UNEP

CBD

CONVENTION ON BIOLOGICAL DIVERSITY

Distr.
GENERAL

UNEP/CBD/SBSTTA/10/INF/17
17 December 2004

ORIGINAL: ENGLISH

SUBSIDIARY BODY ON SCIENTIFIC, TECHNICAL AND TECHNOLOGICAL ADVICE
Tenth meeting
Bangkok, 7-11 February 2005
Item 5.4 of the provisional agenda*

INDICATORS FOR ASSESSING PROGRESS TOWARDS THE 2010 TARGET: NUMBERS AND COST OF ALIEN INVASIONS

Note by the Executive Secretary

I. SUMMARY

1. Invasive alien species—non-native species that become established in a new environment, then proliferate and spread in ways that damage human interests—are now recognized as one of the greatest biological threats to our planet's environmental and economic well-being. 1/ They are considered to be the second leading cause of biodiversity loss, after habitat alteration.

2. Invasive alien species have invaded and affected native biota in virtually every ecosystem type on Earth. They occur in all major taxonomic groups, including viruses, fungi, algae, mosses, ferns, higher plants, invertebrates, fish, amphibians, reptiles, birds and mammals. Invasive species can transform the structure and species composition of ecosystems by repressing or excluding native species, either directly by out-competing them for resources or indirectly by changing the way nutrients are cycled through the system. The environmental cost is the irretrievable loss of native species and ecosystems. 2/

3. Since 1600 AD, invasive alien species have contributed to 39% of all animal extinctions for which the cause is known. 3/ In the United States of America, about 400 of the 958 species on the United States Threatened or Endangered Species List are considered at risk primarily because of competition

* UNEP/CBD/SBSTTA/10/1.

1/ Mooney, H. A., J. A. McNeely, L. E. Neville, P. J. Schei, and J. K. Waage, eds. 2004. Invasive Alien Species: Searching for Solutions. Washington, DC: Island Press.

2/ Rejmanek, M. and J.J. Pitcairn. 2002. When is Eradication of Exotic Plant Pests a Realistic Goal? Pp 249-253 in Veitch, C.R. and M.N. Clout (Eds.). Turning the Tide: the Eradication of Invasive Species. IUCN, Gland, Switzerland and Cambridge, UK.

3/ Groombridge, B., ed. 1992. Global Biodiversity: Status of the Earth's Living Resources. Cambridge, UK, World Conservation Monitoring Centre, Chapman & Hall.

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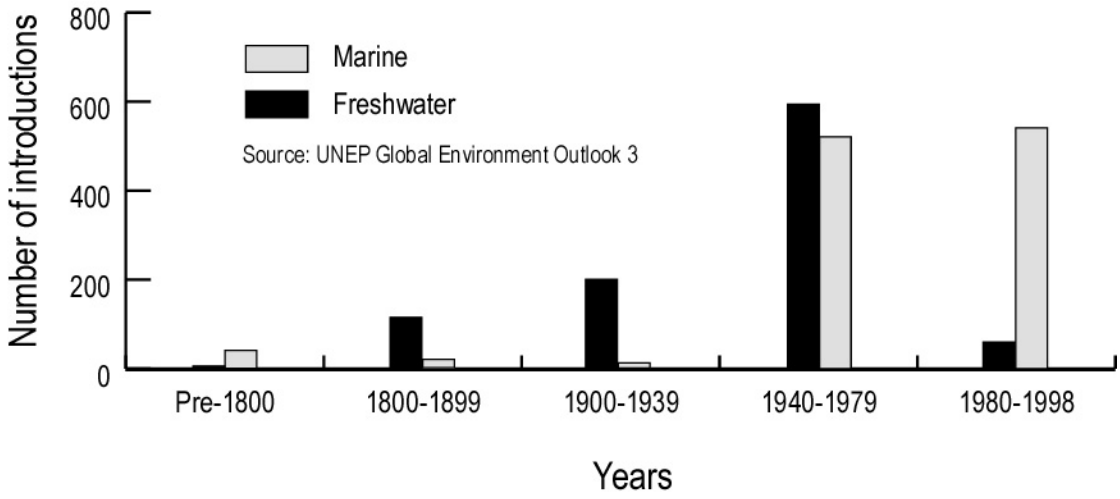
with and predation by non-indigenous species. 4/ In the *fynbos* region of South Africa 80% of the threatened species are endangered because of invading alien species. 5/

