smaller ones with a nervous disposition to the larger size classes, in fairly high densities in about 750 m of waterway that is about 150 to 200 m in width at its widest point.

The status of Roughnut as a peer boss crocodile is demonstrated in his Goose Camp Billabong environment. Roughnut's wives use his presence when feeding, other crocodiles in the 3 m plus size class leave when Roughnut approaches, his harem of females remain in his presence when feeding albeit at a close distance. Roughnut's presence affects peer crocodiles when he approaches. These smaller crocodiles are engaged in predatory observation and stalking of magpie geese flocks; their attention is immediately diverted to when Roughnut approaches the area. What is not understood is how crocodiles sense each other, particularly when Roughnut is approaching from 500 m to a kilometre away. The smaller crocodiles sense his approach and seem to divert their behaviour from predatory observation to wariness and avoidance of the approaching boss crocodile. These observations of boss crocodile behaviour are made by crocodile "wise" people but it is not understood- needs research to fully understand what is occurring. This may also be a guardianship situation to aboriginals fishing from the bank in parts of the billabong in Roughnut's main territorial zone. Other crocodiles are kept away, if a "non-tolerated" smaller male is present its attention is diverted to monitoring Roughnut's presence and it situates itself accordingly while remaining constantly vigilant on the surface, it is clearly visible to other crocodiles and people in the area.

One particular Aboriginal family hunted this group of crocodiles on a fairly regular basis until very recent times. One method used to hunt these animals comprised one family member tying a dead magpie goose to a rope and throwing it out into the billabong. This attracted the attention of a crocodile usually about 1.5 to 2 m long. The dead goose was pulled through the water back towards the bank and as the crocodile approached very close to the goose it was then shot by another family member who was waiting concealed behind a large paper bark tree. The dead crocodile was then retrieved in the shallow water.

Park management approaches to crocodile management

For park management, crocodiles now present an on-going area of active risk and wildlife management. The significance of any incidents (even if irregular in occurrence) and the need for active management means that crocodile management is a regular and routine work responsibility. This responsibility prescribes the need for park-specific assessment and action undertaken under set guidelines that aim to fulfill the Park's Plan of Management objectives;

To monitor potential human/crocodile situations that may occur in relation to:
- personnel working in Kakadu,
- visitor use areas,
- fishing activities,
- Aboriginal outstations and hunting areas; and,
- other likely interaction activities.

In broad summary Kakadu management has responsibility for maintaining a large predator species population, in as near as possible, to its natural wild state while protecting a visiting, and resident, prey species (people) from predation.

Educating people and warning people about the risks of crocodile attack

While crocodile observation is a major attraction to most Kakadu visitors the prey size range of crocodiles extends to animals much larger than humans (eg horses, buffalo, cattle) and territorial aggression in the species results in brawls between crocodiles weighing well over 500 kg, that is, of small boat or typical canoe dimensions.

While observing crocodiles Kakadu visitors are often in the proximity of both a potential man-eating predator and an occasional "boat bashing", strongly territorial, species. Crocodiles may be attracted to distressed fish fighting on fishing lines, geese or other wounded game trying to escape a hunter, or they may get accustomed to food from fisherman discarding unwanted catfish or offal from cleaning fish in their territory. High dog populations (domestic pets) make Aboriginal communities a virtual game farm for local crocodiles.

An important part of the park's approach to managing crocodile risks is to raise awareness among visitors and residents about crocodiles in this 'crocodile environment'. To do this Parks Australia provides information that educates and warns visitors, residents and tour operators about crocodiles and encourage people not to place themselves at risk of attack by crocodiles, using all available cost-effective methods.

The methods used to educate and advise people about crocodiles include development and promoting key messages about crocodiles and safe behaviour in Kakadu, through:

- Signs and displays
- Information in the park Visitor Guide and other park publications, including pre-visit information
- Face-to-face communication with visitors and residents by park staff
- Education of tour guides through a range of methods including the Kakadu Tour Operators' Manual and Tourism Industry Seminars
- Videos shown within Kakadu
- Information provided to the media

Some of the key messages that encourage people to respect crocodiles in Kakadu and not to place themselves at risk of attack by crocodiles are that:

- Most of Kakadu is prime crocodile habitat.
- There is some risk of crocodile attack if you enter the water anywhere in Kakadu.
- In most of Kakadu there is a very high risk of crocodile attack if people enter the water.
- In a few places in Kakadu, Parks Australia takes steps to reduce the risk of attack on people swimming, but even in these places, Parks Australia cannot guarantee people's total safety from all crocodiles. People enter the water at their own risk.
- There are several ways for people to reduce the risk of crocodile attack if they are fishing, boating or near water in Kakadu.

Parks Australia regularly reviews these messages and develops and promotes other messages (as required) to encourage people not to place themselves at risk of attack by crocodiles.

Signs

Parks Australia maintains crocodile warning signs near the entrances to the park, at boat ramps, at camping areas and day use areas near water, and places warning and information signs at other strategic locations.

Crocodile warning signs range in size from small, pictogram-only signs to large signs with detailed information. Several types of signs are used, including:

- warning signs used at locations where estuarine crocodiles are known to live;
- warning signs used at locations where estuarine crocodiles are not known to live but may move in undetected (eg escarpment pools, waterfall plunge pools and adjacent waterways);
- general information signs at park entrances and other strategic locations; and,
- temporary warning signs if there is a higher risk than usual but a closure is not used while the risk is being addressed (eg if there is an inquisitive crocodile near a boat ramp).

All crocodile warning signs include symbols and most sizes of signs that include English text. Some signs also use other languages, including German, Japanese, French and Italian. Parks Australia also works with other agencies to maintain consistency across jurisdictions (Northern Territory, Western Australia, Queensland) in design and wording of crocodile warning signs.

Crocodile surveys

Data has been collected from surveys conducted on tidal areas and inland waters of the Park since 1977. Parks Australia staff have been surveying crocodiles in Kakadu since declaration of the park in 1979, when stage one of the park was declared. In 1979 crocodile numbers were much lower than today, as crocodile hunting had been allowed until 1971 and populations had just started to recover.

In summary the crocodile population had a rapid increase from 1971 to 1988. The rapid increase was consistent with population increase for the rest of the Top End.

Between 1988 and 1998 the population increase declined and steadied and there was an increase in >6 foot (2 m) size class, and the crocodile population was steady. It may still have been a population of young animals but Kakadu may

have achieved a full-grown population. Kakadu might have reached a total recovery in its crocodile numbers during this period. The most recent assessment between 1998 and 2003 has reinforced the view that Kakadu's estuarine crocodile population is reaching or has reached plateaux. The survey results are consistent with crocodile population results for the rest of Top End. The population is dominated by crocodiles in the four foot (1.2 m) size class.

Kakadu survey results suggest that Kakadu's crocodile population is now peaking or is at its peak. Staff and resident field observations support this, with crocodiles dying from:

- territorial disputes;
- predation from other crocodiles;
- heat desiccation, floodplain fires;
- movement into extra-limital range (plunge pools); and,
- peer aggression.

The number of estuarine crocodiles found in freshwater upstream areas is still increasing each year. These upstream habitats are not optimal for estuarine crocodiles and in the 1980s and 1990s crocodiles were seldom found here, but by the 2000s large estuarine crocodiles are common found, albeit in low numbers, but none the less are found regularly in these upstream plunge pool regions of Kakadu.

Continued monitoring of crocodile numbers, size and behaviour is necessary to provide accurate information as a basis for assessing and managing the risks of adverse interactions between crocodiles and people.

Parks Australia will continue the long-term crocodile survey program in Kakadu in order to:

- Monitor changes in crocodile population numbers, age structures and distribution throughout the Park;
- Endeavour to detect and count the crocodiles in water bodies that people visit, boat on or live near;
- Estimate the size class of each crocodile detected in those water bodies; and,
- Monitor the behaviour of crocodiles in those water bodies, as a basis for risk assessment.

Table 1. Trends in mean crocodile density in Wildman River, Kakadu National Park, 1977-2003. Information is specific to time and date of each survey conducted. Very high-count results were achieved when surveys were conducted in cooler months between July and August. Crocodiles are in warmer water when air temperature was very cool and lower than water temperature. * = actual distance not available, mean provided. NH= non-hatchlings.

Year	km Surveyed	Total Count	NH >2 feet	Hatchlings <2 feet	NH Density (per km)	Total Density (per km)
1977	32*		(105.8)		3.31	
Sep 1978	33.5	118	65	53	1.94	3.52
Aug 1979	33.5	155	121	34	3.82	4.63
Jun 1984	33.5	226	200	26	5.97	6.75
1985	32*		(148.7)		4.65	
Oct 1986	32.5	235	123	112	3.78	7.23
Oct 1987	33.5	181	157	24	4.69	5.4
Jul 1988	32	239	196	43	6.13	7.47
1992	32*		(186.1)		5.82	
1993	32*		(191.5)		5.98	
Aug 1994	32*	88	(196.8)	22	6.15	8.8
Jul 1995	28	189	163	26	5.82	6.75
Aug 1996	32	502	203	299	6.34	15.69
Aug 1997	31	340	223	117	7.19	10.97
Jul 1998	32	435	226	209	7.06	13.58
Sep 1999	33	368	201	167	6.3	11.15
Aug 2000	33	519	259	260	7.85	15.72
Sep 2001	33	302	165	137	5	9.15
Sep 2002	32	451	229	222	7.16	14.09
Dec 2003	32	383	291	92	9.09	11.97

Future research options

Further survey data is required to try and monitor any changes to that may be occurring. Some research may be required to determine:

- Size structure of future populations - a mature population may be made up of larger individual animals - leaner and more competitive dominant males?
- Are floodplains still after removal of large numbers of feral water buffalo and what are the implications for crocodile habitat, especially nesting? It appears wetlands recovery from buffalo modification is still far from complete (eg *Phragmites karka* is still rare on the South Alligator system and floodplain swamps, and paleo-channel rafts of this species are still absent). This would have significance to crocodile numbers and distribution.
- Is crocodile age and biomass increasing with this plateau?
- What kinds of interaction between freshwater and estuarine/saltwater crocodiles occurs in plunge pool and gorge areas? How do short-term and long-term estuarine/saltwater incursions into these areas impact on resident freshwater crocodile populations? What impacts are individual outcast vagrant saltwater crocodiles having on freshwater crocodile populations, with no continuous Aboriginal hunting factor?

Removal of Estuarine Crocodiles from specific plunge pools visited by tourists

When the park was first declared the estuarine crocodile population was still very low after many years of hunting and people swam in many locations in the park. The estuarine crocodile population has increased steadily since they were protected from hunting, and now there are very few places in the park where visitors can swim without significant risk of crocodile attack.

Parks Australia uses signs and other methods to advise visitors that estuarine crocodiles inhabit the water and instruct people not to enter the water or to swim in most locations in Kakadu.

In wet seasons since 1991, estuarine crocodiles have moved all the way upstream in major creeks and are now regularly found in some water pools at the base of the Arnhem Land escarpment. Park staff have surveyed and removed any saltwater crocodiles remaining in or near plunge pools that the public visit, before these areas were opened to the public for the season.

Typically, the saltwater crocodiles that move into these areas are males who are vagrant outcast individuals from downstream populations. These saltwater crocodiles can become dangerous due to low prey biomass in the marginal habitats of plunge pool areas. In some cases they may be recovering from injuries that reduce their success at catching their normal prey species. Consequently they can be very dangerous to humans in and near the water.

In terms of the effect on the saltwater crocodile population size and structure, the removal of a small number of saltwater crocodiles a year from these areas of marginal habitat is believed to have the same, effect as previous traditional Aboriginal hunting of crocodiles for food in these areas.

Twin Falls as a case study

Until 2002, visitors swam in Twin Falls gorge, but by 2003 the number of saltwater crocodiles moving into the area each wet season had increased to the extent that park staff could no longer be reasonably certain that all crocodiles had been removed. Concern about the continuing risk of a large crocodile in Twin Falls gorge meant that the area remained closed for all of the 2003 dry season to prevent people swimming where estuarine crocodiles could be present.

Twin Falls is an area with about 4 separate pools of varying sizes. Accessing the plunge pool further upstream requires traversing about 150 to 200 m of water. Historically visitors have swum the section to access the next walking stage that eventually leads to the spectacular falls and plunge pools area. In 2003 a large 3.5 m saltwater crocodile was seen but never captured despite every attempt to do so. In normal circumstances, prior to 2003, the area would probably have been opened to the public once other tasks had been addressed (seasonal opening chores) aside from removing the crocodile problem.

Below is a summary of problem crocodiles, including freshwater crocodiles (where stated) removed from two of the main plunge areas visited during the dry season.

Twin Falls

- 1988: 1.8 m male freshwater crocodile
- 1990: 2 m male freshwater crocodile
- 1991: 2 m male saltwater crocodile
- 1995 6 June: 2.445 m male saltwater crocodile
- 1996 23 May: 2.89 m male saltwater crocodile
- 1996 7 June: 2.6 m male saltwater crocodile
- 2003 8 May: 2.2 m male saltwater crocodile
- 2004 5 April: 2.67 m female saltwater crocodile
- 2004 12 May: 2.2 m saltwater crocodile

This year (2004) a situation occurred that continued to justify the closure of Twin Falls to swimming pending alternate visitor access options (boat ferry and walkway). After the two estuarine crocodiles (2.67 m and 2.2 m - both female) were removed on 5 April and 12 May the area was surveyed a number of times and no further signs of estuarine crocodiles was detected. No bites were detected on the crocodile detection floats, and the free baits remained untouched. Two weeks after the removal of the 2.2 m animal a very large estuarine crocodile about 3.5 m had moved in between 21 May and 27 May the day went it was sighted near the baited trap. The floats had no bite marks prior to 21 May. The animal had bitten all the crocodile detection floats placed in the gorge. It was a recent arrival, presumably from a downstream location. This animal was overtly displaying itself and was actively feeding in full view of rangers on free baits set. The animal represented the most dangerous scenario if swimming had been allowed. The animal at times was puffing itself on the water surface in the area visitors previously entered to swim up the gorge. The crocodile was displaying all the aspects of a large dominant predatory crocodile with no sign of fear toward humans who were observing from the bank. At the time of writing park staff were in the process of attempting to remove this large crocodile.

A the present time (2004), the only natural water bodies in Kakadu where visitors can swim, that is, where there was minimal risk of saltwater crocodiles moving in undetected, are the creeks above the Arnhem Land escarpment; a few pools immediately below the escarpment: namely Jim Jim Falls, Maguk, Gunlom and Koolpin; the Gubara pools below the Mt Brockman outlier, and some small, spring-fed pools in the southern section of the park. At these locations (other than those above the escarpment), signs and other methods are used to warn people that crocodiles may move into the area undetected, and that people swim there at their own risk.

There is increasing concern among traditional Aboriginal owners and experienced park staff that some of these areas may become places where large crocodiles are increasingly present, increasing risks to swimmers.

Groups of Aboriginal people sometimes wade or swim in the shallows of water bodies where estuarine crocodiles occur, while gathering food or for recreation. Adult Aboriginal people who have lived in Kakadu for a long time generally have a very good understanding of crocodile behaviour, and take numerous precautions to reduce the risk of attack. Additional warning signs may be placed at aboriginal residential areas and high use hunting areas to minimise risk of crocodile attacks.

Managing Swimming

In most areas of the park, swimming is strongly discouraged and may be prohibited, due to the presence of estuarine crocodiles. In specific locations, swimming may be allowed, subject to assessments of the risks of crocodiles moving into those areas and the costs of risk management measures.

In most water bodies of Kakadu, either estuarine crocodiles live there permanently or there is a moderate or high likelihood of estuarine crocodiles moving in from time to time. Consequently, in most of Kakadu, Parks Australia aims to strongly discourage swimming, using signs and other methods to instruct people not to enter the water or swim.

As part of the park's risk management approach Parks Australia and the Kakadu Board of Management may review at any time whether crocodiles should be removed or whether the area should be closed to swimming or to public access, either temporarily or long-term.

Procedures

To remove estuarine crocodiles from these areas, park staff take the following steps:

1. Surveys to detect the presence of crocodiles (including use of free baits)
2. Informing and consulting relevant officers and traditional owners if a crocodile is detected
3. Setting traps
4. Harpooning if the crocodile cannot be caught by trap
5. Killing the crocodile by shooting; or
6. Live removal and relocation of the crocodile
7. Keeping baited traps, crocodile detection buoys and nets in place during the dry season
8. Utilising other capture methods if trapping and harpooning fails

Managing freshwater crocodiles

- At times, a freshwater crocodile may start to behave aggressively towards humans intruding into its territory.
- In this case, a line of marker buoys may be set up to keep people out of the crocodile's territory. Signs will be erected to inform the public of the purpose of the buoys and to warn people to stay away from the crocodile.
- If this course of action is insufficient, Parks Australia and traditional owners will consider whether the area will be closed to swimming or whether the freshwater crocodile will be removed and either relocated or destroyed.
- If the crocodile is to be removed, park staff will follow the same procedures used for removing estuarine crocodiles.

Seasonal or temporary closures of some areas to the public due to crocodile attack risks

Seasonal and temporary closures

Each wet season, Parks Australia closes areas of Kakadu that become flooded, due to the risk of crocodile attack and other risks associated with floods. At any time of the year, Parks Australia may also close an area to the public temporarily while dealing with a crocodile that presents a high risk to people. Boat ramps, camping areas near billabongs, plunge pools or any other area may be temporarily closed while action is being taken to deal with a crocodile that presents a high risk to people. These areas are closed by use of signs and temporary barriers.

Managing individual crocodiles that may pose a threat to human safety

Crocodiles now present an on-going issue of concern to park management. Management actions are guided by guidelines to assist in meeting management objectives outlined in the Kakadu Plan of Management. These guidelines are set out in the Kakadu crocodile management strategy.

Most estuarine crocodiles generally avoid or, at most, tolerate people, unless people are swimming or are stationary close to water. A crocodile is considered more likely to attack people if it has:

- Behaved very inquisitively towards people, boats, fishing lines and other objects that people use;
- Stayed close to a boat ramp while people are there;
- Scavenged around camping areas;
- Nested in high visitor use areas;
- Snatched fish from lines close to boats or the water's edge;
- Nudged or bashed boats;
- Taken dogs or other prey from the water's edge close to visitor or residential areas; and,
- Stalked people.

Procedures

The procedures used to manage crocodiles assessed as more likely to attack people are to:

1. Obtain an accurate report of the inquisitive or aggressive behaviour;
2. Inform and consult relevant officers and traditional owners, and decide on the management action to be taken; and,

3. Use temporary signs, barriers, closures or other methods to reduce the risk to people while the management action is being taken; and,
4. Monitor the crocodile; and/or,
5. Capture, measure, mark and release the crocodile; or,
6. Capture and destroy the crocodile; or,
7. Capture and relocate the crocodile.
8. Record information about the incident and the measures taken.

In some situations where crocodiles pose an immediate threat to people the animal may be captured and removed immediately to reduce danger to the public and staff.

Responding to crocodile attacks

Despite the risk management measures that Parks Australia implements, crocodile attacks have occurred in the past, and may in the future. It is essential to be prepared and ready to respond swiftly when attacks occur.

Two human fatalities have resulted from crocodile attacks in Kakadu:

- 1987: during the day a fisherman walking in waist deep water was attacked and killed by a 4.5 to 5 m saltwater crocodile after being washed off by Cahill's Crossing on the East Alligator River;
- 2002: About 11 pm at night a German visitor was taken and killed by a 4.6 m crocodile while swimming in four metres of water about 10 m from the bank at Sandy Billabong (Nourlangie Creek-South Alligator River catchment).

Parks Australia will respond to crocodile attacks promptly and effectively in a manner that minimises risks and distress to the victim, staff, other people and to crocodiles. The response actions taken to address a crocodile attack follow procedures outlined in the Kakadu crocodile management strategy.

Training staff - crocodile management

Crocodile management activities have significant inherent risks to people carrying out those activities. Most field staff in Kakadu have participated in surveys and many have coordinated surveys, but only a small number of staff are fully trained and experienced in crocodile capture and handling.

Crocodile capture operations are carried out only under the supervision of a trained, experienced park officer. The operations are conducted in a manner designed to minimise risks to staff while carrying out the operations and to the public once the area is open, and as far as possible to minimise distress to the animal when caught.

Before carrying out crocodile management actions in the field, park staff with experience and expertise in crocodile management assess the risks to park staff and any other people involved in taking the action, and take steps to minimise the risks.

Parks Australia ensures that all Kakadu staff involved in crocodile management are sufficiently trained and experienced to carry out crocodile management activities in a manner that minimises risk to themselves and other people, and minimises distress to animals.

<u>Procedures</u>

Park staff that are experienced in crocodile survey and capture techniques provide training and supervised practice to other field staff. This training and practice is carried out in the field in a number of 'stages', outlined in the Kakadu crocodile management strategy.

<u>Liaison</u>

Kakadu staff regularly liaise with external crocodile managers and with other wildlife managers to maintain up to date knowledge of crocodile management techniques and issues.

