

Using the Market to Create Incentives for the Conservation of Crocodylians: A Review

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Executive Summary

In many countries, programmes for the conservation of crocodiles, alligators and caimans - collectively known as crocodylians – have been designed around the marketing of products from the consumptive use of wild animals. Some of these schemes have been in operation for over 25 years, and in general they have delivered tangible conservation benefits. However, there have also been difficulties and failures, which are more rarely documented. In reviewing the relationship between markets and conservation here, we have not dwelt on the successes, which are reasonably well known. Rather we have sought to document many of the problems experienced, in the hope that the inherent lessons will be useful to policy-makers, regulatory agencies, academics and practitioners of market-driven conservation.

The general findings are:

1. Markets have created economic incentives for crocodylian conservation in a diverse range of circumstances and contexts. Sustainable use has been achieved many times and some of the most commercially valuable species are widespread and abundant, rather than being threatened with extinction. There is no doubt that the economic importance of crocodylians has often led directly to stronger institutional arrangements for their conservation and ongoing management.
2. The most successful crocodylian programmes are those that: encouraged a broad range of inputs during their preparation and implementation; were flexible enough to adapt to changing circumstances; accounted for the socio-economic environment in which the programme was expected to work; and, ensured that institutions of regulation could operate in an environment as free of perverse incentives as possible.
3. The six most endangered crocodylians in the world today include both commercially valuable and valueless species. In almost every instance, a strong case can be made that the factor most influencing survival is the status of their habitat – not the level of exploitation. With some species there may be little or no scope for conservation strategies based on the marketing of biodiversity products. Other approaches will be required, despite resources being typically limited for such approaches. Unfortunately, one perverse effect of the market is that it has resulted in new and additional resources being found for the most economically important species, while the most critically endangered species have tended to remain neglected.
4. As a generalisation (to which there are some notable exceptions), it has proved more difficult than anticipated to design and implement market-driven schemes which result in crocodylians becoming a significant economic asset to the private or community landholders who live with them, and on whose goodwill their survival will ultimately depend. Government agencies, crocodylian producers (farmers, ranchers) or traders have been the most obvious beneficiaries of market-driven conservation programmes. They have received the conservation incentives and

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have typically been most active in ensuring that resources for crocodilian conservation keep flowing.

5. Crocodilian resources exist mainly in less-developed countries, yet finished products are sold mostly in the more affluent industrialised nations. International trade is fundamental to programmes based on the exploitation of crocodilians, and thus CITES, the convention that controls international trade in wild species, has had an enormous impact on all operations. In the case of crocodilians, CITES has encouraged sustainable commercial use and has devised highly sophisticated mechanisms for the regulation and control of trade. Despite many historical predictions to the contrary, one outstanding result of the market-driven conservation of crocodilians is that illegal trade has all but been eradicated in the face of well-regulated legal trade. Governments and business interests have worked against illegal trade which might compromise their investment in conservation, management and production.
6. Although most crocodilian production programmes started with strong conservation objectives, it has often been difficult to adhere to these over the long term. In this respect, one important lesson from crocodilians is that success hinges on the relationship between government regulators and business interests, from the planning stages forward.
7. The private sector may not understand the conservation focus of crocodilian management programmes as much as governments, but tends to tolerate expenditure during start-up phases even if it considers it cosmetic or unnecessary. However, investment has proved to be a powerful political tool and once programmes are established, economic interests have often conflicted with, and sometimes prevailed over, conservation interests. The financial stress of falling markets in the early 1990s provides an extreme example. In many countries it has resulted in pressures to reduce the costs associated with resource monitoring and other regulation and in some cases there is reason to believe that resources were harvested illegally to bypass regulatory costs. On the other hand, government regulators often have little understanding of, or sympathy for, the needs and realities of sustaining a business. Conservation objectives have sometimes been compromised by governments, notably when they expose business to insecurity with respect to long-term access to wild resources.
8. Even where programmes have been well planned, and income from high-value wild crocodilian resources is generated, reinvestment in the resource has not always followed. Government agencies have sometimes preferred to use revenues for other priorities. Fiscal priorities of governments change regularly, at all levels of administration, and even where the wildlife authority rather than central government receives the funds, other issues can take priority over crocodilians. In some countries, other perverse outcomes have absorbed funds from crocodilian programmes.
9. A central lesson from experiences with crocodilians is that flexibility and a willingness to change is essential to success. It is not simply a matter of implementing a rigid programme and letting it operate indefinitely without change. This is an area where CITES has created problems. Despite its overall positive role in the creation of successful market-led conservation, CITES has been relatively slow to respond to changing circumstances. As a consequence, management has often been restricted to a narrow range of fixed options, such as ranching and captive breeding, regardless of whether these are the best options for conservation or business.
10. A perceived shortcoming of CITES is that it emphasises the biological determinants of sustainability, while the success or failure of most conservation programmes is ultimately determined by economic and social factors. Even at the national level, the biological elements of

market-driven conservation programmes tend to be subjected to close scrutiny, while only scant attention is paid to the social, cultural and economic elements. This is perhaps a legacy of wildlife management decisions having been taken largely by biologists who often seem to assume that the marketing of products – a key element of success – has no relevance to conservation.

11. The market for crocodylian raw materials is determined largely by the economic status of consuming nations and superimposed on this are the unpredictable vagaries of the fashion industry. Demand tends to be elastic while supply is relatively inelastic. As a result the market is characterised by marked price fluctuations with at least two severe crashes in the last 30 years. Although overall production has continued to increase, this is the result of a drive for increased efficiency rather than new investment. Indeed, a number of individual producers have gone out of business during the difficult periods and several national programmes have become uneconomic to operate, which in turn has removed the incentives for conservation.
12. Where the impact of market-related problems on conservation has been recognised, some producers and regulators have been able to work together to reduce costs and increase demand. However, conflicts have arisen between transparency and the protection of intellectual property rights, particularly as new technologies and marketing strategies have been developed.
13. When initiating market-driven conservation programmes for crocodylians, advice has often been sought from experts. There are clear cases where poor information has resulted in unrealistic expectations, poor investment strategies and badly designed programmes, generating neither conservation nor economic benefits.
14. In some circumstances, the drive to reduce costs through increased efficiency has had conservation benefits (more production can be achieved for the same level of harvest from the wild). However, problems with access to the wild resource have tended to encourage captive breeding, perhaps the first step towards domestication. Captive breeding may be a valuable strategy to boost production, or reduce dependence on an unpredictable wild resource (or regulator), but it breaks the link between the market and the wild population, removing incentives for conservation.
15. There have been no real global efforts to regulate supply or demand. On the supply side, there is no international producers' cartel, nor have the costs and benefits of such an approach been evaluated. Producers often seem to react to falling prices and overproduction by increasing production in an effort to maintain profitability. It is also common, particularly in developing countries, for the supply of raw crocodylian materials to continue below financially viable levels due to the attraction of foreign exchange earnings, either to the producer or to the government which then may respond with subsidies. On at least one occasion, producers have been provided with subsidies due to the conservation value of production.
16. A common response to weak markets has been: value-added production, the diversification of products and the creation of new markets. On the whole, outcomes have tended to be positive, but it has not proved easy to add value to the raw product in producer countries due to vested interests. In addition, the technology is expensive and expertise is not freely available. It has proved difficult for many developing countries to produce the high quality required by a market specialising in luxury items. Most success has come, not from the penetration of the luxury market, but rather from the creating of new markets, often of a domestic nature, providing goods of lesser distinction to ordinary consumers.

