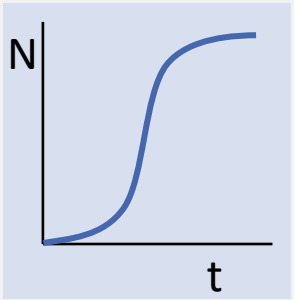


Stano Pekár

Populations

„Population Ecology of Animals“

Population ecology

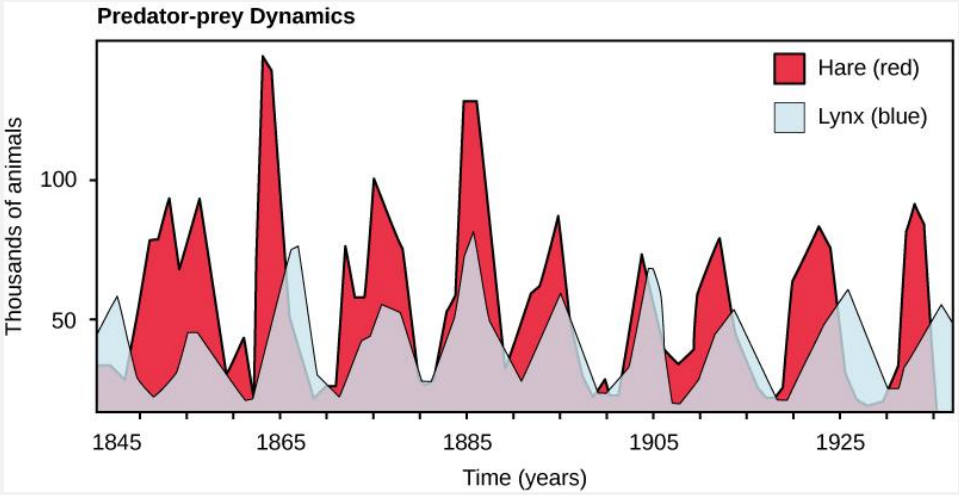
- a major sub-field of ecology

> Deals with description of the structure and the dynamics of populations within species in time and space, and the interactions of populations with environmental factors

- expanding field (Price & Hunter 1995):
  - populations 52 %, communities 9 %, ecosystems 10 %
- main focus on
  - **Demography** – relationship between population structure and dynamics – the core of the discipline
  - **Population dynamics** – describe the change in the numbers of individuals in a population

Motivation example

- populations of member species may show a range of dynamic patterns in time and space
- What regulates populations?



Bellani 2020

- density independent factors, food supply, intraspecific competition, interspecific competition, predators, parasites, diseases

Utilisation

1 Conservation biology

- to assess population status of rare species
- World Conservation Union (IUCN) uses several criterions (population size, generation length, population decline, fragmentation, fluctuation) **to assess species status**
- Population viability analysis estimates the extinction probability of a taxon **based on known life history, habitat requirements, threats and any specified management options**

Saiga tatarica

- **critical**: 50% probability of extinction within 5 years
- **endangered**: 20% probability of extinction within 20 years
- **vulnerable**: 10% probability of extinction within 100 years