Joint Exercises

Parks Australia supports park staff with experience and skills in crocodile surveys, captures and handling to further develop their skills by participating in crocodile management exercises with the Parks and Wildlife Commission of the NT.

Summary - crocodile realities for Kakadu

Kakadu crocodiles are a 'natural heritage' population, of which there are large individual" boss crocs" 4 to 5.6+ m (13 to 18+ foot) crocodiles These large crocodiles, along with their peers, are just as important as when they were critically endangered in 1970.

Kakadu aims to maintain natural populations of native wildlife and the continuing existence of large crocodile populations are justified and appropriate. Crocodiles are only removed when there is a need to address visitor/ resident safety issues arising from human - crocodile interaction. This falls in line with Aboriginal approaches to crocodile management that included removal of estuarine crocodiles at places where Aboriginal people swam. The increasing presence of large crocodiles in waterfall plunge pools, where people like to swim has become a park management issue. These crocodiles are extra-limital individual animals (outcasts, mostly males) from downstream populations and some of these vagrant outcasts may have experienced (and be recovering from) serious injury.

In most of Kakadu breeding populations of resident crocodiles are dominated by large males (eg Roughnut at Gindjela) with vagrant crocodiles in upstream areas (near or at escarpment bases) and small back swamps. These large dominant male boss crocodiles play a role in controlling behaviour of the smaller animals in the peer group. The benefits to Aboriginals and other user groups of this dominance is unknown, but in areas like Gindjela (Goose Camp Billabong) the dominant boss crocodile "Roughnut" keeps 60% of the population at the east end in 25% of the waterway. Aboriginal people enjoy fishing from the banks in the remaining 75% of waterway! They are vigilant for crocodiles but only have to keep an eye on 40% of population, widely dispersed over 2.25 km, as opposed to fishing in 750 m of waterway where about 60 crocodiles are condensed and range in size from 50 cm to 4.5 m. A large proportion of this group are in the 2 to 3 m size class.

Kakadu is a crocodile environment. A large, healthy population of estuarine crocodiles is one of the key World Heritage values of Kakadu National Park. Kakadu management has a responsibility to protect visitors and residents (prey) from predation from crocodiles while at the same time maintaining Kakadu's crocodile population in or near to its natural state.

Literature

Parks Australia (Kakadu National Park) (2004). Kakadu Management Strategy 2004.

Parks Australia (Kakadu National Park) (1996). Draft Kakadu Crocodile Management Policy.

Lindner, G. (1994). Kakadu Crocodile Management Program - an assessment. Natural Resource Management Section, Kakadu National Park.

.

Australian Aboriginal Aspirations and Crocodile Management in Arnhem Land, Northern Territory

Peter Whitehead[1] and Michael Storr[2]

[1]Key Centre for Tropical Wildlife Management, Charles Darwin University, Darwin, NT 0909, Australia; [2]Caring for Country Unit, Northern Land Council, Darwin, NT 0810, Australia

Abstract

Arnhem Land is a large area (94,000 km^2) in the Top End of the Northern Territory held by Aboriginal people under inalienable freehold title. The region maintains high levels of ecological integrity, including large areas of highly favourable crocodile habitat. Aboriginal attitudes to crocodile management are no less diverse than in other segments of the north Australian population. Some seek substantial reductions in crocodile densities because they interfere with fishing and hunting. Others require the removal of particular nuisance animals. A few treat large animals with special deference and strongly promote their protection. Most regard crocodiles as a potentially useful source of food. Others accept special obligations to conduct ceremony and take other related actions intended to maintain the health of populations and their relationships with humans. There are no particular Aboriginal objections to commercial use, provided proper consideration is given to the interests of traditional owners of lands from which crocodiles are taken, as well as the obligations of those with special customary responsibilities. A number of communities harvest eggs, hatch them and sell the hatchlings or take a direct harvest of sub-adults or small adults. Expansion of the range of harvest options has been sought by a number of communities. This paper deals with some of those options. In particular, they and the Northern Land Council have pressed for Federal Government approval of additions to the NT management plan to allow fee-paying "safari" hunters to take 25 large animals per annum. In his preliminary approval of the Northern Territory plan, the Minister explicitly rejected the safari hunting component. Whilst the decision is not final, lobbying by animal rights interests appears to have been effective in blocking this initiative, despite support by both the Northern Territory Government and Opposition. This experience illustrates a wider issue of constraints on Aboriginal aspirations when key elements among the few options for improved livelihoods are arbitrarily blocked by inappropriate regulation that has nothing to do with sustainability.

Introduction

Arnhem Land is one of few areas in Australia that have been comparatively little changed since European settlement in the late 18th Century. Landscape structure is all but unmodified. Clearing of native woody vegetation is limited mostly to the minimum needed to insert sparse infrastructure associated with a few small towns and tiny settlements (outstations), and mostly unsealed roads and tracks linking them. There are no dams or other significant impoundments of rivers and streams. Topography is mostly subdued near the coast, with major rivers often meandering through extensive floodplains that are deeply inundated in the monsoonal wet season, and retain water in often large seasonal and perennial wetlands (see Whitehead and Chatto 1996). Wildlife remains diverse and sometimes spectacular. The human population is small (about 20,000 people) and mostly indigenous. The whole of the area of 94,000 km^2 (about half the area of Great Britain) is held under inalienable communal freehold title issued under the Aboriginal Land Rights Act 1976.

The Arnhem Land economy

Private mainstream economic activity is dominated by mining, mostly concentrated around the township of Nhulunbuy. On-site tourism is presently a relatively minor source of economic activity, although artworks produced in Arnhem Land and sold to visitors through a number of retailing arrangements generate substantial incomes (Altman 2003a). Government at various levels employs some residents, but most Government income support reaches local Aboriginal people through welfare payments to individuals and families. Only about 16% of the Aboriginal population of the Northern Territory is employed within the mainstream economy, and Aboriginal incomes are low compared with other sectors of the Northern Territory population (Taylor 2003). Although no separate analysis has been done for Arnhem Land, it is probable that employment rates are similar or lower than the Territory average. The Community Development Employment Program - a "work for the dole" system - operates variously as minimum income support,

a training scheme, or a source of financial support for other community-based activity (see Altman and Johnson 2000), and is a key source of income for households throughout the region. In addition, the customary (subsistence) economy continues to be important, contributing in excess of 30% of household cash and non-cash income in some locations (Altman 1987, 2003b).

Many indigenous communities suffer high rates of adult and juvenile mortality and morbidity, and social problems like disproportionately high imprisonment rates, poor educational attainment, and domestic violence. Influences on these problems are numerous and complex. Governments, communities and individuals, including Indigenous leaders, are increasingly emphasising the negatives of ongoing dependence on welfare (eg Pearson 1999), and as a consequence, calling for increased efforts from Aboriginal people to enter the mainstream economy. But what economic options are available to Aboriginal residents of Arnhem Land?

Economic options in Arnhem Land

The reasons for many aspects of post-settlement development largely bypassing Aboriginal lands are many, but often derive from the landscape being seen to be inhospitable and unproductive. Those lands were available for return to Aboriginal people only because the early settlers and government administrators did not see them as warranting the investments that would otherwise have led to their alienation and consequent unavailability for claim under land rights legislation. For example, central and western Arnhem Land is dominated by a huge sedimentary (sandstone) platform, the Arnhem Land Plateau, laid down by fluviatile processes about 1700 million years ago (see Russell-Smith 1995). These ancient sediments and surrounding parts of the landscape have been tectonically stable, and extensive erosion and weathering over these extraordinarily long periods has produced large areas of exposed rock and often skeletal, low nutrient soils. Consequently, the landscape is mostly unsuitable for intensive agriculture or sometimes even for extensive pastoralism (Holmes 2002). To now call for their rapid development by a small number of Indigenous residents with limited access to capital and expertise is, at best, disingenuous.

Even when ventures are supported by substantial public capital and operational funds, experience has shown that the origin has been increased by the origin of developments outside communities and consequent weak matches to local interests, aspirations and capabilities, often contribute to failure.

Important elements of contemporary Indigenous interests and aspirations include a determination to avoid gross changes in landscapes and their biological features that often accompany orthodox development. For example, the objectives of the Bawinanga Aboriginal Corporation, operating from the township of Maningrida in central Arnhem Land are to "promote the development of communities…, promote the welfare of residents, and foster the preservation and development of traditional and other cultural .. activities". Principal utilitarian roles are to provide basic housing and access to potable water. But as reflected in formal Corporation objectives, Traditional Owners also regard maintenance of the environment and its capacity to support customary activity as a high priority. These activities include fire management, hunting and gathering and related ceremony (see BAC 2001 and other annual reports for details).

Against this background, the interest expressed by many Aboriginal communities in developing small-scale enterprise based on the application of traditional skills and knowledge to the commercial use of native plants and animals - using what is already present rather than substituting other species - warrants particular attention (Whitehead 2003; Whitehead *et al.* in press).

It is in this context, of community interest in establishing small-scale enterprise based on native species, that I set out what I understand to be the attitudes of some Aboriginal people and their organisations regarding the management of estuarine crocodiles *Crocodylus porosus* in Arnhem Land. I do not suggest that this account is based on a systematic or comprehensive analysis, but is informed by personal experiences in Government and outside it, as member of Boards of national parks jointly managed with Aboriginal people, by formal and informal consultations regarding resource management issues on Aboriginal lands, and in receiving and responding to individual requests for support to design systems for sustainable use. I summarise examples of constraints placed on crocodile management and other use of native species by the Federal (Commonwealth) Government, to illustrate problems created for good land management practice in remote Australia by ill-informed and poorly considered conservation policy.

Attitudes to crocodiles and their use

Aboriginal attitudes to crocodile management are no less diverse than in other segments of the north Australian

population. Some seek substantial reductions in densities of estuarine crocodiles because their presence interferes with fishing, hunting and foraging. Others require the removal of particular nuisance animals. Most regard crocodiles as a potentially useful source of food. A few treat large animals with special deference and strongly promote their protection. Others accept special obligations to conduct ceremony and take other related actions intended to maintain the health of populations and their relationships with humans (see Lanhupuy 1987).

Customary use of crocodiles

The extent to which crocodiles are presently used for food varies regionally, but total usage appears relatively minor. For example, during studies of customary use of wild resources extending over 269 days in 1979/1980, in areas of central Arnhem Land that included favourable estuarine crocodile habitat, Altman (1987) recorded one estuarine crocodile and 60 eggs being taken by Aboriginal hunters. More recent studies (J. Altman and A.J. Griffiths, unpublished data), recorded harvest of a sub-adult estuarine crocodile only once over 80 days and 172 hunts. Clearly customary use of crocodiles in Arnhem Land, despite some limited availability of firearms, is likely to have little impact on the dynamics of crocodile populations. It is noteworthy that rapid recovery following prohibition of commercial hunting for skins (see Webb *et al*. 1984; Stirrat *et al*. 2002), occurred with no change in the law (and hence no restrictions) regarding Indigenous use for food or other customary purposes.

Commercial use of crocodiles

The capacity and willingness of Aboriginal people to meet their customary responsibilities while still making commercial use of crocodiles is well illustrated by the practice adopted by the Gumatj people of eastern Arnhem Land. Whilst the estuarine crocodile is an important totem for Gumatj, and crocodiles cannot be killed or eaten by clan members, they do not object to others with different affiliations using the species for customary or commercial purposes, provided there is consultation and opportunity to discuss implications for customary law and practice (Lanhupuy 1987). Indeed, one of the Northern Territory's crocodile farms is owned and operated by Aboriginal people.

Many Aboriginal groups are presently using crocodiles commercially under the Northern Territory's crocodile management programs. These plans are drafted to comply with both Territory law and the requirements of the Commonwealth's Environmental Protection and Biodiversity Conservation Act 1999, through which Australia meets its obligations under the Convention for International Trade in Endangered Species of Wild Flora and Fauna (CITES). The existing program provides for ranching (collection of eggs from the wild for artificial incubation), as well as a much smaller direct harvest of sub-adult (500) and adult (600) animals from the wild for their skins (Parks and Wildlife Commission of the Northern Territory 2000).

During the period 1995 to 2004, records of the Parks and Wildlife Service indicate a total of 31,819 eggs and 232 adults was harvested from Aboriginal land (Arnhem Land as well as other lands in the western Top End and Gulf of Carpentaria). These harvests represented 60% and 72% respectively of the total for the Northern Territory. However, it is important to note that 41% of these eggs were collected by non-Aboriginal, non-residents of the Aboriginal lands harvested. Whilst royalties of about $5 per egg are paid by crocodile farms, clearly such incomes are relatively minor and do not contribute to the creation of local employment opportunities. At a few sites (eg Maningrida), a substantial proportion of the eggs collected by Aboriginal harvesters are incubated by Aboriginal people and the products sold as hatchlings, which provides a much better return to the community.

Adding options for crocodile use

Following review of its crocodile management program during 2003, the Northern Territory Government proposed that a small number of larger animals should be available to be taken by recreational ("safari") hunters. A total annual quota of 25 animals over 4.0 m in length was proposed (Parks and Wildlife Service of the Northern Territory 2004), many of which would be taken from Aboriginal land. It should be noted that this quota involves no addition to the existing levels of harvest, but is rather a "sub-quota" within the 600 adults available for harvest under the existing plan. A "safari" harvest of this scale is likely to have little effect on the size of the Northern Territory's large and growing crocodile populations, which have been estimated to exceed 60,000 animals. Crocodiles would be required to be taken in accordance with a Draft Code of Practice for the Humane Killing and Treatment of Wild and Captive Australian Crocodiles. The methods used to take such animals will not differ significantly from those already approved for use in other segments of the harvest and in crocodile management more generally.

It is anticipated that the harvest of these animals will involve payment of substantial trophy fees - in the order of several thousand dollars for each crocodile taken - to landowners and employment of local residents in conducting hunts. Clearly the hunting skills and local knowledge of Aboriginal people would be particularly useful in such operations. The Northern Land Council, as administrative agent for traditional landowners in the Top End [Section 23 of the Aboriginal Land Rights (Northern Territory) Act 1976], has supported the proposal, arguing that such use of wildlife constitutes an important opportunity to build local enterprise. In addition there is virtually unanimous political support among both Government and Opposition members of the Northern Territory Parliament and local members of the Federal Parliament.

However, this change to the Territory's management arrangements requires the endorsement of the Federal Minister for Environment and Heritage, if the plan is to retain its status as a Commonwealth "Approved Wildlife Trade Management Plan". Without this endorsement, Northern Territory crocodile producers and processors are denied access to overseas markets.

The (then) Minister, in a draft declaration, approved the Northern Territory plan, with the exception that he did not permit "recreational harvest of crocodiles … for profit" (see http://www.deh.gov.au/biodiversity/trade-use/sources/management-plans/draft/croc/nt-croc-min.html). No reasons were given for the exclusion of safari hunting. However, in the absence of conservation arguments to support the exclusion, it is difficult to avoid the implication that the decision involved exercise of a philosophical or aesthetic position relating to animal rights or similar concerns, with little or no grounding in the objects of the legislation under which the draft declaration was made. Following a change of Minister in a reshuffle of portfolios in August 2004, the decision has yet to be confirmed. However, previous experience of application of the legislation and the particular stance that Australia has taken in international debates about wildlife use, suggests that the opportunity to develop commercial options that promote conservation outcomes may be arbitrarily dismissed. Should this interpretation prove to be correct, then the implications for conservation in northern Australia are profound.

Anti-use philosophies and conservation in northern Australia

The Senate Rural and Regional Affairs and Transport Reference Committee (1998) recognised that commercial use of wildlife represented one of the few enterprise options available to Aboriginal people in remote Australia. The Commonwealth Government endorsed the committee's recommendations, including an apparent acceptance of the argument (Senate Hansard, 9 December 1999) that loss or degradation of habitat was the principal cause of wildlife decline and that commercial use could provide an incentive to better manage habitat to protect its suitability for wildlife. However, there is no evidence in the EPBC Act, as enacted or subsequently amended to incorporate wildlife trade provisions, that this recognition significantly influenced the legislation's emphasis or the detail of its contents. It is relevant to note that constraints imposed on opportunities of Aboriginal people to develop local enterprise extend beyond options that could conceivably evoke concerns about animal rights, to include plants. Cycads for landscaping have been identified as one of the few plant products of higher unit value (like crocodiles) that might conceivably offer favourable enterprise opportunities to Aboriginal people in northern Australia. There is a demonstrable demand that, given large cycad populations in favourable well-managed habitat, could be filled without significant ecological risk. Estimates of potential returns suggest that under reasonable regulatory and other conditions, harvest could provide adequate returns to communities and hence some incentive to actively manage sites to protect their natural values, including the cycad populations themselves (Whitehead *et al*. in press).

However, essentially arbitrary international and national assignment of these plants to categories of special concern militates against successful enterprise. Monitoring requirements designed to reflect this formal status are so onerous that meeting them consumes much of the potential return. Those requirements appear at least in part to be designed to require harvesters to fund work that is of no immediate relevance to the impacts of their activity. Rather it provides basic information on cycad demography that is of wider application and interest and therefore might more reasonably be regarded as the province of Government, rather than the responsibility of a few of Australia's most economically marginalised people.

Imposition of such an over-prescribed monitoring scheme is an example of all-too-common regulatory disincentive for good conservation practice. Attempts to earn a modest return from demonstrably sustainable use of a native plant are saddled with severe financial constraints. Such costs would not be levied if, for example, landowners chose to destroy large parts of the cycad population to foster a cattle grazing enterprise (Whitehead 2000). Thousands of cycads could be bulldozed and burned without penalty under prevailing land clearance guidelines on pastoral leasehold or freehold land. Under these circumstances, sales of salvaged cycads stems actually create incentives for habitat

destruction through land clearing (Liddle 2004).

The anomalous treatment of such options occurs despite some potentially important provisions about the role of Indigenous people in sustainable use and conservation in the EPBC Act. Three of the seven principal objects of the Act refer to obligations to:

- ".. promote a co-operative approach to the protection and management of the environment involving governments, the community, land-holders and indigenous peoples; and,
- .. recognise the role of indigenous people in the conservation and ecologically sustainable use of Australia's biodiversity; and,
- .. promote the use of indigenous peoples' knowledge of biodiversity with the involvement of, and in co-operation with, the owners of the knowledge".

These formal statements are potentially important, because it is clear that without the engagement of Aboriginal people and their active support in choice of management regimes for their lands, Australia will be unable to achieve its stated goals for conservation of biological diversity. Aboriginal people own and manage some of the most bio-diverse lands in the nation (Yibarbuk *et al*. 2001), so their land use decisions will have a major impact on biodiversity conservation at a national scale. However, we are aware of no coherent steps to achieve that engagement in northern Australia. There is certainly no evidence of a comprehensive Commonwealth plan.

This inaction is probably a reflection of the dominant public view of appropriate conservation activity. Unfortunately, many Australians take a very narrow view of good resource management practice and the ways in which it is legitimately achieved. For conservation, they focus on uninhabited parks and reserves as the apex of conservation practice and the set asides they represent as the best way of protecting exploited resources. The difficult reality is that many of the most severe conservation problems in northern Australia result from the absence of humans from large parts of the landscape (Whitehead 1999). Trust in a few sparsely-staffed reserves is unwise.

In the absence of opportunities to use native species commercially, Indigenous landowners will be left with few options but to leave their lands or to turn them over to more intensive forms of land use. History shows that both responses will create conservation problems. In regard to moves away from traditional lands, management of tropical savannas demands active intervention to impose fire regimes that favour wildlife habitat quality (Yibarbuk *et al*. 2001). Regular movement through country by residents provides supplementary benefits in early detection and control of weed and feral animal problems. Uninhabited country is unhealthy country (Whitehead 1999; Whitehead *et al*. 2000).

In regard to intensification of land use, environmental problems often originate in attempts to force unsuitable forms of production from systems that are incapable of sustaining them at the intensity required for profitability (Holmes 1990). Many attempts to transplant orthodox agriculture and forestry to north Australia have failed due to harsh conditions (Lacey 1979; Woinarski and Dawson 2002). Moreover, the adverse change in wildlife values already seen in relatively intact landscapes suggests that the additional impacts on wildlife from forms of development involving significant fragmentation of habitats may be particularly severe (Rankmore and Price 2003).

Building capacity in resource management for remote Australia

It is important to recognise that the regulatory barriers we have identified do much more than damage opportunities for modest incomes from wildlife use and contributions to conservation management of lands. They also have much wider social implications. They arbitrarily deny opportunities for Aboriginal people to pursue the sorts of engagements with the market that they have repeatedly identified as most practical and likely to succeed. The most plausible paths towards improved capacity to interact productively with the mainstream economy are blocked (Whitehead *et al.* in press). To urge people to seek ways to escape dependence and then to erect arbitrary barriers on the routes they seek to follow is worse than perverse. Ultimately, regulatory regimes must be reshaped to exploit opportunities for enhancing both social and conservation outcomes in northern Australia.