17. The dynamics of demand for luxury leather products is complex and poorly understood by most producers. While the post-CITES trade has seen a reduction in the number of the intermediaries between producer and consumer, vertical integration has consolidated the critical role of tanneries. They act as the principal buyers and wholesalers. The number of tanneries has declined, partly due to environmental regulation, and while there is not yet a monopoly, the few tanneries that remain are probably in a position to exert the largest single influence on the market.
18. A significant obstacle to the market-led conservation of crocodilians is the widely held opinion that the economically-driven consumptive use of wildlife is incompatible with conservation. This lingers on, despite dramatic changes in our understanding of the reasons why difficulties occurred so commonly in the past. Wildlife trade is, in some cultures at least, now considered undesirable and even immoral.
19. In order to strengthen markets, producers, traders and some conservationists have called for the endorsement of market-driven conservation programmes by international conservation agencies and have suggested the introduction of a certification or eco-labelling schemes. These possibilities merit detailed investigation, though it is far from clear where the lead will come from and who will benefit most.
20. As far as the market is concerned, the burden of regulation that has been imposed over recent years, often with the best of intentions, has been a major disincentive for business to invest in conservation. Eco-labelling may help, but restrictions on the movement of personal possessions made of crocodilian leather, combined with information discouraging consumers from buying wildlife products (even if these are directly linked to improved conservation) are obvious disincentives to investment. The practice of adopting domestic control and regulation measures that are more restrictive than CITES, which is common in OECD countries, adds a further tier of complexity. If we want to encourage business investment in conservation, these issues must be addressed as a matter of urgency. It is not clear whether this might be best pursued on a generic basis or with respect to crocodilians alone.

Introduction

The natural “ecosystems” and “biodiversity” of resource-rich tropical countries are said to be important and highly valued public goods. Accordingly there is considerable alarm at their current rate of erosion. Part of the concern stems from an appreciation that in many developing countries the use of wild species is essential to human livelihoods and even survival. In addition it is often argued that biodiversity is important for maintaining long-term agricultural output and for producing new generations of medicines. There are also fears that the depletion of natural ecosystems may threaten human well-being more generally: for example, through the destabilisation of local water cycles or even the global climate. Finally, there appears to be a growing acceptance, particularly within economically-powerful industrialised countries, that the natural world should be preserved for its intrinsic values.

Over the last century, our attempts to maintain natural ecosystems and biodiversity have tended to revolve around the regulated protection of land or species against damaging human influences, notably agriculture and harvesting. This reflects the fact that two of the greatest threats to biodiversity are land clearance for farming and the direct exploitation of species, whether for subsistence or commercial purposes. Unfortunately, even where protected areas have been effective, their relatively small size, coupled with human population pressures and the competitive advantage of farming over livelihoods based on the harvesting of wild resources, has resulted in a landscape dominated by agriculture. This is a landscape that is always biodiversity-unfriendly to some degree and which, where agriculture is at its most industrial, specifically excludes most wild species – irrespective of whether or not direct exploitation is prohibited.

The conventional response to this situation, as exemplified by the US Endangered Species Act, is to extend regulation still further to include the prohibition of any act that harms a species of particular interest – including the conversion of its habitat for agriculture (Littell, 1995).

In recent years there has been growing recognition that it is beyond the law enforcement capacity of most governments to implement restrictive regulations, and that for many it is worth more than their political survival to try to do so. As a consequence, wild species continue to disappear despite efforts to save them. As an alternative, two general mechanisms have evolved. In the first, society is asked to pay the true cost of the public goods, usually through direct subsidies to the landholder. However, transfers of this sort are notoriously difficult, especially between developed and less-developed countries. In the absence of workable mechanisms for internalising the cost of public goods, there have been attempts in many parts of the world to overcome macro-economic market failures by reversing the dominant paradigm in which exploitation is outlawed in an attempt to reduce economic rent. Instead, models have emerged in which rents from wild ecosystems are encouraged through markets and enough rent captured by the landholder⁷ to provide an incentive for conservation of the “resource”. This new paradigm is often called “sustainable use”, but we prefer the more accurate term “market-driven conservation”. Market-driven conservation is often controversial and not even its most enthusiastic proponents are suggesting that it is a universal panacea against biodiversity loss. However, there are now many programmes in which markets for biodiversity products and services have successfully been harnessed to generate conservation incentives. At the same time, others have failed conspicuously to do so. We argue here that it is essential for resource managers to review and draw lessons from operating programmes so that we can better understand the factors that contribute to success – and those that lead to failure.

Crocodiles, alligators and caimans (collectively known as “crocodilians”) are found in 90 or more countries around the world. They have been exploited for generations, usually but not exclusively for their hides, used to make fashionable leather items. Over the last 20-30 years there has been a dramatic shift in the relationship between conservation, exploitation and trade. Initially seen as a conservation problem, trade has increasingly been co-opted as a conservation solution. The IUCN/SSC Crocodile Specialist Group (CSG) has responded positively as both a facilitator and arbiter in this process, working with elements of business to promote the sustainable use and legal trade of many crocodilian species all over the world. Management programmes allowing for the consumptive use of crocodilians now operate in some 30 different nations (Table 1). Each programme has its strengths and weaknesses. Over time, the dependence or near dependence of many crocodilian conservation programmes on international markets has highlighted issues which we believe have relevance to other markets for biodiversity products and services. There are many examples where conservation and economic benefits have been achieved simultaneously with crocodilians and we remain confident that:

1. Conservation incentives can and have been generated by markets.
2. The economic importance of the resource has led directly to stronger institutional arrangements specifically for conservation and sustainable management.
3. Illegal international trade, which flourished before CITES encouraged legal trade, has been all but eradicated.

On the other hand, there have been failures. There are dangers in assuming that all conservation programmes involving markets will be successful.

⁷ The individual or group that has defined, exclusive and enforced property rights over the resource.

