PART I
Introduction and rationale

Chapter 1
Introduction and rationale

1.1 IUCN assistance to develop guidance for CITES Scientific Authorities on the making of non-detriment findings, *Alison Rosser*

Introduction

Use of and trade in wildlife is a fact of life for human society around the globe. Despite concerns from the conservation community about the over-exploitation of wildlife, the reality is that in many cases use of wildlife will continue. Consequently, ways must be found to make that use sustainable and to make it work for conservation (see Hutton, this volume, Section 1.2). The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) was established in 1975 to ensure that trade in wildlife species is managed for sustainability. CITES aims to regulate international trade in wildlife products through international co-operation, whilst recognizing national sovereignty over wildlife resources.

CITES is now a conservation tool of major importance. The number of Parties to the Convention has been increasing steadily (numbering, at the time of writing, some 158 countries) and levels of implementation of the provisions of CITES are improving. However, there is still room for considerable improvement in the implementation of Article IV of the Convention. This Article requires, amongst other things, that exporting countries restrict trade in Appendix II species to levels that are not detrimental either to species' survival, or to their role within the ecosystems in which they occur (known as the "non-detriment finding"). In short, CITES requires that trade in Appendix II species must be based on sustainable harvest and consequently, Article IV forms the backbone of the Convention.

Despite this formal requirement for a non-detriment finding, i.e. that the harvest should be sustainable, many species continue to be traded in the absence of information about the impact of such exploitation on the wild population. This is often due to the lack of programmes to monitor both the levels of harvest and the status of wild populations of species exploited for trade. If this inadequate implementation of Article IV for exports of Appendix II species continues to be the rule, rather than the exception, then there will be grave consequences for many species, and their listing on Appendix I may be the ultimate sign of failure. Much of the success or failure of the Convention lies with the implementation of Article IV.

Co-operation amongst Parties is key to the effective implementation of the Convention and the task of fulfilling CITES obligations should be shared between exporting and importing countries. Although CITES places much of the responsibility on exporting countries to ensure that trade in Appendix II species is non-detrimental, many countries lack the necessary financial and technical resources to fulfil these obligations adequately and in some cases even the political will to ensure that the obligations under the Convention are fully implemented. In these countries little progress will be made in improving CITES implementation unless more sustainable resources are made available to aid them in meeting their obligations. Importing countries should also be prepared to provide training, technical and financial inputs to develop the necessary monitoring programmes for species in trade in exporting countries. Strengthening CITES Scientific Authorities in this way, could assist greatly in reducing the risk of trading in wild species, and their products, at unsustainable levels.

Means to improve sustainability assessments under CITES

To develop some pragmatic assistance for Scientific Authorities, IUCN convened a workshop to address the basic question of "what is meant by a non-detriment finding?" and to explore information needs for making such findings. The workshop, held in Hong Kong, brought together biologists, managers, and national CITES staff to explore the issue and develop practical guidance. The focus of the initial workshop was global, to allow general agreement by representatives from the CITES regions on a principle that will affect all Scientific Authorities. A subsequent workshop was held in Cambridge to refine the guidance and to test the recommendations emanating from the first workshop. It was anticipated that a series of regional workshops would be necessary to explore specific regional needs in more depth and to lead to training and awareness raising where necessary. Fortunately, the CITES Secretariat has now developed a work plan which includes a number of regional training workshops, where the guidance on making non-detriment findings can be discussed and further tested.

The first IUCN workshop comprised a series of papers aimed at introducing the problem, and these papers form the basis of this publication, leading on to the checksheets for Scientific Authorities developed at the two workshops. This volume is split into four parts. The first introductory part presents the problem; the second presents insights from CITES staff in producer and consumer countries; the third presents biological factors to consider in managing species for sustainable harvests and the fourth part introduces the final check-sheet approach that was developed, along with some worked examples.

In Part I (Chapter 1.2), Hutton, setting the scene, noted that like it or not, wildlife trade is a fact of life, people are using their natural resources and are unlikely to stop doing so. It was explained that wildlands may need to compete with alternative land uses and the overall aims of conservation may dictate that species are harvested in certain areas. Given this basic fact, Leader-Williams (Chapter 2) looked at the wording of the Convention and underlying harvest theory to produce some guidance on interpreting the term 'detrimental trade', and a discussion of points that should be considered in making non-detriment findings from a biological point of view. He considered harvesting theory and dealt with turning the theory into practice through adaptive management and the information needed to attain such management.

The requirements of the treaty and experiences of CITES Scientific Authority staff form the basis for the second part of the current volume (Part II). Van Vliet from the CITES Secretariat discussed the requirements of the treaty with respect to the non-detriment finding as encapsulated in Article IV of the Treaty and the relevant wording from the CITES listing criteria, etc. Then, Scientific Authority staff from a range of producer and consumer countries presented thoughts on how they interpret the requirement for a non-detriment finding, the methods that they use to make such findings and the problems that they encounter in making such findings, including some practical examples. The methods adopted in different countries vary considerably: from those where a lack of resources make it difficult to make non-detriment findings (NDFs) for a number of species, but the best information is relied upon (China, Cameroon and Togo); to those where resources are prioritized to the most needy species (Indonesia); to those where a system of national quotas based on population assessments is the aim (Namibia); to those where exports are generally prohibited because of the difficulty of making NDFs (Australia and Bolivia). Representatives from Australia and the US, both consumer and producer states, presented a detailed summary of points to consider in making non-detriment findings for imports and exports. As consumers of wildlife products, presentations from the European Commission and one of its member states, the Netherlands, introduced the stricter domestic measures that the EC may recommend after consultation with range states. From this array of papers, it is clear that whilst the interpretation of non-detrimental trade varies considerably amongst Parties, many Parties share a common lack of expertise, resources, and even communication difficulties when trying to make non-detriment findings.