However, because there is considerable discretion in much relevant law, in the short to medium term much can be done to develop and test ideas for wildlife-based enterprise with shifts in policy emphasis and administrative process rather than a revolution in legal frameworks. A collaborative approach supported by Government could provide the information needed to shift public perceptions of the risks of wildlife harvest compared to the alternative orthodox uses of land and foster an evolution in resource use policy and regulation. Whitehead (2000, 2002, 2003) proposed

large scale "experiments" that would explore the conservation, socio-economic and legal issues associated with a local economy based on a range of consumptive and non-consumptive uses of wildlife. Engagement of regulators at both Commonwealth and Territory levels will be an essential component of such experiments.

Conclusions

The EPBC Act follows an old-fashioned, expensive and ultimately ineffectual dichotomisation of resource and conservation management activity into sets of the intensively used and the untouchable, with provisions for bouts of heroic rescue when the effects of heavy use spill over to affect the untouchables. This may make good politics, but historical failures and contemporary trends show that it makes for awful conservation performance.

The present approach also places great demands on public funds, because it disables application of local capacity and interest in managing lands for sustainability over the longer term. In contrast to many other resource users, Aboriginal people holding traditional land under inalienable communal title are directly answerable to their local communities and do not have the option of cashing in and moving on.

There is a critical need to seek additional creative ways of meeting the incontestable obligation to improve the socio-economic position of Aboriginal people, in ways that are compatible with social and cultural norms and contemporary educational and institutional capacity. There is an associated obligation to use these engagements to build capacity to expand the range of options over the longer-term.

Conservationists have long recognised that in situ conservation of viable wild populations in their natural places is greatly to be preferred over artificial maintenance in specially protected places. It is past time to recognise the potential contribution of systems of "*in situ* production" of native species to conservation, and attitudes to wild harvests to be reconsidered.

Aboriginal people are willing to collaborate in novel ways to contribute to the nation's conservation goals. But that willingness should not be abused by either completely denying opportunities for economic advancement based on native species or, more cynically and destructively, saddling Aboriginal enterprise with ongoing compliance costs of a sort not met by promoters of "*ex situ* production" of exotic species that require the immediate or longer-term destruction of entire natural systems.

Despite its modest scale, the proposal to allow hunting of a few large crocodiles is an important test of the willingness and capacity of our conservation institutions to forge genuine conservation partnerships with the Aboriginal people of northern Australia.

Literature

Altman, J.C. (1987). Hunter-gatherers today, Australian Institute of Aboriginal Studies, Canberra.

Altman, J. (2003a). Developing an Indigenous Arts Strategy for the Northern Territory: Issues Paper for Consultations with Practitioner, Organisational and Bureaucratic Stakeholders, April-May 2003. Centre for Aboriginal Economic Policy Research, Australian National University: Canberra.

Altman, J. (2003b). People on country, healthy landscapes and sustainable Indigenous economic futures: The Arnhem Land case. The Drawing Board 4: 65-82.

Altman, J. and Johnson, V. (2000). The CDEP in town and country Arnhem Land. Discussion Paper 209/2000. Centre for Aboriginal Economic Policy Research, Australian National University: Canberra, pp. 18.

Holmes, J.H. (1990). Ricardo revisited: submarginal land and non-viable cattle enterprises in the Northern Territory Gulf District. Journal of Rural Studies 6: 45-65.

Holmes, J. (2002). Diversity and change in Australia's rangelands: a post-productivist transition with a difference. Transactions of the Institute of British Geographers 27: 362-384.

Lacey, C.J. (1979). Forestry in the Top End of the Northern Territory. Search 10: 174-180.

Lanhupuy, W. (1987). Australian Aboriginal attitudes to crocodile management. Pp. 147-149 *in* Wildlife Management: Crocodiles and Alligators, ed. by G.J.W. Webb, S.C. Manolis and P.J. Whitehead. Surrey Beatty and Sons: Sydney.

Liddle, D. (2004). Ecology and management of *Cycas armstrongi*. Unpublished PhD thesis, Key Centre for Tropical Wildlife Management, Charles Darwin University, Darwin.

Morton, S.R., Stafford Smith, D.M., Friedel, M.H., Griffin, G.F. and Pickup, G. (1995). The stewardship of arid Australia: ecology and landscape management. Journal of Environmental Management 43: 195-217.

Parks and Wildlife Commission of the Northern Territory (2000). A management program for *Crocodylus porosus* and *Crocodylus johnstoni* in the Northern Territory of Australia: Approved by the Administrator of the Northern Territory of Australia in pursuance of Section 75(3) of the Territory Parks and Wildlife Conservation Act 1998, on 31 March 2000.

Parks and Wildlife Service of the Northern Territory (2004). A draft management program for *Crocodylus porosus* in the Northern Territory. Parks and Wildlife Service of the Northern Territory: Darwin.

Pearson, N. (1999) Our right to take responsibility. Noel Pearson and Associates, Cairns.

Rankmore, B. and Price, O. (2003). The effects of forest fragmentation on vertebrate fauna in the tropical savannas. *In* Conservation of Australia's Forest Fauna, ed. by D. Lunney. Surrey Beatty and Sons: Sydney.

Russell-Smith, J. (1995). Physical environment. Pp. 94-126 *in* Kakadu: Natural and Cultural Heritage and Management, ed. by A. Press, D. Lea, A. Webb and A. Graham. Australian Nature Conservation Agency and North Australian Research Unit, Australian National University: Darwin.

Senate Rural and Regional Affairs and Transport References Committee (1998). Commercial Utilisation of Australian Native Wildlife. Parliament House: Canberra.

Stirrat, S., Lawson, D., Freeland, W. and Morton, R. (2001). Monitoring *Crocodylus porosus* populations in the Northern Territory of Australia: a retrospective power analysis. Wildlife Research 28: 547-554.

Taylor, J. (2003). Indigenous economic futures in the Northern Territory: The demographic and socioeconomic background. Discussion Paper 246/2003, Centre for Aboriginal Economic Policy Research, Australian National University: Canberra.

Webb, G.J.W., Manolis, S.C., Whitehead, P.J. and Letts, G. (1984). A proposal for the transfer of the Australian population of *Crocodylus porosus* Schneider (1801), from Appendix I to Appendix II of CITES. Conservation Commission of the Northern Territory: Darwin.

Whitehead, P.J. (1999). Is it time to fill the north's empty landscapes? Savanna Links September. October 1999: 6-7.

Whitehead, P. J. (2000). The clever country: where cows manage wildlife. Pp. 155-168 *in* Business as Usual? Local Conflicts and Global Challenges in Northern Australia. North Australian Research Unit, Australian National University: Darwin.

Whitehead, P.J. (2002). Inquiry on Capacity Building in Indigenous Communities: A submission to the House of Representatives Standing Committee on Aboriginal and Torres Strait Islander Affairs. Key Centre for Tropical Wildlife Management, Northern Territory University: Darwin.

Whitehead, P. (2003). Indigenous products from indigenous people: linking enterprise, wildlife use and conservation. Seizing our economic future: A forum sponsored by the Northern Territory Government. 6-7 March 2003, Alice Springs. http://www.indigenousforums.nt.gov.au/dcm/indigenous_policy/forums/pdf/Peter Whitehead.pdf

Whitehead, P.J. and Chatto, R. (1996). Northern Territory. Pp. 119-176 *in* A Directory of Important Wetlands in Australia. Australian Nature Conservation Agency: Canberra.

Whitehead, P.J., Woinarski, J.C.Z., Williams, R.J., Jacklyn, P. and Fell, R. (2000). Defining healthy savanna landscapes: a north Australian perspective. Tropical Savannas CRC Discussion Paper, Darwin.

Whitehead, P.J., Gorman, J., Griffiths, A.D., Wightman, G., Massarella, H. and Altman, J. (2004). Small scale commercial plant harvests by indigenous communities. Key Centre for Tropical Wildlife Management, Charles Darwin University, Darwin. Report to Rural Industries Research and Development Corporation. 186 pp.

Woinarski, J.C.Z. and Dawson, F. (2002). Limitless lands and limited knowledge: coping with uncertainty and ignorance in northern Australia. Pp. 83-115 *in* Ecology, Uncertainty and policy: Managing Ecosystems for Sustainability, ed. by J.W. Handmer, T.W. Norton and S.R. Dovers. Prentice-Hall: New York.

Yibarbuk, D.M., Whitehead,P.J., Russell-Smith, J., Jackson, D., Godjuwa, C., Fisher, A., Cooke, P., Choquenot, D. and Bowman, D.J.M.S. (2001). Fire ecology and Aboriginal land management in central Arnhem Land, northern Australia: a tradition of ecosystem management. Journal of Biogeography 28: 325-344.

Harvest of Saltwater Crocodiles by an Arnhem Land Aboriginal Community

Ray Hall

The Djelk Rangers are the Land Management Agency for the Bawinanga Aboriginal Corporation (BAC). BAC represents around 1000 members who are the landowners of an area of almost 10,000 square kilometres of north-central Arnhem Land. The region is drained by two major rivers, the Blyth and the Liverpool, whose catchments are quality natural ecosystems with almost no economic activity in them. It is the desire of the landowners to maintain the natural ecosystem for cultural, social and subsistence reasons but the need to gain economic outcomes is great and growing as the population expands. The path of choice for economic development has been through the sustainable use of natural resources because it is compatible with the other uses and the desires of the landowners. The economic development activities therefore are also a responsibility of the Djelk Rangers. Crocodiles were the first wildlife used for commercial purposes in the region for several reasons but mostly because it is an established industry. Djelk Rangers harvest and incubate crocodile eggs to sell the hatchlings to crocodile farms and also harvest wild crocodiles for skins.

The Development of the Australian Crocodile Industry

Vicki Simlesa

DBIRD, GPO Box 3000, Darwin, NT 0801, Australia (vicki.simlesa@nt.gov.au)

Pre-Crocodile Industry

- Unregulated hunting of *Crocodylus porosus* occurred between1945 and 1974 in Australia. Wild populations of *C. porosus* were protected in Western Australia (1969), the Northern Territory (1971) and Queensland (1974).
- Australian Freshwater Crocodiles were hunted from 1959 onwards, and wild populations of *C. johnstoni* were protected in Western Australia (1962), Northern Territory (1964) and Queensland (1974).
- Skins exported prior to 1972 were estimated at: Saltwater Crocodiles 330,000 and Freshwater Crocodiles 200,000-300,000.

Crocodile Farming Outcomes

- Production
- Conservation
- Education, tourism
- Employment

Northern Territory

- Currently 6 farms in operation (5 in the Darwin region, one on the Victoria River) (previously 8; see later).
- Based on production, tourism, education and hatchery.
- Captive breeding and ranching of wild eggs.
- Direct harvest of Saltwater and Freshwater Crocodiles.
- Export market for skins.
- Domestic market for live animals, skins and by-products (eg flesh).

Western Australia

- Currently 2 farms in operation (Broome, Wyndham).
- Based on production, tourism, education, research and development programs.
- Captive breeding and ranching of wild eggs.
- Direct harvest of Saltwater and Freshwater Crocodiles.
- Export market for skins and by-products (eg flesh).
- Domestic market for live animals, skins and by-products (eg flesh).

Queensland

- Currently 6 farms in operation [Mareeba, Cairns (2), Innisfail, Rockhampton, Edward River].
- Based on production, tourism, education and hatchery.
- Captive breeding only (no ranching of wild eggs).
- Export market for skins.
- Domestic market for live animals, skins and by-products (eg flesh).

Western Australia and Northern Territory Management Plans

- The crocodile industries in the Northern Territory and Western Australia operate under management programs that aim to:
  - Maintain viable wild populations of crocodiles and protect habitat upon which they depend.
  - Enhance public safety by maintaining public education and mechanism for removing problem crocodiles.
  - Management of the sustainable utilisation of crocodiles as a renewable resource, providing the conservation of the species is not comprised.

- NT: A management program for *Crocodylus porosus* and *Crocodylus johnstoni* in the Northern Territory of Australia.

- WA: Saltwater Crocodile (*Crocodylus porosus*) and Freshwater Crocodile (*Crocodylus johnstoni*) Management Plan for Western Australia.

Queensland Code of Practice

- The Queensland crocodile industry follows a code of practice that aims to have:
  - Management practices ensuring the welfare, health and nutritional requirements, are met for farmed crocodiles.
  - Promote public understanding of the value of crocodiles in the wild.
  - Compliance with any legislative requirements relating to crocodile farming.

- Nature Conservation Act 1992 and Environmental Protection Act 1994.
  Conservation and management of *Crocodylus porosus* in Queensland 1995-1997.

Northern Territory Crocodile Industry

Crocodile Farms NT

Established in 1981 with wild-caught crocodiles. It is located 38 km south of Darwin, on the Stuart Highway. The farm operates as a commercial venture with production and tourism. It has a large captivity breeding program and a kiosk with crocodile products available.

Lagoon Crocodile Farm

Establish in 1987 by the Hannon Group, the farm initially started with purchased hatchlings. The farm is located in Berrimah, about 20 minutes from Darwin City. The farm is a commercial venture exporting to domestic and international markets.

Janamba Croc Farm

Established in 1981, the farm is located 30 km east of Humpty Doo, off the Arnhem Highway, and 50 minutes from Darwin. The farm is a commercial operation, selling raw products to international and domestic markets and has a well established captivity breeding program.

Coolibah Crocodile Farm

Established in 1991, the farm located near the Victoria River, 2 hours from Katherine. Operates as a commercial farm with some tourism. Largely dependent on wild ranching of eggs, mainly from aboriginal land for hatchlings and sells live to the domestic market.

Crocodylus Park

Located at Berrimah and established in 1994 by Grahame Webb as part of Wildlife Management International. Offers production, research, education and tourism. Has a museum, crocodile products available and a range of other wildlife on display.

Elizabeth Valley Crocodile Farm

A small commercial hatchery established in 1995 near Noonamah. Mostly ranching of wild eggs, mainly from aboriginal owned land, and sells to the domestic market.

Garrangali Crocodile Farm

Established in Gove by the Gumatj Aboriginal community. Operated as a hatchery and collected eggs from the Gumatj land. Currently closed, only receiving problem crocodiles.

Letaba Crocodile Ranch

Established in 1981 on Labelle Station, approximately two hours from Darwin. Operated as a commercial venture. Closed when Labelle Station was sold.

Western Australian Crocodile Industry

Wyndham Crocodile Park

Established in 1989, the farm was later sold and merged with the Fremantle Crocodile Park (which had been established after the America's Cup Yacht Race in 1987). It offers commercial production, tourism plus research and development programs. It keeps both species of Australian crocodile and exports both flesh and skins.

Broome Crocodile Park

Established in 1978 on 2.5 ha by Malcolm Douglas. In 1983, wild caught sub-adults were introduced for farm production. The park has the two Australian crocodilian species as well as New Guinea Freshwater Crocodiles, Caimans and American Alligators. Located on Cable Beach Road in Broome, the park is both educational and entertaining.

Queensland Crocodile Industry

Koorana Crocodile Farm

Established and operated by John and Lillian Lever since 1981, it is located 38 km east of Rockhampton. Offers tourism, production and education. Crocodile products available for purchase.

Hartley's Creek

Established since 1933, it has the longest running crocodile shows. Purchased in 1986 by the Freeman family, it is located 40 km north of Cairns. Offers adventure tourism, production, education and range of other Australian wildlife on display.

Edward River

Established in 1969 by the Applied Ecology group as a means to provide employment to indigenous people in the Pormpuraaw Aboriginal Community in the Gulf of Carpentaria. A commercial business operating since the 1980s as a hatchery, producing eggs and raising hatchlings for Cairns Crocodile Farm. Shifted grow-out facilities to Cairns Crocodile Farm (previously Redbank Crocodile Farm) in 1991.

Cairns Crocodile Farm

Established in 1992, it is the largest farm in Queensland and is 45 minutes southeast of Cairns. Originally called Redbank Crocodile Farm, started as off shoot to Edward River Farm. Now a commercial business offering tourism and production.

Johnstone River Crocodile Farm

Established in1986 in Innisfail, south of Cairns. The farm offers , educational guided tours, tourism and production. The farm also has other native wildlife on display.

Melaleuca Crocodile Farm

Established in 1984 by the Fisher family. Located 60 km west of Cairns on 26 ha near Mareeba. Offers Saltwater Crocodile production for the international and domestic markets. The farm is currently expanding which will increase production numbers. The farm is unlike the traditional design, it has sound environmental practices and new concepts for crocodile handling in safety.

Current Markets

- Skins sold overseas (Japan, France, Singapore, Hong Kong)
- Flesh sold overseas (Great Britain, Japan, Korea, Denmark, New Zealand, China)

General Production Figures

State/Territory	No. of *C. porosus* Processed	No. of *C. johnstoni* Processed
NT 2002	3468	0
NT 2003	3127	0
WA 2003	1212	0
QLD 2002	9406	324

Acknowledgements

- QDPI and WA, NT, QLD Crocodile Industry for input.

Literature

www.rirdc.gov.au/pub/handbook/croco
www.koorana.com.au/text-contact
www.crocfarm.com.au/history
www.pormpuraaw.qld.gov.au/crocfarm
www.aph.gov.au/senate/committee/rrat
www.mesa.edu.au/friends/croc
www.users.bigpond.com/PWfisher/overview
www.animalfocus.com
www.deh.gov.au/soe/2001/biodiversity
www.abc.net.au/landline/bo110198
EPA Queensland Parks and Wildlife Service
Other species - crocodiles. ABARE report 03.8

Population Genetics of Australia's Crocodiles: A Comparison Between *Crocodylus johnstoni* and *C. porosus*

Nancy N. FitzSimmons[1,2], Jason Buchan[1], Mark A. Read[4], Jeff D. Miller[5], Winston Kay[1], Craig Moritz[1,3], Colin J. Limpus[6], David Blair[7] and Gordon C. Grigg[1]

[1]Department of Zoology and Entomology, University of Queensland, Brisbane, QLD 4072, Australia; [2]Applied Ecology Research Group, University of Canberra, ACT 2601, Australia (present address); [3]University of California, Berkeley, Museum of Vertebrate Zoology, 3101 Valley Life Sciences Bldg., Berkeley, Ca 94720-3160, USA (present address); [4]Queensland Environmental Protection Agency, Queensland Parks and Wildlife Service, PO Box 5391, Townsville, QLD 4810, Australia; [5]Queensland Environmental Protection Agency, Queensland Parks and Wildlife Service, PO Box 2066, Cairns, QLD 4870, Australia; [6]Queensland Environmental Protection Agency, Queensland Parks and Wildlife Service, PO Box 155, Brisbane, QLD 4002, Australia; [7]Department of Zoology and Tropical Ecology, James Cook University, Townsville, QLD 4811, Australia

Effective management of Australia's crocodile species requires a better understanding of crocodilian population boundaries, migration patterns and the historic relationship among populations. To investigate these features of crocodilian biology, we have taken a comparative approach by looking at both species and using two types of genetic markers; mtDNA and microsatellite loci. Extensive sampling throughout the range of both species has included more than 460 freshwater crocodiles and 570 estuarine crocodiles that were analysed for variation at ten microsatellite loci. More than 150 individuals of each species were sequenced to determine the patterns of mtDNA variation. Our results from the nuclear microsatellites indicate significant genetic heterogeneity among river systems in both species; with gene flow being more limited among populations of the freshwater species relative to the estuarine crocodile. These data indicate a significant correlation between the extent of gene flow and geographic distance observed in each species. Contrasting results were seen at the two genetic markers in terms of genetic diversity, with the nuclear genes showing greater diversity in the estuarine crocodile, whereas the mtDNA revealed greater genetic diversity within freshwater crocodiles. Common mtDNA variants were found in nearly all populations of each species, but there were also unique variants found only in certain regions, indicating moderate genetic structure. These results will be discussed in relation to crocodile biology and management.

Crocodilians and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

Dietrich Jelden

Federal Agency for Nature Conservation, Bonn, Germany

1. Effects of CITES on the World Trade in Crocodilian Skins

- 1960s: 6-8 million skins in world trade
- Today: 1.5-1.8 million skins in world trade

2. Evolution of the Convention

- 1960: First discussion of problems of illegal wildlife trade at 7th General Assembly (GA) of IUCN.
- 1963: 8th GA of IUCN passed resolution on illegal wildlife trade -> call for an International Convention.
- 1964: First draft by IUCN for a Convention.
- 1969: 10th GA of IUCN discussed list of species to be controlled.
- 1972: UN Conference on Human Environment adopted, Recommendation 99.3.
- March 1973: 21 countries signed CITES (Plenipot. Conf. which IUCN had recommended in 1963).
- 1 July 1975: CITES entered into force after 10 Ratifications.

3. Core Contents of the Convention

- CITES protects 7000 animals and 25,000 plants through listing in 3 Appendices (I, II and III).
- CITES regulates international trade through a system of permits required before specimens enter or leave a country -> ANNUAL REPORTS provide trade data.
- National implementation of CITES important (ie designation of authorities, legal protection of CITES species, sanctions).
- Over 95% of CITES protected species are legally classified as not being endangered -> sustainable commercial trade is permitted.

Many exemptions (Article VII) under the Convention (captive-bred, personal effects, pre-Convention, etc.)