Here we review the many practical lessons learned from the market-driven conservation of crocodylians, in the hope that the insights gained will be of broader value to policy-makers, regulatory agencies, academics and practitioners. That we tend to concentrate on the problems and difficulties rather than the successes, should not be misinterpreted. Successes tend to be much better known than failures, but there are important lessons in both.

From Calamity to Conservation

Of the 23 crocodylian species generally recognised, 15 or more have commercially valuable hides. They have experienced remarkably similar histories of utilisation, conservation and management, regardless of the countries in which they occur (Ross, 1989). In historical times, most crocodylian species were regarded as pests. Control measures resulted in local declines and, in some areas, eradication. From the 1800s onward, crocodylian skins were also used commercially in some countries. In the USA, for example, trading firms in New York were handling up to 60,000 American alligator *Alligator mississippiensis* skins a year in the late 19th Century (Fuchs et al., 1989). Demand appears to have increased exponentially after World War II. In the late 1940s it is reported that 120,000 Nile crocodile skins were being exported annually from Madagascar alone to tanneries in France (Games, Ramandimbison and Lippai, 1997) and in the mid-1950s, nearly 60,000 Nile crocodile skins were exported from East Africa every year (Fuchs et al., op cit). By the 1960s almost all wild populations of commercially important species were being exploited for trade to some degree, and in many if not most cases, wild crocodylian densities fell dramatically, sometimes to levels where the populations were in danger of becoming extinct (e.g. Cott, 1961: p215). At that time, few people were concerned about crocodiles and those who were, tended to advocate conservation responses prohibiting use. Research into the biology and population dynamics of crocodylians was in its infancy and the concept of managed harvests that would maximise the long-term benefits derived from the commercial use of crocodylians, had not yet evolved.

The development of programmes through which wild populations of crocodylians were harvested on a sustainable basis in order to generate ongoing economic and conservation benefits, gathered momentum in the 1970s and 1980s. It started in several countries with diverse economic, social and cultural settings, notably Australia, the USA, Papua New Guinea, Venezuela and Zimbabwe, and the impetus for market-driven conservation often came from quite different directions (Webb, Manolis and Whitehead, 1987). Some harvested species had recovered from historical declines and were becoming common in the wild. Others were still classified as “endangered” when the programmes were initiated⁸. In Zimbabwe, for example, Nile crocodile populations were recovering after protection and it was recognised that, as dangerous predators of people and their livestock, crocodiles would soon find themselves in conflict with legitimate human interests. Thus using the market to drive conservation was a pragmatic and contrived response to the need to find alternative long-term conservation strategies (Child, 1987). In contrast, the harvesting of wild crocodiles in Papua New Guinea was a well-established livelihood strategy for rural people and even though wild populations may have been reduced relative to historical times, there was never any serious suggestion that the outlawing of use could be a viable response to the conservation dilemma. The challenge facing wildlife managers in Papua New Guinea was to change existing patterns of exploitation so that use would once again be at sustainable levels (e.g. Genoloangi and Wilmot, 1990).

Those designing market-driven conservation programmes for crocodylians tended to start their work from one of two directions. The first approach was characterised by the gathering of copious biological data on the species and its population ecology⁹, so that harvesting models could be constructed and tested with a view to the establishment of commercial programmes in which the regulator could have a high degree of

⁸ Because the exploitation of endangered species has been allowed in order to generate tangible incentives for conservation, crocodylians are widely regarded as pioneer species for the concept of market-driven conservation.

⁹ An expensive and time-consuming approach.

confidence from day one (e.g. Joanen et al., 1997; Webb, Whitehead and Manolis, 1987). Indeed, there was strong public expectation that this would be the case in some countries. The second approach has been described as ‘adaptive-management’. Baseline indices of abundance were established for the target crocodilian population, commercial harvesting introduced and the effects monitored in order that harvesting levels might be adjusted if the population entered a period of decline beyond expected levels (e.g. Fernandez and Luxmoore, 1996). In reality, these distinctions were blurred and despite a commitment to biological research, a great deal of trial and error was involved in all programmes, while biological research was introduced into many adaptive-management schemes (e.g. Loveridge, 1996).

Today, crocodilians are subject to biologically sustainable harvests linked to markets in a diverse range of circumstances and contexts (Fernandez and Luxmoore, 1996; Joanen et al., 1997; Loveridge, 1996; Thorbjarnarson and Velasco, 1998; Webb, Whitehead and Manolis, 1987). As a result, eleven of the most commercially valuable species are now the species least threatened with extinction (Ross, 1998). The six most endangered crocodilians include some species that have commercial value and others that have never been traded. The main process threatening their survival in each case is the status of their habitat (Ross, op cit.). In these worst cases, there may be little or no scope for conservation strategies based on the marketing of biodiversity products, because: there is insufficient wild habitat; national conservation policy precludes such approaches (e.g. Hutton 1993); or the species is not attractive in the market. The conservation challenge in these cases is considerable, because funding tends to be available for economically important species rather than critically endangered ones (Ross 1997; Thorbjarnarson, 1999).

Despite many predictions to the contrary, one outstanding result of the market-driven conservation of crocodilians is that illegal trade has all but been eradicated by supply from well-regulated legal trade. Both government and business have worked against illegal trade as it compromises investment in management, production and conservation (Anon, 1998).

The Race to Regulation

The exploitation of crocodilian resources is largely a sovereign national issue, but although the wild resources most often originate in developing countries, processing and the markets for finished products are located mainly in the more affluent industrialised nations (Brazaitis, 1989) most of which are OECD members. International trade is fundamental to programmes and thus CITES¹⁰, the convention that controls international trade in wild species in order to prevent them from becoming endangered, impacts on all operations. Enthusiasts of CITES as a conservation tool point to crocodilians as a success story for the convention. Others question whether the gains have been made because of CITES or despite it (e.g. Kievit, 2000). Regardless, there is no doubt that the way that the way in which CITES has impacted upon crocodilians is central to any discussion of the regulated exploitation of these animals. Country after country has had to experience the rigours of international scrutiny before their crocodilians could be transferred from Appendix I to Appendix II of CITES so that market mechanisms could be mobilised for conservation.

Although empirical information is limited, conventional wisdom holds that, as recently as the early 1970s, over two million crocodilian skins were traded each year. The vast majority, perhaps as many as 1.5 million, were caiman *Caiman crocodilus*¹¹ originating in Bolivia, Brazil, Paraguay and Venezuela. The balance was made up of alligator skins from the USA and crocodile skins from many other parts of the world (e.g. Brazaitis, 1989). When CITES came into force in 1975, all crocodilians were listed on the Appendices even though the true status of many was unknown and there were no explicit criteria to guide

¹⁰ The Convention on International Trade in Endangered Species of Wild Fauna and Flora.