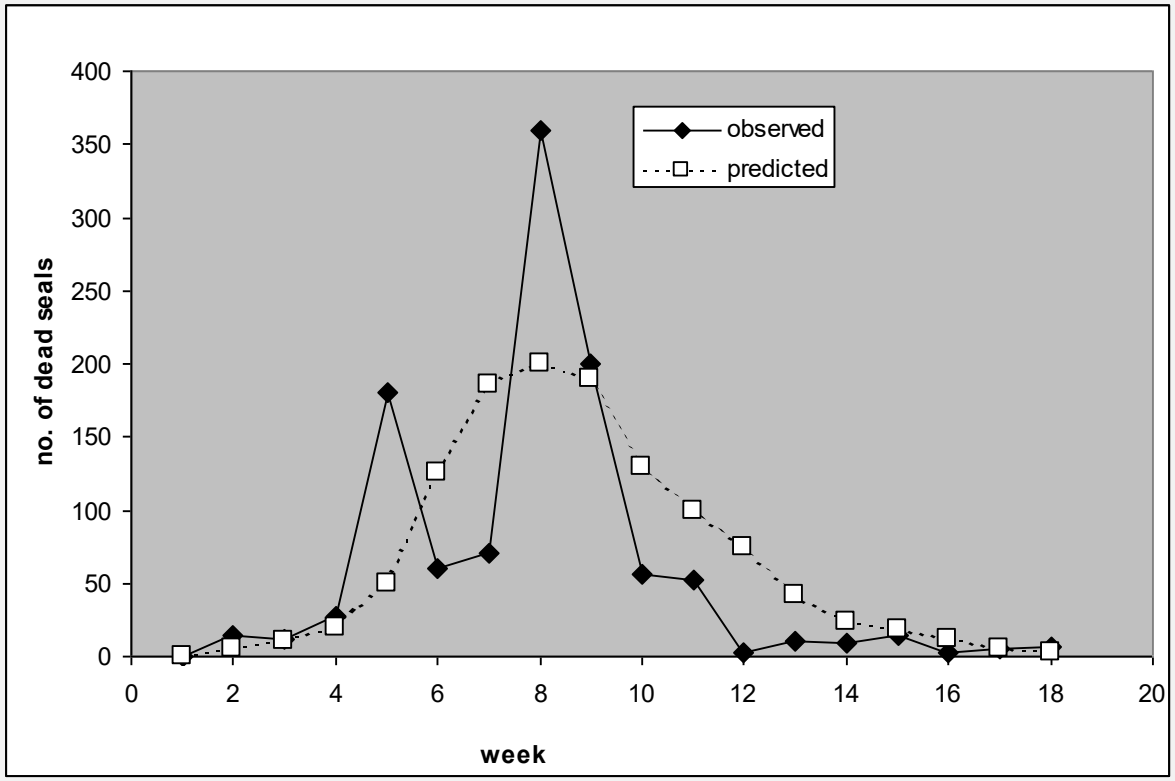
2 Biological control

Rodolia cardinalis (Coccinellidae) eating *Icerya purchasi* (Hemiptera)

- to assess ability of a natural enemy to control a pest
- in 1880 *Icerya purchasi* was causing infestations so severe in California citrus groves that growers were burning their trees
- in winter 1888-1889 *Rodolia cardinalis* and *Cryptochaetum* sp. were introduced into California from Australia, growers took the initiative and applied the natural enemies themselves
- by fall 1889 the pest was completely controlled
- *Rodolia cardinalis* has been exported to many other parts of the world
- the interest of growers and the public in this project was due to its spectacular success: the pest itself was showy and its damage was obvious and critical

3 Epidemiology

- to predict the diffusion of a disease and to plan a vaccination
- phocine distemper virus was identified in 1988 and caused death of 18 000 common seals in Europe
- during 4 months the disease travelled from Denmark to the UK



Observed and predicted epidemic curves for virus in common seals in the UK

Grenfell et al. (1992)