The third part comprises a set of papers that dealt with technical aspects of determining whether harvests are likely to be sustainable. Bodmer considered the utility of models in assessing the sustainability of harvest of forest mammals and looked at practical methods of harvest monitoring in such conditions. Van Dijk focussed on the biological aspects to consider in assessing the suitability of a reptile and amphibian species for harvest. From these biological considerations, Mulliken moved on to discuss underlying harvest and trade management structures in relation to the bird trade, emphasising the importance of developing management plans, monitoring the harvest, and involving stakeholders in decision-making. Bodasingh discussed the utility of CITES annual report data, encouraging Parties to examine not only their own data, but those of other Parties too.

The practical results of the working group sessions at both workshops are presented in the fourth and final part of this volume. In considering what is meant by "a non-detriment finding", the Hong Kong working groups decide to narrow their focus. They agreed to concentrate on Appendix II species, leaving the requirements concerning imports of Appendix I species for non-detrimental purposes to some other occasion. By examining the Convention Text, participants highlighted the elements that should be included in an operational explanation of what is meant by, "non-detrimental to the survival of a species", but did not manage to produce an agreed definition. However, further consideration of these elements helped to focus participants on the information that should be considered in assessing the likely detriment or otherwise of the harvest. In addition to the biological characteristics of the species, socio-economic factors were also thought to provide important influences on the likely sustainability of harvests. It was recognized that in many cases neither detailed biological nor socio-economic information might be readily available, and so monitoring and adaptive management of the harvest must play a central role in ensuring non-detriment. Recognizing the constraints that many Parties are working under, participants determined that guidance must be pragmatic, starting from the lowest common denominator and then working to encourage better monitoring and data collection.

Taking these points further and incorporating items from some of the presentations, the rudiments of a qualitative checklist were established. After the workshop, the checklist was expanded, an explanatory guide was compiled and most usefully, a visual representation of the results was developed by a drafting group. In 1999, the checklist and guide were then expanded to incorporate further specific aspects relating to flora, and tested with a range of plant and animal examples from a variety of CITES regions and finalized during a second workshop. The final checksheet, explanatory material and some species examples are all included in Part IV of these proceedings.

In addition to the difficulty of dividing the requirement for a non-detriment finding into practical tasks, the Scientific Authority staff also noted a number of improvements that could be made in the process for making the non-detriment finding. These included: enhanced communication between national Scientific and Management Authority staff; better links with other institutions in country; better co-operation between importer and exporter nations; and a framework for co-operation between Parties to facilitate technology and capacity transfer.

This volume presents the background to the development of the non-detriment finding checklist and explains how the checklist itself is designed to work, in the hope that Scientific Authority staff will take and develop the parts of the approach that they find useful.

1.2 The contribution that well-managed international trade can make to species conservation, *Jon M. Hutton*

The issue

In considering the role that well-managed trade can make to species conservation, there are two major points to bear in mind. The first point is that wild species are being used and are bound to be used the world over. In many places they form a large part of, or even the entire, foundation for human survival. Only a tiny portion of this use is for international trade and prohibiting trade will reduce wild harvests only in very specific instances. In some cases, the removal of international trade, which returns a high value, can actually result in higher harvests as the harvesters seek to maintain their income from local, lower-value markets or because the species, in losing its value, becomes a pest. The restriction and prohibition of trade can be an important conservation tool, but it is far from a universal panacea. It must be used like a scalpel, not a mallet.

The second point is that the principal threat to wildlife as a whole is not international commercial trade, but habitat loss – closely followed by hunting for reasons other than international trade, and the introduction of invasive alien species. Experience from southern Africa and other areas suggests that one of the most effective tools to fight the pressures which lead to habitat loss (and in some cases to control domestic hunting activities) is to commercialize wild species through international trade. This is not a complex argument. In most, if not all countries of Africa the natural wild habitats which support wildlife are decreasing as they are converted to agriculture and other human uses. As population pressures rise, so even marginal lands are converted and protected areas come under direct pressure. The fundamental problem is that natural habitats cannot compete in economic terms with agricultural uses. If a farmer grows elephants he grows nothing more than a problem. If he grows cattle he can eat and sell them. The proven solution is to make wildlife as much a part of the economy as agricultural commodities, and in so doing to ensure that they are as valuable as possible. In other words, the solution is to give wildlife value, not to take it away – as is so often the case in CITES. Furthermore, where conservation systems are based on the economic incentives which flow from trade, and where well-managed systems of trade have been established it is in noone's interest to see illegal or unethical trade prosper. The conventional wisdom that legal trade inevitably leads to illegal trade is quite clearly wrong. Certainly, the southern African experience is not a universal truth but it is sufficiently important to make it imperative for CITES to evolve in a way that encourages the potential benefits of trade, wherever they might be found, whilst ensuring the sustainability of that harvest.

To ensure that CITES can contribute to conservation through international trade it is vital that the non-detriment requirement of Article IV is properly implemented by exporting nations to ensure sustainability. The failure to do so properly to date has resulted in:

a) a stream of species being transferred to Appendix I from Appendix II, and consequently removed from commercial trade; and

b) a range of stricter domestic measures being implemented by importing Parties which also commonly result in the restriction of trade.

In the first case it is clear that for some species, CITES has had little effect, except for that of monitoring the species as they decline until they reach such dire levels that they can be considered endangered and included on Appendix I. Can this be considered an effective measure for conservation?

