Announcements

- Graphical Analysis – Due Thursday (in-class)
  - If transit strike affects your travel, you can email it to your TA before 9:30am

- Next week:
  - Office hours
    - Nico – Monday 11:00-12:00
    - Wendy – Tuesday 11:30-12:30+
    - *Rylee – Tuesday 1:00-2:00+ (B8271)

Announcements

- **Transit strike resources:**
- Liftango app (carpooling resource)
- Check the SFU homepage

SFU SIMON FRASER UNIVERSITY
ENGAGING THE WORLD

Student Evaluation of Teaching and Courses

Please complete the course evaluation at this link:

https://sfu.bluera.com/SFU

- The deadline for submitting your evaluation is the last day of class (**Nov. 28, 12:00**)
- Please help me to continue improving this course by completing the evaluation

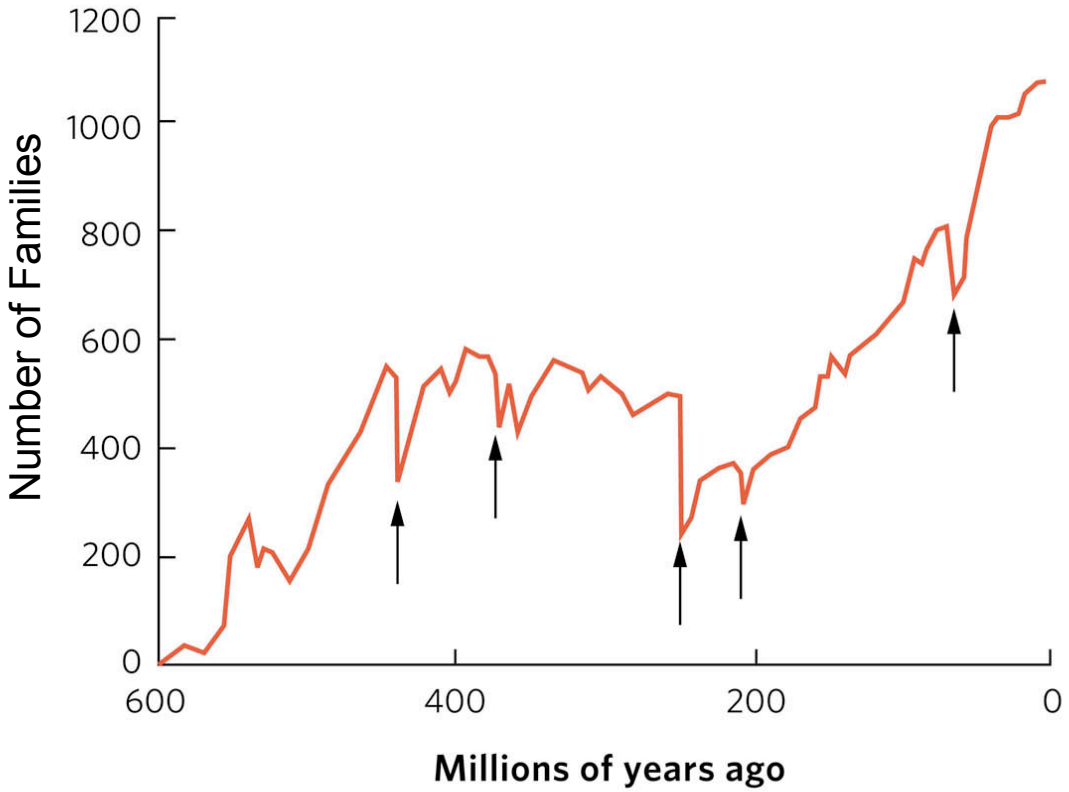
Thank you!

Global Ecology and Global Change

Global species richness

- 1.5 M described species (Latin names)
- 15,000 new species described each year
- ~10 M (estimated) species on Earth