4. Crocodilians in CITES Appendix I (1975/2003)

1973	2003
Alligator mississippiensis	-
Alligator sinensis	*Alligator sinensis* (CR)
Caiman c. apaporiensis	*Caiman c. apaporiensis*
Caiman latirostris	*Caiman latirostris*
Melanosuchus niger	*Melanosuchus niger* (LR)
-	*Crocodylus acutus* (VU)
Crocodylus cataphractus	*Crocodylus cataphractus* (DD)
Crocodylus intermedius	*Crocodylus intermedius* (CR)
Crocodylus n. mindorensis	*Crocodylus mindorensis* (CR)
Crocodylus moreletii	*Crocodylus moreletii* (LR)
Crocodylus niloticus	*Crocodylus niloticus*
Crocodylus palustris	*Crocodylus palustris* (VU)
-	*Crocodylus porosus*
Crocodylus rhombifer	*Crocodylus rhombifer* (EN)
Crocodylus siamensis	*Crocodylus siamensis* (CR)
Osteolaemus tetraspis	*Osteolaemus tetraspis* (VU)
Tomistoma schlegelii	*Tomistoma schlegelii* (EN)
Gavialis gangeticus	*Gavialis gangeticus* (EN)

5. Major Crocodilian Conservation Relevant Decisions Adopted at CITES Conferences

5.1. CITES - 1st Conference of the Parties (1977)

- Criteria for the **addition** of species and other taxa to CITES Appendix I and II (biological and trade criteria) - Resolution Conf. 1.1 (now Resolution Conf. 9.24)
- Criteria for **deletion** of a taxon from Appendix I or **transfer** to Appendix II - Resolution Conf. 1.2 (now Resolution Conf. 9.24)

5.2. CITES - 2nd Conference of the Parties (1979)

- Transfer of the American Alligator to Appendix II
- Trade in hunting trophies - Resolution Conf. 2.11:
  - Only for non-commercial activities;
  - Acknowledgment that killing of App. I animals could enhance the survival of a species
- Specimens bred in captivity or artificially bred - Resolution Conf. 2.12:
  - Aims to avoid that wild taken specimens are considered as captive-bred (ie ranched specimen);
  - Defines term 'captive bred' for Appendix-I species (biologically and legally)
  - Marking requirements

5.3. CITES - 3rd Conference of the Parties (1981)

- Transfer of the Saltwater and the American Crocodile (*C. porosus* and *C. acutus*) to Appendix I
- Trade in ranched specimens - Resolution Conf. 3.15 (now 11.16):
  - New system for transfer of populations from Appendix I -> Appendix II
  - Initiative originated from adoption of CITES captive breeding Resolution (Resolution Conf. 2.12)
  - Focus on crocodilians
  - Rearing wild specimens in controlled environment must be beneficial to wild population
  - Monitoring, reporting and marking requirements

5.4. CITES - 4th Conference of the Parties (1983)

- Transfer of Zimbabwe Nile Crocodile population to Appendix II persuant to CITES Resolution on "Ranching"
- Control of captive breeding operations of Appendix I species (Resolution Conf. 4.15 now 12.10):
  - Establishment of a register of operations based on Parties information;
  - No trade with operations which are not registered

5.5. CITES - 5th Conference of the Parties (1985)

- Transfer of several crocodile populations to Appendix II under temporary system based on annual export quotas (Kenya, Somalia, Malawi, Sudan, Zambia, Indonesia, etc.)
- Legal basis: CITES Resolution Conf. 5.21 (Special criteria for transfer of taxa from Appendix I to Appendix II)
  - Transfer **under quota system** only for species (in reality mostly crocodiles) sufficiently safe in the wild (studies);
  - No application of Berne Criteria (Resolution Conf. 1.2) necessary if species were included in CITES Appendix I before listing criteria existed;
  - Temporary approach only (review at COP7 and COP9).

5.6. CITES - 7th Conference of the Parties (1989)

- CITES Resolution Conf. 7.14 (Special criteria for the transfer of taxa from Appendix I to Appendix II):
  - Extension of mandate of quota resolution adopted at COP5 until COP9;
  - After COP9 either maintainance of populations in Appendix II under normal downlisting criteria or ranching criteria;
  - Evaluation: in many, but not all cases quota system was useful (Madagascar, Somalia, Sudan).

5.7. CITES - 8th Conference of the Parties (1992)

- CITES Resolution Conf. 8.3 (Recognition of the benefits of trade in wildlife)
- CITES Resolution Conf. 8.14 (Universal tagging system for the identification of crocodilian skins)
- CITES Resolution Conf. 8.22 (Additional criteria for the establishment of captive breeding operations and for the assessment of ranching proposals for crocodilians):
  - Acknowledges ranching as valuable conservation tool;
  - Being more beneficial for conservation ranching should be given priority over farming;
  - No wild-caught animals should form the breeding stock unless justified by national management plan.

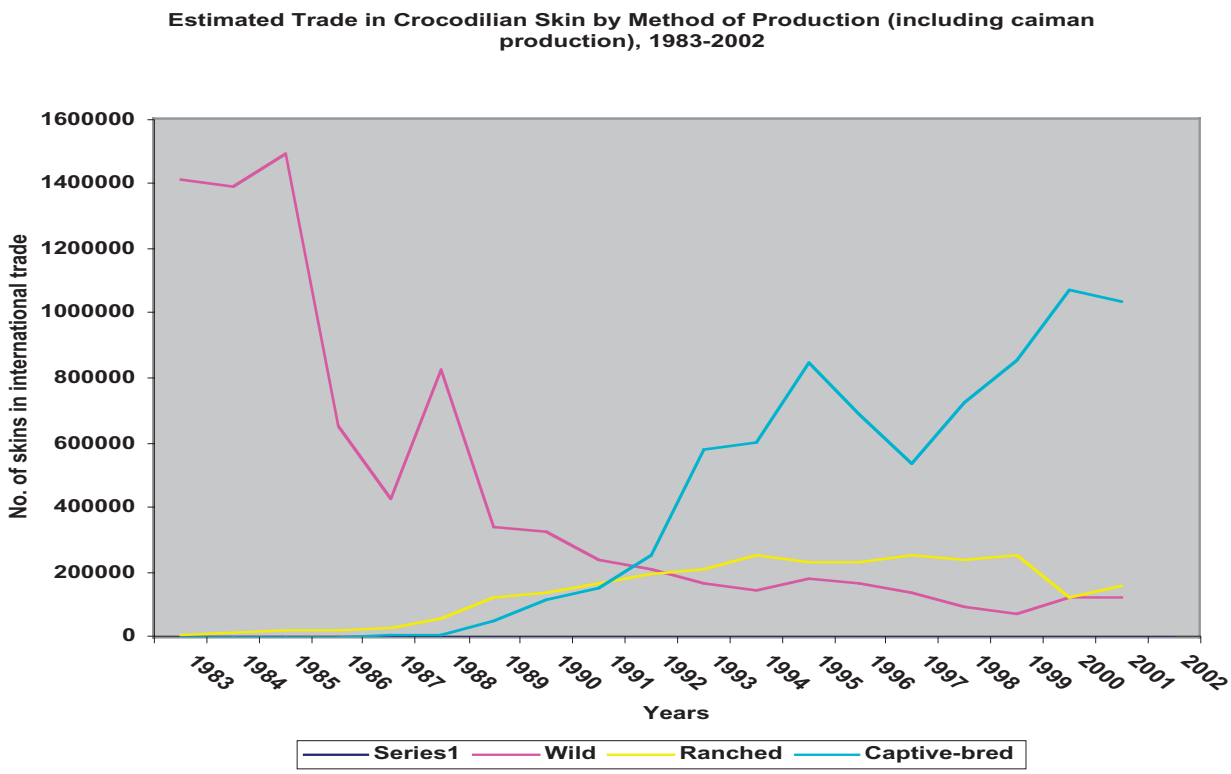
5.8. CITES - 10th Conference of the Parties (1997)

- CITES Resolution Conf. 10.17 (Animal hybrids)
  - COP decided that trade in hybrids should be controlled in order to support controls on trade in the species included in Appendix I and II;
  - Determination of legal status of hybrids through the respective CITES protected animal (Appendix I or II) in the recent lineage (= 4 generations).

5.9. CITES - 12th Conference of the Parties (2002)

- CITES Resolution Conf. 12.9 (Personal and household effects):
  - definition of term personal and household effects (legality, personal owned and possessed);
  - no CITES documents for up to 4 specimens per person made of crocodilian leather from Appendix II species;
  - Parties should provide in general information on CITES for tourists and more specific at places of international departure, etc.

6. CITES Generates Trade Data



Compliance with CITES

Tomme Rosanne Young

Senior Legal Officer, IUCN Environmental Law Centre (Distillation)[1]

Context (Current Proposals)

This October, the 13th Conference of the Parties (COP) to the Convention on International Trade in Endangered Species of Fauna and Flora (CITES) will consider adopting a new document entitled "Guidelines on Compliance with the Convention" (still as of this writing, available as SC 50, Doc. 27 in the documents of the 50th Meeting of the CITES Standing Committee[2]). Although this document speaks of a primary objective of "preventing non-compliance," it focuses on enforcement at the international level - specifically, the creation of a detailed quasi-judicial process that will apply where the Standing Committee and COP believe that a Party is not complying with its obligations under the Convention.

Based on the CSG's valuable involvement in the CITES processes, as well as the experiences of other Conventions and international institutions[3] , this paper notes that a broader view of compliance is essential. A greater focus on remedying situations of non-compliance and on re-evaluating administrative/systemic requirements of on-the-ground implementation must receive predominant attention in all discussions of compliance with CITES.

In general

At all levels (including intergovernmental objectives, domestic governance, and private-sector industry initiatives), CITES approach to compliance must be "outcome oriented." In other words, rather than perceiving the issue as one of "enforcing the Convention" (making sure that all requirements are met "to the letter"), it should seek to promote the ultimate outcomes. Those outcomes can be expressed in two ways:

- maximizing compliance with the overall CITES system (optimizing the operations of that system), or
- promoting the conservation of species through their sustainable use.

To this end, CITES's compliance strategy should focus on improvement of capacity and development of mechanisms to improve the efficiency and usability of the CITES system. This necessarily means that even questions of the inter-governmental compliance should primarily focus on the on-the-ground system, how it works, and how governments, individually and collectively, can improve its functioning.

"Enforcement" only or all aspects "Compliance"?

In many instances, CITES has tended to address compliance questions entirely in the context of "enforcement" - a process that consists of: (i) identifying instances of non-compliance; (ii) calling on the non-complying party to come into compliance; and, (iii) if necessary, imposing sanctions. Often its attention to enforcement focuses entirely in the context of national commitments under the Convention (the national obligations to identify management and scientific authorities, to adopt relevant legislation, to apply permit and certificate requirements, enforce border controls, to authorise the imposition of sufficient penalties, etc.).

However, an outcome-focused approach requires that these issues be considered in tandem with several other key elements of compliance:
- assisting the Parties to bring their activities into compliance,
- improving capacity of relevant agencies and others,
- addressing systemic problems that inhibit compliance at the national level,

---

[1] A longer discussion of CITES compliance issues and their relationship to the objectives of the Convention and sustainable trade in crocodilians can be found at www.iucn.org/themes/law under the heading "Developments _____." This paper is the source of this distillation and of the presentation made to the CSG's 15th Working Meeting.

[2] CITES documents, including the documents of the 50th Standing Committee and the documents tabled for COP13, are available on the internet at www.cites.org.

[3] Detailed in the paper cited at footnote 1.

- identifying and promoting factors that would provide an incentive for compliance by the regulated community (harvesters, ranchers, breeders, traders, etc.),
- relationships with the private sector and markets that can both be benefited by and provide incentives for the existence of an effective functional system.

One can easily see, after the briefest examination of the relevant issues and opportunities, that these latter elements of compliance often have a far greater impact on achievement of the above-described outcomes than the enforcement of national obligations.

Limitations on Enforcement of National Obligations under CITES

The ability of the international community (the other Parties to CITES, the Secretariat, etc.) to directly and formally compel a country to implement CITES is relatively limited. No person or government may assume rights of any sovereign government, unless that government agrees. This means that unless the Government has adopted and implemented/enforced CITES legislation, no other government or group may force the people within the country to comply with CITES. Similarly, in normal circumstances, no formal legal process (including hearings in international tribunals) may be brought against a country that is not complying with its international obligations, unless that country agrees to participate in the tribunal and to accept its judgement.

For this reason, there are two mechanisms for directly enforcing a country's obligations. So-called "citizen's suits" - persons or companies under the jurisdiction of the country are sometimes empowered to sue the government when it is not meeting its obligations. In a few countries, this power includes compelling government to implement its obligations under national convention. CITES existing process under which other Parties are adjured to voluntarily refrain from permitting import of goods from a country that has failed to comply with the Convention. In general, enforcement of national obligations does not include examination of matters of judgement or planning. This means it is rarely possible to bring action against a country for actions that may be seriously harmful to the objectives of the CITES system, including:

- Failure to issue permits or certificates;
- Refusal of an application;
- Failure to comply with domestic quotas or management plans; and,
- Failure to cooperate with other agencies, including especially habitat-protection authorities.

Broader Approach to Compliance - Promoting Key Outcomes

More important than the fact that enforcement is not always a strong option, is the fact that it is not an effective strategy for achieving key outcomes. It is not possible to guard every specimen, to directly oversee every user, or to inspect every packet, suitcase or container passing national boundaries. The success of a compliance programme is not measured by enforcement activities, but by the extent of compliance by to which governments and affected individuals or groups without direct compulsion or enforcement.

Effective, Functional System*:* Applying an outcome focus, compliance questions should begin with analysis of the on-the-ground issues:

CITES clearly identifies the actions to be regulated (transboundary movement of species by humans) and the reasons why (to ensure that trade does not harm the conservation status of species, and the role it plays in the ecosystem);

Since CITES adoption, the Parties to CITES have collectively recognised that in many cases, the promotion of sustainable international (and domestic) trade in species can actually be a positive tool for conservation, suggesting a further obligation to promote controlled and sustainable trade.

Thus, it is essential to examine both the current limitations on government's ability to take action (set quotas, adopt plans and policies, issue or deny permits) in a commercially reasonable time, other "bottlenecks" and systemic components that can be made more efficient without sacrificing conservation and sustainability objectives. Addressing these matters is a key element of compliance, in that it will make it easier for the regulated community to comply without governmental compulsion. Some examples of how this approach has been used come from the Crocodile Specialist Group, which has successfully promoted numerous improvements in the CITES permit system with regard to crocodile trade, including the universal crocodilian-skin tagging system, clarification of the "personal effects

exemption from CITES (simplifying and clarifying the rights of retail purchasers, thereby giving them more confidence to purchase crocodilian items, while at the same time, ensuring that the exemption does not become a cover for smuggling by non-CITES (unsustainable) producers and traders).

Other improvements, including a simplified process for permits for the cross-border movement of trade fair sample of crocodilian skins, are being developed, and will be submitted to the Conference of Parties in October. This approach, helping to reshape the specific elements of compliance by management authorities and by the regulated individuals and industries, appears to be a key element to achievement of the primary objectives of compliance. A number of other factors may be relevant as well, including collaboration among various key agencies and authorities.

Enabling and Enhancing the Capacity of Agencies: National compliance is most effective where the Parties are clearly aware of two sides of their obligation - the obligations directly assumed under the Convention (designation of MA/SA, national legislation, sufficient penalties, etc.), and the institutional and practical needs that will make the CITES permit system more functional and effective on the ground.

At this point, the most effective components of compliance are usually those that are not involved with compulsion (ie assistance in bringing their activities into compliance, capacity-building, and identification and confrontation of systemic problems that inhibit compliance at the national level). (While the underlying power of enforcement through the recommendation of voluntary moratoriums is undoubtedly an incentive underlying compliance, it is generally true, as noted above, that the situations in which CITES has to resort to enforcement represent failures of the Convention. Rather, it is the larger number of cases in which non-enforcement activities result in positive compliance that provide the best evidence of its success.)

One of the best examples of this approach is the CITES Secretariat's work on the "legislation project". Under this project, the Secretariat and other organisations analyse each country's CITES implementation legislation to determine if it meets the requirements of the Convention. Countries are graded as category 1 (fully in compliance), category 2 (partly in compliance) and category 3 (generally not in compliance). Parties in categories 2 and 3 are given assistance in amending or developing legislation that is fully compliant. Only where it appears that Parties have not made or attempted to make progress after a significant time would enforcement action be considered.

Involvement and Initiatives of the Affected Industry: Often direct relationship with traders and other commercial and industrial actors, can have a major impact on CITES compliance. Trade in crocodilian skins and their products provides a useful example of this, where many members of the crocodile products industry recognise that they benefit by the existence of a controlled and functional sustainable trade system. Programmes that promote demand for CITES-permitted skins have been a major contributor to the current comparative successes of the crocodilian trade under CITES.

Recommendations

Future development in CITES compliance should focus on the positive aspects of compliance, giving attention to enforcement as a final back-up tool. Accordingly, it is important for work on consistency to focus on;

- Improvement of the on-the-ground system, by considering the nature of current problems and limitations that inhibit the functioning of that system;
- Identification of the reasons underlying those problems, and development and authorisation of practical solutions to those problems, while ensuring that streamlining of the system does not have negative conservation impacts or create opportunities for circumventing the law;
- Enabling and enhancing governmental compliance and more efficient application of the CITES system, through direct assistance with the creation, empowerment and implementation of relevant institutions and processes, and;
- Programmes for enhancing national capacity to implement the Convention, including planning, management, evaluation and system development;
- Addressing key deficiencies in the existing international-level enforcement system, by clarifying a consistent process for identifying possible situations of non-compliance for further deliberation, clear investigatory authorities and procedures (including the rights of the Party being investigated); and,
- clarifying the role of enforcement as a final option in cases in which other types of compliance have not been successful.

Article IV of CITES and the Concept of "Non-detriment"

Grahame J.W. Webb

Wildlife Management International, PO Box 530, Sanderson, NT 0812, Australia; Key Centre for Tropical Wildlife Management, Charles Darwin University, Darwin, NT 0909, Australia (gwebb@wmi.com.au)

CITES - A Brief Overview

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) was agreed in 1973, and the treaty came into force in 1975. CITES has now been acceded to by 165 Parties (by 2004). The core business of CITES is to ensure that international demand for wild plants and animals does not causes the wild populations of these species within Range States, to become extinct or be threatened with extinction (Article II). Demand, international trade and threats to survival are all linked to each other, sometimes in simple and obvious ways, but often in ways masked by the complexities of trade and processing routes (Fig. 1).

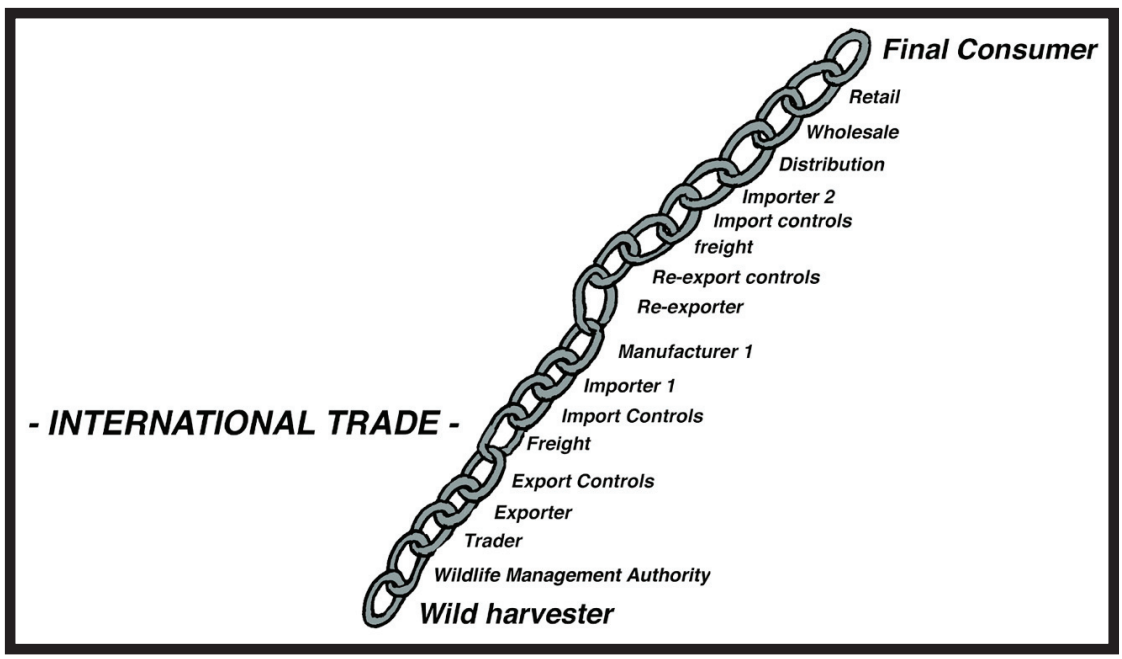


Figure 1. A hypothetical chain of events linking supply and demand for a wildlife product in international trade (Webb *et al*. 2004).