¹¹ The taxonomy of the caiman is subject to considerable debate. For the purposes of this paper the term ‘caiman’ includes all variations of *Caiman crocodilus* including what is sometimes known as *Caiman yacare*.

the listing process (Kievit, 2000). In what was seen as a precautionary move, most species were included in Appendix I which prohibited commercial international trade, and the remainder in Appendix II where trade could take place if the exporting country made certain findings and implemented trade controls (Luxmoore, 1992).

In reality, Appendix I listing in 1975 did not stop commercial trade. Trade was often able to continue through several different mechanisms. Firstly, at that time a number of important producer and consumer nations were not Parties to CITES (including Zimbabwe, France and Italy) and continued to trade. Secondly, as more and more countries did joint CITES in the 1970s and 1980s, many took ‘reservations’¹² on crocodylian species, which protected their harvesting and industry programmes (including, for example, Botswana, Zambia, Zimbabwe, France, Italy and Japan). In addition, Appendix I still allowed products from animals that were bred in captivity for commercial purposes to be traded. Perhaps most importantly, illegal trade continued to thrive because of a combination of continuing high demand for crocodylian hides and poor national controls and regulation in several countries.

During the 1980s, loopholes were gradually tightened. With more countries in CITES the scope for trading amongst non-members declined rapidly. Member countries came under pressure to withdraw their reservations¹³ and it was decided that ‘bred in captivity’ excluded specimens taken from the wild when young, which was the basis of several important new market-driven conservation programmes such as that in Zimbabwe (Kievit, op cit.). Finally, CITES began to make some headway against the widespread unregulated or illegal trade (Anon, 1998). With the closure of these loopholes the attention of many countries, especially those with newly developed exploitation programmes, turned to ways in which crocodylians could be transferred from Appendix I to Appendix II to allow legal, well regulated trade to continue. Others focused on captive breeding that could benefit from the exemptions afforded to Appendix I species under such programmes.

During the early days of CITES the only mechanism for transferring species from Appendix I to Appendix II was the Berne Criteria¹⁴, but this required evidence that species had recovered sufficiently to allow trade. Since there had been no data on the status of most crocodylian species at the time of listing it was often impossible to prove that the species had recovered. The only crocodylian ever downlisted pursuant to these criteria was the American alligator in 1979. CITES overcame this problem for crocodylians by introducing the concept that came to be called ‘ranching’. Implicit within this was the recognition that exploitation based on the collection of young life-stages (ranching)¹⁵ was both biologically safe and could provide economic incentives for conservation.

A new CITES resolution was adopted that allowed the transfer of individual national crocodylian populations from Appendix I to Appendix II if it could be demonstrated that a ranching programme was in place, and that it was contributing positively to the conservation of the species. Zimbabwe was the first country to achieve an Appendix II listing based on ranching of its Nile crocodiles. It was followed by Australia which transferred its saltwater crocodile *Crocodylus porosus* to Appendix II under the ranching scheme a few years later. However, ranching proved technically complex and expensive in terms of infrastructure and management, and start-up difficulties prevented many other countries, particularly less developed countries, from following suit. To deal with this problem, CITES introduced an interim system of quotas through which crocodylian populations could be transferred to Appendix II on a temporary basis.

¹² A country that takes a ‘reservation’ against the listing of a species in CITES is not bound by that listing decision.

¹³ For example, the EC required member nations to withdraw their reservations.

¹⁴ Laid out in Resolution Conf. 1.2

¹⁵ Ranching is considered a highly precautionary and biologically “safe” method of harvesting because it relies on harvesting of the youngest life stages that regularly experience high mortality in the wild.

Eventually the Berne Criteria were abandoned in favour of new, scientifically-based criteria for listing on the Appendices which allowed both ranching and quotas to be used as precautionary measures in a management programme.

CITES was central to the gradual replacement of unregulated crocodylian exploitation with exploitation based on sustainable resource management. Today, CITES allows at least 30 countries to use wild harvests, ranching and captive breeding to produce crocodylians of 12 species for international trade (Table 1), but only on the understanding that these programmes do not threaten the future of any of the species in the wild. This proviso is by no means cosmetic. For example, it is quite possible to find examples where one species found in eight countries is much sought after by the market, but only one country is considered by CITES to have met the requirements for legal export.

Patterns of Production

The articles and regulations of CITES have marked effects on trade in both raw and manufactured crocodylian products. CITES influences which species can be sold, when they can be sold, to whom they can be sold, and in what form they can be sold. In determining the terms of trade in this way, CITES has a fundamental impact on the traditional crocodylian leather industry in which the relative occurrence of different species in trade has always been of critical importance. The American alligator and most crocodiles are considered to have high value 'classic' belly skins because they are free of osteoderms¹⁶, while the belly skins of caimans, especially the larger sized ones traditionally taken from the wild, are strongly ossified and less valuable, and only the flanks are used to produce leather goods (e.g. Thorbjarnarson, 1999). Even within the classic species there are differences in value based on various perceived skin characteristics or supply differences, with saltwater crocodiles traditionally being favoured ahead of other species.

In the early 1980s, CITES began severely to impact both the number and composition of species in trade. By 1989, the total volume of crocodylian skins in trade had been reduced from an estimated high of 1.5 million a year to a low of about 500,000. Thereafter it began to rise again until it reached a new peak of almost 1.2 million skins in 1999 creating a U-shaped historical supply. This pattern broadly mirrors the end of unregulated exploitation, dominated by illegal trade, and the ushering in of sustainable use. However, things become more complicated when the composition of species in trade and the mode of their production (and in association with this, their size) are considered.

The total number of "classic" skins from crocodiles and alligators entering trade before 1977 is unknown. The best known estimate of 300,000 is largely speculative (Ashley & David 1985). Figures for legal trade are available from 1977 when 40,000 skins entered trade, almost all from cropping in the wild, until 1999 when 390,000 skins entered trade. The number of animals taken from the wild hardly changed over the period. Almost all the increase came as a result of production from ranching, which rapidly increased from 6,500 in 1983 to 263,000 in 1999, and captive breeding, which increased from 5,600 in 1988 to 73,000 in 1999 (MacGregor, 2001, in prep.).

The data show a very different pattern for South American caimans. Here wild harvesting remained the dominant form of production until 1985, when more than 1.4 million wild-taken skins were reported in trade. Thereafter the number of wild skins in trade dramatically decreased to as few as 34,000 by 1999, principally from just one country, Venezuela. Amazingly, over the same period the number of caiman skins produced by captive breeding (principally in Colombia) increased from zero to over 770,000 (Table 1) (MacGregor, 2001 in prep).