Background Extinction Rates

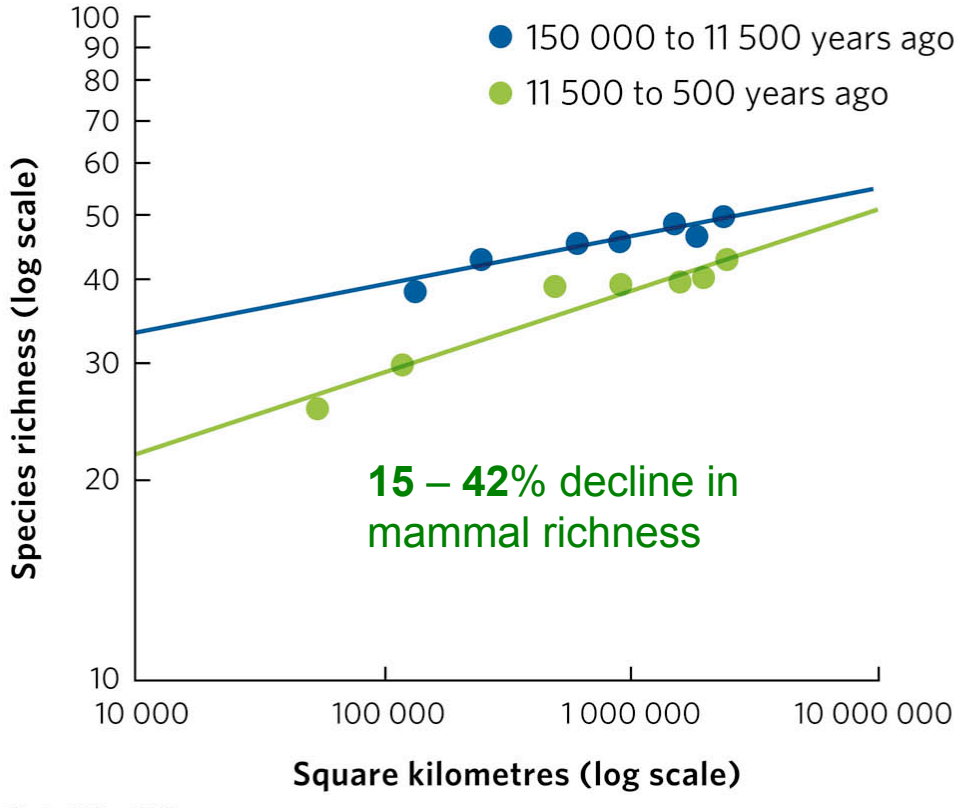


Mass extinction= >75% of species extinct in 2M yrs

5th Asteroid collision (180km wide crater)

The 6th Great Extinction [extinction rates ~1000X]

Background Extinction Rates



Species-Area curves for mammals

Prior to human arrival (blue)

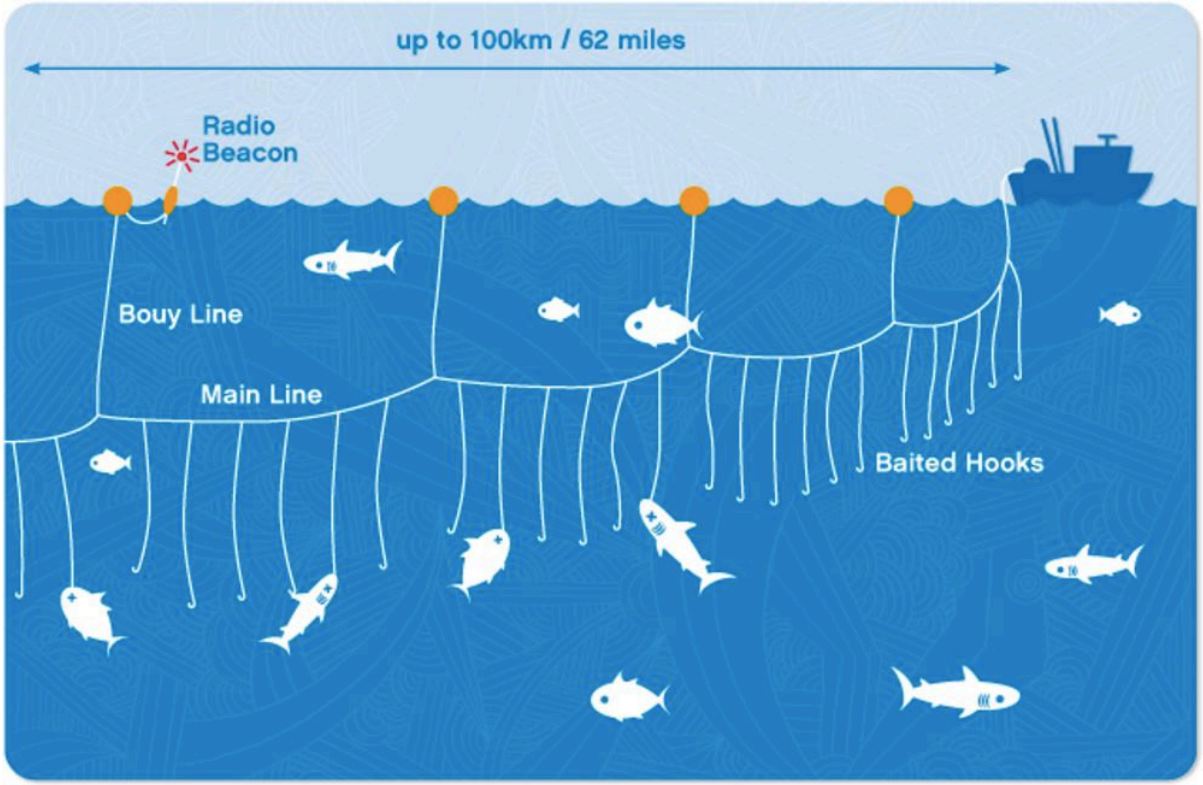
After (green)

