Invasive species: a global threat to biodiversity

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Invasive Alien Species (IAS)

- *alien* species = non-native species
  - occurring by human agency in an area where it is not native
- *invasive alien* species:
  - alien species colonising natural ecosystems and threatening native biodiversity

IUCN and IAS

- IUCN (The World Conservation Union) has been engaged in invasive alien species (IAS) work since the early 1990s
- There is now an integrative approach to IAS work in IUCN
  - All ecosystems
  - Global, regional, national and community level
  - All IUCN themes / programmes / initiatives

IUCN and IAS worldwide

- Marine Programme
- Endangered species / Species assessments
- Forestry
- Wetlands
- Protected Areas
- Environmental Law Centre
- Biodiversity Policy (e.g.conventions)
- Ecosystem Management & Restoration
- Valuation of ecosystem services
- Trade and environment
- Precaution project
- Biodiversity Forums
- Antarctic Advisory Committee

The IUCN Invasive Species Specialist Group

- 180 expert members (all volunteers) in 42 countries
- Global HQ (8 staff) at the University of Auckland
- International exchange of information and expertise
  - Global Invasive Species Database, Aliens listserver etc.
- Major programmes:
  - Thematic programme on island invasives
  - Marine working group, Predators working group
  - Work on international instruments (including ATS)
  - Produced IUCN guidelines on IAS

The IUCN 'Guidelines for the Prevention of Biodiversity Loss caused by Invasive Alien Species

- Comprehensive guidelines, adopted by IUCN. Basis for CBD Interim Guiding Principles.
  - increase awareness of invasive alien species (IAS)
  - minimise the number of unintentional introductions of IAS
  - prevent unauthorised introductions of IAS.
  - encourage management action against established IAS

- English *http://www.iucn.org/themes/ssc/pubs/policy/invasivesEng.htm*
- Spanish *http://www.iucn.org/themes/ssc/pubs/policy/invasivesSp.htm*
- French *http://www.iucn.org/themes/ssc/pubs/policy/invasivesFr.htm*

Global Invasive Species Database

- Free data on > 400 invasive alien species
- Information on impacts, management
- Collaborative effort of ISSG, UOA, Landcare, USGS etc., and 1000s of experts (voluntary)
- USA/NZ bilateral climate change programme
- 700 individual users (50,700 hits per day)

www.issg.org/database and *www.invasivespecies.net/database*

IUCN and non native species issues in Antarctic Treaty System

IUCN has been active in bringing the IAS issue to attention of the ATS since 1998:

- Raising awareness of the issue
- Encouraging action
- Highlighting the need for a precautionary approach

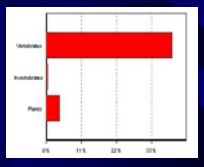
See also ATCM XXII (CEPI) IP-53 (IUCN), ATCMXXVIII (CEP4) IP-63 (IUCN)

SO, what's the problem with invasive species?

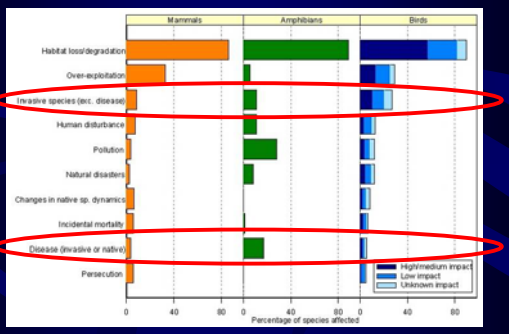
Global biodiversity crisis: the IUCN Red List

- < 3% of the world's species assessed
- Of those assessed: 15,589 species threatened with extinction (2004 Red List)

- Proportions threatened:
  .12% of all birds
  . 23% of mammals
  . 32% of amphibians



Threats to vertebrates: IAS are among the worst



Islands and other isolated ecosystems are especially threatened by IAS

- 3 times as many alien birds and 1.6 times as many alien mammals have established on islands than on continents (King 1986)
- Isolated floras and faunas have high endemism and high vulnerability to invasion

Worldwide, invasive alien species are:

- The second or third major threat to biodiversity
- The main threat on islands
- Recognised as fifth biggest threat to marine biodiversity

The threat is global

Trade and travel are causing an exponential increase in the movement of species outside their native range

Asterias amurensis (CSIRO)

Species introductions can be intentional…

- Forestry
- Aquaculture
- Horticulture
- Erosion control
- Aid programmes
- Gardens
- Pets
- Research

Photos: GISP, Strahm

And unintentional…

- Contaminants of agricultural produce, flower trade, timber..
- Ballast water and hull fouling
- 'Hitchhikers' in containers
- Inside luggage
- On boots, tents
- In soil
- On vehicles

Photos: IMO, Aphis

Biodiversity impacts of invasive alien species

- Predation on native fauna
- Herbivory: damage to native plants
- Competition for resources
- Habitat change
- Disease (vectors and/or pathogens)
- Hybridisation

Examples of biodiversity impacts: *Predation*

- Stoats (*Mustela erminea*) introduced to New Zealand for rabbit control -> bird extinctions
- Nile perch (*Lates niloticus*) introduced to L. Victoria -> loss of c. 200 spp of endemic cichlids

Examples of biodiversity impacts: *Herbivory*

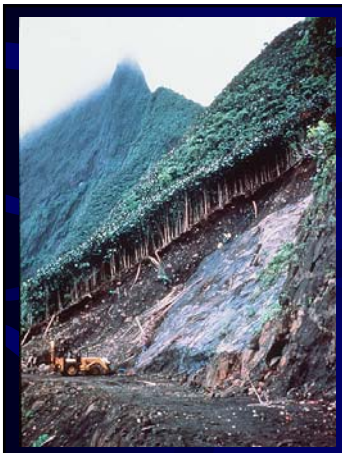
- Red deer introduced to New Zealand-> inhibit regeneration of palatable plants in native forests, even at <2/sq km (Nugent *et al.*2001, Biol. Cons. 99:65-79)
- Goats introduced to St Helena in 1513 -> loss of 7+ endemic plants (Groombridge 1992)

Examples of biodiversity impacts: *Competition*

- Grey squirrels introduced to UK & Italy -> replacement of red squirrel (Bertolini & Genovesi 2003 Biol Cons. 109: 351-8)
- European wasps introduced to NZ -> effect on native birds and insects (Beggs 2001 Biol. Cons. 99: 17-28)
- Invasive plants competing for light & nutrients with native species (many examples)

Examples of biodiversity impacts: *Habitat change*

- Pigs introduced to oceanic islands -> 'rooting' damage and dispersal of invasive plants
- Invasive plants dominating ecosystems e.g. *Miconia calvescens* in Pacific (Meyer & Florence 1996)



Miconia calvescens on Tahiti

Examples of biodiversity impacts: *Disease vectors*

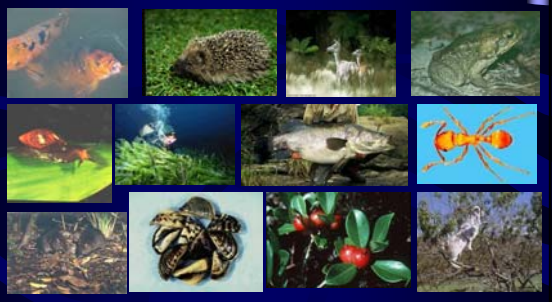
- Songbirds introduced to Hawaii -> bird pox and avian malaria decimated endemic birds
- Grey squirrel parapox virus infecting red squirrels in UK

(Tompkins *et al.* 2003. Ecology Letters 6: 189-196)

Examples of biodiversity impacts: *Hybridisation*

- Ruddy duck introduced to UK -> genetic swamping of white-headed duck (B. Hughes pers. comm.)
- Mallard introduced to NZ -> genetic swamping of grey duck (M. Williams, pers. comm.)

