Approaches to recovery modelling under the Species at Risk Act: interactions of allowable harm, critical habitat and recovery targets

Marten A. Koops and L. Antonio Vélez-Espino

Great Lakes Laboratory for Fisheries and Aquatic Sciences
Fisheries and Oceans Canada
Burlington, Ontario

Introduction to Species at Risk (SAR)

- Many countries have legislation to protect species at risk (or endangered species).
- Canada has the federal *Species at Risk Act* (SARA).
- SARA received Royal Assent in 2002.
- Intent of SARA (and other similar forms of legislation) is to preserve native biodiversity by protecting and restoring species identified as being at risk of extinction (or extirpation).

The SAR Process in Canada

1. Council on the Status of Endangered Wildlife in Canada (COSEWIC) assesses and recommends (to the Government of Canada) listing of species.

2. For aquatic species, the Fisheries Minister must make a decision. The following process is currently in place:
   - DFO Science sector conducts a recovery potential assessment (RPA);
   - DFO Policy sector conducts a socio-economic assessment;
   - Consultations are conducted;
   - Recommendation is provided to the Minister;
   - Minister makes a decision (list, don’t list, re-assess).

3. If listed, a Recovery Strategy must be prepared.

Key Features of SARA

- **recovery targets:**
  - abundance target: how many individuals in a population?
  - distribution target: how many populations?

- **critical habitat:** amount of habitat to support a recovered population

- **allowable harm:** harm to a population that will not jeopardize survival or recovery

- **threats:**
  - alternatives: how can humans act differently to not harm a SAR?
  - mitigations: how can human actions be modified to reduce harm to a SAR?

Science Advice for SARA

Objective is to provide science advice to inform:

- socio-economic analyses
- consultations
- Minister's listing decision
- permitting
- recovery strategies

Four main components to an RPA:

- population statuses
- habitat requirements
- threats
- population modelling

RPA Modelling

Components of the population modelling:

- scope for allowable harm
- recovery efforts
- long-term projections
- timeframes for recovery

Abundance recovery targets

Identifying Recovery Targets

Population-based approach to setting recovery target	Goal	Analytical method	Reference
Demographic sustainability	Self-sustaining population	PVA	Beissinger and McCullough 2002
Evolutionary potential	Maintain genetic diversity	Population genetics	Simberloff 1988
Ecological function	Interactions between ecosystem components	Community- and ecosystem-based research	Redford and Feisinger 2001
Social dynamics	Maintain social behaviors	Long-term demographic and behavioral research	Anthony and Blumstein 2000
Historical baseline	As many as in the past	Historical ecology research	Jackson 2001
Maximum	As many as possible	Carrying capacity	Caughley and Sinclair 1994
Status quo	Current population size	Monitoring of relative abundance	Tear et al. 1993

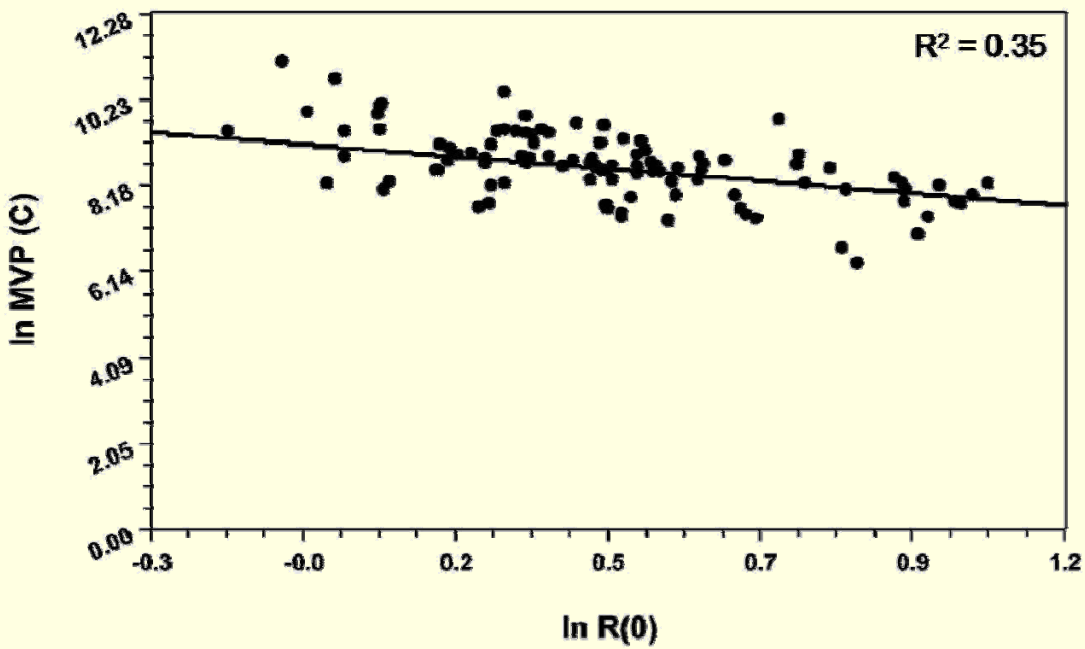
Abundance

Two approaches:

1.

Reed et al. (2003) meta-analysis of minimum viable population (MVP) size for vertebrates.

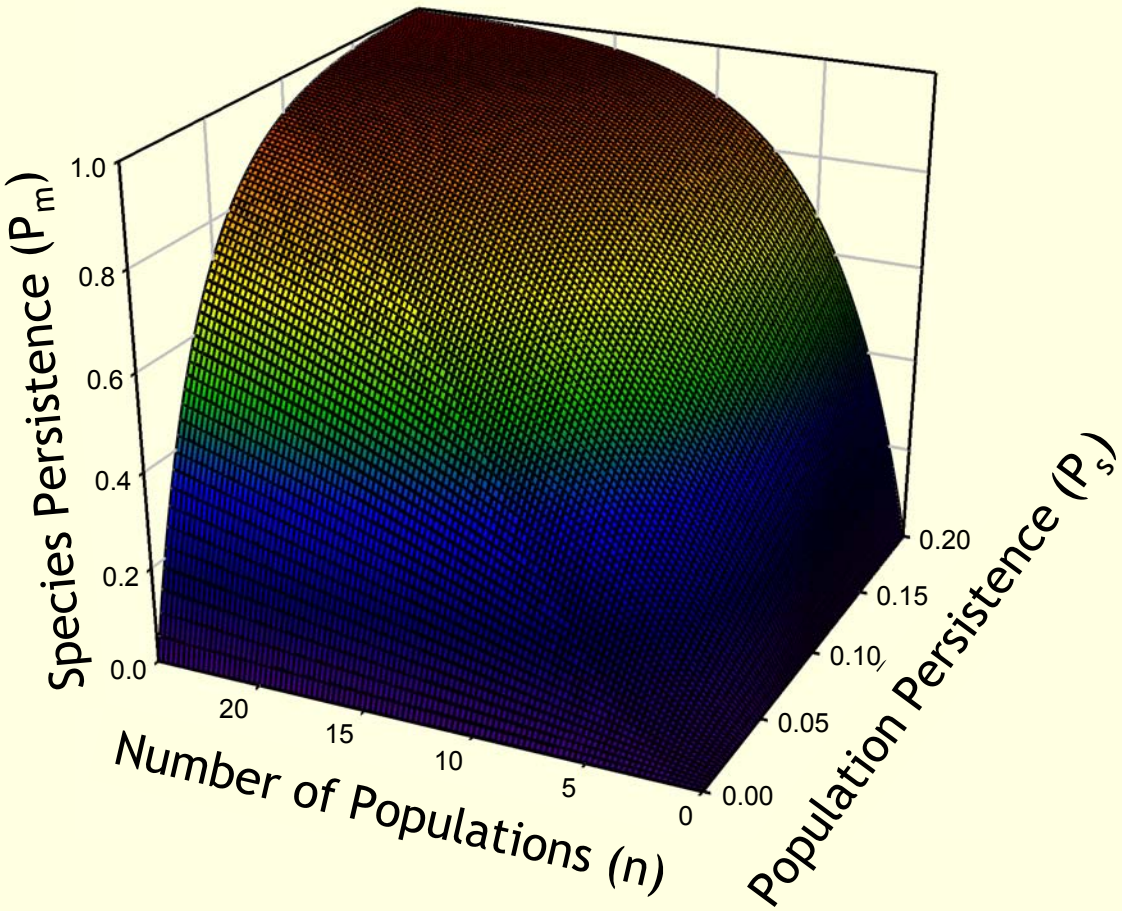
99% probability of persistence over 40 generations