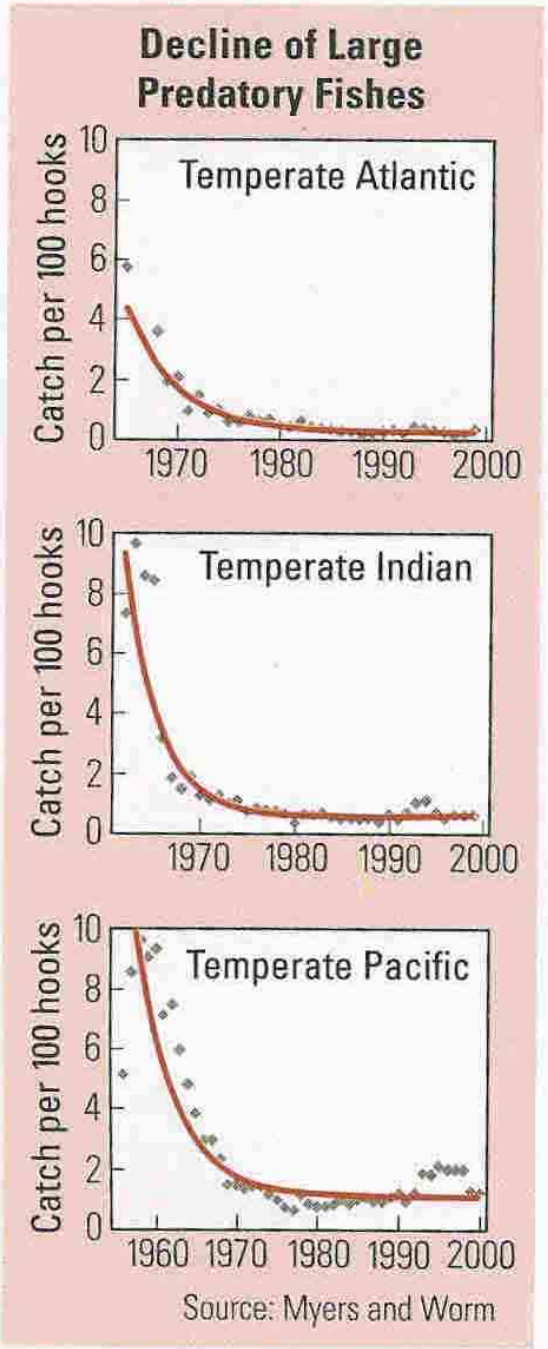
Remember the equation for Species-Area curves?

Major Drivers of Biodiversity Loss

1. Exploitation (especially of top predators)
2. Invasive/exotic species
3. Land modification (aka Habitat Loss)
4. Appropriation of freshwaters
5. Nutrient pollution (eutrophication)
6. Contaminant pollution
7. Stratospheric ozone depletion
8. Climate warming/change

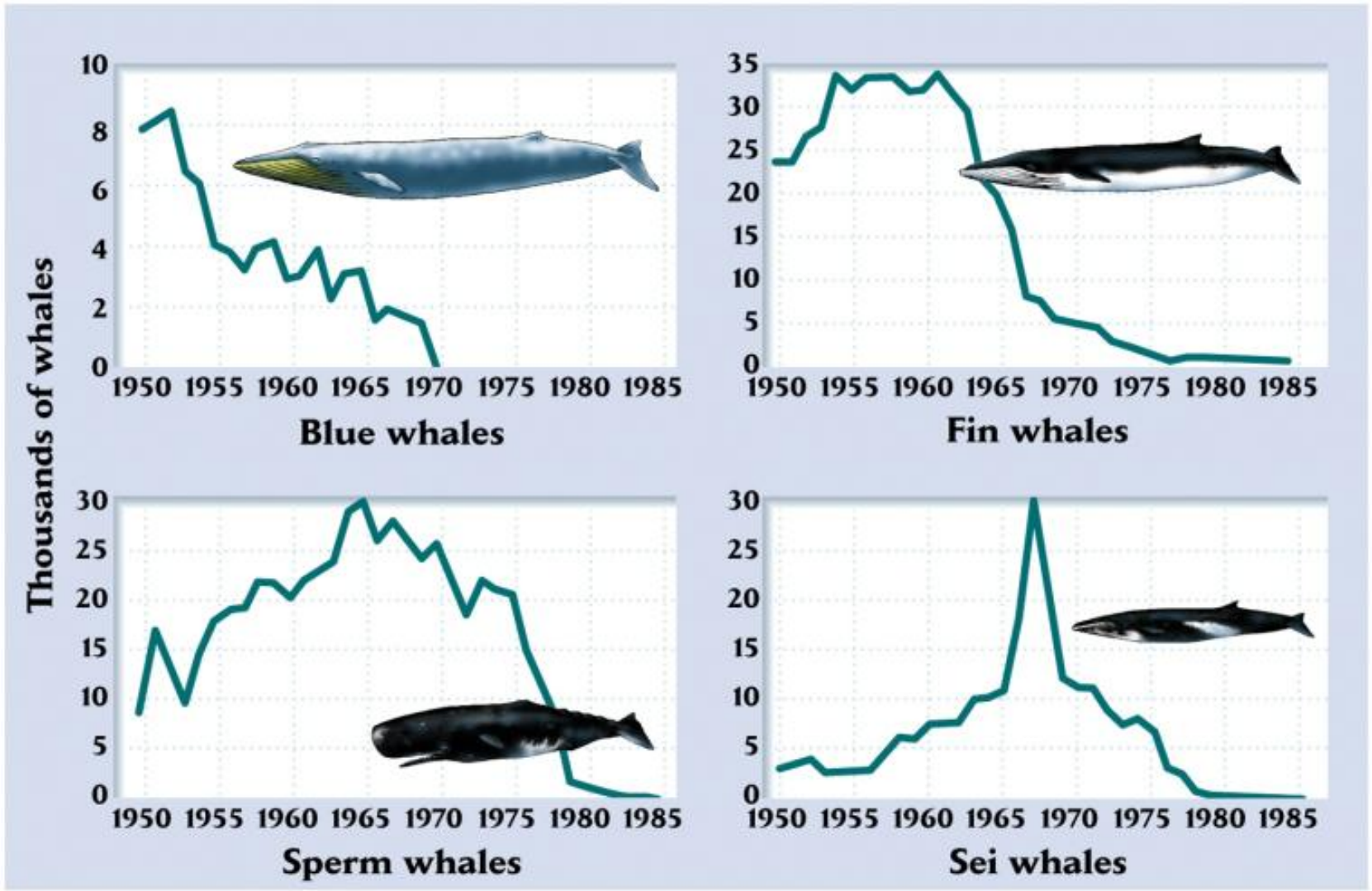
1. Exploitation of food webs and top predators