Through CITES, the contracting Parties agree to some "broad-brush" cooperative approaches to controlling international wildlife trade. One of the first priorities is to identify species threatened by trade and allocate them to the Appendices of CITES in accordance with the degree of threat.

In extreme cases, where international trade is known to be causing extinction, the primary mechanism of CITES intervention is to list the affected species on Appendix I (Article II). This action effectively bans international trade between Parties to CITES and breaks the chain linking supply and demand (Fig. 2). [An exception is made for Appendix-I specimens bred in captivity for commercial purposes (see below)]. Appendix-I listing is the ultimate coercive action within the trade-based mandate and agreed boundaries of CITES.

Where a threat exists, but it is not extreme enough to merit a trade ban, species are usually listed on Appendix II. Specific directions about Appendix II listing are:

1. If a species is considered vulnerable to becoming threatened with extinction through international trade, and thus become a candidate for Appendix I [Article II.2(a]; or,
2. If a species is so similar in appearance to a vulnerable species listed in Appendix II, that for the practical purposes of controlling trade, the "look-a-like" species also needs to be listed [Article II.2(b)], even though its status in the wild may not be in question.

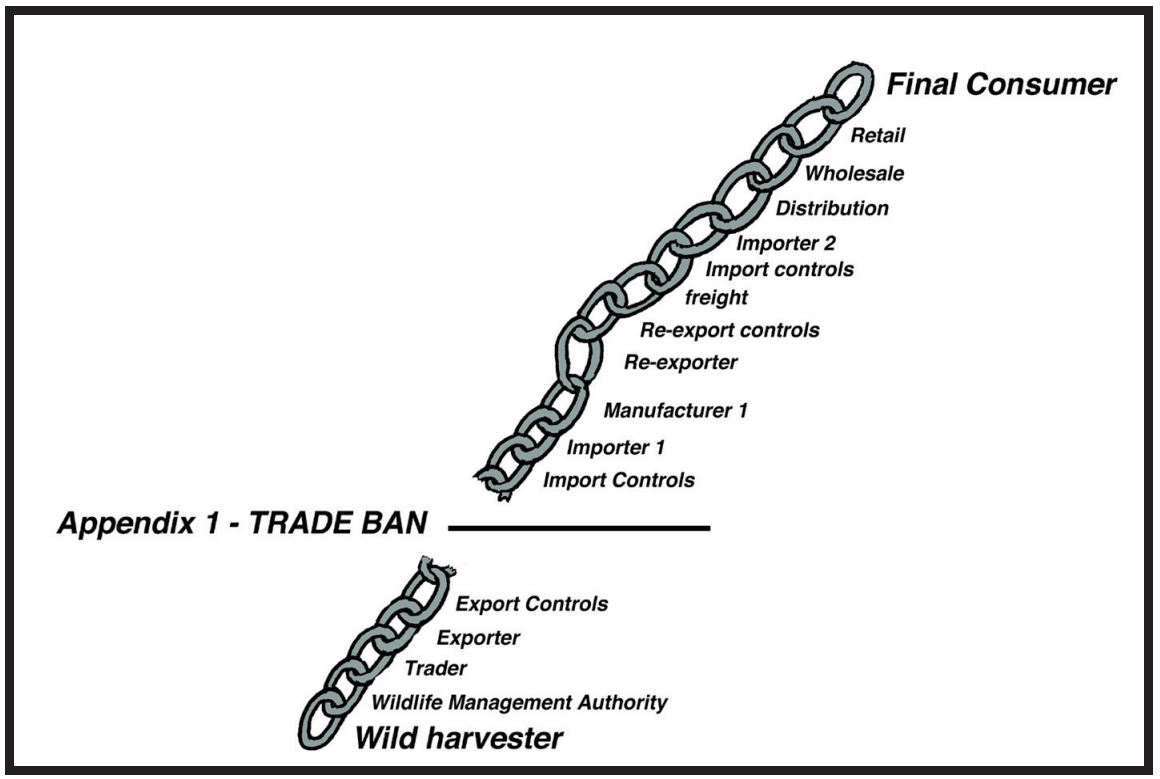


Figure 2. Appendix I bans international trade and breaks the chain of events through which international trade is providing commercial incentives for excessive harvesting of threatened species (Webb *et al*. 2004).

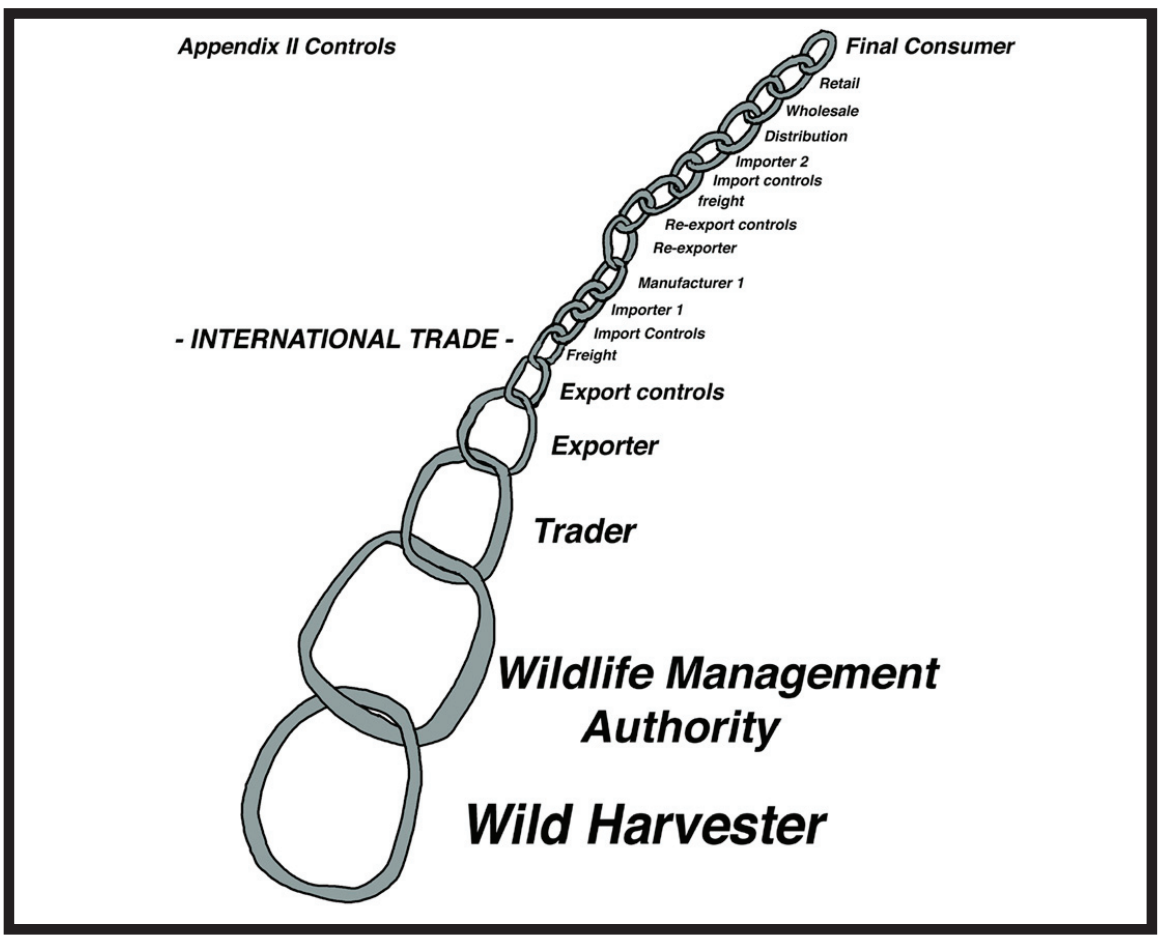


Figure 3. Appendix II-listed species can be traded if the conditions of Article IV are met ("Regulation of Trade in Specimens of Species included in Appendix II"). This represents a significant challenge, cost and responsibility to producing (exporting) nations.

International trade in Appendix II listed species is allowed if certain conditions are met. These conditions are contained in Article IV - "Regulation of Trade in Specimens of Species included in Appendix II". The central aim of this paper is to look more closely at the interpretation of Article IV, which underpins most crocodilian trade and represents a significant technical expense and responsibility for exporting Parties (Fig. 3).

Individual nations can list any species in international trade on Appendix III if they consider they need increased cooperation from other Parties to help them control trade. All crocodilians were listed on Appendix I or Appendix II in 1975, because they were experiencing genuine declines due to international trade, and/or the species were difficult to distinguish from each other in trade.

Article IV

General

Trade in CITES-listed species is fundamentally restricted to Appendix II species, and Article IV must be satisfied before export permits can be issued and trade can take place. There are no exemptions in Article IV, so regardless of whether a species were listed on Appendix II because they were threatened with extinction [Article II.2(a)] or because they looked like a threatened species [Article II.2(b)], compliance with Article IV is mandatory.

It is not always clear how all the provisions of Article IV should be implemented or complied with. Nowhere is this confusion more entrenched than with the biological safeguards. Article IV.2(a) requires assurance that each export will not be detrimental to the survival of that species and Article IV.3 requires assurance that the species' role in the ecosystem is being maintained. Both are serious technical challenges.

Not detrimental (Article IV.2(a)

Rosser and Haywood (2002) attempted to provide guidance on "non-detriment". Their basic assumption was that exports were less likely to be detrimental if they came from a sophisticated (versus simple) management program.

The degree complexity or sophistication of a large sample of management programs may be correlated with the degree of detriment caused by management, but assuming cause and effect would be fraught with peril. For example, some of the most sophisticated management programs (eg Atlantic Cod) have resulted in grossly unsustainable patterns of use, causing real threats to the survival of species. Against this, some of the simplest of management protocols (eg Aboriginal harvesting of many species in northern Australia), with no formal scientific monitoring, have resulted in harvests being sustained for tens of thousands of years. The approach proposed by Rosser and Haywood (2002) sheds insights into management practices but provides no real guidance on how Article IV.2(a) should be assessed.

In provide guidance on Article IV.2(a) it is important to recognise that it refers specifically to detriment in terms of the survival of that species. In other words, actions that truly threaten the survival of the species are deemed detrimental, whereas actions that do not threaten survival of the species per se (despite numerous other potential adverse impacts) are not detrimental.

Given that significant population reductions can occur without a wild population's ability to survive and recover being truly compromised, the detriment in Article IV.2(a) is not a particularly sensitive trigger for action. It is more about ensuring no obvious and gross negative impact of harvesting is being allowed to continue operating while a species is being exported.

But even in this context it is a fine line between detriment and non-detriment. Survival of the species has rarely been tested for any species, and gross errors may exist between theory and practice. For example, the recovery rates of depleted crocodile and sea turtle populations may be many times greater than rates predicted from theory alone (Webb et al. 2004). Satisfying Article IV.2(a) will always be difficult.

Role in the Ecosystem (Article IV.3)

The implicit assumption in Article IV.3 is that role in the ecosystem for each Appendix II species in trade can and will be monitored, and if the role is compromised anywhere in a species' range, the cessation of trade would be a first step response, regardless of whether trade was involved in compromising the role or not. Article IV.3 clearly extends the

Article IV

"Regulation of Trade in Specimens of Species Included in Appendix II"

1. All trade in specimens of species included in Appendix II shall be in accordance with the provisions of this Article.

2. The export of any specimen of a species included in Appendix II shall require the prior grant and presentation of an export permit. An export permit shall only be granted when the following conditions have been met:

   (a) a Scientific Authority of the State of export has advised that such export will not be detrimental to the survival of that species;

   (b) a Management Authority of the State of export is satisfied that the specimen was not obtained in contravention of the laws of that State for the protection of fauna and flora; and

   (c) a Management Authority of the State of export is satisfied that any living specimen will be so prepared and shipped as to minimize the risk of injury, damage to health or cruel treatment.

3. A Scientific Authority in each Party shall monitor both the export permits granted by that State for specimens of species included in Appendix II and the actual exports of such specimens. Whenever a Scientific Authority determines that the export of specimens of any such species should be limited 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 that species might become eligible for inclusion in Appendix I, the Scientific Authority shall advise the appropriate Management Authority of suitable measures to be taken to limit the grant of export permits for specimens of that species.

4. The import of any specimen of a species included in Appendix II shall require the prior presentation of either an export permit or a re-export certificate.

5. The re-export of any specimen of a species included in Appendix II shall require the prior grant and presentation of a re-export certificate. A re-export certificate shall only be granted when the following conditions have been met:

   (a) a Management Authority of the State of re-export is satisfied that the specimen was imported into that State in accordance with the provisions of the present Convention; and

   (b) a Management Authority of the State of re-export is satisfied that any living specimen will be so prepared and shipped as to minimize the risk of injury, damage to health or cruel treatment.

6. The introduction from the sea of any specimen of a species included in Appendix II shall require the prior grant of a certificate from a Management Authority of the State of introduction. A certificate shall only be granted when the following conditions have been met:

   (a) a Scientific Authority of the State of introduction advises that the introduction will not be detrimental to the survival of the species involved; and

   (b) a Management Authority of the State of introduction is satisfied that any living specimen will be so handled as to minimize the risk of injury, damage to health or cruel treatment.

7. Certificates referred to in paragraph 6 of this Article may be granted on the advice of a Scientific Authority, in consultation with other national scientific authorities or, when appropriate, international scientific authorities, in respect of periods not exceeding one year for total numbers of specimens to be introduced in such periods.

notion of "detriment" well beyond survival of the species *per se*, to virtually any aspect of the species existence within its ecosystem.

Although the spirit of Article IV.3 is obvious, in terms of laying down a safeguard that restricts trade to reasonably healthy wild populations, no Party has yet been expected to comply with Article IV.3 in any way other than generalities. The technical challenges would be truly enormous for any species.

Sustainable Use

Regardless of how sustainable use of wildlife is defined, the concept involves three main components: i) use, both consumptive and non-consumptive; ii) sustainability, a process, simple or complex, to keep uses going indefinitely; and, iii) impacts, the ability to specify limits on potential unwanted effects of use. Sustainable use of wildlife can thus be defined as: use of wildlife associated with a process aimed at ensuring the use can continue indefinitely and that its impacts are maintained within prescribed limits. In practical terms this usually means use associated with a management program that aims to sustain a harvest program indefinitely and ensure adverse impacts are avoided or minimized.

The text of CITES does not specifically mention sustainable use, yet sustainable use is now recognised as being fundamental to wildlife conservation and managed use, and its application to Article IV is clearly recognised in the CITES Strategic Plan. Perhaps most important, the evidence usually presented to satisfy the biological safeguards of Article IV typically relates directly to sustainable use. For example:

i. if sustainable use can be demonstrated, the probability of detriment to survival [Article IV.2(a)] can be rejected.
ii. if uses are demonstrated as being unsustainable, the probability of detriment to survival [Article IV.2(a)] cannot be rejected and further study would be required to determine whether survival itself is compromised.
iii. by prescribing and monitoring the impacts of use, a mechanism is provided for defining and monitoring elements of role in the ecosystem over time [Article IV.3].

When crocodilian programs are assessed from a sustainable use perspective, information germane to two basic questions are needed: i) is the wild population sustaining the harvest? ii) are the impacts of the harvest being controlled within the context-specific levels prescribed? These approaches provide the only practical approach for complying with Article IV.2(a) and Article IV.3.

Appendix-I Animals Bred in Captivity for Commercial Purposes

The Convention (Article VII.4) establishes that the progeny of Appendix-I species bred in captivity for commercial purposes should be deemed, for the purposes of international trade, to be specimens in Appendix II.

In terms of regulating trade in such captive-bred Appendix-I specimens, Article VII.5 establishes that a certificate issued by the Management Authority shall be accepted in lieu of any of the permits or certificates required under the provisions of Article III, IV or V. However, there is no blanket exemption from Articles III, IV or V as explicitly exists with personal or household effects (Article VII.3).

This raises the issue of whether Article IV.2(a) and Article IV.3 (biological safeguards) do have some role to play in the regulation of trade in captive bred Appendix I specimens. Bearing in mind that captive breeding for commercial purposes can directly compete against sustainable use programs, and thus undermine conservation of wild populations, this issue should not be dismissed lightly.

When the Parties agreed to Resolution Conf. 12.10 (Guidelines for a procedure to register and monitor operations that breed Appendix-I animal species for commercial purposes), at COP12 in Santiago, Chile (2002), it was clear that where trade in Appendix-I captive-bred specimens was concerned, the Parties did expect compliance with Article IV:

(Resolves e) Parties shall strictly implement the provisions of Article IV of the Convention with respect to specimens of species included in Appendix I originating from operations that breed such specimens in captivity for commercial purposes.

Conclusions

At the time CITES was enacted, banning trade in species whose survival was directly threatened by trade was the major priority. Through listing on Appendix I, such bans were achieved reasonably easily and effectively, and they did help reduce the pressure on wild populations. As wild populations of crocodilians began to recover in Range States, transfers from Appendix I back to Appendix II became commonplace, with controlled use and trade replacing the uncontrolled and excessive uses of the past.

The major obligations of exporting countries were clearly to comply with Article IV, and particularly, to be able to demonstrate "non-detriment". In addition, special "Ranching" provisions were agreed for transferring from Appendix I to Appendix I. In addition to complying with Article IV (non-detriment), proponents of ranching programs also needed to demonstrate a "conservation advantage" from their program (Resolution Conf. 11.16).

As experience has been gained with crocodilian management there is now a lot more confidence that wild populations can be used sustainably, with no serious threat to the survival of species. That is, that the intent of Article IV can be satisfied with confidence. The ability to demonstrate sustainable use is perhaps now far more relevant than considerations of survival and extinction for all but a handful of species.

Literature

Rosser, A.R. and Haywood, M.J. (Compilers) (2002). Guidance for CITES Scientific Authorities. Checklist To Assist in Making Non-detriment Findings for Appendix II Exports. IUCN: Gland.

Webb, G.J.W., Brook, B., Whitehead, P. and Manolis, S.C. (2004) Harvesting and Trade in CITES-listed Wildlife Species: The Role of Wildlife Management Principles and Practices. Prepared for CITES Secretariat.

Precautionary Principle

Rosie Cooney and Jon Hutton

The precautionary principle has become, over recent years, an ever-more prominent principle in environmental policy, decision-making and advocacy. But what does it mean? How should it be applied? This paper describes a series of issues raised by the precautionary principle in biodiversity conservation and natural resource management (NRM), with special reference to crocodilians, and introduces a collaborative project aimed at developing guidance on the meaning and implementation of precaution.

Risk and uncertainty

Uncertainty is ever-present and fundament in conservation and management of living natural resources. The dynamics, behaviour, and responses to disturbance, disease, habitat destruction and hunting, extraction or fishing even of single species are usually poorly understood. Ecosystems, particularly the most biodiverse, are composed of myriad interacting species engaged in complex interactions with each other and with abiotic factors such a nutrient, temperature, and hydrological regimes. Uncertainty is magnified at the ecosystem level: these are complex systems, composed of myriad interacting components, characterised by chaotic dynamics, threshold effects, and inherent stochasticity. Experimentation involving any but the simplest variables is not generally possible. The history of natural resource management is characterised by "surprise", and ecology is unlikely ever to become a predictive science. Tackling this uncertainty poses major challenges to governance and management systems.

Environmental law and policy have evolved two principles which are relevant here, which is it important to distinguish: the principle of prevention and the principle of precaution. Risk involves negative outcomes that may or may not occur. Sometimes, usually from quantitative assessment of past occurrences, it is possible to reliably identify possible outcomes and assign to each a likelihood of occurrence. This is "classic" risk: the system, the possible outcomes and their likelihoods are well understood. Action to protect the environment from such outcomes is prevention. This can be contrasted with the situation where there is uncertainty surrounding possible outcomes and their likelihood of occurrence. There is no clear rational basis for assigning probabilities to identified outcomes. This is where the precautionary principle is relevant.

The precautionary principle: what is it?

The precautionary principle is various described as the fundamental principle underlying all environmental policy, or as a pointless distraction from the real issues. It is seen as anti-scientific, subject to abuse, inherently Northern, anti-innovation, and anti-sustainable use. It is seen as safeguarding future generations, a fundamental element of sustainable development, and countering a tendency to overlook scientific uncertainties in an unscientific manner. It raises issues which are central to many current international debates around environment, poverty, sustainable development and biodiversity, including protectionist approaches vs sustainable use; indigenous and local people's involvement in conservation and protected area management; biodiversity conservation for its own sake vs for the people that rely on it; around regulatory vs incentive-based approaches. It has generated an enormous literature over the last decade or so from the standpoint of lawyers, environmentalists, economists and ethicists.

While it is used in different ways by different people, the core of the precautionary principle is about anticipating, foreseeing and acting to avert possible, uncertain harm, rather than waiting until there is clear scientific evidence of harm before taking action to avoid it. It emerged into environmental law in the context of marine pollution, where the prevailing approach had been to allow emissions until the point where there was evidence of harm. Precaution can be viewed as related to and evolving from two other well-established principles of environmental law: the polluter-pays principle, and the principle of prevention. All these principles have as their aim environmental protection, and they can be seen as reflecting a progression in the law in the time at which it addresses environmental harm: from reactive law, responding to damage after it has occurred (polluter-pays); addressing known risks before harm occurs (prevention); and anticipating and guarding against unknown risks (precaution). It is now very widely adopted in environmental agreements. Formulations of the principle differ, but the most widely cited is that of the Rio Declaration Principle 15 (1992):

> "In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."