2. Stochastic simulations of persistence and extinction.

99% probability of persistence over 250 years.

$$P_m = 1 - (1 - P_s)^n$$


Species Persistence (P_m)
1.0
0.8
0.6
0.4
0.2
0.0
20
15
10
5
0
Number of Populations (n)
0.00
0.05
0.10
0.15
0.20
Population Persistence (P_s)

WANTED!

RPA methodology that:

- does not *need* time series data
- assesses harm for all vital rates
- includes habitat
- provides guidance for data poor species
- handles complex life cycles
- follows a precautionary approach

RPA Modelling

Population Viability Analysis (PVA):

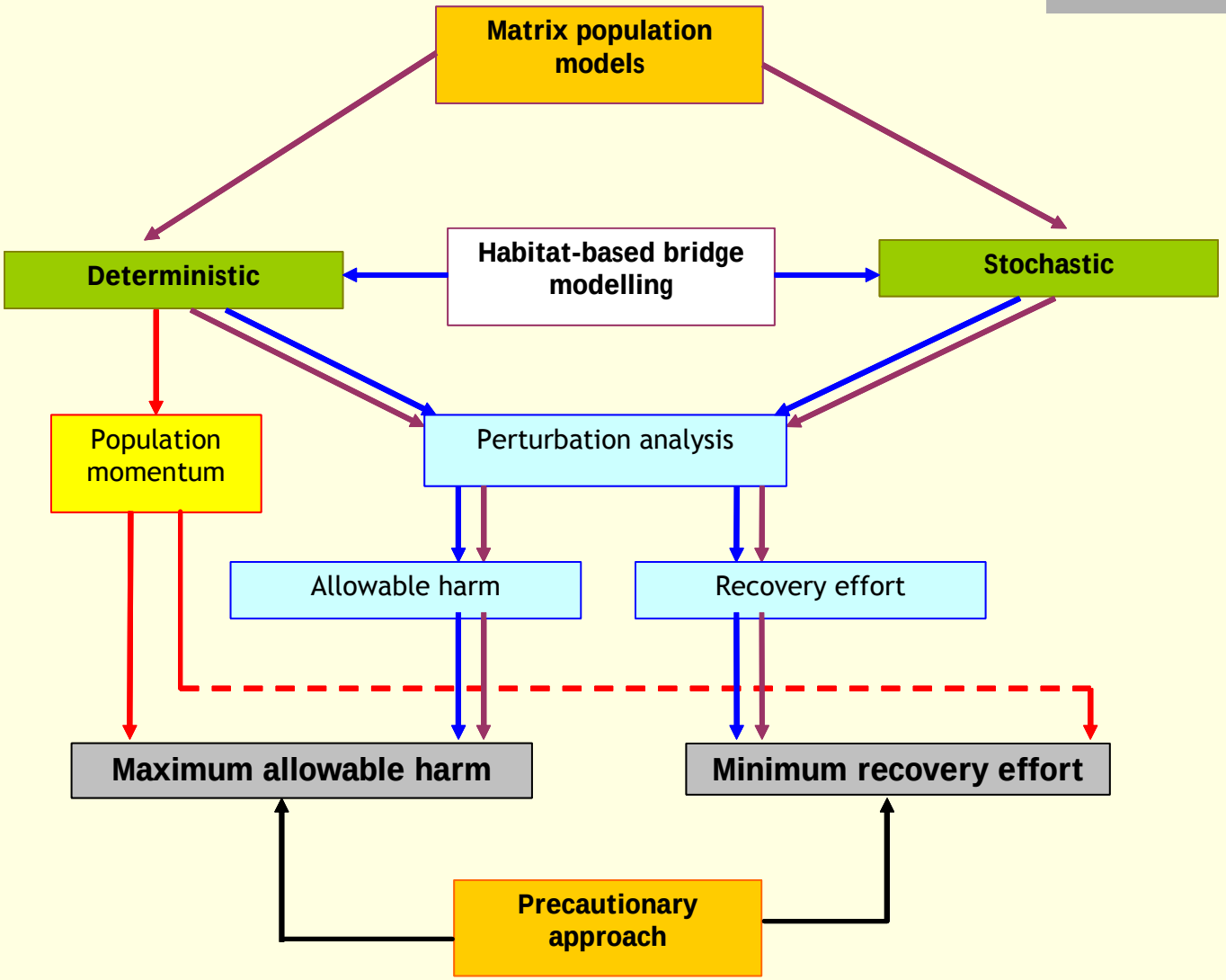
- stage-based
- life history based
- stochastic approach
- precautionary

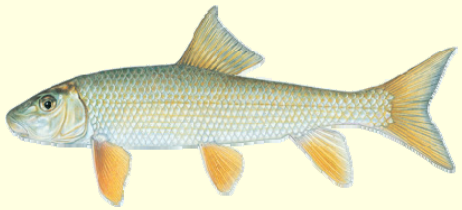
Data requirements

- **Age at maturity**
- **Length or weight at maturity**
- **Longevity or maximum reproductive age**
- **Number of eggs at age or length or weight**
- **Annual number of reproductive batches**
- **Spawning periodicity (annual, semi-annual, etc.)**
- **Survival rates per age or life cycle stage**
- **Adult sex ratio**
- **Length-age-weight relationships** (growth)
- Optional: time series