Decline of many large ocean predators: tuna, marlin, swordfish, sharks, cod, halibut, skates, and flounder, have been fished down in the past 50 years.

Serial Depletion of Top Predators



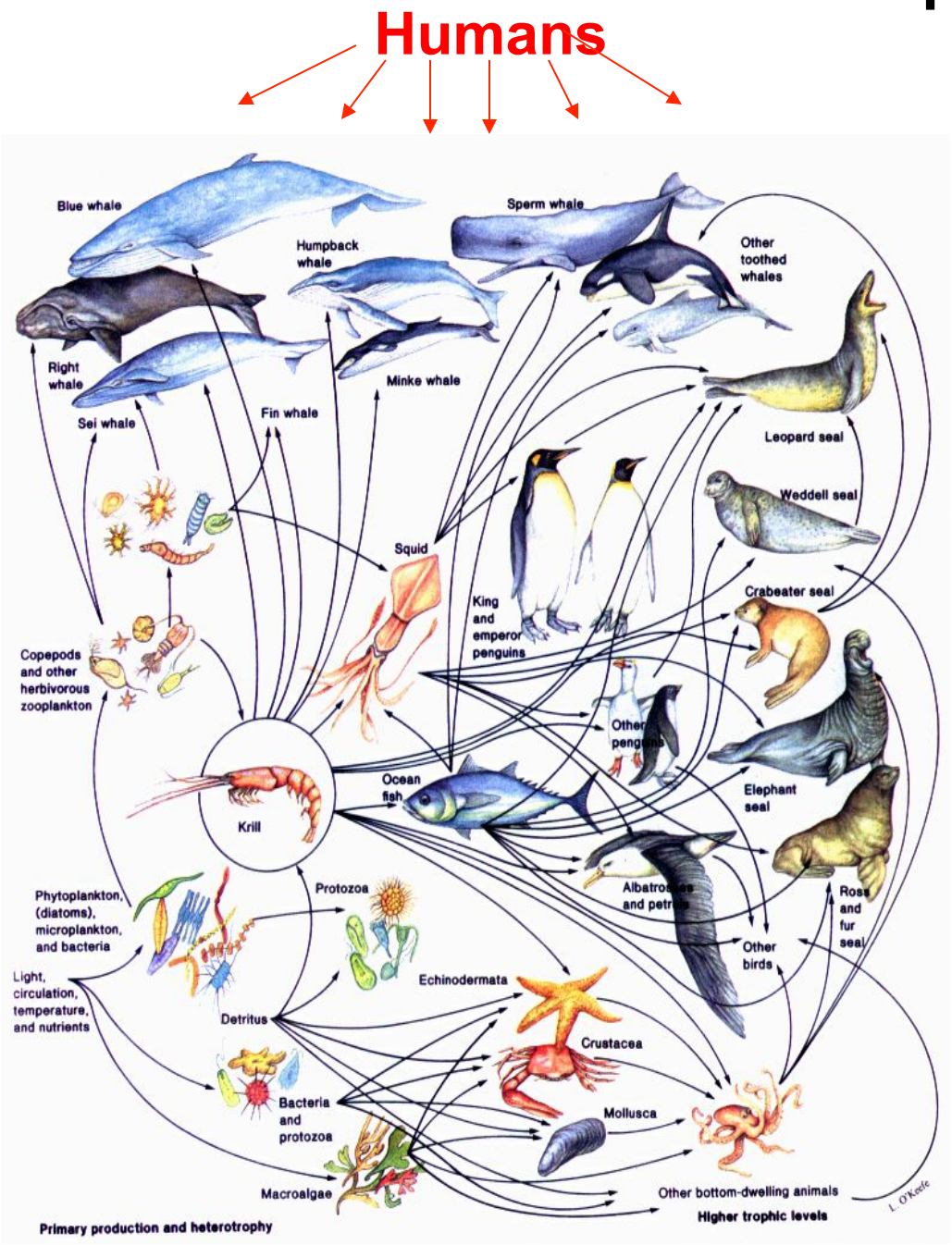
International Whaling Commission (IWC)