4. A total of more than 120,000 non-indigenous species of plants, animals, and microbes have invaded the United States, the United Kingdom, Australia, India, South Africa, and Brazil. Given the number of species that have invaded these six nations studied, it has been estimated that a total of 480,000 alien species have been introduced into the varied ecosystems on Earth. An estimated 20–30% of the introduced species are pests and cause major environmental problems.

5. In the recent past, the rate and risk associated with alien species introductions have increased enormously because human population growth and human activities altering the environment have escalated rapidly. 6/ However, consistent information on trends in the numbers of alien invasive species is limited. One exception is the FAO database on introductions of aquatic species (DIAS), 7/ which provides trends on the number of new introductions of species in inland water and marine ecosystems (figure 1). 8/

Figure 1. Number of new introductions of species into freshwater and marine environments



6. The costs of preventing, controlling and/or eradicating invasive alien species and the environmental and economic damages are significant. The annual economic losses to introduced pests in crops, pastures, and forests in the United States, United Kingdom, Australia, South Africa, India, and Brazil amount to nearly US$ 230 billion. The annual environmental losses to introduced pests in the same countries were calculated at over $100 billion. The calculated dollar cost per capita for the losses incurred due to biological invaders in the six nations investigated were approximately $240 per year.

4/ The Nature Conservancy, 1996. *America's Least Wanted: Alien Species Invasions of US Ecosystems*. The Nature Conservancy, Arlington, VA.

5/ Armstrong, S., 1995. Rare plants protect Cape's water supplies. New Scientist 11, 8.

6/ Pimentel, D., Lach, L., Zuniga, R., Morrison, D., 2000. Environmental and economic costs associated with non-indigenous species in the United States. BioScience 50 (1), 53–65.

7/ http://www.fao.org/waicent/faoinfo/fishery/statist/fisoft/dias/mainpage.htm

8/ Welcomme, R.L. 1998. International introductions of inland aquatic species. Fisheries Technical Paper 294. FAO, Rome.

Assuming similar costs worldwide, damage from invasive species would be more than $1.4 trillion per year, representing nearly 5% of the world economy. 9/

II. RELATION OF INDICATOR TO FOCAL AREA

7. Together with land use change (addressed through the indicator on extent of biomes, ecosystems and habitats), pollution/eutrophication (addressed through the indicators on nitrogen deposition and water quality) and climate change (addressed through indicators under the United Nations Framework Convention on Climate Change), invasive alien species are a key threat to biodiversity. Invasive alien species can modify and degrade natural ecosystems, contribute to ecosystem fragmentation and to human-induced ecosystem failure. They can outcompete and replace native species (addressed through the indicator on trends in abundance and distribution of selected species) and cause their extinction (addressed through the indicator on change in status of threatened species).

III. GENERAL DESCRIPTION OF INDICATOR

8. Invasive alien species are considered to be one of the main causes of biodiversity loss. They cause serious economic and environmental losses and the cost of prevention and control of invasive alien species and the rehabilitation of habitats degraded by such species are significant. The rate and risk associated with alien species introductions have increased considerably because human population growth and human activities altering the environment have increased. At the same time, awareness about the risks and cost of alien invasions and the number and sophistication of tools available to prevent and control these invasions have increased. Quarantine legislation and procedures are in place in most countries. The indicator quantifies new invasions and calculates their cost to society.

