-selected, fast

K-selected, slow

Maximum sustained yield



- *SY* zero when *N* zero
- *SY* also zero when *N* at K
- any offtake from population of size *K* will decrease population size
- between *N* = 0 and *N* = *K*, *SY* first rises and then falls
- *MSY* is taken from population size of *N* = 0.5*K*

How is MSY less usually calculated?

MSY can be calculated directly from population's r_m and size *K* in absence of harvesting, combined with various other attributes of species and its environment

Requires data……!!!

Produces fixed yield

Biological shortcomings of MSY?

Setting MSY as fixed quota intrinsically unstable, for two main reasons:

- conceptual problems with parameter: same SY for different levels of harvesting effort
- populations fluctuate in size: MSY must be modified accordingly

Unified harvest model sets MSY at:

- 80-90% of *K* for large bodied species
- 60-70% of *K* for medium bodied species

Setting yield as harvesting effort?

Setting MSY in terms of harvesting effort more self-correcting

- within limits, given harvesting effort takes same proportion of population whether at high or low density

Safeguards needed for harvesting species:

- whose numbers fluctuate annually
- whose size not monitored regularly

Saiga antelope

Ground orchids

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Methods of regulating a harvest

Harvest constant number

Administrators prefer harvest of relatively fixed yield, but less biologically robust

Harvest with constant effort

More biologically robust but harder to administer as quotas can change each year

Harvest constant proportion of population

Same underlying theoretical basis of self-correction, but only possible with well-monitored populations

Avoiding genetic effects

- Lions with blackest noses

- Rams with biggest curl

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Switch to more sustainable part of life cycle

- Crocodile ranching

- Ginseng seed and propogation

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Detecting overuse

Caughley's (1992) definitions

Over-use occurs when:

- N harvested each year exceeds MSY of species
- % harvested each year exceeds R_m of the species
- harvesting reduces species to level where vulnerable to other threats

How to detect overuse?

- if population <50% of unharvested density and continuing to decline, presumption of over-utilisation justifiable

- sometimes offtake estimated reasonably accurately, while population size poorly known within very wide limits. Nonetheless, sheer magnitude of offtake such that confident above MSY for any plausible population size,

eg African elephant numbers vs. volumes of ivory entering trade in 1980s

- sometimes enough known about size and dynamics of population to infer offtake is above MSY

Data poor harvests

Problems still remain if no estimates of population size and life history to set against offtake rates, eg

- how harvests of 100,000's snakes per annum from rattlesnake drive relate to snake population?
- how export of 1000's finches per year for live bird trade relate to finch population?

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Data poor harvests

How is MSY usually calculated?

MSY seldom estimated directly, due to lack of data on many harvested populations

- set annual yield set **well below** possible MSY (as with unified harvest model)
- monitor population to confirm behaving as predicted
- later fine-tune yield to probe **closer to** MSY
- *adaptive management* approach to estimating MSY
- much to recommend it

Establish monitoring programmes

Enough and increasingly complex models, but other key challenges remain:

- relatively few harvests monitored or adaptively managed, whether locally or internationally?
- insufficient political process on best ways to regulate harvests?
- less focus on approaches that do not remove individuals?

First steps for monitoring

- review basic biology: large vs. small size, specialist vs generalist
- assess geographic distribution: endemic & localised vs. widespread
- determine % of range effectively protected: availability of protected source areas for harvested sink areas
- assess other forms of harvesting than international trade: whether illegal & uncontrolled vs long standing & well-regulated
- surveys of representative areas to determine upper and lower bounds of population
- determine conservative harvests and apportion to different uses, eg international trade vs local use

Value of secondary and local data

Secondary data

- WCMC Protected area databases
- IUCN Red List of threatened species
- FAO Forest and Fish Assessments
- CITES trade databases

Local data

- site-based academic research
- government data
- interviews with traders, hunters, collectors

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Monitor harvests and quotas

Allocate harvest between resource users

- assess extent of illegal use
- assess post capture/collection mortality
- sample harvest for age and sex structure
- measure body size and collect samples to determine age structure
- assess by-catch

Conclusions

Wide gap between theory and practice:

- harvesting theory useful starting point for better monitored harvests
- adopt precautionary harvest limits, and use increasingly robust indicators to increasingly monitor trends in abundance
- for many species in international trade, main requirement is practical monitoring system, to
- allow future harvest regulation through adaptive management

Thanks

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