Most would agree that this central core of the principle is extremely sensible in conservation and NRM: waiting until there is absolutely clear scientific evidence of impending harm will successfully delay any efforts to avert it indefinitely. However, in the context of management and use of wildlife and natural resources, there are some major questions surrounding the way precaution is interpreted and applied.

The precautionary principle and crocodilians: why is it relevant?

The principle is reflected in many international and national environment instruments. The Convention on Biological Diversity contains a formulation of the principle in its Preamble, and operational guidelines for Principle 5 of the Addis Ababa Principles on Sustainable Use, on minimising ecosystem impacts, include applying a precautionary approach in management decisions. Within CITES, the Convention on International Trade in Endangered Species of Wild Fauna and Flora, the precautionary principle is incorporated into criteria on listing species in the CITES Appendices. When Parties are deciding which species should be placed in the Appendices, in the case of scientific uncertainty it is provided that Parties should act "in the best interests of the species", and further specific "Precautionary measures" restrict the circumstances under which species can be transferred from Appendix I to Appendix II. At national level the precautionary principle is increasingly being incorporated into national environmental, biodiversity, or natural resources legislation and policy, for instance in Australia, South Africa, and Ecuador. Even where not specifically set out in law or policy, the precautionary principle is often a very important principle used in advocacy or management.

Issues for management and policy

Can protectionist interpretations of precaution conflict with sustainable use or incentive-driven conservation?

Applying the precautionary principle in NRM and biodiversity conservation is often equated with restriction or prohibition of utilisation or trade of species and natural resources. In particular, precaution is frequently used to argue against extractive use, in which individuals (or parts thereof) are permanently removed from wild populations. For instance, the precautionary principle is commonly used in advocacy and debate within CITES as an argument specifically in favour of increased trade regulation and of trade bans/restrictions (see Dickson 1999). This equation of precaution and protection is perhaps particularly evident where larger, more "charismatic" animals are concerned.

Extractive utilisation may pose a wide range of threats both to target species and to other components of the ecosystem, including not just overexploitation, but spread of disease (through e.g. release from captivity in ranching programmes); change to selective pressures on populations and consequent genetic change; and social or ecological disruption or disturbance to the target species or more broadly. Consideration of such threats may promptly lead decision-makers to view restriction of utilisation as the appropriate precautionary response. However, assessing only the risks of exploitation may lead to inappropriate and ineffective application of the precautionary principle. Under some circumstances it is clear that utilisation and trade of wild species may assist conservation of target species and broader ecosystems. Consumptive use may provide economic incentives for communities, private interests or states to conserve and maintain wild lands, outweighing benefits of conversion to intensive revenue-producing uses such as agriculture and plantations, or it may provide incentives for management of wild species rather than allowing uncontrolled hunting or grazing. Benefits to non-target species can flow from maintenance of lands as wild, control of hunting, and reduction of grazing pressure. Conversion and degradation of wild habitat remains the primary threat to biodiversity worldwide, so the importance of these incentives, where they exist, should not be understated. Less direct benefits may also exist. Revenue from wildlife utilisation and trade, including from direct sales of specimens or of permits and licences, is sometimes responsible for a substantial proportion of budgets of wildlife departments.

Restrictions on utilisation and trade may undermine these conservation benefits, and have a range of further negative impacts. Trade restrictions, particularly when applied in the absence of a clear scientific rationale, can provoke antagonism among disenfranchised resource users toward conservation instruments or conservation organisations. Prohibition of use or trade in specific species may lead simply to deflection of demand to other species. Finally, consumptive use will sometimes be simpler to implement than alternative conservation strategies, and avoid other environmental risks associated with them. Ecotourism, for instance, frequently put forward as a precautionary conservation strategy, requires substantial institutional capacity and infrastructure development, is vulnerable to a fickle tourist market, and carries attendant environmental risks such as habitat degradation and pollution.

This complex set of conservation risks and benefits of utilisation and trade, even leaving aside considerations of socio-economic impact and practical feasibility, illustrates the difficulty in interpreting "precautionary" as necessarily

"protectionist". This raises the broader issue of what guidance is provided by the precautionary principle when a decision-maker is confronted by multiple risks. The typical conceptual paradigm of precautionary decision-making involves an activity (such as releasing a pollutant, clear-cutting a forest, harvesting a fish stock) that poses clear potential environmental risks as compared to absence of the action. Decisions are between "risk" and "caution". However in practice, natural resource decision-makers are often confronted with a choice of strategies which each carry attendant environmental risks - the choice is between risk and risk. If a species does not yield some commercial income, the land will be put to more "productive" uses. If harvest of crocodilians for trade in meat or hides is prohibited, people may resent such restrictions and oppose further conservation efforts. Management of an ecosystem for the benefit of commercially valuable species may yield economic benefits that ensure the habitat is not converted to agriculture, but may lead to alterations detrimental to other species. What does applying the precautionary principle mean in these situations? Risks may arise from different sources and over different time-scales - should the precautionary principle be understood as requiring consideration, and some sort of balancing, of all of them?

Should biological information be the sole basis for "precautionary" policy?

This equation of precautionary strategies with protectionist strategies often stems from a narrow definition of what information is seen as relevant in assessing conservation risk. Specifically, the "conservation risks" facing species or populations are often defined purely in terms of biological status. A population is small or declining and there is uncertainty regarding impacts of utilisation, so use or trade is restricted.

However, application of the precautionary principle on this basis may fail to address the full range of threats faced by species and ecosystems. Exploitation of wildlife and natural resources takes place as part of a complex interaction involving people and human economies and institutions, and assessment of threats may need to take into account non-biological factors including social, economic, and institutional impacts and responses. As set out above, one set of risks that may be ignored involve loss of conservation incentives, although such risks may be diverse, complex and long-term.

The conservation impacts of CITES listings, for instance, may not be straightforward. One example is provided by the listing of an Indonesian bird, the Tanimbar corella *Cacatua goffini* in Appendix I of CITES. This has been argued to have a number of problematic impacts (Jepson *et al*. 2001), and similar dynamics may be relevant to crocodilians. Concern about biological impacts of international trade of the corellas from Indonesia led to successful calls for banning international trade through listing in Appendix I. Listing was based on the precautionary principle, as biological information on species status was lacking. This action has been argued to have led to a range of negative conservation consequences, including leading to the resentment of local people, who perceived the bird as abundant and an agricultural pest , local hostility toward conservation NGOs, and consequent abandonment of plans for a protected area in the region. Such long-term and indirect conservation threats were not taken into account in the application of the precautionary principle.

A direct link between biological status and policy/management response is a reasonably common feature of policy and advocacy relating to conservation of wildlife. Under CITES, listing in Appendix I and prohibition of commercial trade is consequent on biological status characteristics, coupled with a finding that the species is in trade. The convention text does not require attention to non-biological threat factors, such as socio-economic factors or management context, or explicitly require consideration of the conservation impacts of the listing. Likewise, in many countries' national legislation, harvest or trade restrictions follow automatically from assessment of biological status.

What are the socio-economic impacts of applying the precautionary principle?

Faced with urgent priorities of poverty alleviation and development, some argue that poor nations can ill afford the "luxury" of a precautionary approach, or that precaution must be interpreted within the overriding priority of poverty alleviation. Alternatively, some argue that adopting a precautionary approach to biodiversity conservation is necessary to sustain the basis for all future resource use and development.

The impacts of the precautionary principle on livelihoods, particularly of the rural poor, are not straightforward. Non-precautionary approaches to biodiversity conservation and NRM may lead to overexploitation and degradation of the natural resource base on which the poor often rely. In particular, where precautionary approaches to resource use are not applied to (or are evaded by) commercial/industrial interests, this can lead to appropriation of or exploitation of resources on which local people are dependent. However, where the precautionary principle is relied on as an

argument to restrict use or trade of wild resources such as crocodilians by local people, it may have serious impacts on livelihoods and income. Listing of a species on precautionary grounds under CITES, for instance, may close off livelihood options for local people reliant on trade of the resource. Applying a precautionary approach in protected area management may mean excluding local communities from use of resources from within such areas. Furthermore, it will be problematic when the precautionary principle is implemented in such as way that the burden of proof to show lack of harm is placed on local communities with little technical expertise or resources.

precautionary principle in NRM and conservation are likely to be complex and dependent on governance context. Who bears the obligations and burdens and who gains the benefits of precaution? Should these be taken into consideration when precaution is applied? Whose perspectives, view and priorities influence precautionary decision-making? And how can precautionary governance frameworks seek to ensure equity in application?

Can the precautionary principle be misused to impose the values or approaches of dominant groups?

The precautionary principle becomes relevant when scientific or objective knowledge is an insufficient guide to action. Its application therefore must be guided by subjective and usually divergent values and perceptions of risks, costs and benefits. So who decides? Whose values and perceptions count?

In the context of NRM and biodiversity conservation, reliance on the precautionary principle may provide scope for arbitrary or biased perceptions of environmental risk to dictate policy and management measures, without careful analysis of risks and threats. For example, some advocates for indigenous people's rights point out the potential for the precautionary principle to be used to oppose indigenous and local people's use of wildlife and natural resources. In this view, the Western conservation tradition is based largely on a conception of nature as separate to humans and humans as a threat to nature, justifying strategies of exclusion. These dynamics may also shape decision-making under uncertainty at the international level. Dominant groups, primarily those from Northern countries, may impose particular perceptions of environmental risk and related conservation approaches on other countries. In the WTO and at the World Summit for Sustainable Development, for instance, developing countries have expressed concern that the precautionary principle may be used by the North to impose its own environmental agenda on developing countries, which may have both different priorities and different conservation approaches. Some see conservation approaches based on sustainable use, for instance, as more responsive to sustainable development priorities of developing countries than protectionist approaches (eg Mohammed-Katerere 2001). Northern NGOs exercise considerable influence, and in decision-making fora such as CITES may have many times the resources, representation and media impact of smaller countries.

Precaution may provide scope for "abuse" by more powerful groups to pursue undeclared motives of various forms. In most conservation policy arenas concerns for animal welfare and animal rights are not accepted as legitimate bases for decision-making, and some suspect that in these circumstances animal welfare advocates adopt rhetorical "tools of convenience". Reliance on the precautionary principle, particularly by animal welfare NGOs, to consistently oppose wildlife utilisation and trade has prompted suspicion in some quarters that precaution provides a convenient disguise for ideological objections to use under any circumstances. In some circumstances it is not clear that any level of scientific/technical certainty would preclude such an approach. Unfortunately, the potential for such abuses may contribute to corrosion of the legitimacy of the precautionary principle within certain constituencies.

In practice, use of the precautionary principle can lead to the imposition of particular values or perspectives of more powerful groups, with potentially negative consequences for marginalised groups. In order to avoid serious inequities, therefore, reliance on the precautionary principle may need to address difficult questions of transparency and participation in decision-making, to avoid the misuse of the precautionary principle to impose particular groups' conceptions of threat and risk.

Towards best practice guidance

The precautionary principle builds on an intuitively sensible idea: that sometimes we need to take action against harm before we are entirely scientifically certain of the harm, as otherwise it may be too late. Uncertainty in NRM and biodiversity conservation is fundamental, and the precautionary principle of obvious and widespread relevance. However, it is clear that incorporation and implementation of the precautionary principle in this area is both complex and contentious, and guidance for effective and equitable implementation will require careful consideration of a number of issues. In NRM and biodiversity conservation recognition of uncertainty, and acceptance of the precautionary principle as a governance/management tool, is inconsistent across sectors and controversial in practice. Precaution

is often equated with "protectionist", which may ignore the complex balancing act of risks and benefits involved in conservation decisions. The meaning of the principle when sources of risk are multiple and complex, and there is no clear "low risk" strategy, is unclear. The impacts of the precautionary principle for conservation and for livelihoods may vary widely. Governance issues are crucial: including who bears the obligations and the costs of precaution, who participates in decision-making, whose perceptions, priorities and values inform decisions, and the role of science and other expertise in the decision-making process. In the NRM/conservation context, uncritical conceptions of precaution or poorly designed processes can lead to imposition of the priorities or values of "Northern" or urban constituencies on local resource users; restriction of local livelihood options through restrictions on resource access, use or trade; or imposition of inappropriate models of conservation.

These and other issues are being explored by the Precautionary Principle Project, a joint initiative of IUCN, Fauna & Flora International, TRAFFIC and ResourceAfrica, supported largely by the European Union (see www.pprinciple.net for more details). The major aim of this project is to develop best-practice guidance for the implementation of the precautionary principle in biodiversity conservation and NRM, in a manner that respects the priorities of both biodiversity conservation and of livelihoods, poverty alleviation and sustainable development. The project involves case studies, currently underway, on application of the precautionary principle in specific sectors, regions and policy arenas, regional workshops in developing countries, engagement with relevant conventions, and a final international workshop in mid-2005. Best-practice guidance will be developed through a broad consultative and review process, including through regional and international workshops, and will be actively disseminated through engagement with relevant decision-makers, conventions, donors and organisations.

Literature

Dickson, B. (1999). The Precautionary Principle in CITES: a critical assessment. Natural Resources Journal 39(2): 211-228.

Jepson, P., Brickle, N. and Chayadin, Y. (2001). The Conservation Status of Tanimbar corella and blue-streaked lory on the Tanimbar Islands, Indonesia: results of a rapid contextual survey. Oryx 35: 224-233.

Mohammed-Katerere, J. (2001). The Precautionary Principle: Implications for Development and Poverty Alleviation in Southern Africa. IUCN Environmental Law Programme Newsletter 1: 7-9.

IUCN Red List of Threatened Species - Strengths and Weaknesses

Barry W. Brook

Key Centre for Tropical Wildlife Management, Charles Darwin University, Darwin, NT 0909, Australia

The most prominent system used to assess levels of (mainly anthropogenic) threat faced by species, including crocodilians, is the World Conservation Union (IUCN) Red List, which assigns taxa a "threat ranking" via assessment of their past, present and future demographic and ecological characteristics, and human impacts. I will briefly review some of the strengths and weaknesses of the IUCN endangered species categorization system. For instance, IUCN threat rankings help support the legislative protection of species and guide the prioritization of conservation programs, and may also be used to inform reserve selection, constrain development and exploitation, and report on the state of the environment. Yet it in attempting to be a "universal" system, it fails to properly contextualize wide ranging species, take full account of conservation actions, and suffers from data collection biases, mismatches across different threat indices, and untested quantification of extinction risk. I will illustrate my points with some examples (crocodiles, sea turtles, tuna and small mammals) which are particularly pertinent to sustainable use of wildlife populations and their habitats.

Wildlife Management Principles and Practices in Crocodilian Conservation and Sustainable Use

Grahame J.W. Webb[1,2] Barry Brook[2], Peter Whitehead[2] and S. Charlie Manolis[1]

[1]Wildlife Management International, PO Box 530, Sanderson, NT 0812, Australia (gwebb@wmi.com.au); [2]Key Centre for Tropical Wildlife Management, Charles Darwin University, Darwin, NT 0909, Australia

Introduction

Crocodilians are long-lived, slow maturing animals, with modest annual clutch sizes, and high natural mortality rates amongst juveniles. They exist mainly in the equatorial regions of the world where poverty is widespread, and where expenditure on wildlife conservation and management is limited by other priorities. These biological and socioeconomic traits would normally be associated with high "vulnerability" to extinction through harvesting. Yet with crocodilians, there is a long history of conservation and sustainable use working together (Hutton and Webb 2002). This paper examines some of the key wildlife management practices and principles involved in crocodilian conservation management and sustainable use, and emanates from two reports (Webb *et al*. 2004; Webb and Manolis 2004) prepared for the CITES Secretariat.

Basic Approaches to Management

Crocodilians are large, long-lived, late-maturing animals, with modest clutch sizes and high mortality rates amongst juveniles. Like other animals, they exist with people in ways that are complex and often unique (Fig. 1).

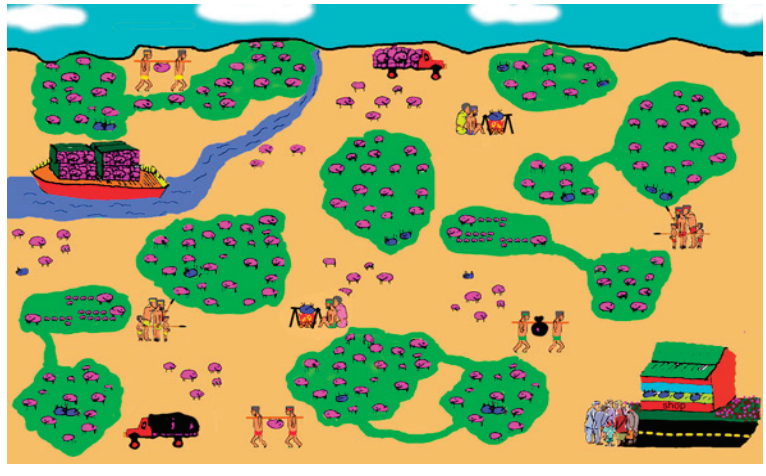


Figure 1. Wildlife and people exist in complex interactive landscapes.

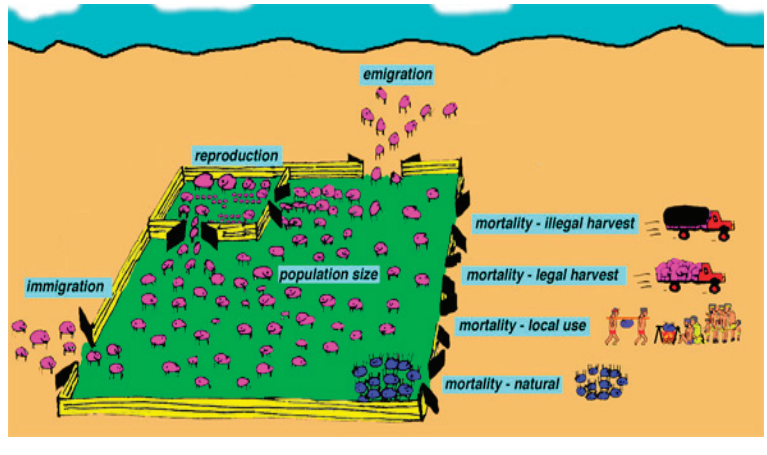


Figure 2. Key population dynamics of a wildlife population.

The first step in quantifying the "dynamics" of this relationship is to define the boundaries and key dynamics (Fig. 2). The analogy of a farm has high utility, because all farm animals were derived from wild ones and they respond to changes in the environment in similar ways. For example, stock on farms are maintained at high levels by harvesting. If the gates were closed completely, carrying capacity would be reduced - perhaps greatly.

Management will always be a compromise between social, economic and biological variables (Fig. 3), with new influences and threats that need to be countered or adjusted for continually. Management needs to be dynamic. There is no perfect knowledge and the only definitive way of learning about management is through experimental and adaptive management. But management is itself a predictive science at its own level of resolution (Fig. 4). Management questions are best addressed by experimental management, and not by diverting scarce research resources into fine level of resolution natural history questions.

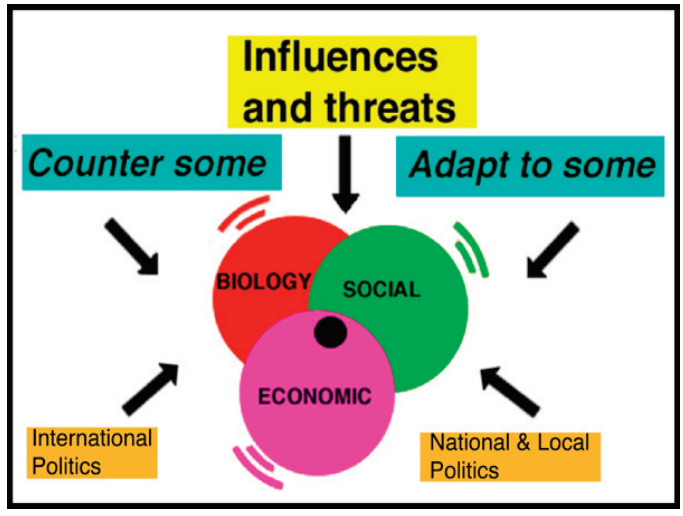


Figure 3. Dynamic variables involved in management.