International treaty banning commercial whaling in 1986

Japan (and Norway) harvest >1000 whales/ yr. using ‘research’ loophole

Ecological data suggest that limited whaling would be sustainable

"Fishing Down the Food Web"



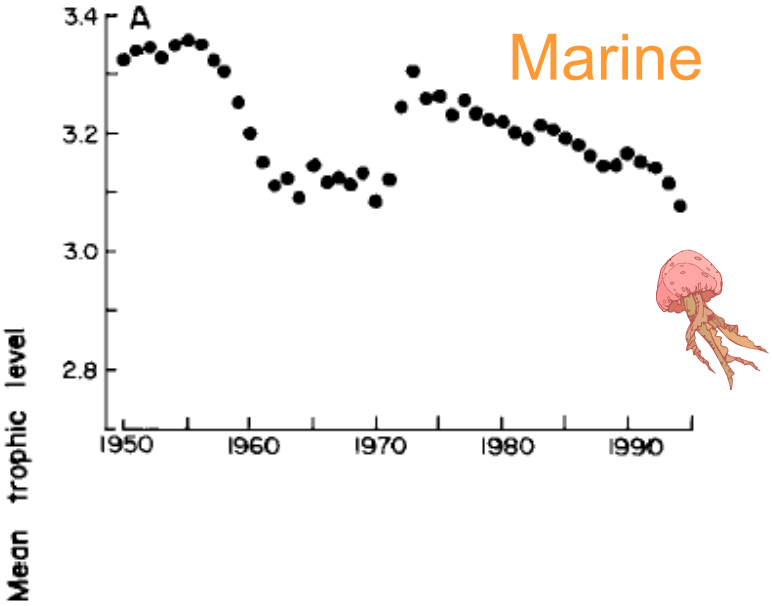
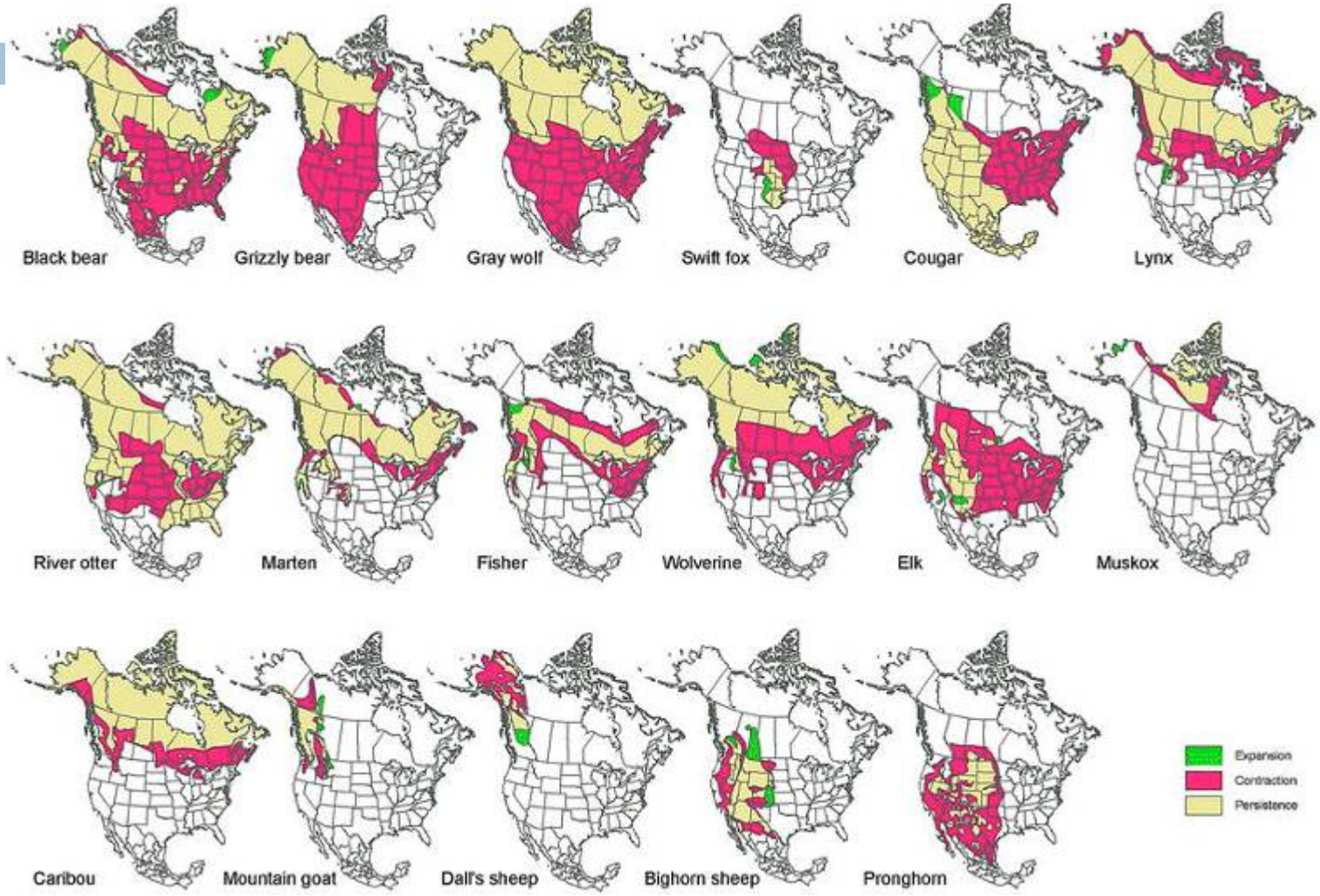