Variation in these traits

RPA Modelling

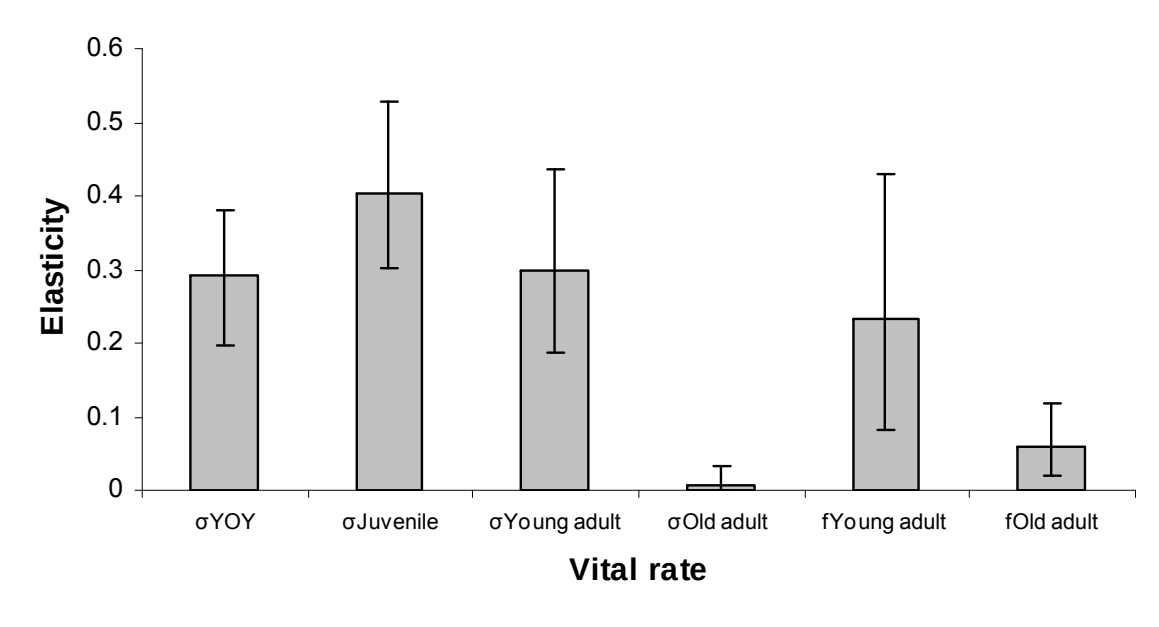


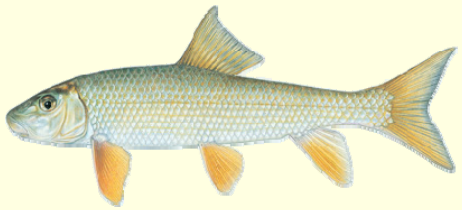


Allowable Harm

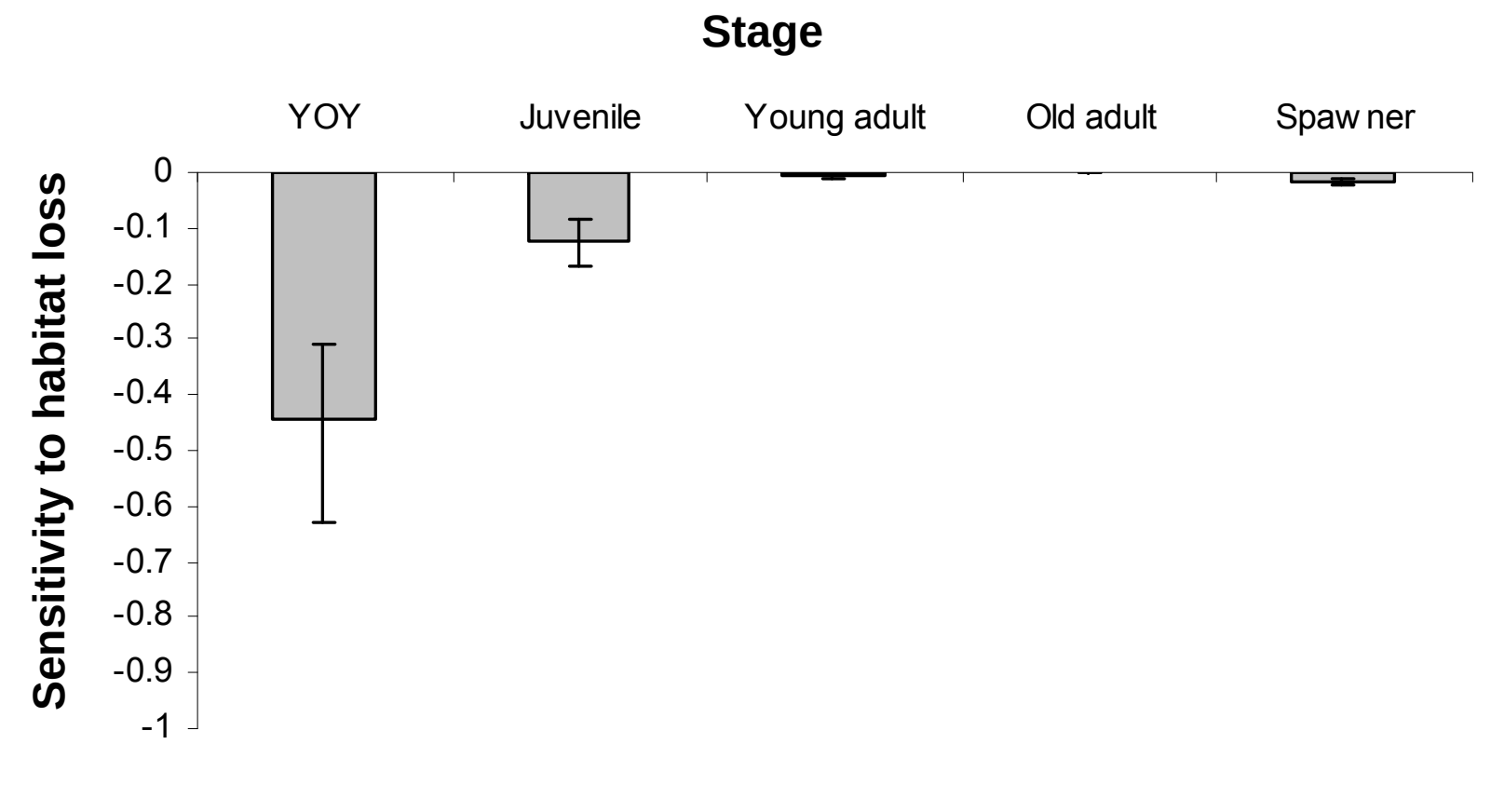
Human-induced harm is a negative perturbation that can target one or more vital rates and life stages.

Allowable Harm: $\tau_{\upsilon} \leq (1/\varepsilon_{\upsilon})\ [(1 - \Lambda) / \Lambda]$