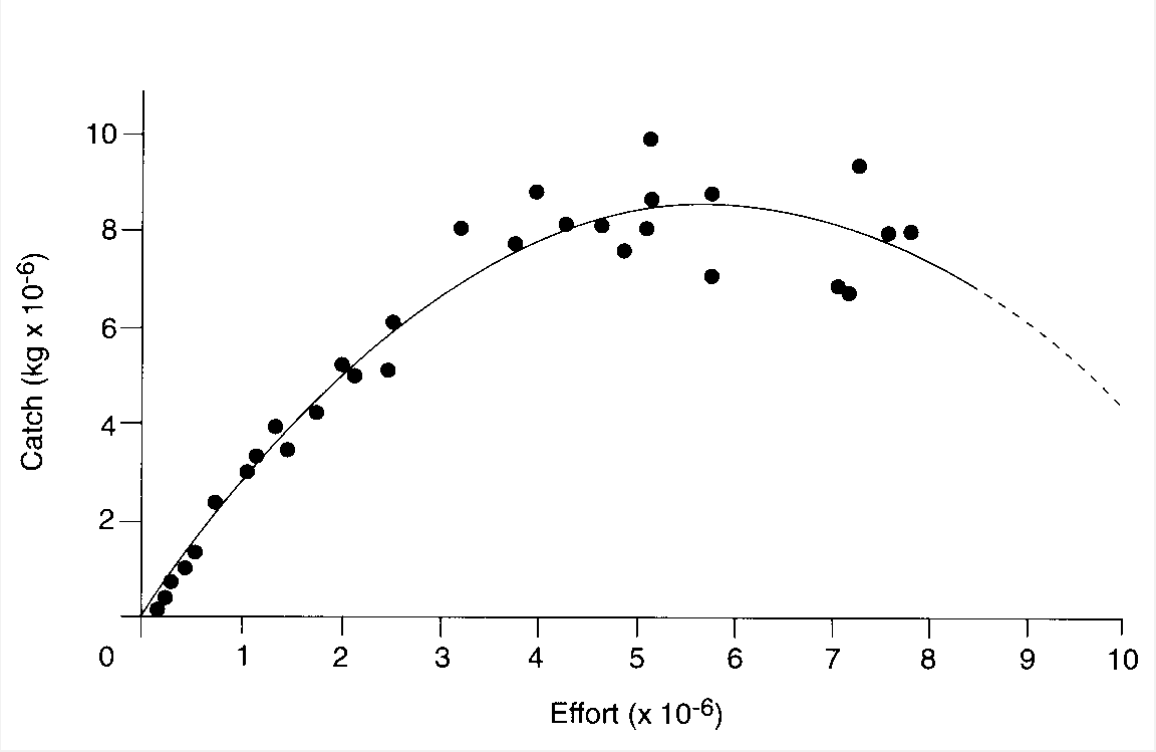
4 Harvesting

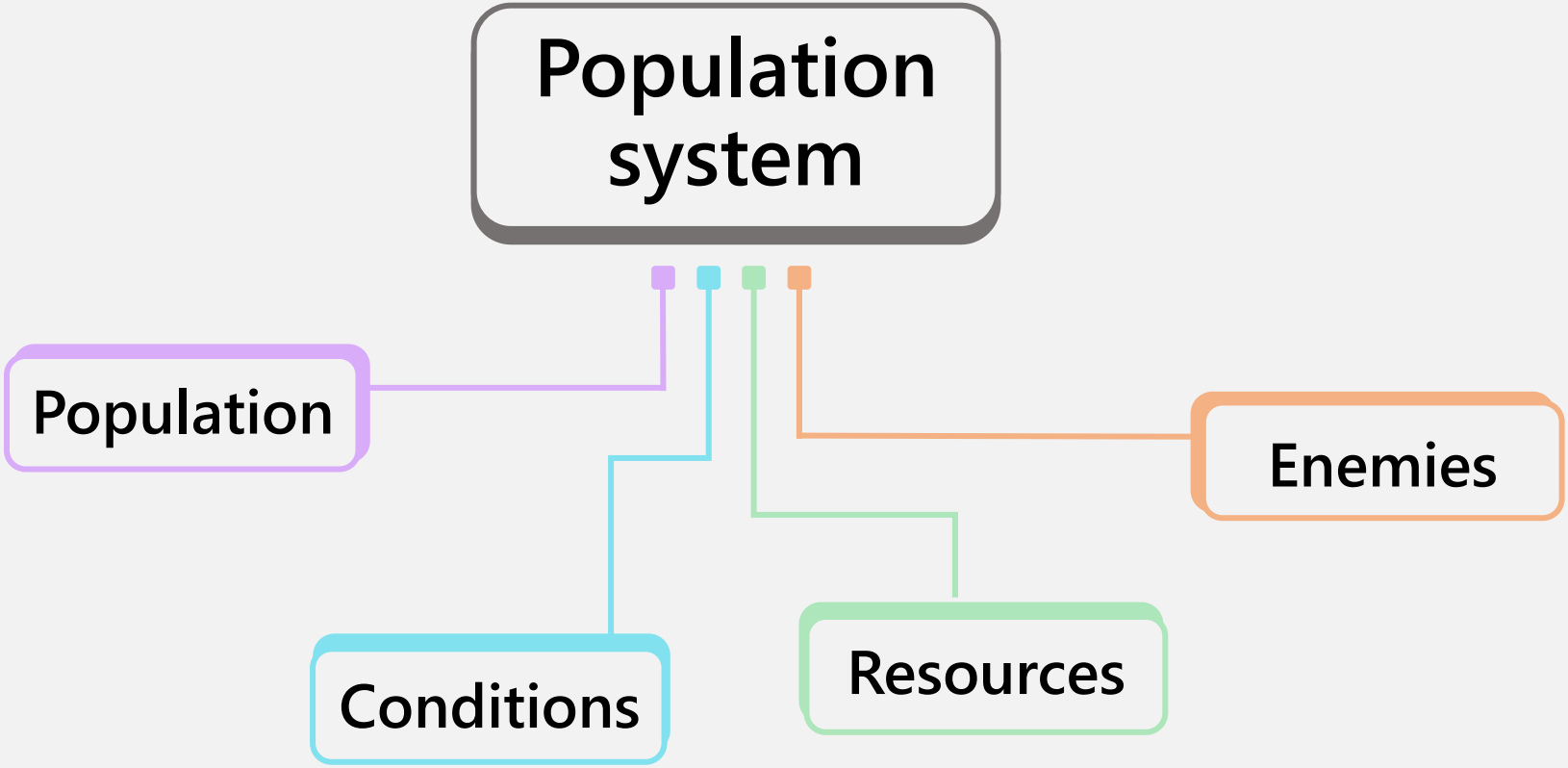
- to predict maximum sustainable harvest in fisheries and forestry
- also used to regulate whale or elephant hunting
- when population is growing most rapidly (K/2) then part of population can be harvested **without causing extinction**

Beddington (1979)

Relationship between capture and fishing effort

Panulirus cygnus





- population ecology aims to study interactions among components of the system
- a **dynamic system** characterised by events and processes

Population

- Biosphere
- Landscape
- Ecosystem
- Communities
- **Populations**
- Organisms
- Organ systems
- Organs
- Tissues
- Cells
- Organelles
- Molecules

A group of organisms of the same species that occupies a particular area at the same time and is characterised by an average characteristic (e.g., mortality)

  - Particular area – area in which a change in density is **mainly** due to mortality and natality not due to emigration an immigration

- Population ecology uses proximate approach – how the response happened
- Population defines fitness (relative genetic contribution to the next generation) of an individual based on his response to a current situation

Events & Processes

- **Event** – an identifiable change in a population
- **Process** – a series of identical events (in time)
  - *rate* of a process – number of events per unit time

Event		Process
Birth [inds]	»	**Natality** (birth rate)
Death [inds]	»	**Mortality** (mortality rate)
Increment [gram]	»	**Growth** (growth rate)
Increment [number]	»	**Population increase** (rate of increase)
Acquisition of food [gram]	»	**Consumption** (consumption rate)

Population characteristics

- Events

Individual	Population
Developmental stage	Stage structure
Age	Age structure
Size	Size structure
Sex	Sex ratio
Territorial behaviour	Spatial distribution