¹⁶ Boney plate-like growths within the skin

The marked changes in the source of skins reflect two paradigms within crocodile conservation that have been supported by the evolving regulations of CITES. For some years it was held as conventional wisdom that the preferred conservation strategy for crocodilians, and many other species, was “captive breeding” in which adult animals were held in farms to produce eggs so that production could be completely independent of wild populations. The usual justification for this approach was that, in situations where demand for wildlife products persisted, the production of captive bred specimens would take the pressure off wild populations.

The feathers of this dogma were severely ruffled in the late 1980s when it became clear that the effective conservation of crocodilians often depended on giving wild populations an economic value in order to provide conspicuous and tangible incentives for their long-term sustainable management. Not only was captive breeding eroding the pivotal link with the wild, but production was beginning to move ex-situ, from the Range States¹⁷ to important consuming countries, or even to countries that hitherto had played no role in the crocodilian industry. As noted by Thorbjarnarson (1999) this had the effect of “reducing the potential for developing sustainable-use programmes based on native species and increasing the likelihood of introducing exotic species through escapes.” Colombia commenced the captive breeding of caiman in the late 1980s and by 1995 was producing over 700,000 skins a year in what is, essentially, a new agricultural business. The industry no longer impacts on the wild, but nor does it provide obvious incentives for conservation. A similar situation exists in Thailand, where virtually all the production of Siamese crocodiles *Crocodylus siamensis* is based on captive breeding, and the wild population, reduced to a few individuals at best, benefits little if at all. Today, commercial production through captive breeding remains controversial as it is often perceived as a threat to incentive-based conservation, although an element of captive breeding may be needed to sustain the business elements of a ranching programme, providing security of through-put and insurance against regulatory and other changes out of the investor’s control.

As our experience mounts, flexibility and a willingness to change are emerging as the essential ingredients of successful market-driven conservation programmes for crocodilians. It is not simply a matter of implementing a prescriptive programme and letting it operate indefinitely without change. Rather, it is one of implementing a programme that can adapt rapidly and smoothly to changed circumstances. Unfortunately, the machinery of CITES is not designed to adapt rapidly to change. It tends to force new programmes of economic consumptive use into a narrow range of fixed options, such as captive breeding and ranching¹⁸. Market-driven conservation programmes based on ranching require a major investment in infrastructure to collect and incubate eggs, and to grow the young animals. In times of weak markets, governments and investors have often wished to switch to less expensive forms of production to maintain incentives for conserving wild stocks: options such as the export of eggs and hatchlings or the cropping of larger, market-ready animals directly from the wild. But the export of eggs or hatchlings is generally frowned upon, partly because it is assumed that value-adding of the resource benefits a nation, even if it is not economically viable to do so. Direct cropping from the wild may be the only viable option for poorer countries to participate in the market, and generate incentives for conservation, but despite compelling economic arguments, it is commonly resisted because it is less precautionary in biological terms.

Because the economics of the market-driven conservation of crocodilians has never been examined in any detail, the nature of the relationship between conservation objectives and financial returns is largely speculative. However, preliminary examination of the economics of the crocodilian industry has suggested that demand is elastic and supply is relatively inelastic (Woodward, Dennis and Degner, 1993). As a result

¹⁷ The countries in which the resource occurred naturally.

¹⁸ The terminology in crocodilian production can be confusing. In terms of the wild population there is a major distinction between ‘captive breeding’ and ‘ranching’, but this distinction is not always made clear. The term ‘farming’ is commonly used to describe both forms of production.

the market is characterised by marked price fluctuations. During the 1980s prices steadily increased as the demand for legal classic hides exceeded supply. It appears that some traders, tanners and manufacturers responded to the rising market by increasing their stocks, without fully considering the many new production facilities coming online. In 1990, prices started to fall and then crashed as speculators tried to cut their losses (Figure 2). The downturn was less severely felt by the producers of saltwater crocodiles, a species which has traditionally been in short supply, than by the producers of other species, where prices often fell to uneconomic levels and remained there for several years.

Prices started to rise again in 1993, but crashed again in 1996 – almost certainly in response to the Asian economic crisis. Asia is the principal end-market for luxury goods, including leather goods made from crocodilians (Woodward, Dennis and Degner, 1993). The price for crocodilian raw materials is determined largely by the economic status within consuming nations, although superimposed on this are the unpredictable vagaries of the fashion industry. During these two difficult periods a number of individual producers went out of business and several national market-driven conservation operations (particularly in Africa, which had a number of new programmes in which the costs of investment had not yet been amortised) were reduced to holding-operations, or closed altogether. This created conservation crises in some instances (Thorbjarnarson, 1999). However, global production continued to increase (Figure 1) as producers increased efficiency and adopted new strategies to produce economies of scale within the industry.

It has long been recognised that one of the potential problems with market-driven crocodilian conservation is that considerations of sustainability may be set aside in order to overcome short-term, economic problems (e.g. Loveridge, 1996; Thorbjarnarson, 1999; Woodward, Dennis and Degner, 1993). The responses to a weaker market in the early 1990s were varied. There were attempts to better control market fluctuations through producers working together to reduce costs, restrict supply and increase demand. Attention to production efficiency on most farms resulted in more production or profit from the same level of harvest. In some countries producers tended to swing towards captive breeding rather than ranching, which although more secure economically, eroded conservation advantages.

It appears that producers and conservationists met little success in controlling either supply or demand. On the supply side, the concept of an international producers' cartel to restrict production was neither researched in depth nor implemented. Indeed, some producers reacted to falling prices by increasing production in an effort to maintain profitability. In some developing countries, the subsidised export of raw crocodilian materials continued, regardless of viability, because there was an acute need for foreign exchange. In a positive vein, on at least one occasion producers were provided with a subsidy in recognition of the conservation value of production¹⁹ (Loveridge, 1996).

On the demand-side, producers tended to have such a poor understanding of the dynamics of the traditional luxury crocodilian leather industry that they were unable to exert any influence. While trade over the last 20 years has seen a reduction in the number of the intermediaries between producers and consumers, vertical integration has consolidated the critical role of tanneries which have become the principal buyers and wholesalers. The number of tanneries has also declined, partly due to environmental regulation, but their capacity has increased. While there is not yet a monopoly, the few remaining tanneries probably exert the largest single influence on the market. The concept that producers, tanners, manufacturers and retailers could work together to influence demand, remains embryonic; it would require levels of transparency unlikely to be forthcoming.

Finally, when considering the economics of production it is appropriate once again to visit CITES as it affects the final price of items in numerous ways. Regulation and control systems create costs and these

¹⁹ Crocodile farmers in Zimbabwe were preferentially issued permits to catch fish to feed crocodiles on farms.

are largely borne by the producer. Even the price of the permits and skin tags that are required by CITES can be a significant part of the profit margin with some species. As larger and larger numbers of specimens are produced, the resources needed for regulating trade at the level of the individual animals or even parts of individuals (such as teeth and other curios), as required by CITES, may increase out of all proportion to the value of the resource and to the conservation priorities that spawned the need for regulation.