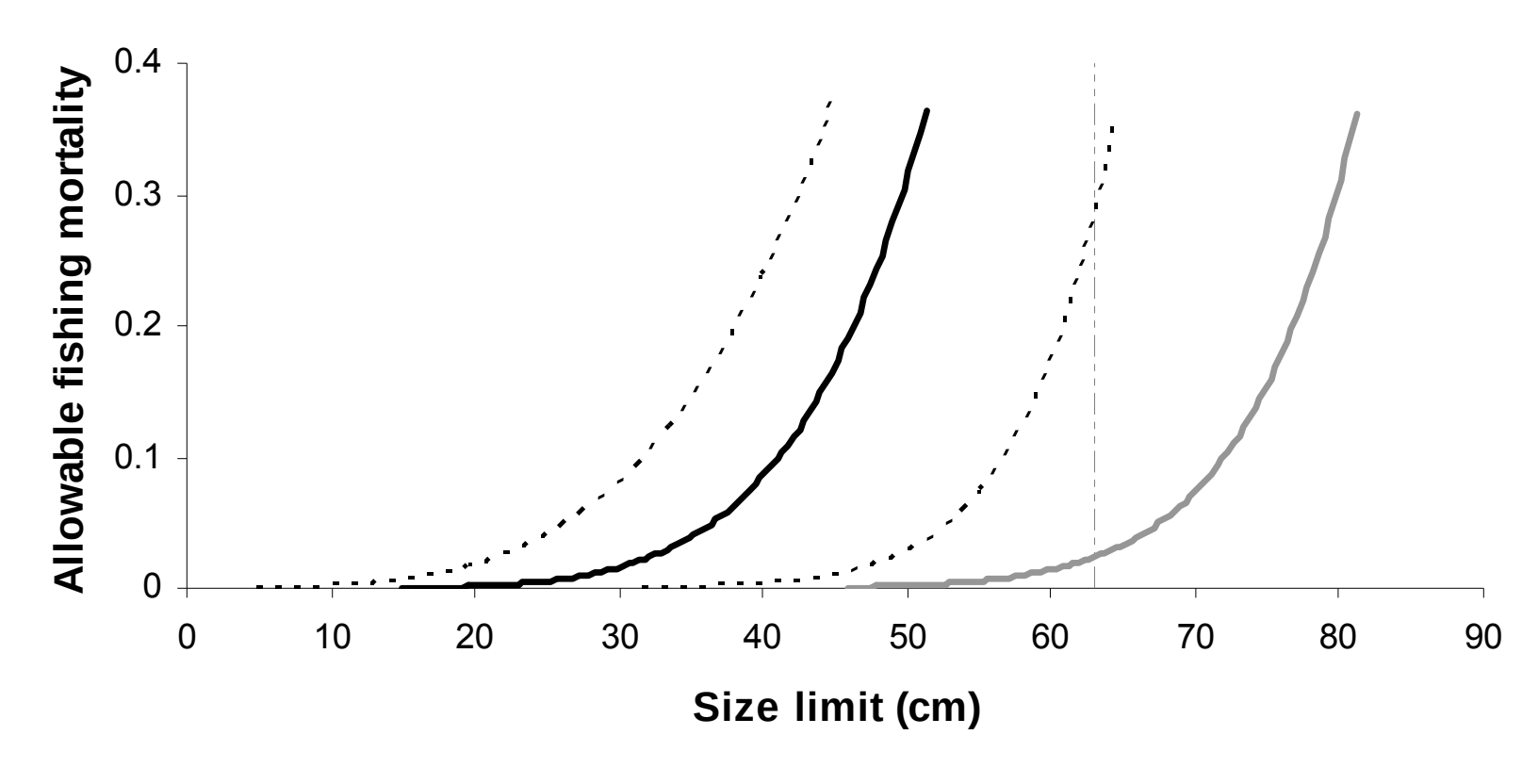




Habitat-loss equivalent elasticities



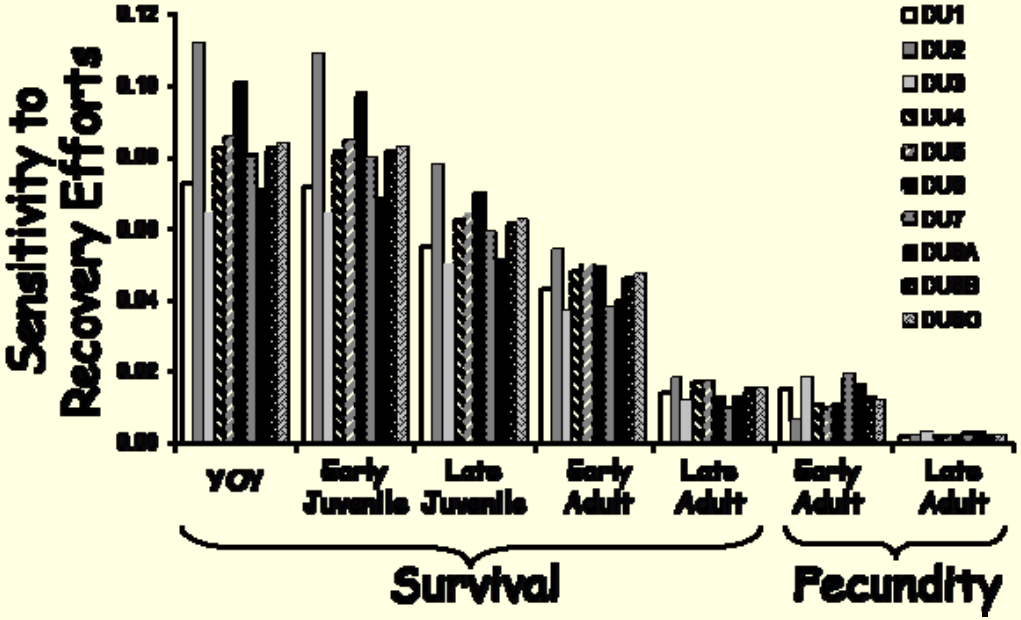
Allowable Harm



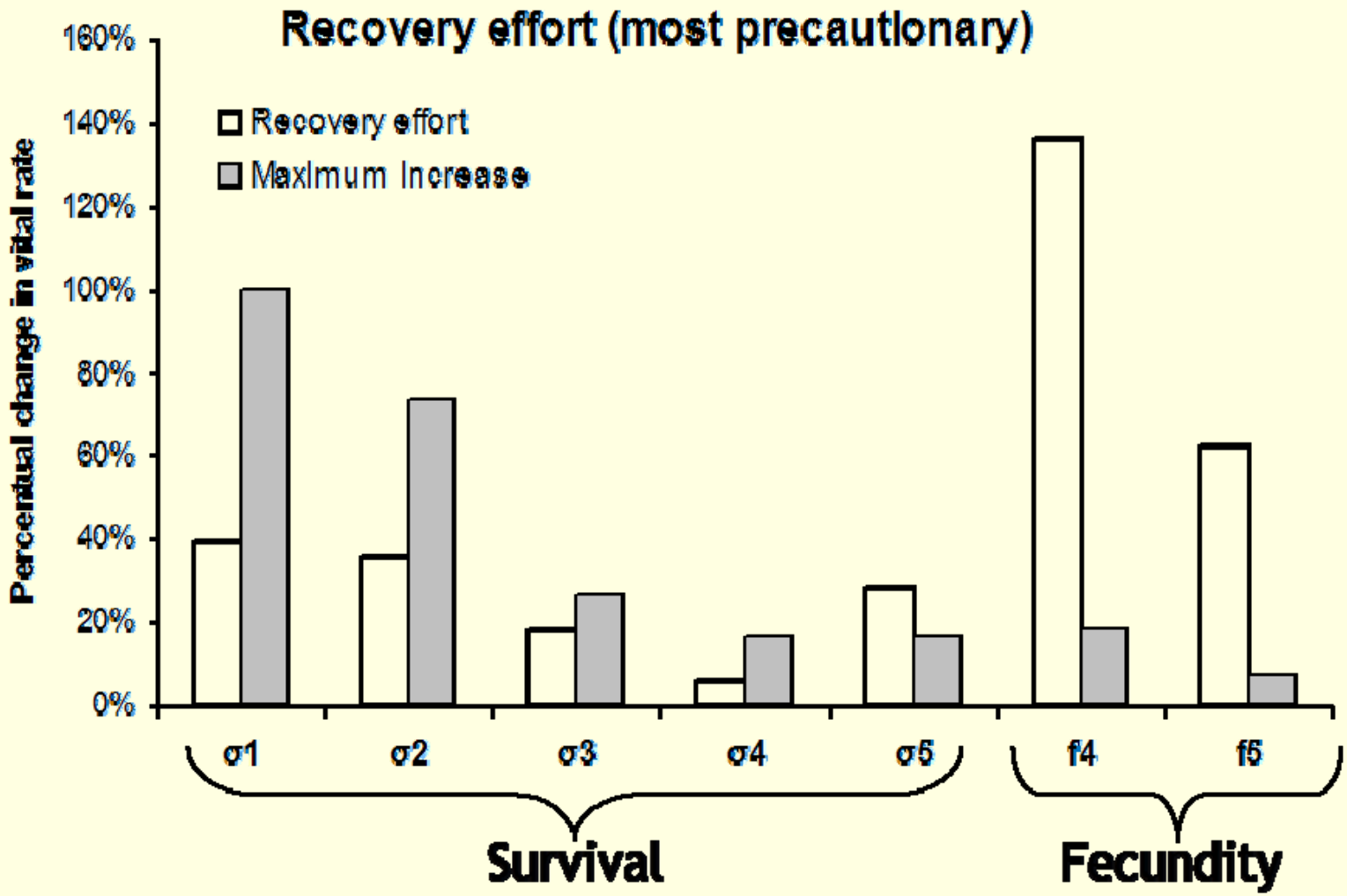
Recovery Efforts

A recovery effort is a positive perturbation that can target one or more vital rates and life stages.