With respect to the second case, the unilateral imposition of stricter domestic measures is hardly a sound basis for a multilateral environmental agreement.

As the Convention stands, the implementation of non-detriment findings for Appendix II exports relies entirely on the capacity of the exporting country – the Articles exclude any role for the importing country or the international community – and herein lies the root of the problem. The extent to which the provisions of Article IV are implemented by Parties differs considerably and is highly dependent on several variables – the most significant of which appears to be inadequate legislative, administrative and technical capacity within the exporting country. In practice, what this has tended to mean is that CITES is constructed around one list of species (Appendix I) where authority lies with the international community and no commercial trade is possible, and another (Appendix II) where all trade is possible and its control is dependent entirely on the capacity and integrity of the exporting authorities.

Possible solutions

Possible solutions to deal with these problems include:

a) Improve the way that range states implement Article IV (the purpose of this workshop);

b) Devise a 'patch' or 'safety net' for the Convention (the Significant Trade Process fills this role);

c) Entrench the response which results in more species being removed from trade through an Appendix I listing or unilateral stricter domestic measures.

We suggest that the first two options are reasonable, the third is not. Furthermore, we urge caution in the way that a) and b) are implemented. There is an unfortunate tendency in some quarters to assume that international commercial trade is inherently incompatible with conservation, an attitude which leads to a 'hard line' approach to Article IV and Resolution Conf. 8.9.

In urging a more moderate, gradual and co-operative approach which recognises trade restriction and prohibition as the measures of last resort, the goal must be to ensure that trade is sustainable. Only through ensuring that non-detriment findings are properly implemented can we enjoy the benefits that well-managed trade can make to species conservation in the long term.

Chapter 2
When is international trade in wild animals detrimental to survival: principles, avoidance and monitoring?

Nigel Leader-Williams

Introduction

Determining when international trade is likely to prove detrimental to the survival of species is essential to achieving the aims of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). If species become threatened with extinction as a result of use incompatible with their survival, Parties to CITES face the prospect of including more species on restrictive appendices. Indeed, every transfer of a species from Appendix II to Appendix I could in this context be considered as an example of the failure of the Parties to fulfil their obligations under the Convention (Wijnstekers 1988–92). Therefore, it is very important that those responsible for implementing this key step in Scientific Authorities fully understand its implications. Accordingly, this paper has the overall goal of leading workshop participants towards appropriate working definition(s) of "detrimental to survival". In order to achieve its goal, the paper has the following specific objectives:

- to outline obligations with regard to making non-detriment findings under the Convention;
- to examine the theoretical differences behind approaches to harvesting that do, and do not, remove animals from the wild population;
- to briefly consider harvesting theory and the consequent definitions of over-utilization, that in turn both allows the non-detriment finding to be applied to well-studied species traded internationally, and sets a benchmark for little studied species;
- to recognise that many species and populations now being harvested are currently little-studied, such that ongoing harvests must be managed adaptively; and
- to outline the importance of establishing basic facts and an adequate monitoring system for a programme of adaptive management.

Convention and resolution text

The term "detrimental" appears in the articles of CITES, with reference to a Scientific Authority advising that international trade "will not be detrimental to the survival of the species involved" (Box 1). Despite these requirements, successive Conferences of the Parties (COP) have acknowledged that non-detriment findings were not always being made. Therefore, various resolutions have been adopted that have increasingly brought in others to provide advice on the non-detriment finding. Nevertheless, the most recent resolution still emphasises the role of Scientific Authorities and their ability to make appropriate non-detriment findings (Box 1). The language of the Convention and this resolution place emphasis on the Scientific Authority of the exporting state undertaking the necessary scientific review to determine whether harvests of species listed on Appendix I and II, and destined for international export, are appropriate in relation to factors affecting the status of populations under their care. In contrast, the Scientific Authority of the importing state only determines whether the purpose for which the import of a species listed on Appendix I is intended is appropriate. Hence, the goal of this paper has been formulated in the spirit of leading towards some clarification in the roles of different Scientific Authorities in making non-detriment findings.

The language of Articles III and IV and subsequent resolutions ties the term "detrimental" specifically to the survival of the particular species. When applied to single species, survival is the opposite of extinction. On this basis, biological principles would appear to provide the best hope of leading towards appropriate definition(s) of the term "detrimental" in relation to international trade in species included on Appendices I and II. On this basis, this paper does not discuss economic or social sustainability as they apply to our current understanding of sustainable use (e.g. Freese 1997), as the Convention does not appear to require a Scientific Authority to give advice on these two issues.

This paper also does not deal with the role of an Appendix II species in its ecosystem. This issue is avoided for three main reasons. First, because the word "detrimental" is not stated explicitly, even though it might well be implied. Second, because our knowledge of the role of species in ecosystems is rudimentary in relation to making decisions of this complexity. Third, because the workshop will have quite sufficient work to accomplish in working through explicit statements related to "detrimental to the survival of the species involved".

Box 1. Convention text and important resolutions referring to the role of a Scientific Authority in making a non-detriment finding.