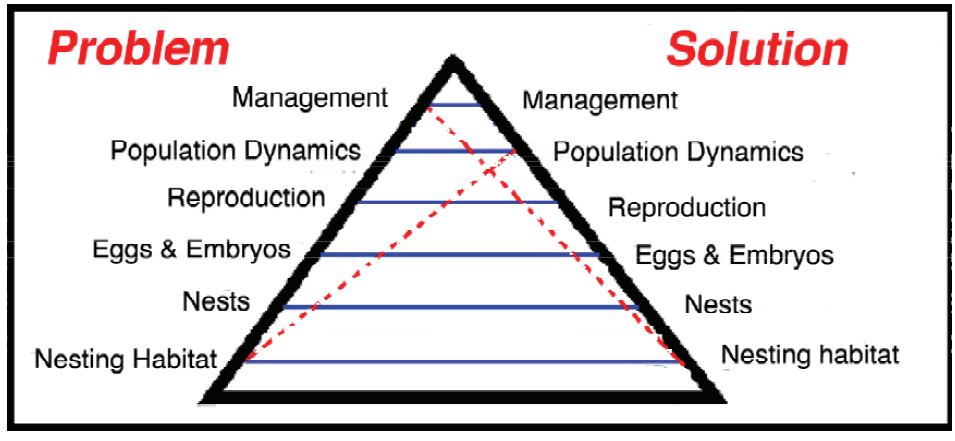


Figure 4. Aligning the levels of resolution of problem and solution are critical to efficient management - misalignment (dashed lines) wastes resources.

Perhaps most important, wildlife populations are dynamic entities in their own right (Fig. 5).

The separate measured population dynamics at any one point in time are not fixed entities. Density-dependent influences on population dynamics are perhaps the most common. In a population at carrying capacity the dynamics are balanced in the sense that the dynamics increasing the population (immigration, reproduction) match those decreasing the population (mortality, emigration). If these were fixed entities, populations would lose their ability to recover from any form of reduction.

Recovering Wild Populations

One of the best models for understanding wildlife population processes is the amniotic egg (Fig. 6). A population of

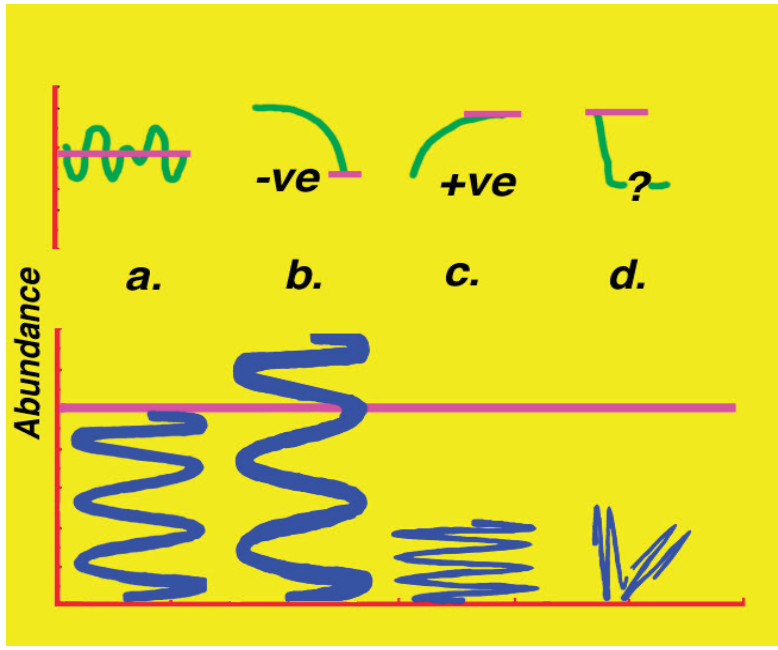


Figure 5. Wildlife populations function like a spring, and if harvested below carrying capacity (c) will tend to recover.

cells (embryo) grows with limited food resources (yolk), water resources (albumin) and space. Emigration and immigration are controlled, and there is no mortality due to predators. The pattern of increase in living tissue over time is logistic.

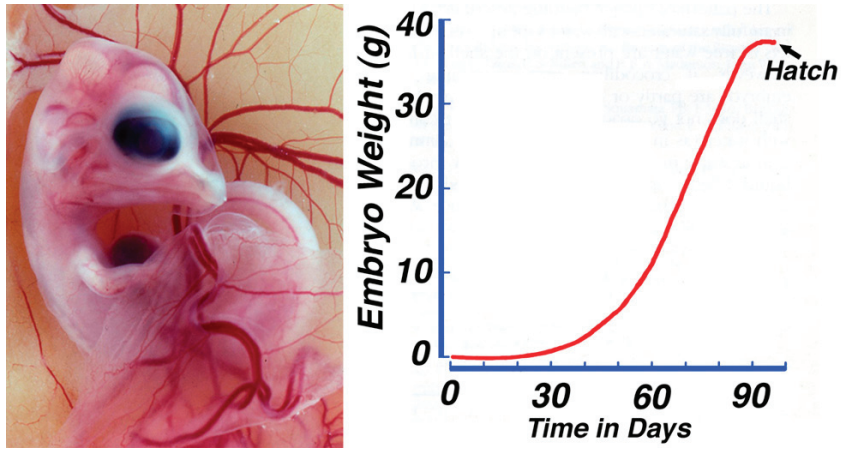


Figure 6. The logistic pattern of increase in living tissue within an egg.

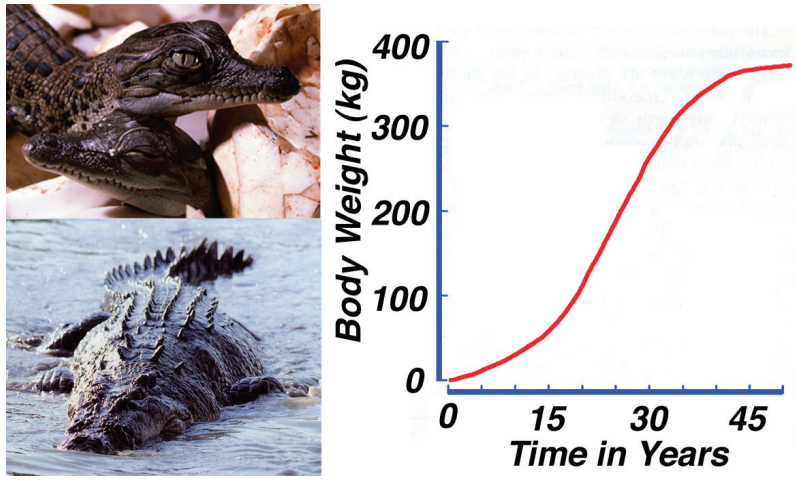


Figure 7. The increase in body mass from hatching to adulthood.

The pattern of increase in body mass from hatchling to adulthood is also logistic, as is the pattern of recovery of a wild population afforded effective protection after being dramatically reduced through wild harvest (Fig. 8).

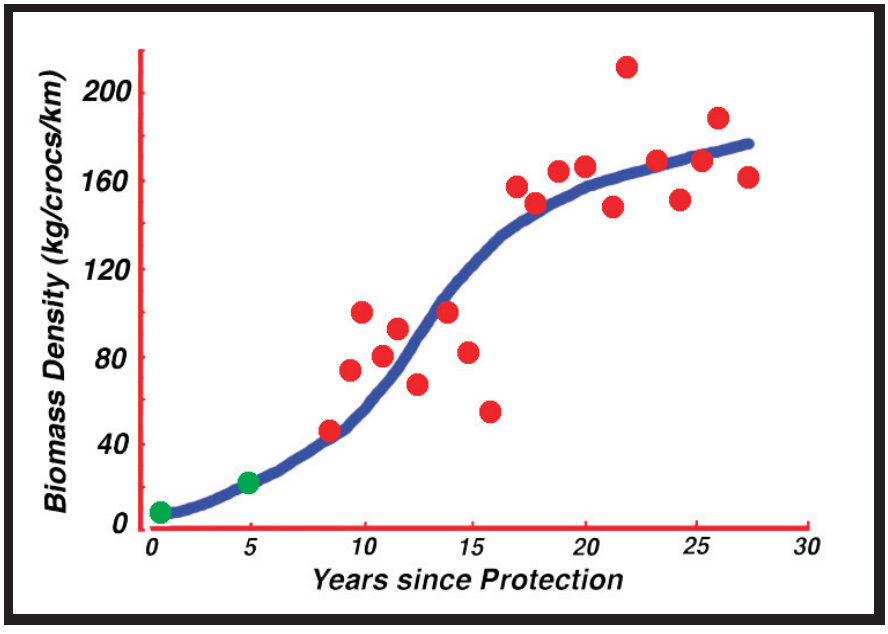


Figure 8. Recovery in biomass of a wild population of Saltwater Crocodiles *Crocodylus porosus* in the Northern Territory of Australia.

The importance of this underlying logistic curve lies in the demonstration that rates of increase in any living population are continually changing - they are not constant. The further a population is reduced below carrying capacity, the faster it will try to recover.

If two hypothetical wild populations of 1000 individuals (Fig. 9) in which complete recovery took 5 years and 30 years respectively are examined, the importance of variable rates of recovery can be demonstrated (Fig. 9).

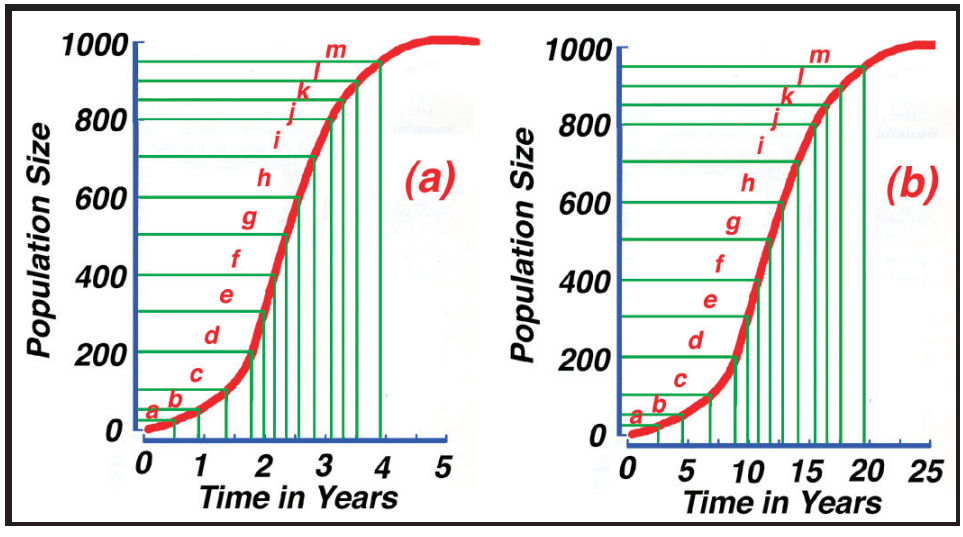


Figure 9. Recovery curves for two hypothetical populations of 1000 individuals that took 5 years (a) and 25 years (b) to complete. Lines are for calculating population increases each year.

For example, in the fast growing population of 1000 individuals, the maximum annual harvest (500 per year) would be extracted if the wild population was reduced by 70%. With the show growing population, the maximum annual harvest (100 per year) is much less and would be available if the population was reduced to 40% below carrying capacity.

Management in Practice

When crocodilian populations are seriously depleted - say 95+% decrease in carrying capacity - protection is a strategy that will boost populations quickly if habitats are in tact. However, as crocodilian numbers increase, public pressure to reduce populations (control) or to extract a sustainable harvest, can be expected to mount. Crocodilians are widely considered pest species, because they compete with people for resources, and they often prey on people and domestic stock.

With Saltwater crocodiles in the Northern Territory of Australia (Fig. 10), calls for culling became very strong 9 years after protection. The negative values the public attributed to large crocodiles were reinstating themselves. Economic incentives based on sustainable use (Fig. 11) boosted the value of crocodiles in the eyes of the community, and won public support for the ongoing conservation of crocodiles.

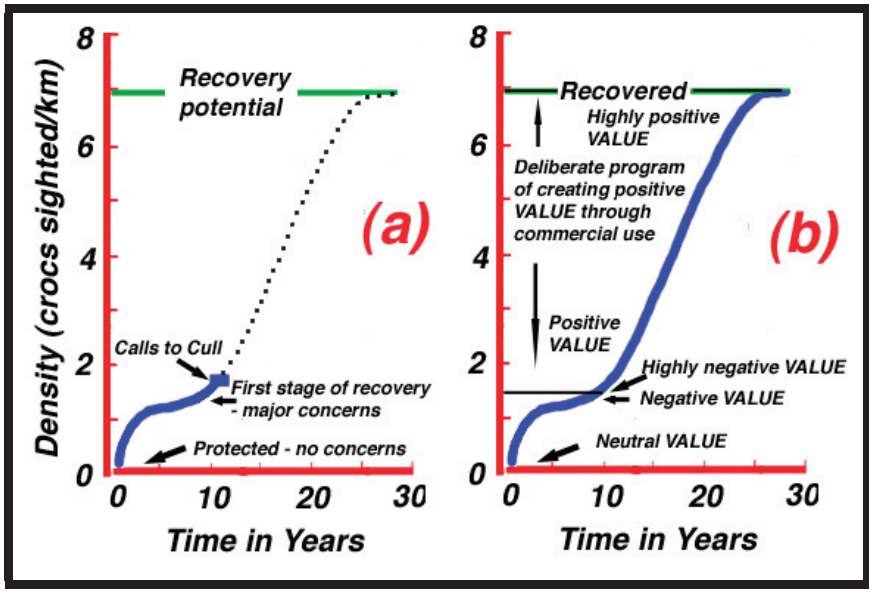


Figure 10. When numbers of wild Saltwater Crocodiles in the Northern Territory of Australia reached 20-30% of carrying capacity, incentives (through sustainable use) were needed to increase the value of crocodiles in the eyes of the community.

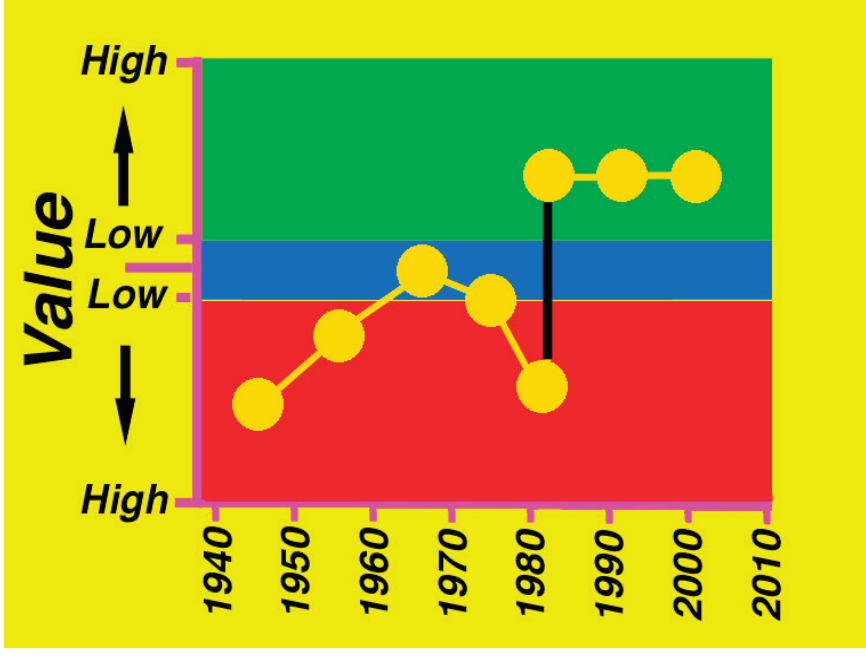


Figure 11. Economic values (black line) increased the overall value of Saltwater Crocodiles in the eyes of the community, and won their support for conservation.

A very good example of a wild population of crocodilians being progressively used more intensively as it recovered comes with American Alligators (*Alligator mississippiensis*) in Louisiana (Fig. 12).

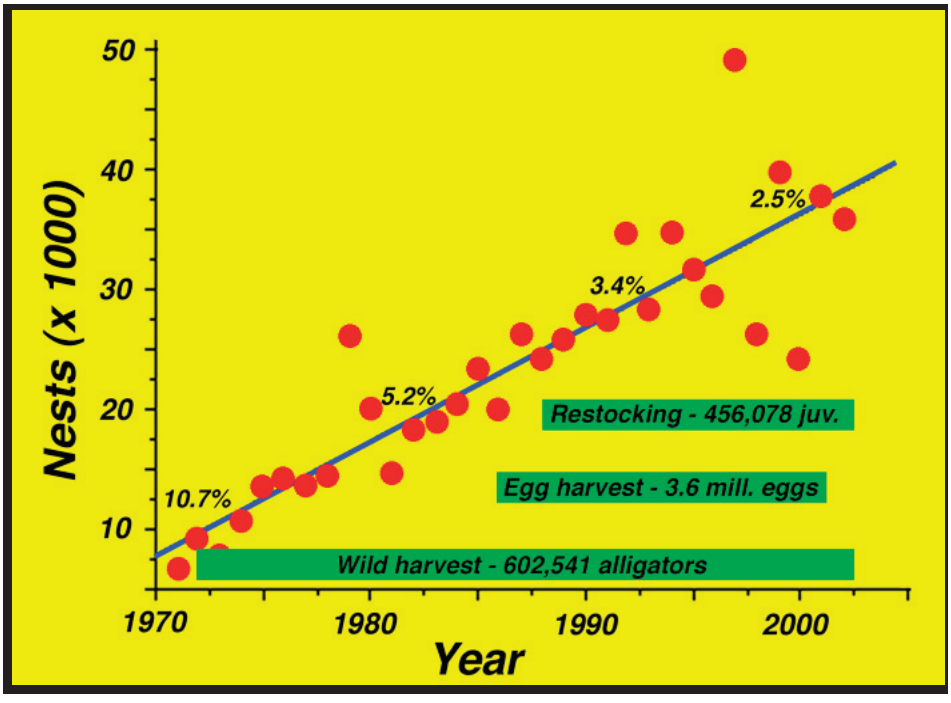


Figure 12. As the American alligator population in Louisiana increased, the levels of harvest were increased, and a compensation scheme was introduced (return-back-to-the-wild) to ensure sustainable use (see Webb and Manolis 2004).

If wild crocodilian populations were harvested modestly, rather than reducing populations to extract a maximum sustainable yield, the wild populations may increase (Fig. 13).

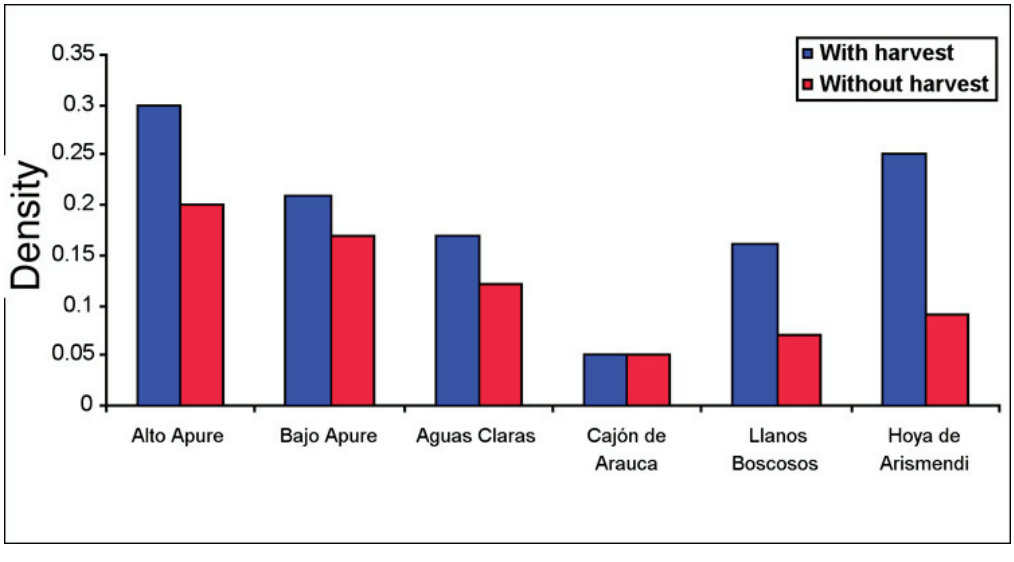


Figure 13. Final densities in harvested versus non-harvested populations of *Caiman crocodilus crocodilus* in Venezuela (Velasco *et al*. 2003).

That is, the disruption of social hierarchies in a wild population induced through hunting may significantly increase the carrying capacity (Fig. 14).

One of the clearest examples of density-dependent adjustments to reproductive rates comes from Hines and Abercrombie (1987) in Florida (Fig. 15).