Biology, Business and Benefits

Although many, if not most, crocodylian production programmes started with strong conservation objectives, it has often been difficult to adhere to these over the long-term. For example, even where programmes have been well planned in biological terms, the high value of wild crocodylian resources has not always resulted in re-investment in the resource. Government agencies have sometimes preferred to use revenues for other priorities.

Most of these difficulties could have been predicted if broader expertise had been included in the development of programmes, because the success or failure of these programmes has ultimately proved to be governed largely by economic and institutional factors. Key questions that should be considered are: Is the programme profitable for those investing? Is the structure of incentives likely to deliver the desired results?

These elements are largely ignored by CITES which emphasises the biological determinants of sustainability. This is not surprising, because most of the 'actors' in wildlife management are biologists or aspiring biologists. However, it has resulted in the biological elements of market-related programmes being subjected to close scrutiny while the social, cultural and economic elements have often been ignored. With crocodylians, biologists have tended to play the leading role in developing market-driven conservation programmes despite most of them having limited skills in marketing, animal production, economics, or the socio-economic constraints on business. With the benefit of hindsight, biology has proved to be one of the least relevant (and most easily addressed) factors in achieving sustainability, despite the disproportionate emphasis given to it by CITES. In contrast, conservation benefits ultimately depend on the socio-economic context and the institutional mechanisms in place. Yet business risk and uncertainty analysis are not involved in most proposals to CITES.

One important lesson from crocodylian management is that success has always hinged on the establishment and maintenance of good relations between the government regulators and business interests, from the planning stages onwards. Business may not understand the conservation focus of management programmes as much as governments, but tends to tolerate expenditure during start-up phases even if it considers it cosmetic or unnecessary. But investment has proved to be a powerful political tool and once programmes are established, economic interests have often conflicted with, and sometimes prevailed over, conservation interests. The financial stress of falling markets in the early 1990s provides an extreme example. It resulted in pressures to reduce the costs associated with resource monitoring and other regulation in many countries. In some cases, it promoted efforts to bypass regulation completely (illegal harvesting), and some wild-caught animals probably entered trade under the guise of farm-raised animals.

On the other hand, government regulators often have little understanding of, or sympathy for, the needs and realities of sustaining a business. They have sometimes compromised the conservation objectives of programmes themselves, by inappropriate actions that directly affect the interests of the business partner. In some instances the state regulator has introduced uncertainty over long-term access to wild resources. The principal lesson here is that compromises between conservation and business interests are commonplace, and they need to be accepted as a normal part of any market-linked programme. If short-

term business interests are put before sound long-term conservation gains, sustainability can be compromised, but it can equally be compromised by the reverse situation. There is no easy answer to this problem, although building in transparency - where changes have to be justified publicly - may perhaps be one step in the right direction.

Long-standing and effective partnerships between government and business have sometimes been compromised by staff changes and loss of institutional memory. Any programme trying to achieve sustainability will have to confront an array of new and unpredictable problems born of the interaction between social, cultural, economic and biological variables. Yet as staff change in regulatory institutions, the experience of resolving these complex issues is often lost. This difficulty is perhaps most critical in small and poorly financed institutions within developing countries, where changes in personnel and record-keeping protocols occur at a much faster rate than would normally be the case in any business operation. New regulators facing experienced business interests for the first time often face a series of difficulties in rebuilding partnerships based on confidence. The original conservation focus may have changed over time, perhaps for sound reasons, but if these are not well understood by both parties, distrust can be created and programmes compromised. The results of these difficulties sometimes benefit business interests in the short-term, but are often costly in the longer term. Governments typically have problems with:

- Keeping track of the changes in policy and management plans that have been implemented over time, and of the original reasons for those changes;
- Training staff so that programmes are not compromised by individuals leaving or being promoted;
- Maintaining long-term monitoring programmes with the necessary levels of accuracy and precision;
- Making commitments for long-term monitoring in say, three or five year cycles;
- Maintaining a stable relationship between business and regulatory interests;
- Maintaining a clear understanding of the interactions between social, cultural, economic and biological variables that govern success or failure;
- Maintaining records in such a way that past experience can be readily called upon.

Unfortunately, government regulators have been known to compromise sustainable use programmes for political or personal gain. Where impoverished government agencies have the opportunity to receive significant revenues from crocodile production there have been instances where the regulator has raised unrealistically high “taxes” on business, issued harvest quotas beyond levels likely to be sustainable, tried to enter the production business as a competitor to private investment, or used potential financial benefits as a political tool (e.g. Loveridge, 1996). There are also examples of rent-seeking on the part of individual bureaucrats. All of these have detracted from the sustainability of management programmes.

Despite these negative observations, the economic importance of crocodilians has usually led directly to stronger institutional arrangements for their sustainable management, largely because governments are often obvious beneficiaries and have a strong incentive for conservation. The benefits that flow to a handful of crocodilian producers or traders create a potentially powerful supporting constituency and many programmes rely on this dualism. Often, however, the State is not the ‘owner’ of the resource or the land on which it is found. In Australia the state claims ownership of wildlife including crocodiles (e.g. Webb et al., 2000), but the situation varies from country to country. In Papua New Guinea, crocodiles are owned legally by rural communities (e.g., Fernandez and Luxmoore, 1996), whereas effective ownership is bestowed upon private land-owners in a number of countries, for example Venezuela (Thorbjarnarson and Velasco 1998). Unfortunately, with a few well-known exceptions, it has often proved to be a challenge to design schemes in which crocodilians become a significant economic asset to private or

community landholders who live with them, and on whose goodwill their survival will ultimately depend (e.g., Loveridge, 1996).

The Mission to Market

Conservationists, particularly those who focus on the biological and regulatory aspects of management, often assume that the marketing of products is a strictly private, commercial element of the programme, with little relevance to management of the resource. Yet marketing, sales and profitability are absolutely fundamental to the success of these conservation schemes. There can be no economic incentive without profitable sales, and conservation interests can be eroded. For example, in the early years of a market-driven conservation programme in Tanzania in the 1990s, the poor marketing of crocodile skins resulted in the a request to take off twice as many crocodiles from the wild - something that could have been avoided had the true value of the final product - the cured skin - been returned to the correct authorities (Hutton, 1992). Thus, there are sound reasons for regulatory authorities to embrace marketing as one of the variables associated with sustainability.