The Convention makes some similar requirements for species listed on Appendices I and II. Articles III.2.(a) and 5.(a) require that the Scientific Authority of the State of export or of introduction, respectively, advise that the export or introduction from the sea of specimens of species included in Appendix I "will not be detrimental to the survival of the species involved". Articles IV.2.(a) and 6.(a) make the same requirement for the export or introduction from the sea of specimens from species included on Appendix II. However, the Convention also makes two differing requirements for species listed on Appendices I and II. Article III.3.(a) requires that the Scientific Authority of the State of import advises that the import of specimens of species included in Appendix I "will be for purposes which are not detrimental to the survival of the species involved". Article IV.3 also requires the Scientific Authority of the State of export to determine when to limit the granting of export permits for Appendix II species "in order to maintain that species throughout its range at a level consistent with its role in the ecosystems in which it occurs, and well above the level at which the species might become eligible for inclusion in Appendix I". Articles III and IV both stipulate that the issuance of a CITES permit by the Management Authority should be contingent upon a prior finding of non-detriment by the Scientific Authority. Article XIII vests authority with the CITES Secretariat to intervene with a Party when there are problems with implementation.

Various resolutions have been adopted (Resolution Conf. 2.6, 4.7, 6.1 and 8.9) that allow others to make decisions on the non-detriment finding, including other Parties (Resolution Conf. 2.6), the Animals Committee (Resolution Conf. 6.1), and the Standing Committee and Secretariat of CITES (Resolution Conf. 8.9). Nevertheless, Resolution Conf. 10.3 recommends, *inter alia*, that:

- the appropriate Scientific Authority advise on the issuance of export permits or of certificates for introduction from the sea for Appendix-I or -II species, stating whether or not the proposed trade would be detrimental to the survival of the species in question, and that every export permit or certificate of introduction from the sea be covered by Scientific Authority advice;
- the findings and advice of the Scientific Authority of the country of export be based on the scientific review of available information on the population status, distribution, population trend, harvest and other biological and ecological factors, as appropriate, and trade information relating to the species concerned;
- the appropriate Scientific Authority of the importing country advise on the issuance of permits for the import of specimens of Appendix-I species, stating whether the import will be for purposes detrimental to the survival of the species.

Effects of different harvesting regimes

Background to harvesting

Man has harvested wild species of animals and plants since time immemorial. Nevertheless, trade in wildlife and its products makes many conservationists nervous, because over-harvesting for monetary profit has so often over-ridden biological concerns (Caughley and Gunn 1996, Freese 1997, Milner-Gulland and Mace 1998). Hence, there are many examples of collapse in trade and/or stocks, particularly of large-bodied mammals whose relatively slow rate of reproduction is less than the rate at which interest can be earned on money placed in the bank through liquidating the stock (Clark 1990), and over-harvesting has been a prominent member of the evil quartet responsible for causing documented extinctions of mammals and birds since the 1600s (Diamond 1989). A few examples of stock declines are cited below:

- Monk seal *Monarchus* spp., sea lion *Zalophus* spp., and fur seal *Arctocephalus* spp. trade
- Southern Ocean whaling industry
- Tuna *Thunnus* spp. fishing industry
- illegal harvesting of Sumatran *Dicerorhinus sumatrensis* and black rhinos *Diceros bicornis*

At the same time, protection of wildlife from trade makes many other conservationists nervous. They argue that, with sustainable and well-regulated harvesting, profits can be generated that should strengthen the case for conservation. However, there are far fewer examples of actual positive success in improving the status of species but the best examples are:

- ranching of crocodilians Order Crocodylia
- hunting of leopards *Panthera pardus*
- live sale and hunting of white rhinos *Ceratotherium simum*

Even though there are relatively few examples of positive success, many would also argue that continued consumptive use has done less to impoverish biodiversity than converting land to other forms of use such as clear cutting of forests or cattle grazing of native grasslands. Hence, a comparison of rates of loss also needs to be considered in the "use it or lose it" debate, as well as positive successes (Freese 1997).

Theoretical requirements for different approaches to harvesting

There are two main approaches to harvesting, the first where the animal remains in the wild population, and the second where the animal is removed from the wild population. This distinction is important, because each approach is underlaid by different theoretical and practical implications.

The animal remains in the wild population:
Numerous examples exist of actual or possible harvesting strategies where the animal remains alive in the wild population, for example:

- down collected from nests of eider ducks *Somateria* spp.
- birds' nests collected from swiftlets *Collocalia* spp.
- wool sheared from vicuña *Vicugna vicugna*
- hair collected from muskox *Ovibos moschatus*
- horn taken from white rhinos *Ceratotherium simum*

A harvest of this kind may result in some impact to the population, for example, through capture or disturbance. The productivity of such harvests is generally highest when populations are **at their largest size or maximum carrying capacity**. However, there is little theoretical basis to deciding whether or not to harvest and upon appropriate quotas. The decision of whether to harvest, e.g. vicuña wool, or not to harvest, e.g. white rhino horn, and of appropriate quota levels, is largely based on the likely success of imposing trade controls and/or the effects of allowing a legal trade upon other related species and populations.

The animal does not remain in the wild population:
The other more widespread approach to harvesting is where the animal does not remain in the wild population, either because it is killed or is removed live. Examples of harvesting by this route abound, and include the following:

- hunting and cropping in their various forms, whether for sport, trophies, food, medicine or other animal products;
- fishing in its different forms, whether for sport or food, or other fish products;
- live capture in its various forms, whether for zoos, aquaria or the pet trade.

In contrast to the approach where an animal remains in the wild population, a strong theoretical basis underlies the approach to harvesting where the live animal does not remain in the wild population.

Harvesting theory for removal of animals

Harvesting models

Several different models, of varying degrees of complexity, are available to underpin the theory of harvesting as it applies to removal of animals from the wild population (for details see Clark 1976, 1990; Caughley 1977; and Milner-Gulland and Mace 1998). The simplest is the logistic model (Box 2). The theory underlying the logistic model was succinctly summarised for a previous IUCN workshop by Caughley (1992), and the points he made previously are largely re-iterated here:

- generally, the highest sustainable productivity comes when populations are **below their largest size or maximum carrying capacity**;
- if populations are reduced in numbers to below carrying capacity, they tend to increase;
- the biologically optimal strategy of harvesting is to lower the density to the point at which the population achieves maximum productivity, and then to harvest at the same rate as the population reproduces;
- harvesting always reduces density of a species, and numbers will decline during the first few years of a harvesting operation, and this initial decline does **not** mean that the species is being over-utilized.