9. More than 120,000 non-indigenous species of plants, animals, and microbes have invaded the United States of America, the United Kingdom, Australia, India, South Africa, and Brazil. In the United States, there has been a 4,000% increase in the number of alien insects that have established themselves since 1800. In some of Australia's diverse marine environments, more than 200 alien species can be found—some of them are known marine pests. 10/ There are numerous similar examples from around the world. 11/

10. Based on published data on invasive species in six countries, it has been estimated that 480,000 alien species may have been introduced into the varied ecosystems on Earth. An estimated 20–30% of the introduced species are pests and cause major environmental problems, 12/ although their direct contribution to the extinction of species is not always clear. 13/

9/ Pimentel, D., S. McNair, J. Janecka, J. Wightman, C. Simmonds, C. O'Connell, E. Wong, L. Russel, J. Zern, T. Aquino, T. Tsomondo 2001. Economic and environmental threats of alien plant, animal, and microbe invasions. Agriculture, Ecosystems and Environment 84 (2001) 1–20.

10/ Dr Keith Hayes, Risk Analyst, Division of Marine Research, Commonwealth Science & Research Organisation (CSIRO), Tasmania, Australia

11/ Pimentel, D.; Lach, L.; Zuniga, R.; Morrison, D. 1999. Environmental and economic costs associated with non-indigenous species in the United States

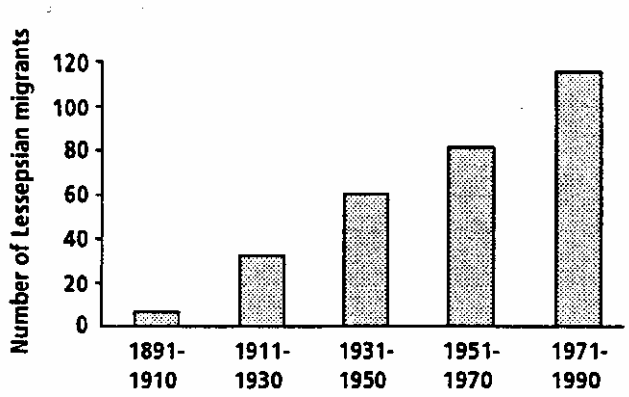
12/ Pimentel, D., S. McNair, J. Janecka, J. Wightman, C. Simmonds, C. O'Connell, E. Wong, L. Russel, J. Zern, T. Aquino, T. Tsomondo 2001. Economic and environmental threats of alien plant, animal, and microbe invasions. Agriculture, Ecosystems and Environment 84 (2001) 1–20.

13/ Gurevitch, J. and D. K. Padilla. 2004. Are invasive species a major cause of extinctions? Trends in Ecology & Evolution 29 (9): 470-474.

11. Islands are particularly vulnerable to the impacts of invasive alien species. Invasive alien species are the most significant driver of the decline of plant and animal populations and species extinctions in island ecosystems. 14/ In the Galápagos archipelago for example, the plant species introduced since the island's discovery in 1535 (600 species) now outnumber the native flora (500 species.). A significant percentage of these are invasive or potentially invasive 15/ and aggressively out-compete the Galápagos' endemic and native plants, altering the unique habitats that host numerous endemic animal species. 16/ In New Zealand, 1,790 native plant species compete with 1,590 invasive plants. 17/ A similar ratio is found in Hawaii, with 956 indigenous opposed to 861 invasive plant species. 18/

12. Information about trends in numbers of invasive alien species is rare. One notable exception is the data on the migration flow from the Red Sea to the Mediterranean through the Suez Canal. Being almost exclusively unidirectional, nearly 300 species of these Lessepsian migrants, including decapod crustaceans, molluscs and fishes, have entered the Mediterranean since 1891. Against expectations, according to which this migration should eventually approach a plateau, 19/ the number of introduced species continues to increase in an exponential way (figure 2).

Figure 2. Number of Lessepsian migrants, by periods of 20 years (data non cumulative), according to the date of first observation (or when it is not specified, the date of publication). 20/



13. In terms of costs losses to agriculture, forestry and fisheries are best documented: about a quarter of the United States agricultural gross national product is lost each year to foreign plant pests and the

14/ Pilot assessments: The ecological and socio-economic impact of invasive alien species on island ecosystems (UNEP/CBD/SBSTTA/9/INF/33).

15/ Magee, J., C. K. McMullen J.K. Reaser, E. Spitzer, S. Struve, C. Tufts, A. Tye, and G. Woodruff. 2001. Green invaders of the Galapagos Islands. Science 294:1279-1280.