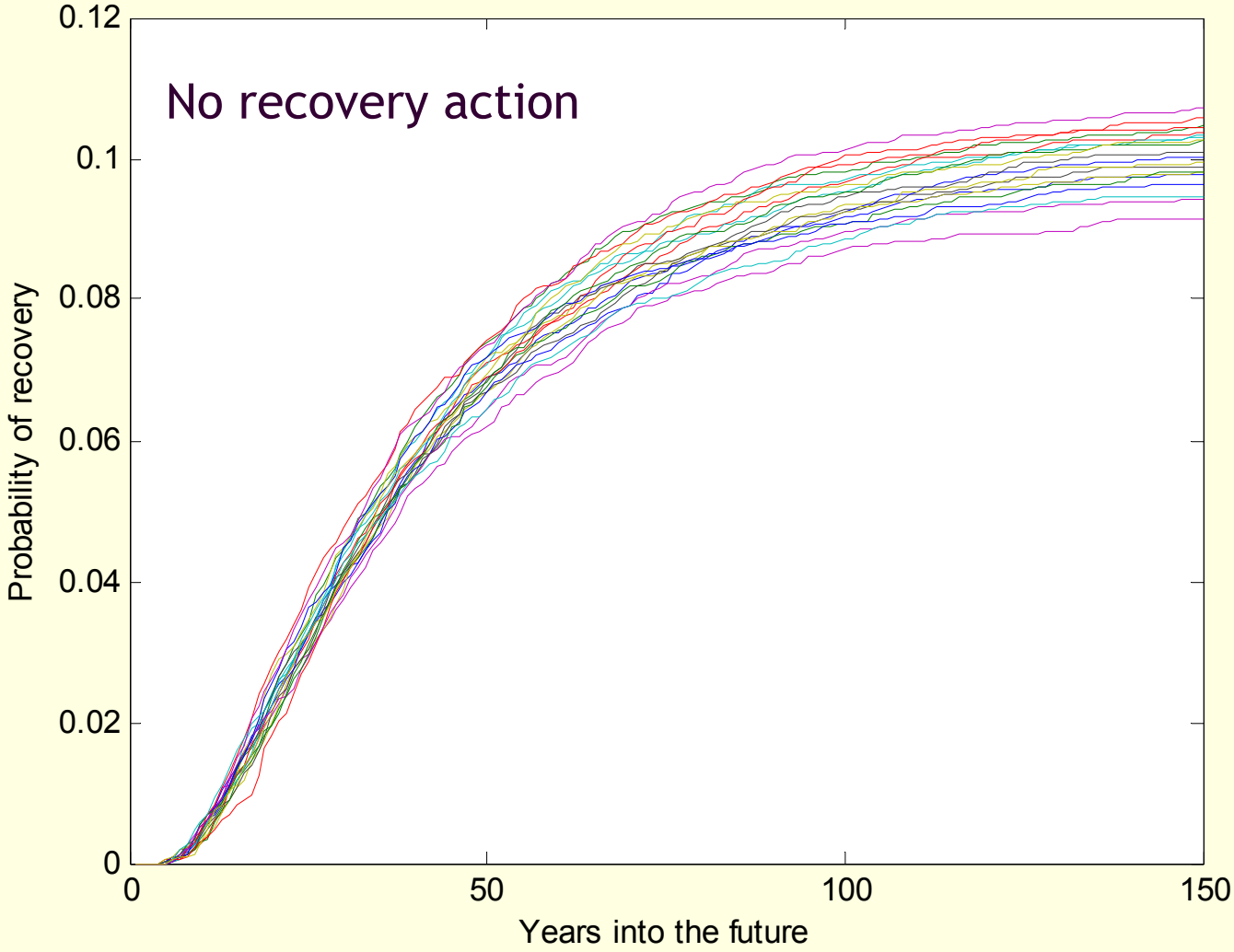
Recovery Effort: $\psi_{\upsilon} \geq (1/\varepsilon_{\upsilon})\ [(\lambda_{Target} - \Lambda)\ /\ \Lambda]$