Invasive Alien Species are found in all taxonomic groups



All ecosystem types are at risk

"Alien" refers to an ecological border – not a political or country border

- Brazil: *Cichla ocelaris* (tucunaré fish)
  - Amazon basin: native
  - Parana river: alien and invasive
- Scotland: Hedgehog (*Erinaceus europaeus*)
  - Mainland: native
  - Western Isles (Uist): alien and invasive

Examples of impacts

NZ native birds preyed on by ship rats

Photos: David Mudge

Example

21 of the 23 possible extinctions of endemic animals on NW Mexican islands were caused by introduced mammals. Feral cats caused most of these.

ICEG Island Conservation Database (2000) & Wood *et al* (2001)

Example

Florida cypress smothered by climbing fern (Photo: Scott Kam)

Example

Water hyacinth infesting a river in Benin (Photo: Fen Beed)

Example

Alien jellyfish, *Rhopilema nomadica*, swarming in the Mediterranean
(Photo: Bella Galil)

Impacts over time: oil pollution vs bio-invasions

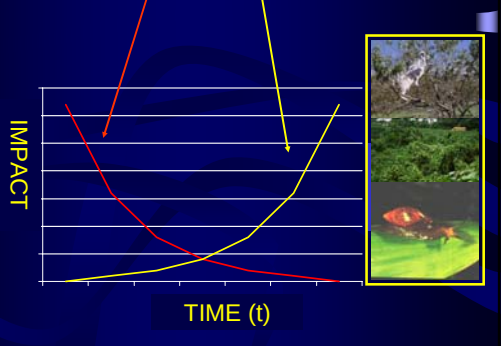
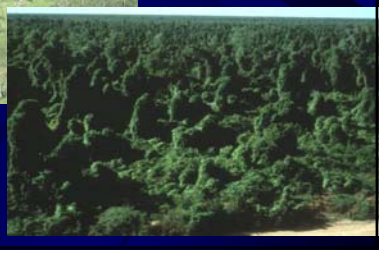


Diagram: after Raaymakers-IMO

Impacts at landscape/ecosystem scale

Native Eucalyptus forest, Northern Queensland, Australia
(Ellis, CABI)

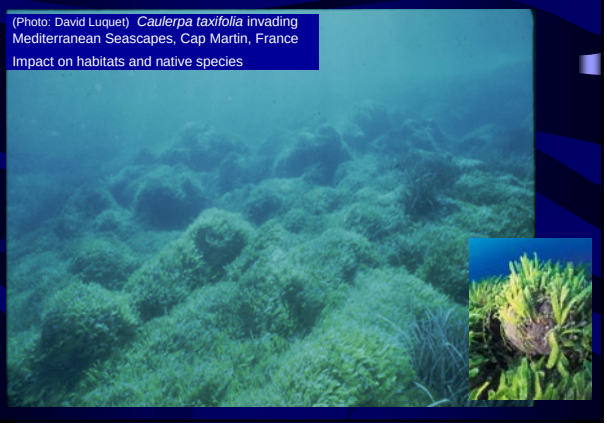


Invasion by rubber vine weed of native Eucalyptus forest, Northern Queensland, Australia
(Ellis, CABI)

Impacts at landscape/ ecosystem scale

(Photo: David Luquet) *Caulerpa taxifolia* invading Mediterranean Seascapes, Cap Martin, France

Impact on habitats and native species



Impacts at landscape/ ecosystem scale

(Photo: M Mumba) Water hyacinth, Kafue Dam, Zambia

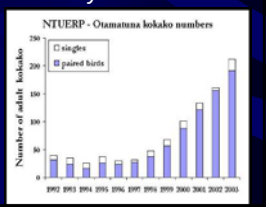
Fighting back against IAS: a global effort

Dealing with invasive alien species

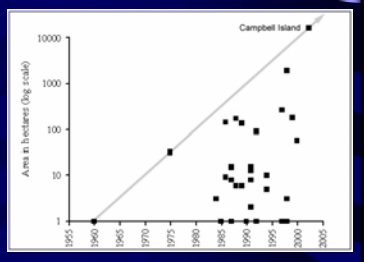
- Prevention
- Eradication
- Control

Example of control success: kokako response to pest mammal control

- Adult population doubled
- More even sex ratio
- Early breeding/high productivity
- High fledgling survival
- However – Sustained control is costly