Marketing and technical knowledge has itself become a tradeable commodity in the crocodilian industry, with mixed results. Significant improvements in production efficiency have been gained from research, and in most cases investment in market research has resulted in better market prices, mostly due to improved quality and eliminating “middlemen” from the trading chain. However, in each case a recurrent problem has been the conflict between transparency and the protection of the intellectual property rights associated with market and technical research. In the early 1970s, research results tended to be available for all to use, but this has changed over time and it can be argued that secrecy has been a major impediment to progress in some countries, partly because it has constrained the ability of those receiving information to validate it. The impacts of poor or uninformed advice, or advice given by people who did not necessarily have the credentials to give it, is difficult to evaluate. There are clear cases where ‘expert’ advice has resulted in unrealistic expectations amongst both the government and private sector and, as a consequence, has been directly implicated in poor investment strategies. For example, ranching or captive breeding programmes were inappropriately developed for certain species or populations. As a result, a number of national programmes have shrunk dramatically, or closed altogether, and the whole concept of market-based conservation has suffered when unrealistic expectations, based on poor advice, have not been met.

In the absence of effective information allowing producers to influence the demand for traditional high-value crocodilian leather goods, producers commonly investigate value-added production, diversification and creating new markets. On the whole these are regarded as positive outcomes, but it has not proved easy to add value to the raw product in producer countries. Not only has there been strong opposition from vested interests, but the technology is expensive and expertise is not freely available. It has proved difficult for developing countries to produce the high quality required by a market specialising in luxury items. Attempts by government regulators to force value-adding have also had dubious results. For example, Indonesia insisted that skins be partly tanned before export, but the price was often higher for raw skins than for partly tanned ones (Jenkins, pers. comm.).

Most successes in value-adding have come from joint ventures between producers or groups of producers and established processing businesses. However, the principal result has not been penetration of the luxury market, but rather the creation of new markets, often of a domestic nature, providing goods of lesser distinction to ordinary consumers. In terms of diversification, crocodilian meat is an important by-product and in some species it may be worth as much, or more than the raw hide. Other by-products include curios and a variety of products made locally from low grade skins. These all generate income and stimulate secondary businesses, and are typically oriented towards domestic sales to tourists, who subsequently export the items.

It is not only tourist souvenirs that are moved across borders. The principal manufactured end-products of the crocodilian industry, luxury leather clothing and accessories, are commonly carried from country to country. Although CITES itself may exempt these legally-held personal possessions from inconvenient controls, such as permits and tags, many of the key consuming countries have adopted domestic trade control measures for wildlife products that are stricter than those under the Convention. It results in difficulties and inconveniences for the final consumer. Added to this, campaigns by NGOs and governments, such as those at many airports, often urge citizens to avoid buying any wildlife products, or at the very least, to exercise extreme caution. Travellers are urged to be aware of the strict regulatory requirements associated with any movement of wildlife products across international borders, and are often confronted with impressive penalties. While these exhortations and difficulties may be valid for some wildlife products, they rarely apply to crocodilians today - yet buyers are naturally discouraged from purchasing crocodilian products.

This situation persists, at least in part, because the commercial use of wildlife disturbs many conservationists, perhaps with considerable justification. History is littered with examples of where market forces have resulted in over-exploitation and declines in wild species. The widely held opinion that economically driven consumptive use of wildlife is incompatible with conservation lingers on, despite dramatic changes in our understanding of the reasons why this occurred so commonly in the past. Over-exploitation almost invariably occurred in situations of “open access” without appropriate institutional arrangements, and without any incentives to conserve or use sustainably. Thus, despite situations which rectify these problems today, wildlife trade is, at least in some cultures, now considered undesirable and even immoral.

Discussion and Conclusions

Markets have created economic incentives for crocodilian conservation in a diverse range of circumstances and contexts. There is no doubt that the most successful crocodilian programmes are those that have used a broad range of inputs during their preparation and implementation, and were flexible enough to adapt to changing circumstances. These are programmes that have been mindful of the socio-economic environment, and have ensured that the institutions of regulation could operate in an environment relatively free of perverse incentives.

It is also clear from the global experience that the development and maintenance of successful programmes requires effective partnerships between regulators and all other stakeholders. Not least to prevent the loss of institutional memory, which is the substance of building long-term partnerships. Policy and management are best developed cooperatively, so that all sides understand the conservation elements and the way business is expected to contribute to them. To ensure consistency with respect to conservation objectives, long-term management plans should be supported by precise and long term contracts to achieve the goals required. Management programmes should stipulate transparent procedures for developing and allocating quotas, to constrain the ease with which they can be manipulated. To avoid unrealistic expectations it is desirable to increase transparency in research, marketing and the provision of advice, even though there are important issues to tackle with respect to the balance between openness and the protection of commercially sensitive information.

CITES has always been the biggest international influence on the commercial use of crocodilians because most programmes were developed before Agenda 21 and the introduction of the Convention on Biological Diversity (CBD). As a result, there has been little attention paid to issues of equity and benefit-sharing which are important considerations with respect to sustainable use in the context of the CBD, but of lesser concern within CITES. In fact, experience suggests that it is difficult to extend benefit sharing beyond business and the government regulator, down to the landholder and others who live with crocodilians. One

difficult issue to consider is how conservation benefits of the market can be maintained in the face of a seemingly inexorable drift towards the domestication of crocodilians in some countries: a trend which reduces the link between business investment and wild populations. The issue of long-term access to crocodilian resources is much more important and fundamental to business interests than would appear from most management programmes, and has often resulted in the pursuit of captive breeding. The ecology of wild crocodilians introduces significant variation in the numbers of eggs and hatchlings available from the wild each year, making life unpredictable for business interests. It is important to seek ways to ensure that supplementary production through captive breeding can add security to operations based on wild harvest without making captive breeding the most cost-effective option for obtaining stock.

While the market-driven conservation of crocodilians has its problems, many of these could have been predicted at the time of planning had there been any honest and objective assessment of the market environment. Far too much emphasis was placed on biological variables and far too little on economic factors. A large share of the responsibility for this lies with the biologists²⁰ who played a central role in the design of most programmes, as they typically sought little input and involvement from specialists in economics, business and marketing – a situation exacerbated by CITES. There is no doubt that CITES, which has been the most critically important instrument fostering the sustainable management of crocodilians, would benefit from the inclusion of standard economic issues in its deliberations. At the moment it attempts to regulate trade in commodities without any detailed considerations of the market. As a result, it receives no warning of major economic problems, and its inflexible structure constrains its ability to respond to them when they arise. Unnecessary and burdensome regulation, often cosmetic and typically costly to implement, are of continual concern. CITES may have been the principal tool for change and improvement in the sustainable commercial use of crocodilians, but it has not been the driving force behind those changes. The impetus has been provided by strong national interests that have been supported by a strong constituency of voluntary crocodilian ‘experts’, particularly those under the auspices of the Crocodile Specialist Group which is part of the Species Survival Commission of IUCN – the World Conservation Union.