16/ Tye, A., M.C. Soria, and M.R. Gardener. 2002. A strategy for Galapagos weeds. Pages 336-341 *in* Veitch, C.R. and M.N. Clout. Turning the tide: the eradication of invasive species. IUCN Species Specialist Group. IUCN, Gland Switzerland and Cambridge, UK. (see http://www.issg.org/Eradicat.html).

17/ Heywood, V. 1989. Patterns, extents and modes of invasions by terrestrial plants. Pp. 31-51 in: Drake, J. A., H. A. Mooney, F. di Castri, R. H. Groves, F. J. Kruger, M. Rejmanek, and M. Williamson, editors. 1989. Biological invasions: a global perspective. John Wiley & Sons, New York. 525 pp.

18/ Wagner, WL, DR Herbst, and SH Sohmer. 1990. Manual of the flowering plants of Hawai`i. Bishop Mus. Spec. Pub. 83. Honolulu: Univ. Hawaii and Bishop Mus. Press

19/ Por, F.D. 1978. Lessepsian Migrations. The influx of Red Sea biota into the Mediterranean by way of the Suez Canal. Springer Verlag - Berlin, Heidleberg, New York.

20/ Boudouresque, C.F. 1996. The Red Sea- Mediterranean link: unwanted effects of canals. Pp 107-115 In: Proceedings of the Norway/UN Conference on Alien Species. O. T. Sandlund, P. J. Schei, and Å. Viken, eds. The Trondheim Conferences on Biodiversity, July 1-5, 1996. Trondheim, Norway: Directorate for Nature Management/Norwegian Institute for Nature Research.

costs of controlling them, although a large portion does not concern native biota. In eastern forests, losses to European gypsy moths in 1981 were valued at $764 million, while the Asian strain that has invaded the Pacific Northwest has already necessitated a $20 million eradication campaign. About $100 million is spent annually to keep United States waterways clear of such plants as the Sri Lankan hydrilla and water hyacinth. 21/ The European zebra mussel has infested over 40% of internal waterways in the United States and may have cost between $750 million and $1 billion on control measures between 1989 and 2000.

14. The cumulative economic costs between 1988 and 2000 of the zebra mussel to European and North American industrial plants are estimated at between $750 million and $1 billion. Society could benefit from prevention of zebra mussels based on market values of damage to industry by spending up to $336,000 a year to prevent invasions into each lake with a power plant. In contrast, the United States Fish and Wildlife Service spent $825,000 in 2001 to manage all aquatic invaders for all US lakes. 22/

15. The annual economic losses to introduced pests in crops, pastures, and forests in the United States, United Kingdom, Australia, South Africa, India, and Brazil amount to nearly $230 billion. The annual environmental losses to introduced pests in the same countries were calculated at over $100 billion. The calculated dollar cost per capita for the losses incurred due to biological invaders in the six countries investigated were approximately $240 per year.

21/ Simberloff, D. (1996) Impacts of Introduced Species in the United States Consequences 2(2), 13-23. The Congressional Office of Technology Assessment "Harmful Non-Indigenous Species in the United States"

22/ Leung, B., D. M. Lodge, et al. 2002. An ounce of prevention or a pound of cure: bio-economic risk analysis of invasive species. Proc. R. Soc. Land. B 269: 2407-2413.

16. Assuming similar costs worldwide, damages from invasive species would be more than $1.4 trillion per year representing nearly 5% of the world economy. 23/

IV. POLICY RELEVANCE

17. Numerous international instruments, binding and non-binding, have been developed to provide certain elements of controlling the spread of invasive alien species. The most comprehensive is the Convention on Biological Diversity (CBD), which calls on its Parties to "prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats, or species" (Article 8(h)) and has adopted guiding principles for the prevention, introduction and mitigation of impacts of alien species that threaten ecosystems, habitats or species (decision VI/23*). Two much older institutions are the Office International des Epizooties (OIE), which was created in 1924 and focuses on global animal health, and the 1952 International Plant Protection Convention (IPPC), which applies primarily to plant pests, based on a system of phytosanitary certificates. Regional agreements further strengthen the IPPC. Other instruments deal with invasive alien species in specific regions (such as Antarctica), sectors (such as fishing in the Danube), or vectors (such as invasive alien species in ballast water, through the International Maritime Organization). Over 40 instruments or programmes are already in force, and many more are awaiting finalization and ratification. 24/ However, a number of gaps and inconsistencies in the international regulatory framework remain. 25/