Regulating harvests

All harvesting theory refers to the idea of maximum sustained yield (MSY). Theoretically, MSY is the largest harvest that can be taken from a population indefinitely, without driving the population towards extinction (Box 2). The manager may calculate or arrive at estimates of MSY in two different ways:

- in theory, MSY may be calculated directly but the biological information necessary for such a calculation is rarely available;
- in reality, MSY is more often arrived at through the trial and error or adaptive management approach, and this has much to recommend it.

Box 2. Details of logistic model

Populations can grow in a logistic fashion, represented by an S-shaped (sigmoidal) curve, until the population reaches its maximum size *K*. The rate of growth is slow initially, increases to its maximum r_m and slows latterly as *K* is approached. If the population is now harvested at an instantaneous rate to hold the population size constant, the instantaneous harvest rate must equal the instantaneous growth increment. If the logistic equation is substituted, this produces an equation that has the algebraic form of an upwardly convex parabola passing through the origin. The sustained yield (*SY*) is the same as the harvesting increment, and this parabolic equation informs us that:

- *SY* is zero when *N* is zero (i.e. no population, and therefore no yield);
- *SY* is also zero when *N* is set at its maximum unharvested size of *K* (because the realised growth rate when $N = K$ is zero). Thus any harvest from a population of size *K* will decrease the size of the population;
- Between $N = 0$ and $N = K$, the *SY* first rises and then falls;
- The *MSY* (maximum sustained yield) is taken from a population size of $N = 0.5K$ at the instantaneous rate $H = 0.5r_m$.

Hence, the logistic model allows MSY to be defined as the harvest that keeps the population at half the carrying capacity. The manager may calculate or arrive at estimates of MSY in two different ways:

- In theory, MSY may be calculated directly from the **size of a population** before harvesting and its **maximum rate of increase**, combined with various other attributes of the species and its environment;
- In reality, population size is often not known prior to or during harvesting, so MSY can seldom be calculated directly. The approach used most often is to begin harvesting with an annual yield set well below the likely MSY. The population is monitored directly or through indices of abundance to confirm that it is behaving according to prediction, in other words it is not decreasing. After several years, the yield may be cautiously fine-tuned up towards the MSY. This is the trial and error or **adaptive management** approach to estimating MSY.

N.B. It is increasingly recognised that due to the unpredictability of environmental and other stochastic events, harvesters should not aim to achieve MSY, but rather aim for a more precautionary level of harvest.

Both these methods of calculating or arriving at MSY result in a relatively fixed yield or constant harvest. Administrators prefer the option of harvesting a constant number, because it allows the annual setting of a fixed quota that is easy to visualize, to justify to officials, to share between resource users or to report to national or international bodies. However, this approach has a number of biological disadvantages, including not taking account of year-to-year changes in population size and not limiting harvesting effort to reach allowed quotas (Box 3).

Alternative approaches to managing harvesting include either limiting harvesting effort or taking a constant proportion of the population (Box 3). Both these approaches to harvest regulation can be much safer biologically than setting a constant numerical harvest, because they are self-correcting as a population changes in size. Unfortunately, neither approach produces a fixed yield. The yield is likely to vary from year to year. Hence, the approach of regulating harvesting effort, which has the advantage of not requiring information on population size (Box 3), has the drawback that most administrators responsible for harvests will become nervous because they no longer have direct control over the size of the actual yield. Furthermore, regulating harvest effort is likely to prove difficult within the context of CITES, where relatively fixed quotas are easier for Parties to understand, approve, report and regulate. Equally, the approach of harvesting a constant proportion of the population requires accurate information on population size, which is often not available in the context of species traded under CITES.

Complications of harvesting

Despite all the underlying biological theory, most population harvesting is a highly practical affair. Either the resource users take:

- an arbitrary harvest each year, or
- as many as they can get with the time and equipment available.

This pragmatic approach sometimes results in a sustained yield, sometimes in over-utilization, for example:

- yields taken by recreational/sport/tourist hunters, the harvest being controlled by a government department, are usually inefficient SY, the yield being conservative.

Box 3. Methods of regulating a harvest

a) Harvesting a constant number

For the administrator, the harvest of a relatively fixed yield, or constant number, is the preferred option as it allows the annual setting of a fixed quota. However, setting a constant number for harvest can, and often does, push a population below the size yielding MSY because:

- environmental variation, such as bad winters or prolonged dry seasons, can cause considerable year to year variations in population size; and,
- it encourages greater harvesting effort or the introduction of improved technology, in other words working more and enjoying it less, as in the case of most fisheries heading for collapse.

Hence, the harvest of a constant number, and any subsequent quotas, should be set at considerably less than MSY.

b) Harvesting with a constant effort

Within limits, a given harvesting effort takes about the same percentage of a population whether it is at high or low density. Regulating by effort thus tracks population size by taking more animals when the population is larger and fewer when it is smaller. Such a safeguard is exactly what is needed when harvesting those species whose numbers fluctuate from year to year (for example, the irregular entry of a strong age class into the population, or irregular climatic changes that are a feature of the life history and ecology of the saiga antelope, *Saiga tartarica*) or whose size is not monitored regularly. The maximum sustainable harvesting effort represents that level of effort that takes a proportion of the population each year equal to the population's maximum rate of increase in that environment.