Feasibility of Recovery



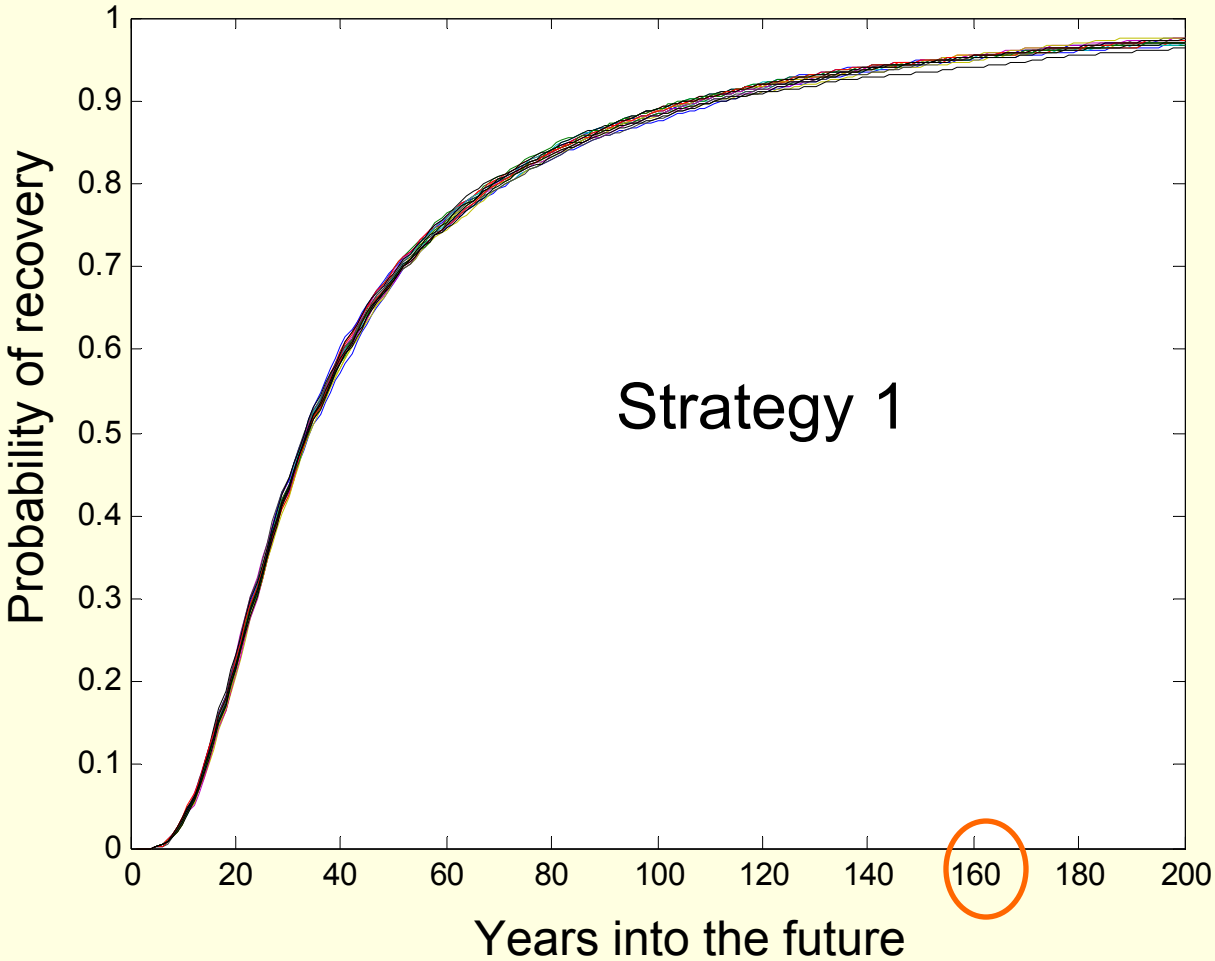
Long-Term Projections



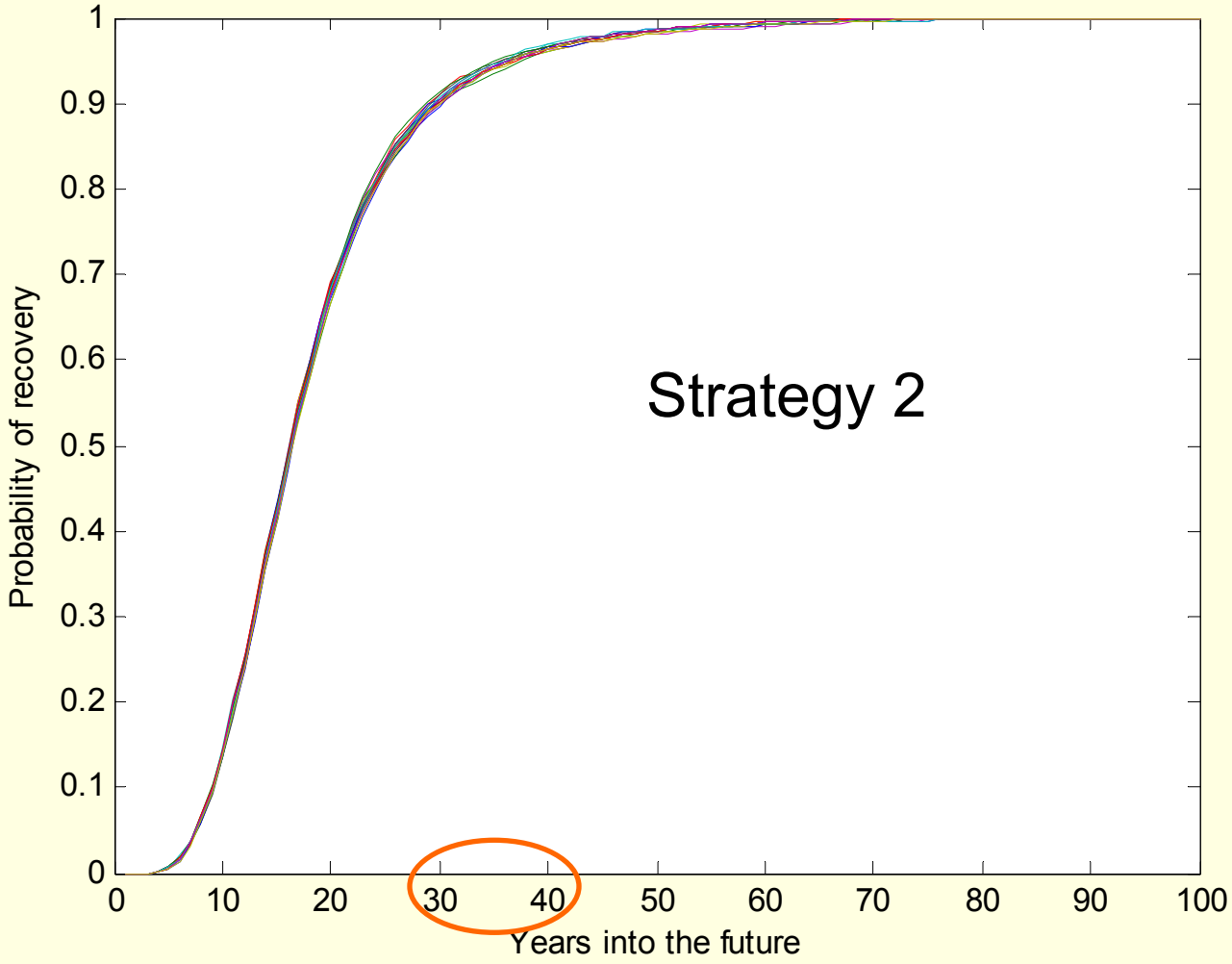
Management strategies

Strategy	$\sigma_{1,2,3}$	Fecundity	Implementation
1	10%	0%	Habitat rehabilitation
2	20%	0%	
			+
3	30%	0%	
4	40%	10%	Enhancement of spawning habitat
5	50%	20%	