V. TECHNICAL INFORMATION

18. Data on invasive species are available from IUCN Invasive Species Specialist Group, the Global Invasive Species Programme (GISP) and CABI. The GEF/UNDP/IMO Global Ballast Water Management Programme (GloBallast) 26/ maintains links to national, regional and global databases relevant to aquatic invasions. The FAO database on introductions of aquatic species (DIAS) 27/ was established in the early 1980s. It initially included mainly freshwater species of fish and has been expanded to include additional taxa, such as more molluscs and crustaceans, and marine species. In the mid-1990s a questionnaire was sent to national experts to gather additional information on introductions and transfers of aquatic species in their countries. The database, which contains now about 3,150 records, can be queried through the search form.

19. Scientific and technical information on invasive alien species is at present distributed in a wide variety of databases, many of them using incompatible standards and protocols. The Global Invasive Species Programme network therefore seeks to establish a Global Invasive Species Information Network (GISIN). The objective of GISIN is to enable these databases through the establishment of common gateways to allow for global searches and comparisons of information on invasive alien species.

23/ Pimentel, D., S. McNair, J. Janecka, J. Wightman, C. Simmonds, C. O'Connell, E. Wong, L. Russel, J. Zern, T. Aquino, T. Tsomondo 2001. Economic and environmental threats of alien plant, animal, and microbe invasions. Agriculture, Ecosystems and Environment 84 (2001) 1–20.

* One representative entered a formal objection during the process leading to the adoption of this decision and underlined that he did not believe that the Conference of the Parties could legitimately adopt a motion or a text with a formal objection in place. A few representatives expressed reservations regarding the procedure leading to the adoption of this decision (see UNEP/CBD/COP/6/20, paras. 294-324).

24/ Shine, C., N. Williams, and L. Gündling. 2000. *A Guide to Designing Legal and Institutional Frameworks on Alien Invasive Species*. IUCN, Gland, Switzerland.

25/ See the note by the Executive Secretary on identification of specific gaps and inconsistencies in the international regulatory framework, prepared for the ninth meeting of SBSTTA (UNEP/CBD/SBSTTA/9/15).

26/ http://globallast.imo.org/index.asp

27/ http://www.fao.org/waicent/faoinfo/fishery/statist/fisoft/dias/mainpage.htm

20. Data on the economic and ecological costs of invasive alien species are available for some countries, although calculations may differ. There is no published time series information on such costs.

21. While there is a wealth of information related to numbers and cost of invasive alien species a methodology to derive global trends information is yet to be developed.

VI. APPLICATION OF THE INDICATOR AT NATIONAL/REGIONAL LEVEL

22. Invasive alien species are a global problem requiring responses at all levels. Many countries have established systems to prevent and control invasive alien species and, as part of risk assessments, to predict the likelihood of alien species becoming invasive and the potential ecological and economic cost they may cause. While numbers and cost of invasive alien species are therefore relevant at the national and regional level this indicator is rarely used.

VII. SUGGESTIONS FOR THE IMPROVEMENT OF THE INDICATOR

23. There is a need to develop a methodology that allows integrating information on numbers and/or cost of alien invasions into a cohesive indicator. Only if statistics for one country or region are derived using a consistent methodology, it is possible to calculate trends. In the longer term, it would be desirable to develop a common methodology for counting alien invasions and for calculating the associated cost.

24. In additional to numbers and cost it would be relevant to add information on the area affected by alien invasions. This would provide a qualitative element to the indicator on trends in extent of selected biomes, ecosystems and habitats and might *inter alia* provide information on threats to protected areas.