Regulating harvesting with a constant effort may take the form of:

- in the case of a fishery, a limit on the number of boats licensed to harvest a fish stock, a specified type of fishing equipment or a limit on boat-days, or,
- in the case of a hunting area, a limit on the number of recreational hunters licensed to hunt a particular area, a fixed hunting season, or a limit on numbers of hunter days, and so on.

The approach of regulating harvest through a constant effort is biologically more robust than regulating it through a constant number. Among its major advantages are:

- that it needs less fine tuning than constant yield harvesting, and can produce higher yields; and,
- it can be administered without monitoring population size or knowing the relationship between population size and population growth rate.

Among its disadvantages are:

- that it tempts harvesters to use more sophisticated technology to circumvent limits on hunting or fishing days;
- yields vary from year to year, depending on population size; and,
- the resource users may not see a clear relationship between policy and practice.

c) Harvesting a constant proportion of the population

Regulating harvesting by taking a constant proportion of the population has the same underlying theoretical basis of self-correction as harvesting with a constant effort. The optimum sustainable harvesting effort takes a percentage of the population each year approximately equal to half the intrinsic rate of increase. This is not half of the population size before harvesting starts, but half of the much reduced size to which the population is held down by harvesting. The approach of regulating harvesting by taking a constant proportion of the population offers a different mix of advantages and disadvantages to the approach of harvesting with a constant effort. Among the advantages of the former are:

- resource users can see a clear relationship between harvesting a constant proportion of the population and its biological characteristics; and,
- harvesters can use any technology they please, to ensure that harvesting is economically more efficient than constant effort harvesting.

Among its major disadvantages are:

- the population size must be known in order to set the harvest, which may prove a considerable expense for the regulator; and,
- yields will vary from year to year depending on population size.

- yields taken by professional fishermen or full-time hunters, even when harvest is being controlled by a government department or an international convention, are usually too high, the stock being forced down to a level that is uneconomic to harvest. The fishing fleet or hunting gang then moves to a new stock.

Even scientifically sanctioned calculations of sustained yield do not necessarily produce more success in conserving stocks than the pragmatic option, e.g.,

- year-to-year variations in the environment are often not included, and tend to lower the actual sustained yield that can be harvested; and,
- economic considerations are often omitted.

What is over-utilization?

The theory of harvesting outlined above suggests several ways that, under ideal and data-rich conditions, over-utilization detrimental to the survival of a species may be detected and defined (Caughley 1992).

What are the indications of over-utilization?

Over-utilization may be indicated in several ways:

- in a system where population data are available, and that population is below half its unharvested density and is continuing to decline under harvesting, there is a justifiable presumption of over-utilization;
- sometimes harvest can be estimated reasonably accurately, whereas population size is known only within very wide limits, if at all. Nonetheless, the sheer magnitude of the harvest may be such that it can confidently be declared above the MSY for any plausible population size. As an example, comparing very crude estimates of African elephant numbers with the volumes of ivory entering the trade in the 1980s suggested that elephants were being harvested above their MSY in many areas of Africa (Caughley *et al*. 1990);
- sometimes enough is known about the size and dynamics of the population to show that harvest is above the MSY. Many examples derive from the literature on whaling (Clark 1990).

How can over-utilization be defined?

On the basis of his considerations of underlying theory, Caughley (1992) formulated three possible definitions of over-utilization as follows:

- the number harvested each year exceeds the maximum sustained yield of the species; or
- the percentage harvested each year exceeds the intrinsic rate of increase of the species; or
- the harvesting reduces the species to a level at which it is vulnerable to other influences upon its survival.

This forms a very useful basis on which to move forward for relatively well known species groups such as elephants or whales. However, problems still remain for less well known groups if no estimates of population size or of life history variables are available to set against harvest rates. As examples, how does the harvest of several hundred thousand snakes per annum from a rattlesnake drive relate to the size or rate of increase of the snake population, or how does the export of several thousand finches per year for the live bird trade relate to the finch population?

Adaptive management

Adaptive management, a concept formalized from the process of trial and error, has proven a useful approach to the paucity of data that often surrounds issues of harvesting less well known species groups. Even for species where some basic facts of biology and ecology such as population size or maximum rate of increase are known, adaptive management is a crucial concept because:

- ecological systems are very complex and great uncertainties surround consequences of the use of those systems, and of the consequences of environmental, social and economic changes; and,
- management itself must be sustainable, and able to adapt to changing conditions.

A system of adaptive management reviews decisions and procedures and uses the lessons learned to adjust the management system. The central component of effective adaptive management is the monitoring system that is incorporated to evaluate management activities. Hence, an act of management, such as harvesting, is designed as a trial, the outcome of which can be assessed scientifically and improved upon where necessary. Hence, I now move to some practical considerations of both a biological and an anthropogenic nature, before describing a basic monitoring system that ensures the establishment of an effective system of adaptive management.

Practical needs for determining if harvests are detrimental

The following points should be considered when developing a framework for assessing the impacts of harvesting for international trade on the status of species:

- harvests for international trade may be only one of several biological or harvesting impacts acting upon a population;
- species have different biological characteristics depending on their body size and different positions in the food chain, which in turn affect their robustness to different levels of harvest; and,
- different harvesting operations target very different segments and volumes of the population, and will vary in their level of impact upon the population.

Once these basic points have been considered in a general approach for setting quotas for different kinds of species and for different kinds of harvesting operations, it then becomes important to establish a basic monitoring system.