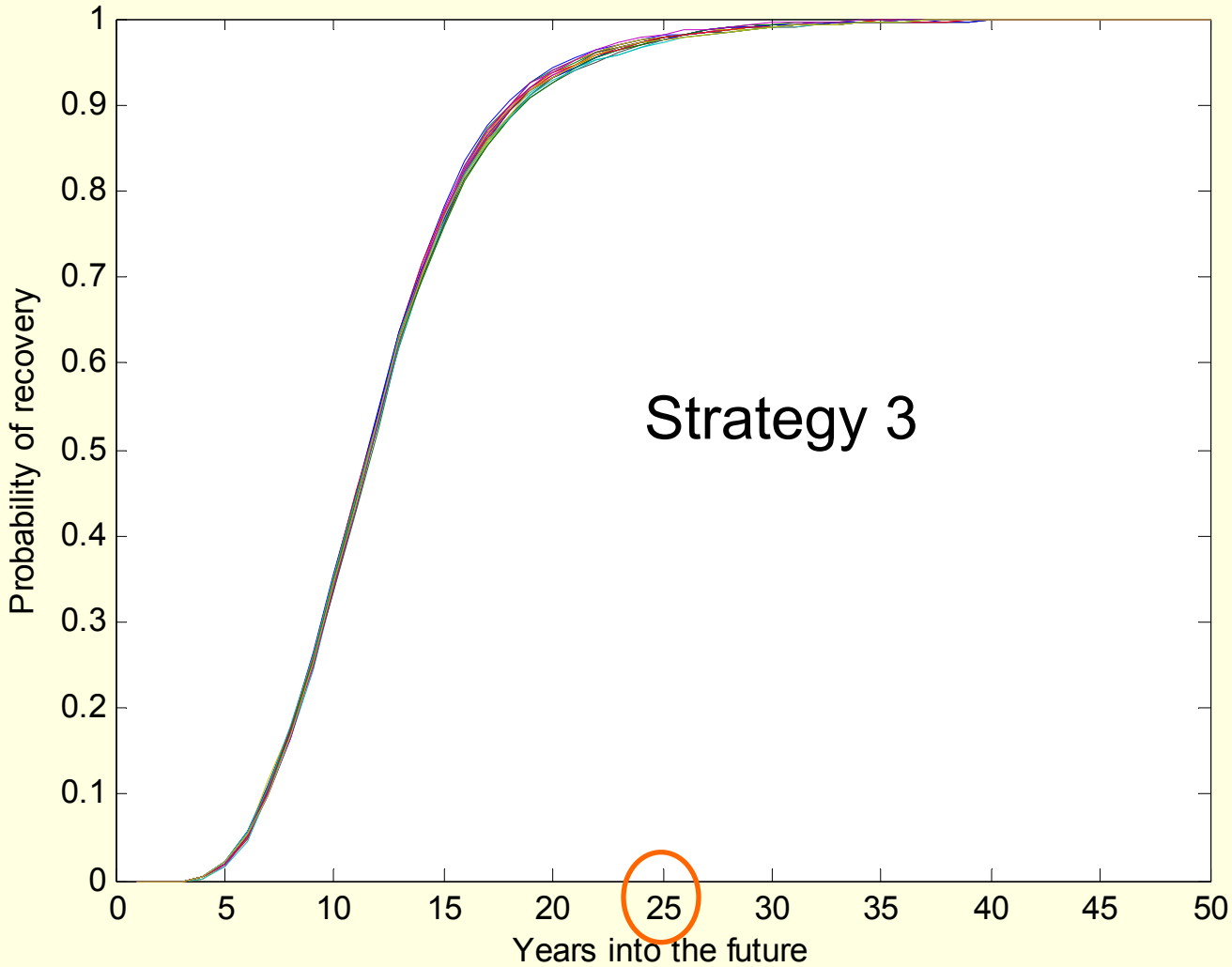
Long-Term Projections



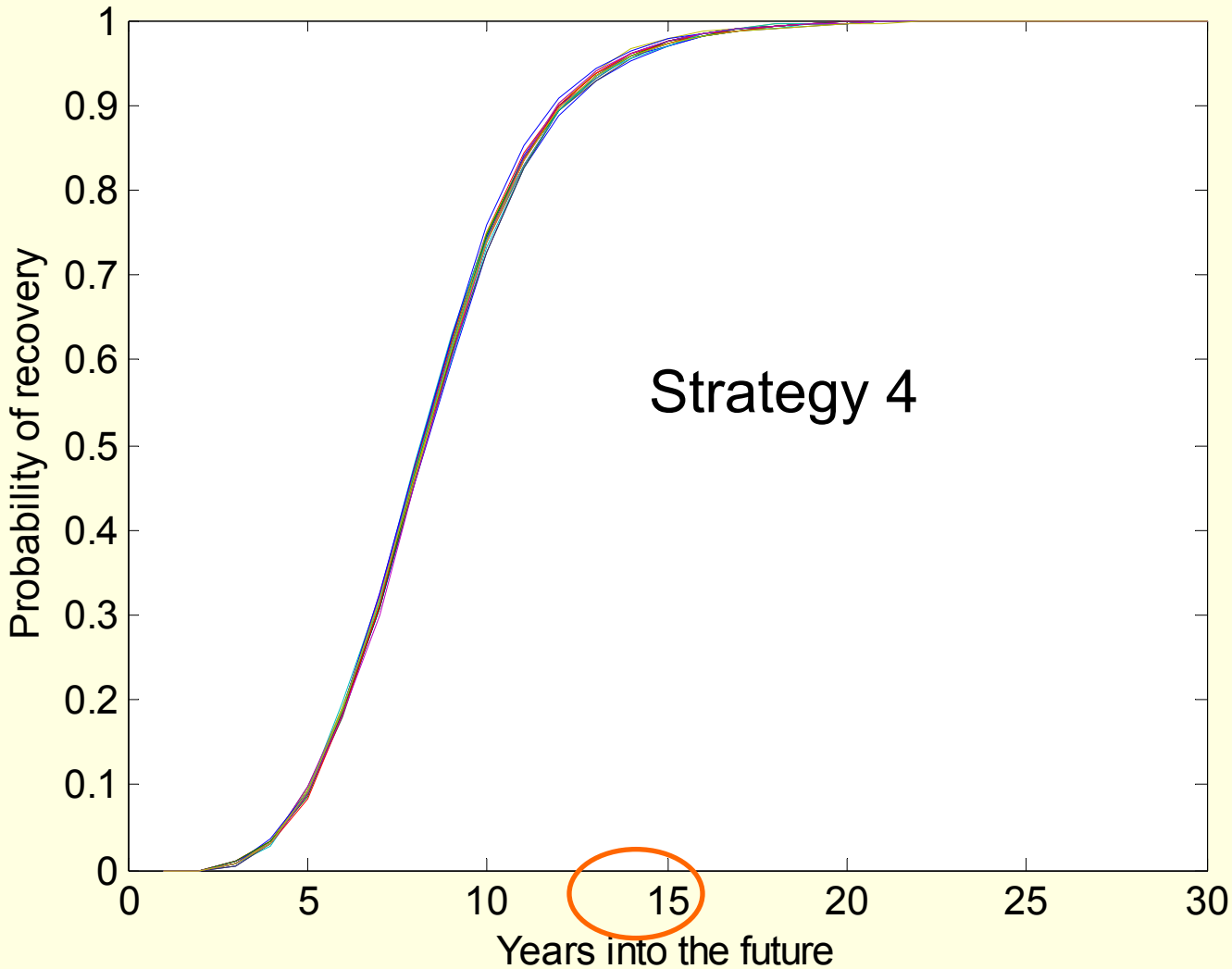
Long-Term Projections



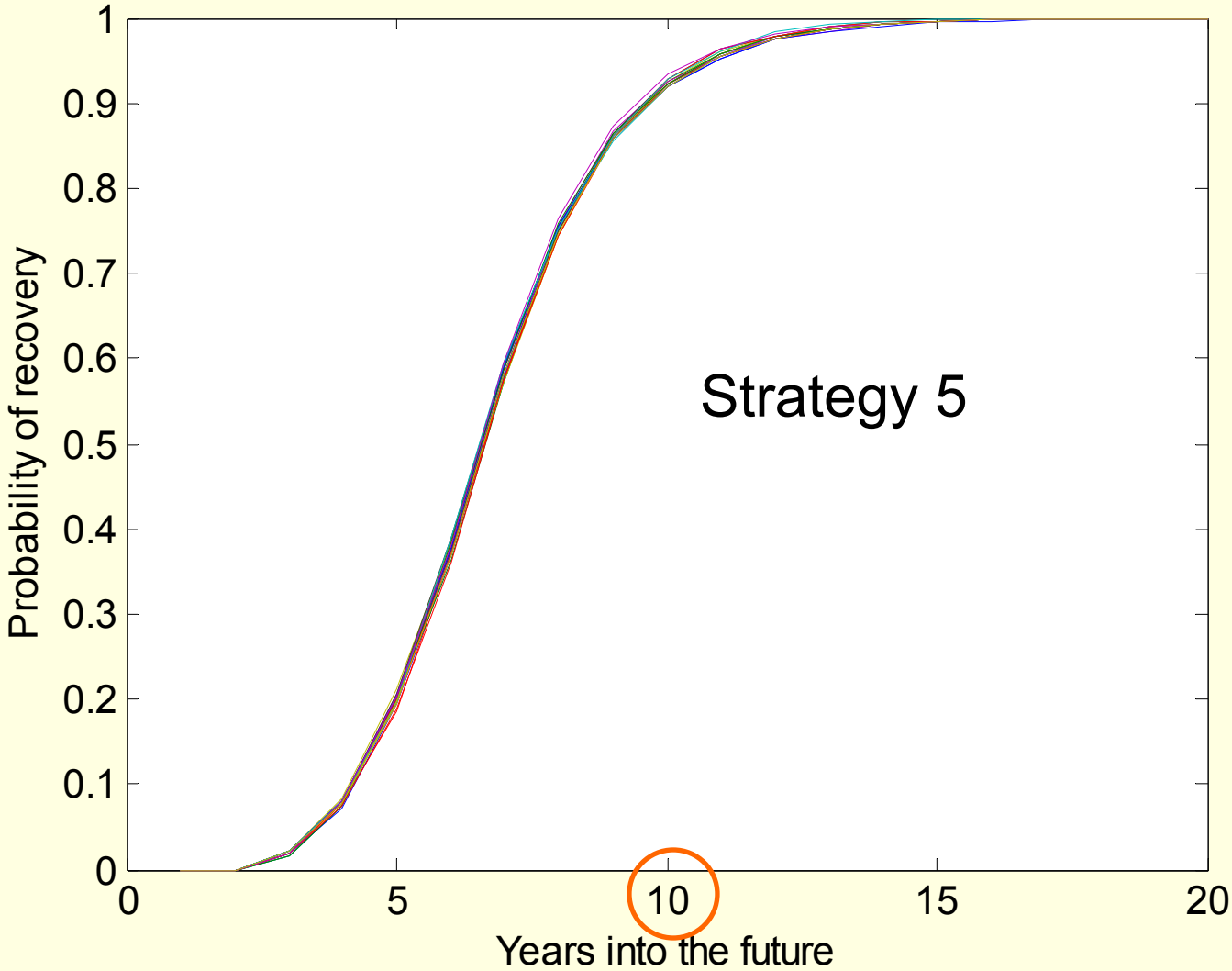
Long-Term Projections



Long-Term Projections



Long-Term Projections

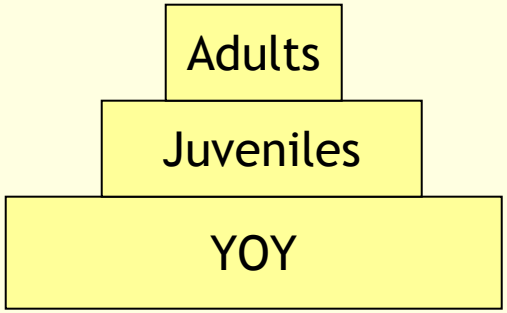


Minimum Area for Population Viability

Recovery Target x Area Needed per Individual = Estimate of Critical Habitat Area

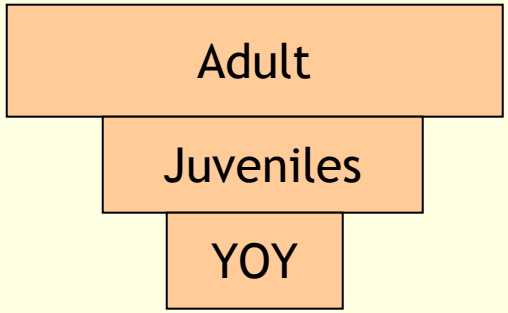