Fig. 1. Global trends of mean trophic level of fisheries landings, 1950 to 1994. (**A**) Marine areas; (**B**) inland areas.

Pauly et al. (1998)


Scott Gende

Changes in distribution of large N. American mammals



Laliberte and Ripple (2004) BioScience

2. Exotic and invasive species

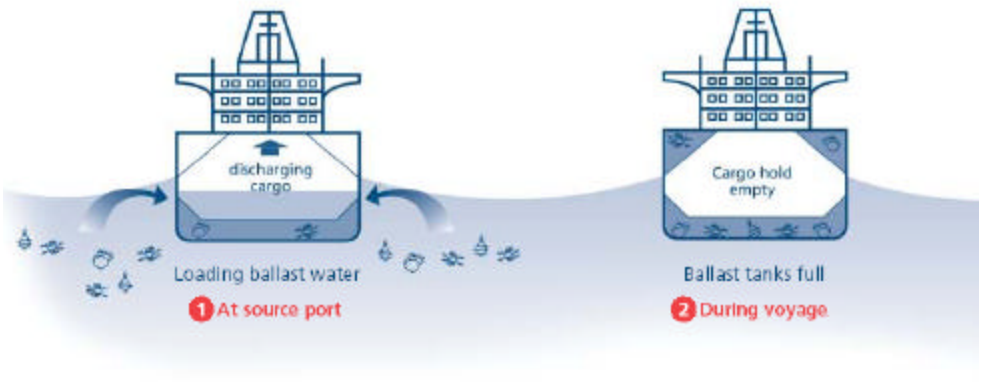



Photo: Snohomish County Surface Water Management

The spectrum of native to invasive

Native	Introduced	Invasive
Live in place of origin		
Endemic or indigenous		

The spectrum of native to invasive

Native	Introduced	Invasive
Live in place of origin	Non-native, alien, exotic	
Endemic or indigenous	Require human intervention to persist	

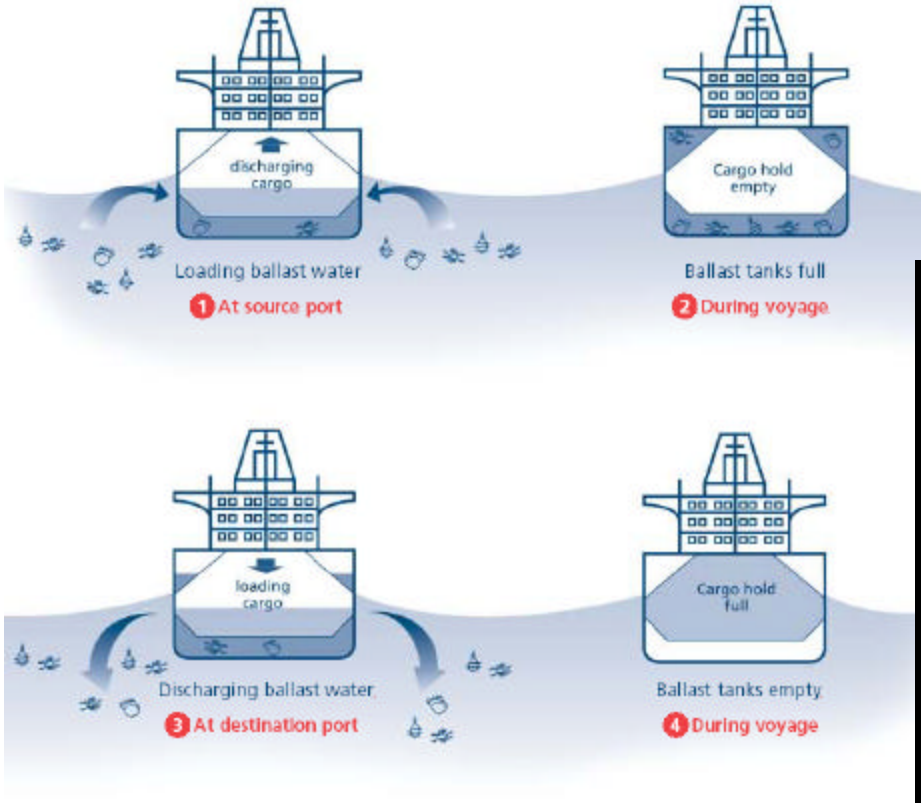
The spectrum of native to invasive

Native	Introduced	Invasive
Live in place of origin	Non-native, alien, exotic	Introduced or other
Endemic or indigenous	Require human intervention to persist	Pervasive in new environment