International trade as one of multiple impacts upon a population

The harvesting of specimens for export is part of a range of impacts to, and threats that face species. Scientific Authorities need to be aware of, and take account of, these other impacts. Impacts range from those of a more biological nature, to those that are related to different forms of use.

Biological impacts:
Biological factors that may cause threats, particularly to small populations of a species, are divided into intrinsic and extrinsic factors (Mace and Lande 1991). Intrinsic factors include population dynamics, such as age structure and variation in rates of birth and death, population characteristics, such as genetic variability and dispersal patterns, and patterns of distribution, such as restricted ranges and numbers of sub-populations. Extrinsic factors include patterns and rates of environmental variability, habitat quality and availability, interactions with other species, catastrophes and contagious diseases. In an ideal world, knowledge of these impacts would allow harvests to be modified to improve the chances of species survival. However, it is often not economically or logistically possible to collect data on these impacts for species in international trade.

Harvesting impacts:
Species may be harvested for a range of uses other than for the international trade that comes under the purview of CITES. These uses may include local or domestic hunting or capture of species for sport, trophies, food, medicine or other animal products, carried out with or without legal sanction. In addition, consideration must be given to the scale of any international trade that is carried out illegally. Furthermore, there may be additional losses to the population that occur before export, for example due to unrecovered fatal wounding of hunted animals, or capture, post-capture or transport mortality of live-caught animals.

At its extreme, international trade that is non-detrimental to the survival of a particular species must avoid reducing, either directly or indirectly in association with a biological impact or another type of harvest, the total population of that species to a size, structure or number of sub-populations that is in any greater risk of extinction than it is already. However, there is an important practical implication of this definition. International trade in threatened species need not necessarily be precluded, providing it can be shown that it at least contributes to the lessening of threats such as habitat conversion or pest control that are occurring anyway. The classic example here are the crocodilians, where ranching has led to improved status of several species as opposed to continued and increasing threats causing further declines in status.

Species characteristics and type of harvesting

Species that are harvested display a range of life history patterns. Equally, different types of harvesting may target different segments and proportions of the population. These factors in turn can interact in determining whether international trade might be detrimental to the survival of the species.

Species characteristics:
Two important ecological characteristics of individual species need to be considered: the concept of *r* and *K* selection, and principles underlying the trophic structure within ecological communities (see for example Begon, Harper and Townsend 1996).

In very general terms, species of large body size within particular taxonomic groups tend to grow slowly and have a high age of sexual maturity, have a low reproductive rate, produce few young and invest in their survival, have a low rate of adult mortality and be selected to survive at carrying capacity, *K*, in relatively stable environments. Among mammals, the classic example is an elephant. In contrast, species of small body size tend to have a low age of sexual maturity and a high reproductive rate, produce more young and invest less in their survival, have a high rate of adult mortality and be selected to survive and reproduce rapidly, with a high *r*, in a more variable environment. This generalization of *r* and *K* selected species, like all dichotomies, is an oversimplification. However, it provides a useful framework in which to consider the biologically optimal strategies by which to harvest particular species.

Energy is lost each time it is converted through different trophic layers of an ecological community. Hence, there is a lower biomass of carnivores than there is of herbivores, while in turn there is a lower biomass of herbivores than there is of primary productivity. This generalization also provides a useful framework in which to consider proposed quotas. There should be fewer lions than buffaloes on an African hunting quota, and fewer raptors than finches on a live bird quota, without raising suspicions of trade detrimental to the survival of those species.

Harvesting characteristics:
Different types of harvesting target different segments and quantities of the population, as the following examples highlight:

- legalized trophy hunting specifically targets small numbers of prime males, usually well below MSY, while unregulated meat hunters harvest age and sex classes more indiscriminately and in larger numbers, and often close to or above MSY;
- live capture of birds and reptiles for the commercial pet trade also targets sub-adult and adult age and sex classes relatively indiscriminately and in large numbers, while live capture of animals for zoos, terraria and aquaria is generally more selective and of lower volume;
- a crocodilian ranching operation specifically targets the harvest of eggs and juveniles, which otherwise experience very high levels of mortality of around 98% annually. In contrast, the harvest of adult crocodilians, which are generally long-lived, slow to reach sexual maturity and experience low mortality of some 5–6% annually, for skins and/or pest control is generally above MSY and can result in a population decline.

The crocodilian example shows a very clear recognition of the need to combine biological characteristics of the species and the approach taken to harvesting in a manner that is least detrimental to the survival of the species concerned. In contrast, any high volume and indiscriminate harvesting of a large-bodied predator would give grave cause for concern, as MSY could easily be exceeded, while a high volume trade in a small bodied and rapidly reproducing herbivore or granivore would give less cause for concern.

Establishing a monitoring programme in an exporting country

The theory of harvesting already outlined has been developed from well monitored fishing and whaling operations, and added to with examples from well known terrestrial mammals. At present, monitoring of both populations and of capture effort in many exporting countries is poor or non-existent for many species in international trade, particularly for those species that are hard to census directly. So, the basic requirements for ensuring that utilization is not detrimental to survival are not being met at present for many species. Thus, there is a yawning gap in both practice and understanding between the principles established through harvesting theory, and the practical management of many harvesting operations, including for international trade. Given that much harvesting will continue anyway, whether or not attempts are made to outlaw it through domestic or international measures, and given the concept of adaptive management, it is incumbent upon resource managers to review harvesting operations under their management. Thus, a recent resolution (Box 1) recommends that countries of export base their regimes of harvest management on the scientific review of available information on the population status, distribution, population trend, harvest and other biological and ecological factors, as appropriate, and trade information relating to the species concerned. There is no qualitative difference between the steps that a Scientific Authority of an exporting country need take for species on Appendix I or II, as recognised both by Convention text and recent resolutions (Box 1).