Minimum Area for Population Viability

Stage Structure Relative to MVP



X

Area per individual

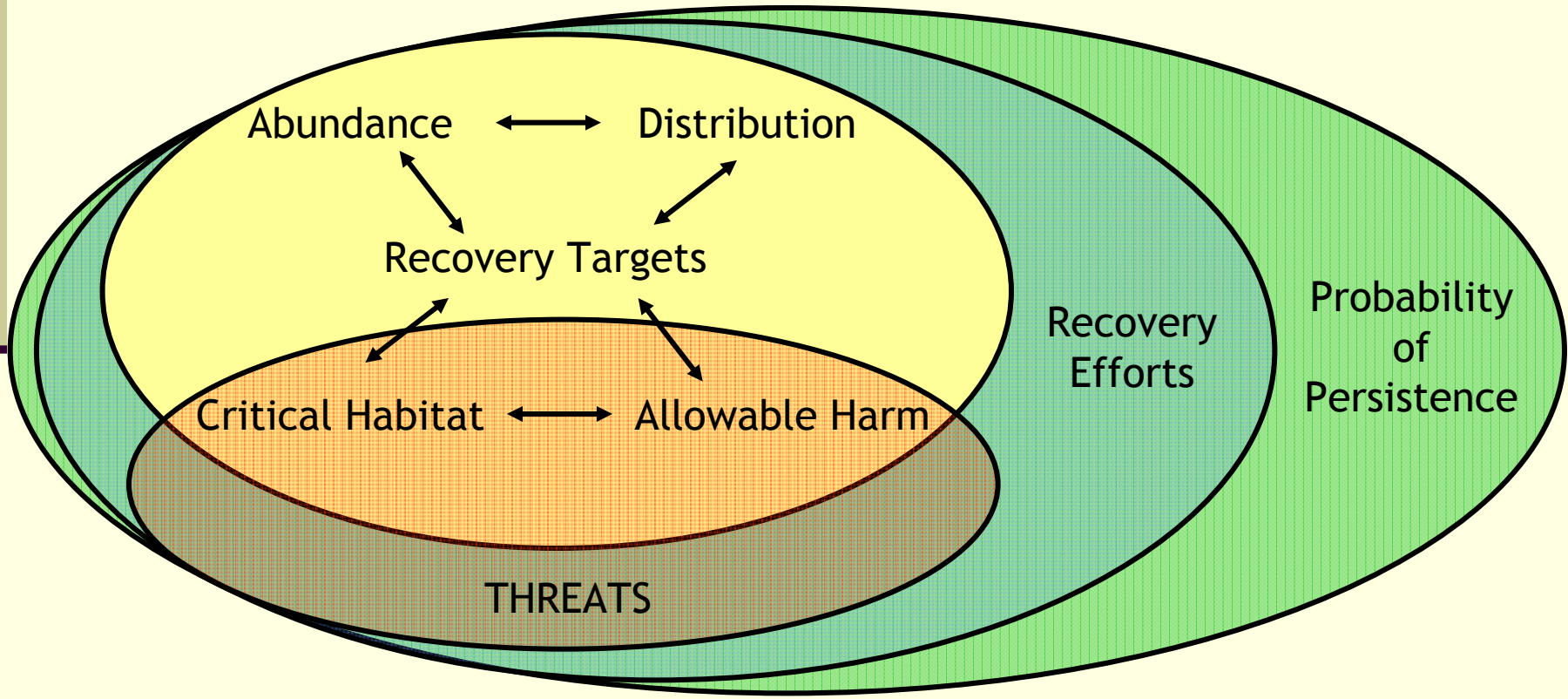


=

Estimate of Critical Habitat

Management Objectives:

"...to prevent wildlife species from being extirpated or becoming extinct"

"...recovery of wildlife species that are extirpated, endangered or threatened as a result of human activity"

- *Species at Risk Act*, section 6