Price fluctuations cause major problems for businesses and ultimately threaten conservation of the resource. The question must be addressed as to whether or not there are any appropriate interventions that can be made to support the conservation premium where this exists? Producers, traders and some conservationists are calling for the endorsement of programmes of market-driven conservation by international conservation agencies and have suggested the introduction of certification and/or eco-labelling schemes. A number of initiatives endorse sustainably-harvested marine and forest products and these could, perhaps, be models for crocodilian harvesting regimes. In addition, given that Appendix II of CITES is supposed to act to prevent commercial international trade from threatening wild species, there may be potential for CITES itself to develop a certification role. These possibilities merit detailed investigation, though it is far from clear where the lead will come from. This is something that the IUCN Crocodile Specialist Group might consider further.

Of more importance, as far as the market is concerned, is the disincentive to business created by the burden of regulation imposed over recent years, regardless of the good intentions involved. Eco-labelling may be a far less important issue than removing restrictions on the movement of personal possessions, and amending information which discourages the public from buying products that are directly linked to better conservation. The practice of many OECD countries of adopting domestic control and regulation measures that are more restrictive than CITES adds a further tier of complexity. These issues must be addressed as a matter of urgency to ensure that the gains made from the market-driven conservation of crocodilians over the last decade or so are not lost over the next.

²⁰ Possibly including some of those who have contributed to this paper.

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Table 1. List of countries with crocodylian production programmes indicating mode of use. Wild harvest is direct harvest of adults or sub-adults from the wild. Ranching is collecting eggs from the wild for hatching and rising in captivity. Captive breeding is the production of eggs from adults held in captivity.

| Country | Species | Mode of use |
|------------------|----------------------------|--|
| United States | <i>A. mississippiensis</i> | Ranching, wild harvest and captive breeding |
| Mexico | <i>C. moreletii</i> | Captive breeding, ranching under development |
| Honduras | <i>C. acutus</i> | Captive breeding |
| Nicaragua | <i>Caiman crocodilus</i> | Wild harvest |
| Cuba | <i>C. rhombifer</i> | Captive breeding |
| Colombia | <i>Caiman crocodilus</i> | Captive breeding |
| | <i>C. acutus</i> | Captive breeding |
| Venezuela | <i>Caiman crocodilus</i> | Wild harvest and captive breeding |
| Guyana | <i>Caiman crocodilus</i> | Wild harvest |
| Brazil | <i>Caiman crocodilus</i> | Captive breeding, Ranching under development |
| Bolivia | <i>Caiman crocodilus</i> | Wild harvest |
| Paraguay | <i>Caiman crocodilus</i> | Wild harvest |
| Argentina | <i>Caiman latirostris</i> | Ranching |
| South Africa | <i>C. niloticus</i> | Captive breeding, ranching |
| Mozambique | <i>C. niloticus</i> | Ranching |
| Botswana | <i>C. niloticus</i> | Ranching |
| Malawi | <i>C. niloticus</i> | Ranching |
| Zimbabwe | <i>C. niloticus</i> | Ranching, captive breeding |
| Zambia | <i>C. niloticus</i> | Ranching |
| Uganda | <i>C. niloticus</i> | Ranching |
| Kenya | <i>C. niloticus</i> | Ranching, captive breeding |
| Tanzania | <i>C. niloticus</i> | Wild harvest, ranching |
| Ethiopia | <i>C. niloticus</i> | Ranching |
| Madagascar | <i>C. niloticus</i> | Ranching, captive breeding |
| Thailand | <i>C. siamensis</i> | Captive breeding |
| China | <i>Alligator sinensis</i> | Captive breeding |
| | <i>C. porosus</i> | Captive breeding |
| Cambodia | <i>C. siamensis</i> | Captive breeding |
| Indonesia | <i>C. porosus</i> | Captive breeding, wild harvest |
| | <i>C. novaeguineae</i> | Wild harvest |
| Malaysia | <i>C. porosus</i> | Captive breeding |
| Singapore | <i>C. porosus</i> | Captive breeding |
| Papua New Guinea | <i>C. porosus</i> | Ranching, wild harvest |
| | <i>C. novaeguineae</i> | Ranching, wild harvest |
| Australia | <i>C. porosus</i> | Ranching, captive breeding |
| | <i>C. johnsoni</i> | Ranching, captive breeding |

Figure 1 – Estimated Trade in Crocodilian Skin by Method of Production, 1977–99

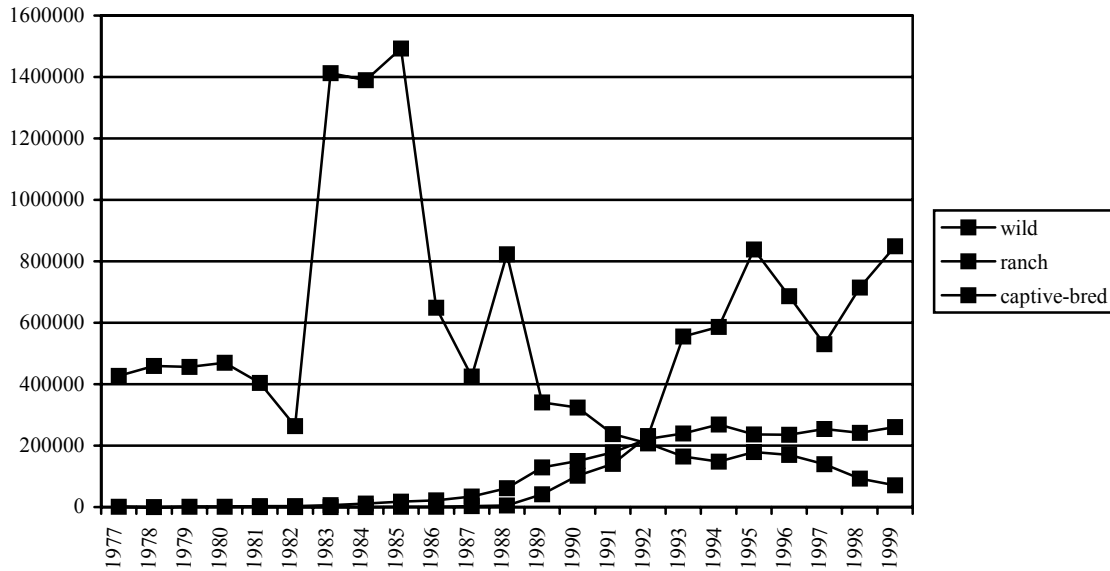


Figure 2 - Producer Price Indexes for Crocodilian Skins, 1984–2000