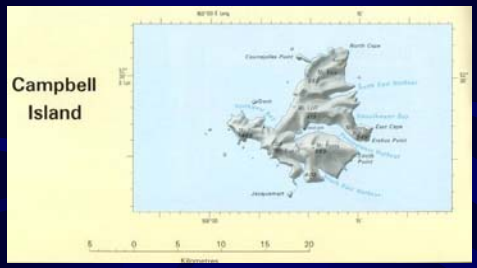
Eradication sometimes possible: rats on islands



Rats have been eradicated from increasingly larger NZ islands

(Clout & Veitch 2002: Turning the tide. IUCN)

Example: Campbell Island



- Subantarctic island (11,400 ha) settled in C19th
- Cattle, sheep, cats & *Rattus norvegicus* introduced
- Flightless teal & snipe lost.Vegetation damaged.

Campbell Island (contd.)

- Cattle eradicated in 1984, sheep eradicated in 1991. Vegetation recovered
- Cats died out in 1990s (denser vegetation?)
- Norway rats were eradicated in 2001.
- Flightless teal and snipe have been reintroduced/are recolonising

Example: Grass Island, South Georgia

- November 2000: start of baiting trials and a two year rat eradication feasibility study on Grass Island (30 ha) in Stromness Bay, South Georgia.
- Rat eradication declared a success in 2002, after no signs of rats on the annual inspection visit.
- The first pipit was seen on the island in 2003, and 2005/06 saw the first nesting pair [Poncet *et al* 2006]

Photo: Tony Martin of British Antarctic Survey

Fighting back is possible, BUT:

- Control means ongoing commitment
- Eradication is not easy, not cheap, often not feasible
- Prevention is by far the most preferred option
- Can we predict which species will become invasive where?

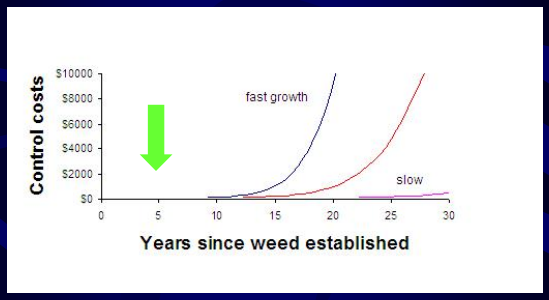
Prediction of invasive alien species

We are getting better at predicting further spread once an alien species has been recognised as invasive in a country, e.g. ecoclimatic prediction of spread of *Mimosa pigra*, N Australia (Finlayson)

BUT

Predicting the likelihood of an alien species becoming invasive in a new environment remains elusive…..

…yet critical because prevention is first line of defence
early detection / rapid response is second line of defence



Why prediction is difficult
Complexity of biodiversity impacts

The environmental impacts caused by IAS are wide-ranging, and are often complex and surprising, due to indirect effects and interactions between species

Examples of indirect effects (1)

- Invasive alien plant *Chromolaena odorata*, a major invader of wetlands in S. Africa: ……
- is a potential risk to:

CROCODILE SEX RATIO

Examples of indirect effects (2)

Subantarctic Auckland islands: invasive alien rabbits, in addition to devastation due to herbivory, also increased mortality of Hooker sea lion pups. Pups got stuck in rabbit burrows and starved.

Examples of indirect effects (3)

Alien yellow crazy ants on Christmas Island (Australia) since the mid-1990s. Red crabs are highly vulnerable. This has further consequences, including changes in seedling recruitment. Due to the crab's migratory nature, effects also result in areas not (yet) invaded by the yellow crazy ants.

Other indirect effects: facilitating the invasion of more alien species

Mutualism between invasive yellow crazy ants and introduced/cryptogenic scale insects: synergistic effect

Crazy ant invasion has also facilitated the invasion of native rainforest by giant African land snail (*Achatina fulicata*), woody alien weeds and alien cockroaches

RESULT: amplified impacts on native rain forest -> 'invasional meltdown'? (Green *et al*, O'Dowd *et al*).