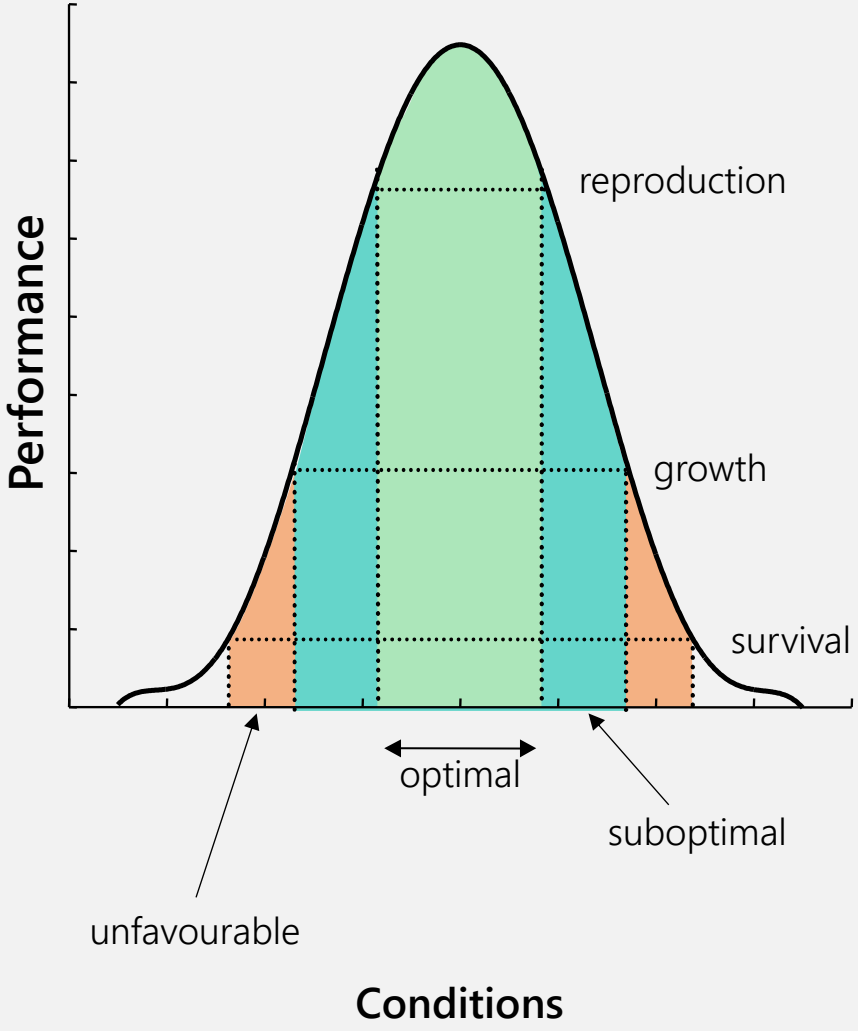
- Processes

Individual	Population
Individual growth	Population growth
Aging	Age structure change
Reproduction	Natality
Death	Mortality

Conditions

Inherent biotic and abiotic characteristics of the environment (pH, salinity, temperature, moisture, wind speed, etc.)

- **independent of population size**
- affect the population - **limit population size**
- not consumed by population
  - **no feedback mechanisms**
  - do not regulate population size
- exogenous effect - random and forcing processes



Resources

Any entity whose quantity is reduced (food, space, water, minerals, oxygen, sun radiation, etc.)

- **modified (reduced) by populations**
- defended by individuals (interference competition – self-regulation)
- regulate population size – **bottom-up regulation**
- **renewable** and **non-renewable** resources (space)

Renewable resources

- **Type 1** - regeneration centre **outside** the population system
  - no effect of the consumer (e.g., oxygen, water)
- **Type 2** - regeneration centre **inside** of the population system
  - influenced by the consumer (e.g., prey)
- **Type 3** - regeneration centre **inside** of the population system
  - access to the resource via secondary consumer (e.g., nitrogen)

Enemies

- competitors, predators, (macro) parasites, (micro) pathogens
- negative effect on the population
- **top-down regulation** of the population