Invasive species are organisms introduced by humans into places out of their natural range, where they become established and disperse, generating a negative impact on the local ecosystem or economy

Exotic and invasive species

Many unintentional forms of transport



Ten of the Most Unwanted

Marine plants, animals and microbes are being carried around the world attached to the hulls of ships and in ships' ballast water. When discharged into new environments, they may become invaders and seriously disrupt the native ecology and economy. Introduced pathogens may cause diseases and death in humans.

Cholera

Vibrio cholerae (various strains)

Native to: Various strains with broad ranges.

Introduced to: South America, Gulf of Mexico and other areas.

Impacts: Some cholera epidemics appear to be directly associated with ballast water. One example is an epidemic that began simultaneously at three separate ports in Peru in 1991, sweeping across South America, affecting more than a million people and killing more than ten thousand by 1994. This strain had previously been reported only in Bangladesh.

Cladoceran Water Flea

Cercopagis pengoi

Native to: Black and Caspian Seas

Introduced to: Baltic Sea

Impacts: Reproduces to form very large populations that dominate the zooplankton community and clog fishing nets and trawls, with associated economic impacts.

Mitten Crab

Eriocheir sinensis

Native to: Northern Asia

Introduced to: Western Europe, Baltic Sea and West Coast North America

Impacts: Undergoes mass migrations for reproductive purposes. Burrows into river banks and dykes causing erosion and siltation. Preys on native fish and invertebrate species, causing local extinctions during population outbreaks. Interferes with fishing activities.

Toxic Algae (Red/Brown/Green Tides)

Various species

Native to: Various species with broad ranges.

Introduced to: Several species have been transferred to new areas in ships' ballast water.

Impacts: May form Harmful Algae Blooms. Depending on the species, can cause massive kills of marine life through oxygen depletion, release of toxins and/or mucus. Can foul beaches and impact on tourism and recreation. Some species may contaminate filter-feeding shellfish and cause fisheries to be closed. Consumption of contaminated shellfish by humans may cause severe illness and death.

North American Comb Jelly

Mnemiopsis leidyi

Native to: Eastern Seaboard of the Americas

Introduced to: Black, Azov and Caspian Seas

Impacts: Reproduces rapidly (self fertilising hermaphrodite) under favourable conditions. Feeds excessively on zooplankton. Depletes zooplankton stocks; altering food web and ecosystem function. Contributed significantly to collapse of Black and Azov Sea fisheries in 1990s, with massive economic and social impact. Now threatens similar impact in Caspian Sea.

North Pacific Seastar

Asterias amurensis

Native to: Northern Pacific

Introduced to: Southern Australia

Impacts: Reproduces in large numbers, reaching 'plague' proportions rapidly in invaded environments. Feeds on shellfish, including commercially valuable scallop, oyster and clam species.

Zebra Mussel

Dreissena polymorpha

Native to: Eastern Europe (Black Sea)

Introduced to: Western and northern Europe, including Ireland and Baltic Sea; eastern half of North America

Impacts: Fouls all available hard surfaces in mass numbers. Displaces native aquatic life. Alters habitat, ecosystem and food web. Causes severe fouling problems on infrastructure and vessels. Blocks water intake pipes, sluices and irrigation ditches. Economic costs to USA alone of around US$750 million to $1 billion between 1989 and 2000.

Asian Kelp

Undaria pinnatifida

Native to: Northern Asia

Introduced to: Southern Australia, New Zealand, West Coast of USA, Europe and Argentina

Impacts: Grows and spreads rapidly, both vegetatively and through dispersal of spores. Displaces native algae and marine life. Alters habitat, ecosystem and food web. May affect commercial shellfish stocks through space competition and alteration of habitat.

Round Goby

Neogobius melanostomus

Native to: Black, Azov and Caspian Seas

Introduced to: Baltic Sea and North America

Impacts: Highly adaptable and invasive. Increases in numbers and spreads quickly. Competes for food and habitat with native fishes including commercially important species, and preys on their eggs and young. Spawns multiple times per season and survives in poor water quality.

European Green Crab

Carcinus maenas

Native to: European Atlantic Coast

Introduced to: Southern Australia, South Africa, USA and Japan

Impacts: Highly adaptable and invasive. Resistant to predation due to hard shell. Competes with and displaces native crabs and becomes a dominant species in invaded areas. Consumes and depletes wide range of prey species. Alters inter-tidal rocky shore ecosystem.