The potentially magnifying effect of climate change

- Climate change could amplify IAS risks and problems:
  - change in potential range of IAS
  - more storms, floods, leading to IAS spread
  - some natural barriers may disappear (e.g. melting of glaciers may allow rats passage to hitherto rat-free areas in South Georgia)
  - interaction between impacts from climate change and impacts from IAS?

Dealing with invasive alien species can be a complex business

- Time lags
- Surprising indirect effects
- Interactions between invasive species
- Potential for 'invasional meltdown'?
- Interaction with climate change?
- Adaptation/evolution of alien species?

Is Antarctica a special case?

From: UNEP/CBD/SBSTTA/11/7/Add.1 31 August 2005 IMPLICATIONS OF THE FINDINGS OF THE MILLENNIUM ECOSYSTEM ASSESSMENT FOR THE FUTURE WORK OF THE CONVENTION (Addendum)

IAS recognised as one of main drivers of biodiversity impacts globally in Millennium Ecosystem Assessment

Polar systems: IAS impact relatively low compared to other areas of world

Antarctica: a special case?

1) Chance to be much more pro-active than elsewhere?

2) No reason for complacency:
Millennium Ecosystem Assessment looks at biodiversity threats / extinction risks. In the Antarctic context, concerns for biodiversity extend beyond simply avoiding extinction

3) Other Antarctic values: (eg. intrinsic, wilderness, and science values) imply a lower threshold for tolerance of alien species

4) Is Antarctica really safe from effects of IAS?

Too remote for accidental introductions to be likely?

1) Invasive alien species have been introduced into many other isolated ecosystems worldwide

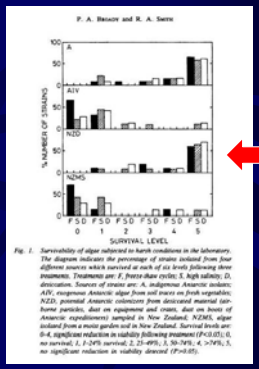
2) Invasive alien species have already established in the Subantarctic and have done MAJOR damage

3) Transport into the Antarctic is increasing, including fishing and polar research vessels from the Arctic.

Are Antarctic environments so hostile that introduced species are unlikely to establish there?

Experimental work on potential survivability in the Antarctic of algae found in New Zealand

(Broady 1994)



Are Antarctic environments so hostile that introduced species are unlikely to establish there?

- Several invertebrates survived several seasons in imported soil (Schirmacher)
- *Poa trivialis* at Syowa Station: has been there for some time, including several winters in Antarctic soil
- Grasses and other plants in Vestfold Hills
- N. Atlantic spider crab in Antarctic Peninsula waters

Spread of *Poa annua* at Arctowski Station

(Olech 1994)

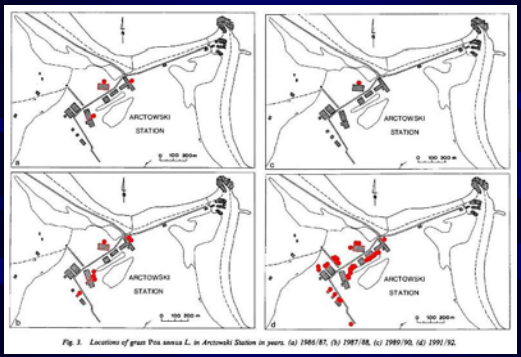


Fig. 3. Locations of grass Poa annua L. in Arctowski Station in years. (a) 1986/87, (b) 1987/88, (c) 1989/90, (d) 1991/92.

Conclusions:

- Although the Antarctic has (so far) escaped the worst effects of alien species, pressures are building….
- Transport of people and goods is increasing
- Alien species (terrestrial & marine) have been found surviving in the Antarctic, even on the continent
- Global climate change may heighten the threat
- Conservation is not just about avoiding extinction
- Wilderness and science values have a lower threshold
- Need for an interagency, international approach

Conclusions

- Need to be pro-active
- Learn from disasters elsewhere
- Need to deal with:
  - All pathways
  - All taxa
  - All receiving environments (terrestrial, freshwater, marine)
  - Introductions into Antarctica
  - Introductions within Antarctica
  - Introductions from Antarctica into other ecosystems
- Precautionary approach: guilty until proven innocent!