In order to set their international trade, and any subsequent monitoring programme in context, the first step for any exporting country is to establish an appropriate policy and legislative regime. The subsequent implementation and success of any harvesting programme is first determined by defining the objectives of such programmes. Management regimes and trade controls for particular species must be part of a larger overall government policy for wildlife conservation and utilization. Governments should determine their priorities, for example, habitat and/or species conservation, generation of foreign currency, development of employment opportunities, and so on. Once identified, these priorities can provide the foundation of government policy, and the general framework within which to develop management schemes for single species or species groups in international trade.

There are then two main components for a comprehensive monitoring programme, first biological monitoring and second, the monitoring of harvests and export controls (quota, permit and trade-monitoring system). In an ideal world, biological monitoring should precede the monitoring of harvests and export controls. However, harvesting is often the way in to establishing MSY through adaptive management, and this more often precedes the gathering of detailed biological information. Nevertheless, this section will follow events in an idealized world and first discusses the requirements of biological monitoring.

Establishing a simple biological monitoring programme:

This first requires the collection of baseline population data, where none previously exists. A practical and sensible methodology would comprise the following:

Assessing suitability of species for harvest:

- ascertain the basic biology of the species, with large-bodied species or rare species or food specialists more at risk than small-bodied species or generalists;
- assess the geographic distribution and range of the species, with endemic and localized species more at risk than widespread, non-endemic species;
- determine the area of available habitat within the range and the proportion that is protected, with those species receiving no effective protection more at risk.

Assessing risks of harvest:

- assess extent of other forms of harvesting other than international trade;
- survey the population density in representative parts of the range, and compute the likely upper and lower population levels, coupled with an evaluation of reproductive and recruitment rates;
- based on the above, the calculation of conservative harvest quotas, using the lowest likely population level and taking note of the intended method of harvest, and apportionment of allowable harvests to international trade and other categories.

To make some of the initial assessments, Scientific Authorities can, at the very least, refer to field guides, international lists of protected areas (IUCN 1994), and Red Lists (IUCN 1996), if good local data are not available. Lists of protected areas show how much of that range is theoretically under protection. Red Lists provide an international assessment of threats to species, however coarse grained these may be for the situation in individual range states. Local data sources might comprise: biologists and anthropologists from local universities who have undertaken studies of distribution and status, or of use; national or regional biodiversity inventories (e.g. Stuart and Adams (1990) for sub-Saharan Africa); government departments of forestry, fisheries, agriculture and environment, who may have figures on rates of habitat conversion, livestock density, pesticide use and pollution; protected area managers, who can assess the proportion of the range or population under effective protection; and so on.

This initial assessment can be developed into a regular monitoring programme that undertakes annual censuses of density in the same areas of the range as above, using game scouts, local communities, university students, CITES Scientific Authority, and others. This should also be accompanied by the annual monitoring of capture effort, using an index relevant to the system of harvesting, for example hunter days, and regular reviews of distribution and habitat availability. Quotas can be revised as necessary based on information collected through regular monitoring.

Monitoring of harvest and quotas:

Governments of exporting countries should aim to establish an annual harvest for each species harvested for domestic use or export, and allocate that harvest between different resource users according to policy objectives. This will be relatively more easy for the larger mammals, but even for this group, assessing levels of illegal harvest remains difficult. It may be necessary to develop these levels of harvest with input from qualified scientific experts, depending on the levels of local capacity.

Harvest should be allocated and harvesting effort monitored in a manner that both recognises the importance of maintaining harvests within established limits and also recognises other possible losses from the population, such as illegal harvest, fatal wounding or capture and transport mortality. In many cases, quotas alone do not provide adequate control of harvests and exports. To be effective, they must be combined with an integrated capture and export permit system that is tracked and monitored. Permits must identify permissible harvests of each species for both domestic and international trade.

At the same time as the size of harvest is monitored, the harvest should also be sampled for its age and sex structure. This would entail the weighing, measuring, ageing and sexing of an appropriate proportion of the harvest. For example, every leopard hunted in an export quota in the low hundreds could be weighed and measured, and a tooth be taken for ageing. In contrast, the weight, length and carapace of every tenth tortoise in a quota of several thousand tortoises could provide an adequate sample on which to look for tell-tale signs of exceeding MSY, using the approaches successfully pioneered by fisheries biologists.

Assessing the purpose of an import

Convention text and a recent resolution (see Box 1) recommend that the Scientific Authority of the importing country advise on issuing permits for Appendix-I species, stating whether the import will be for **purposes** detrimental to the survival of the species. This wording suggests that importing countries must pay particular attention to this basic aspect of harvesting. A Scientific Authority must consider, for example, the purpose of:

- a harvest that does not remove an animal from the population;
- harvesting of hunting trophies, as a generally low volume trade affecting large males;
- ranching, as a biologically well targeted harvest; or
- importing live animals for bona-fide captive breeding programmes; or
- collecting specimens for appropriate scientific research; and

compare the purpose of such imports with a possible higher volume or quasi commercial trade, for example:

- importing specimens from adult harvests killed under the guise of pest control; or
- importing live animals to boost revenues through their display.

Conclusions

The gap between theory and practice in the regulation of harvests is large for many species in international trade. The theory of harvesting provides a useful starting point that has been shown to have a firm empirical basis for better known and monitored species. However, for many other species in international trade, the application of theory is far removed, and the main requirement is to establish simple and practical monitoring systems that allow harvests to be regulated in future through adaptive management.