Further Information:

Global Ballast Water Management Programme

International Maritime Organization, London, UK

Fax +44 (0)20 7587 3261

Web http://globallast.imo.org

The species presented here are for illustrative purposes only. Their introduced ranges may be greater than depicted. There are numerous other examples of serious marine bio-invasions around the world.

Global Ballast Water Management Programme · GEF · undp · IMO

Pathway to becoming invasive:

Transport to a new area

Establishment

Population increase and range expansion

Ecological or economic impact

Pathway to becoming invasive:

Transport to a new area

Establishment

Population increase and range expansion

Ecological or economic impact

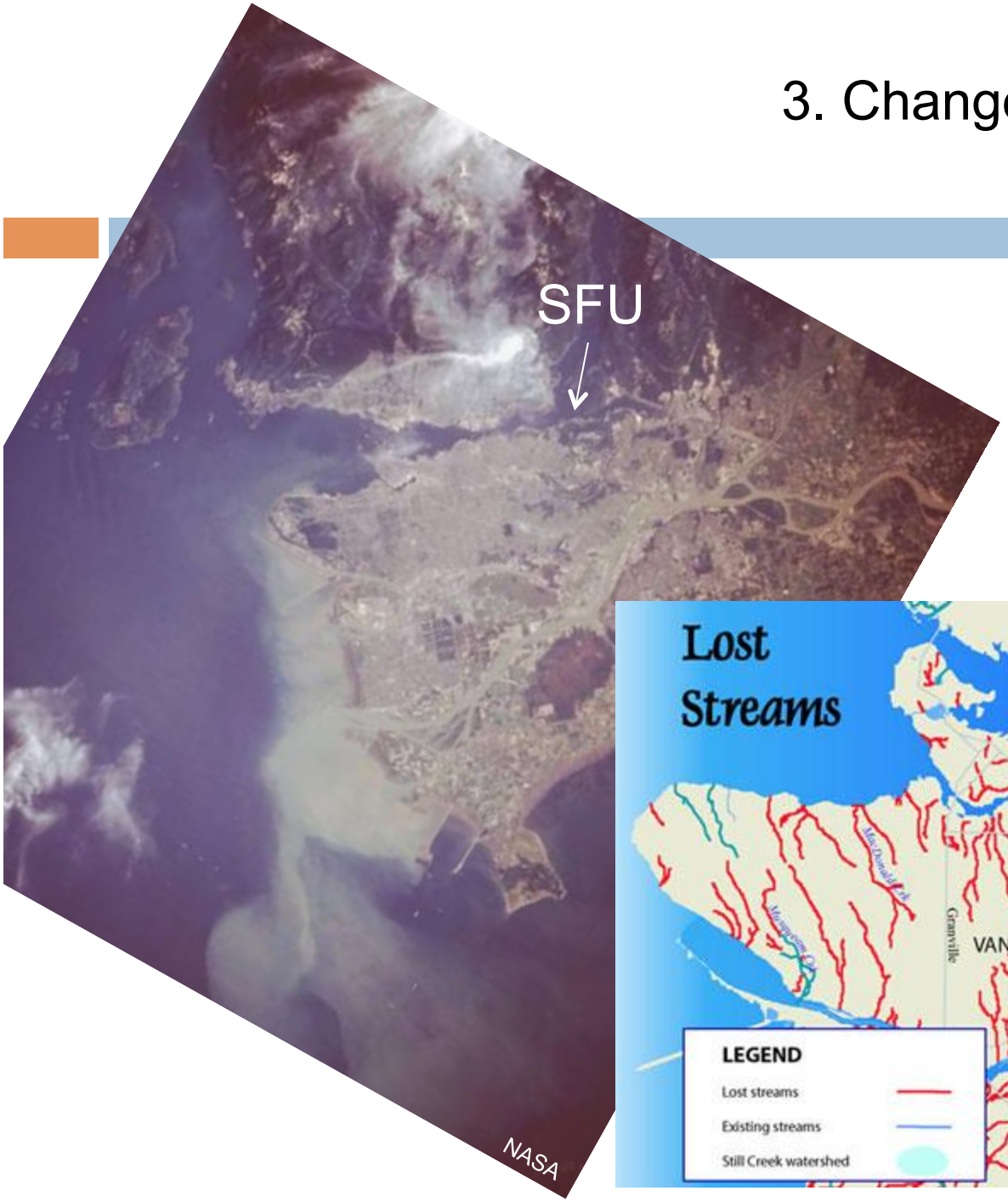
Characteristics
Short generation time
Multiple life stages
Freq. reproduction
Large no. offspring
Veg. reproduction
Habitat generalist
Small size
Can disperse easily
Few predators

Exotic & Invasive species

- Long human history of moving organisms around (Polynesians, rats-> Hawaii, Aboriginals, dingos -> Australia)
- >50,000 exotic species introduced to US alone
- Scale is important (trans-continental, trans-oceanic, regional, local)

Do you think the distance involved between native and introduced range matters for an exotic species' impact?

3. Changes in land-use



Forestry, Agriculture, Urbanization