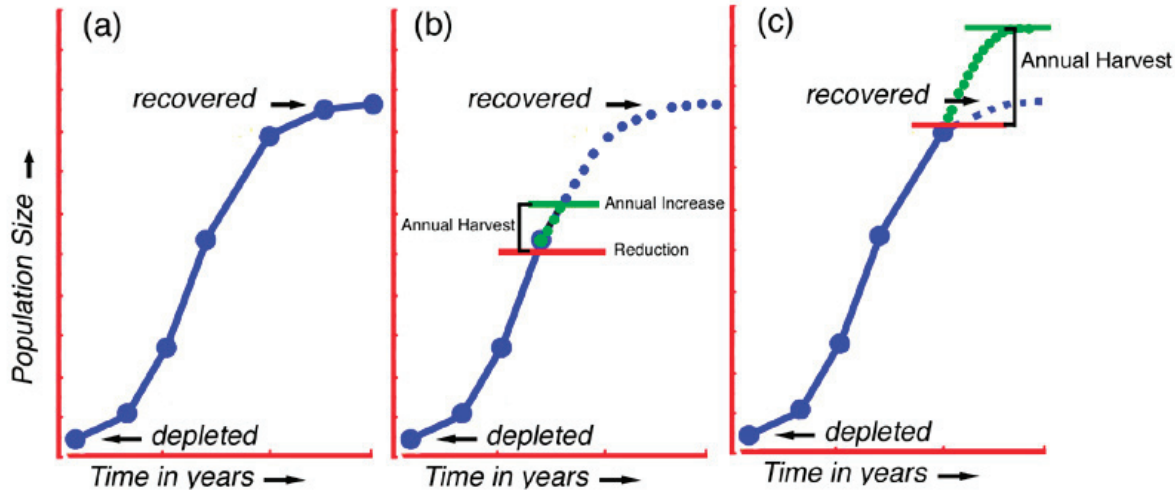


Figure 14. Given a normal recovery pattern (a), one strategy for maximising the harvest is to reduce the population and harvest recovery annually (b). However, a conservative wild harvest (c) may well increase the wild population significantly.

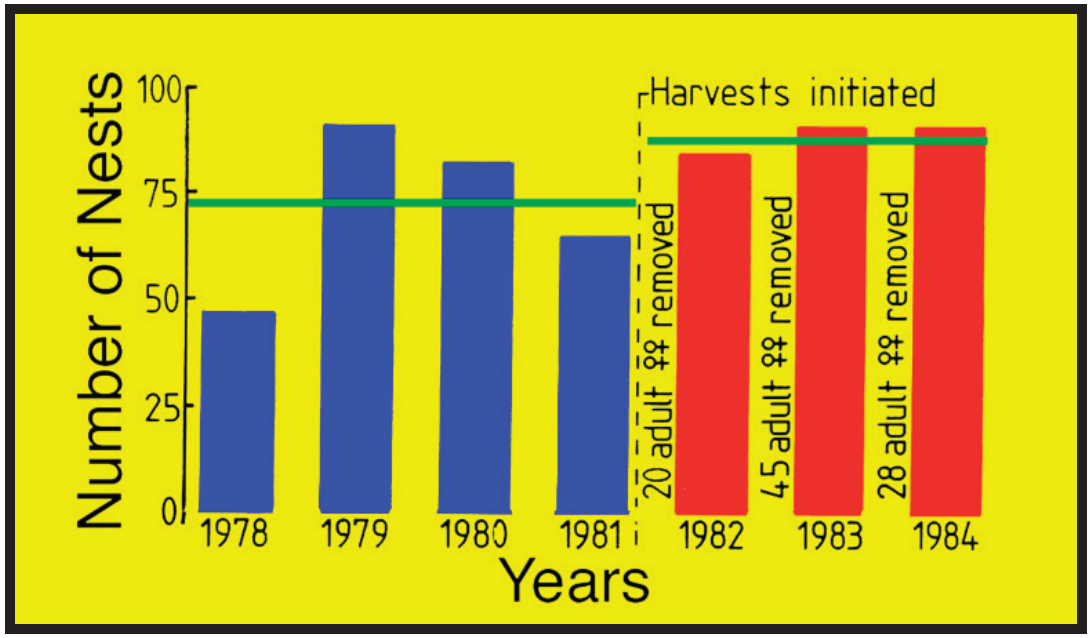


Figure 15. Numbers of adult female American Alligators nesting in a swamp in Forida before and after an adult female harvest (Hines and Abercrombie 1987).

The number of American alligator nests in the lake was monitored for 3 years, and adult females equivalent to the maximum number of nests was removed over the next three years. Nest numbers stablised rather than declined, suggesting that large numbers of "potential" adult females were in the swamp, but not nesting until an opportunity presented itself through an existing adult female being removed.

Conclusions

World crocodilians are a group of long-lived, late-maturing reptiles where considerable experience with management has been gained over the last 20-30 years. This experience all indicates that they are vulnerable to severe depletion if harvested without controls, but they are also tenacious survivors. They will recover rapidly if given the opportunity, and are being managed for sustainable use in many countries.

The basic wildlife management principles which underly crocodilian conservation and management appear are well grounded in theory and practice. They form a sound base for increased experimentation at the management level of resolution, which is where new and important information remains to be gathered.

Literature

Hutton, J. and Webb, G.J.W. (2002). Crocodiles: legal trade snaps back. Pp. 108-120 *in* Trade in Wildlife: Regulation for Conservation, ed. by S. Oldfield. Earthscan Publications: London.

Webb, G.J.W., Brook, B., Whitehead, P. and Manolis, S.C. (2004) Harvesting and Trade in CITES-listed Wildlife Species: The Role of Wildlife Management Principles and Practices. Prepared for CITES Secretariat.

Webb, G.J.W. and Manolis, S.C. (2004). Guidelines on the Harvesting and Management of Wild Crocodilian Populations and the Determination of "Detriment" within the Context of CITES. Prepared for CITES Secretariat.

Hines, T. and Abercrombie, C.L. (1987). The management of alligators in Florida, USA. Pp. 43-47 *in* Wildlife Management: Crocodiles and Alligators, ed. by G.J.W. Webb, S.C. Manolis and P.J. Whitehead. Surrey Beatty and Sons: Chipping Norton.

Velasco, A., Colomine, G., De Sola, R. and Villarroel, G. (2003). Effect of sustained harvests on wild populations of *Caiman crocodilus crocodilus* in Venezuela. Interciencia 28(9): 544-548.

Louisiana's Alligator Program: Adapting Management as Populations Recover and Risk of Unsustainable Use Decreases

Ruth M. Elsey[1] and Noel Kinler[2]

[1]Louisiana Department of Wildlife and Fisheries, Rockefeller Wildlife Refuge, 5476 Grand Chenier Highway, Grand Chenier, Louisiana 70643, USA;
[2]Louisiana Department of Wildlife and Fisheries, 2415 Darnall Road, New Iberia, Louisiana 70560, USA

Abstract

The American alligator (*Alligator mississippiensis*) has been used commercially for its valuable leather for many years, and the management and sustained use of this resource as a conservation tool is well documented. This paper serves to briefly review the research that led to the development of sustained use programs (harvest of wild adults, and egg ranching for commercial rearing of juveniles) and how these management programs have been adapted over the last thirty years. The wild harvest of sub-adults and adults has been in place since 1972, and regulated commercial egg ranching by private landowners was initiated in 1986. Although these programs are no longer "new", constant adaptations are made to try to improve both programs. Harvest quotas are reviewed and changed annually based on coast wide nesting surveys used as a population index. Requests by many user groups (farmers, ranchers, trappers, landowners, buyers, dealers, and other industry personnel) are received and considered as the LDWF tries to safely manage this resource to the benefit of many user groups with varied interests.

Introduction/History

The American alligator (*Alligator mississippiensis*) has been used commercially for its valuable leather since 1800 (Stevenson 1904). The history of trade in alligator hides has been outlined in detail (Joanen and McNease 1991) and the management and sustained use of this resource as a conservation tool has been documented (Joanen *et al*. 1997). This paper serves to briefly review the research and management that led to the development of a sustained use program, and how the management program in Louisiana has been adapted over the last thirty years.

A detailed narrative on the historic use of alligators in southeastern states has previously been published (Joanen and McNease 1991). This harvest was generally unregulated and alligator populations declined in the early 1950s. In 1962, the alligator season in Louisiana was closed, and research studies were undertaken which later led to a biologically sound management program.

Early research efforts focused on general life history factors, such as alligator nesting (Joanen 1969) and habitat preferences based on telemetry of nesting females, adult males, and immature alligators (Joanen and McNease 1970, 1972; McNease and Joanen 1974). Of tremendous importance was the establishment of a rigorous survey method to estimate and monitor population trends.

Aerial surveys of coastal alligator nests were initiated in 1970. Longitudinal north-south lines were flown along the entire coast of Louisiana. A total of 51 census lines were used, with 28 lines at 3.8˚ intervals in the three southwestern parishes, and 23 lines at 7.5˚ intervals in the remaining coastal parishes (McNease and Joanen 1978), for a sampling intensity of 0.76% of 1.3 million ha (3.2 million acres) of alligator habitat (excluding 0.4 million ha categorized as salt marsh).

Initial Wild Harvests

In 1970, the Louisiana State Legislature (Act 550) gave the Department of Wildlife and Fisheries full authority to regulate the alligator season in Louisiana (Joanen and McNease 1991). After the initial surveys were conducted in 1970 and 1971, the LDWF developed a system of hunter applications, licenses, tags, etc. to initiate an experimental harvest of wild alligators, and distribute the take according to population levels. Based on field research and the telemetry studies, a harvest conducted in autumn (when nesting female alligators are in the remote interior marsh with new hatchlings at nest sites) would select the take for adult males, or immature alligators of either sex.

In September 1972, the experimental alligator harvest was conducted in Cameron Parish, Louisiana. A total of 1350 alligators (80.3% males) were taken by 59 trappers in 13 days. A detailed analysis of the harvest was reported (Palmisano *et al*. 1973) and in 1973, Vermilion Parish was also included in the harvest, which was increased to 19 days. In that year, 2921 alligators were taken by 107 hunters. The program expanded with time, and Calcasieu Parish was also hunted in 1975. As nest surveys continued to show rising population trends, all coastal parishes were hunted starting in 1979; and by 1981 the harvest was expanded statewide to include all 63 parishes (Table 1).

Table 1. Wild alligator seasons in Louisiana. ** Added Iberia, St. Mary, Terrebonne, Lafourche, St. Charles, Jefferson, Plaquemines, St. Bernard and St. Tammany parishes.

Year	Season Dates	Hunting Days	Parishes
1972	Sept. 5-17	13	Cameron
1973	Sept. 10-28	19	Added Vermillion
1974	Season Closed - Endangered Species Act of 1973		
1975	Sept. 20-Oct. 19	30	Added Calcasieu
1976	Sept. 9 - Oct. 8	30	No change
1977	Sept. 1-30	30	No change
1978	Season Closed - CITES/No Export Authority		
1979	Sept. 7 - Oct. 7	31	Added Coastal Parishes **
1980	Sept. 4 - Oct. 4	31	No change
1981	Aug. 31 - Sept. 30	31	Statewide (63 parishes)

The quota for the total numbers of alligators to be allowed for harvest (how many CITES tags to be issued to landowners/trappers) is related to the population of alligator estimated to occur on each piece of property. The alligator nest count by aerial transect gives an estimate of the total population, based on the theory that a certain proportion of the entire population consists of nesting females.

Transect lines (and therefore nest counts) are categorized into marsh types, based on the vegetative types present. Certain "indicator" species of plants, depending on their salinity tolerances occur in different marsh zones. The marsh types are fresh, intermediate, brackish, and saline with increasing salinity levels in each zone. Very little (if any) alligator nesting occurs in salt (saline) marsh.

Transect lines are also categorized by location of the 63 parishes (counties) in Louisiana. Tag allotments are determined for each parish, by marsh type. For example, in 2003 in Cameron Parish, one tag was allocated for each 90 acres of fresh marsh, while 170 acres of brackish marsh were needed to qualify for one CITES tag. In the western portion of Vermilion Parish, high nesting rates were seen, and only 75 acres of intermediate or brackish marsh qualified for one CITES tag. Poorer habitat and lower nesting rates led to a quota of only one tag per 500 acres of brackish marsh in St. Bernard Parish (Table 2).

Wild Harvest Expansion

As the experimental harvests proved successful and the program gradually became larger, nesting surveys were intensified to ensure the harvest did not cause any detriment to the wild alligator population. Additional "B" transect lines were added in 1981 (McNease *et al*. 1994) at midpoints between the established lines to increase sampling intensity to a total of 106 lines. In 1999, another series of "C" lines were added (now 143 transect lines), such that some 3500 linear miles (5645 km) are flown each July. The survey takes some nine days and costs approximately $US 60,000. The sampling intensity covers approximately 3.4% of 2.4 million acres of private coastal wetlands, and 4.2-10.4% of some 567,000 acres of public lands (federal refuges and state-owned refuges and management areas) which are surveyed intensively.

With expansion of the program beyond the coastal marsh zone, other habitat types (cypress-tupelo swamp, northern lakes, dewatered marsh, transitional/deteriorating marsh) also have tag quotas (Table 2). Further refinement of the analysis in recent years has even led to some parishes being subdivided into east and west zones.

To avoid large fluctuations in annual tag quotas due to weather-induced changes one year's nesting effort, the tag quota was changed to being based on the average of the most recent five year surveys in approximately 1992.

Table 2. 2003 marsh alligator tag allotment by Parish (see text). (a) = marsh between Calcasieu Lake/Calcasieu River and Mermentau River will be issued at the rate of 1 tag:175 acres in intermediate marsh and 1 tag:225 acres in brackish marsh; (b) = the dividing line for Vermilion East and West is the Vermilion River Cutoff (4-mile cut); (c) = marsh west of Mississippi River; (d) = marsh east of Mississippi River; (e) = marsh areas which are characterized by a generally declining alligator population caused by degradation of alligator habitat.

Parish	Tag Allotment/Marsh Type		
	Brackish	Intermediate	Fresh
Cameron (a)	1:170	1:85	1:90
Calcasieu	1:250	1:110	1:90
Jeff Davis			1:90
Vermillion West (b)	1:75	1:75	1:125
Vermillion East (b)	1:275	1:275	1:75
Iberia		1:175	1:175
St. Mary		1:75	1:75
Terrebonne	1:150	1:70	1:65
Lafourche	1:200	1:70	1:80
St. Charles	1:125	1:125	1:70
St. John the Baptist		1:100	1:70
Jefferson	1:250	1:80	1:65
Orleans	1:500	1:500	
Plaquemines West (c)	1:300	1:200	1:65
Plaquemines East (d)	1:500	1:125	1:65
Plaquemines Delta	1:300	1:175	1:160
St. Bernard	1:500	1:115	
St. Tammany	1:200	1:125	1:125
Tangipahoa		1:100	1:140

Cypress-Tupelo Swamp 1:200; Dewatered Marsh 1:700; Transitional Marsh (e) 1:500

As the wild harvest program in Louisiana readily appeared to be sustainable, it was adapted again in 1999 to make use of the more plentiful alligators in the 4-5' size classes (122-183 cm). Starting in 1999, trappers were issued an additional quantity of "bonus" tags to be used on alligators less than 183 cm in length. The number of "bonus" tags issued is 10% of the trapper's regular quota. For example, a trapper whose normal CITES tag quota is 21 would also be issued 2 bonus tags to be used on smaller alligators. The "regular" tags may be used on alligator of any size. A trapper who qualifies for 43 regular tags would be issued 4 "bonus" tags. Some 3200-3300 bonus tags have been issued annually since 1999; the average size is approximately 5'9" (175 cm) to 5'10" (178 cm). Fortunately these hides are much larger than the hides from the average farm-raised alligators in Louisiana which average 3.69-3.81 feet (112-117 cm) total length. Thus the two markets have little (if any) overlap.

The wild alligator harvest initially was limited to a few major land companies who hired local citizens to trap their quota, and trappers who harvested alligators from family owned land. Trappers would skin their own alligators, and sell the salted hides to buyers at local auctions. Alligator meat was sometimes used for home consumption.

As the wild harvest expanded, centralized processing sheds were established by dealers. Trappers bring their lot of hides to the shed, or dealers transport alligator carcasses from rural collecting points to the processing shed in refrigerated trucks. The alligator meat has become a secondary source of revenue to benefit to landowner and dealer. Refinements in the alligator skinning procedure and care of the hide have been developed to try to minimize damages in transport, skinning, and storage, to maintain and improve the quality of the raw hide. The wild harvest in Louisiana has developed into a multi-million dollar source of income for the state's landowners and trappers (Table 3).

Table 3. September wild alligator harvest in Louisiana, 1972-2003 (not including Salvador and Marsh Island experimental, nuisance, and farm harvests). ** = sale of meat not permitted; La. Health Department regulations first allowed meat sales in 1979; *** = bone in from 1979-1984, deboned from 1985-present.

Year	Commercial Hunters	Tags* Issued	No. Taken	Success (%)	Avg TL (feet)	Value of Skins Avg/foot	Value of Skins Total $US	Amount Meat (lbs) ***	Value of Meat ($US)
1972	59	1961	1350	68.8	6.92	$8.10	$75,670	**	**
1973	107	3243	2921	90.1	7.58	$13.13	$290,714	**	**
1975	191	4645	4420	95.2	7.51	$7.88	$261,570	**	**
1976	198	4767	4389	92.1	7.09	$16.55	$515,003	**	**
1977	236	5760	5474	95.0	7.35	$12.23	$492,061	**	**
1979	708	17,516	16,300	93.1	6.92	$15.00	$1,691,940	100,089	$125,000
1980	796	19,134	17,692	92.5	6.59	$13.00	$1,515,674	100,089	$125,000
1981	913	15,534	14,870	95.7	6.92	$17.50	$1,800,757	100,089	$125,000
1982	1184	18,188	17,142	94.2	6.82	$13.50	$1,578,264	100,089	$125,000
1983	945	17,130	16,154	94.3	6.92	$13.00	$1,453,214	100,089	$125,000
1984	1104	18,386	17,389	94.6	6.99	$21.00	$2,552,531	100,089	$125,000
1985	1076	17,466	16,691	95.6	7.09	$21.00	$2,485,123	150,133	$675,000
1986	1207	23,267	22,429	96.4	6.92	$23.00	$3,569,800	310,275	$1,395,000
1987	1370	24,635	23,892	97.0	7.09	$40.00	$6,775,771	500,444	$2,250,000
1988	1545	24,111	23,526	97.6	7.25	$48.00	$8,187,048	600,533	$3,000,000
1989	1769	25,492	24,846	97.4	7.25	$50.00	$9,006,675	747,448	$3,000,000
1990	1921	26,051	25,575	98.2	7.25	$57.00	$10,568,869	701,063	$3,000,000
1991	1995	24,532	23,870	97.3	7.45	$32.00	$5,690,608	684,109	$2,935,000
1992	1686	25,378	24,000	94.6	7.25	$23.00	$4,002,000	687,835	$2,951,520
1993	1702	24,805	23,991	96.7	7.25	$23.00	$4,000,499	687,615	$2,889,000
1994	1774	27,694	27,120	97.9	7.35	$37.00	$7,375,284	771,610	$3,243,000
1995	1877	28,931	28,442	98.3	7.35	$41.00	$8,570,997	809,088	$3,400,000
1996	1948	26,578	25,789	97.0	7.41	$25.00	$4,777,412	734,793	$3,967,800
1997	1973	29,900	29,085	97.3	7.08	$18.00	$3,706,592	828,423	$4,473,000
1998	1888	30,198	28,639	94.8	7.08	$15.00	$3,041,462	804,679	$4,350,000
1999 reg	1902	33,279	32,097	96.4	7.17	$22.00	$5,062,981	909,398	$4,881,000
1999 bonus		3308	3173	95.9	5.75	$15.50	$282,794	44,335	$237,250
2000 reg	1941	32,006	30,539	95.4	7.17	$27.00	$5,912,045	1,062,146	$5,703,726
2000 bonus		3292	3139	95.4	5.75	$23.00	$415,133	56,659	$303,125
2001 reg	1916	32,738	31,935	97.5	7.33	$22.00	$5,149,838	734,505	$3,305,273
2001 bonus		3333	3213	96.4	5.83	$20.00	$374,636	73,899	$332,546
2002 reg	1955	31,847	30,485	95.7	7.25	$16.00	$3,536,260	701,155	$3,155,198
2002 bonus		3280	2896	88.3	5.83	$16.00	$270,139	66,608	$299,736
2003 reg	1872	30,533	28,455	93.2	7.17	$13.00	$2,652,291	654,465	$2,945,093
2003 bonus		3270	2997	91.7	5.83	$13.00	$227,143	68,931	$310,190

(___ Subject to change, numbers updated April 12, 2004).

The vegetative type lines used to determine CITES tag quotas for wild alligators (and alligator egg quotas for ranching, see below) were initially delineated in 1968 (Chabreck *et al.* 1968). Numerous environmental factors such as salt water intrusion, wetlands erosion, etc., cause changes in marsh types over time. The vegetative type surveys were flown approximately every ten years (1978, 1988, 1997, and then 2001) to document the changes and adjust quotas accordingly. Recent efforts have been made to fly this survey more frequently (perhaps every five years) to closely monitor the critical problems of wetlands loss, saltwater intrusion, and marsh deterioration in coastal Louisiana.

Evaluating each trapper's family property or land owned by large private corporations and determining the quantity of various marsh types on the wetlands is very labor intensive. One piece of property may have divided interest ownership as the property was passed down from generation to generation. Property descriptions are obtained from tax assessors offices in each parish to determine exact locations and boundaries for each piece of property. Maps of vegetative/marsh types and ownership are compared to calculate how many acres of each marsh type exist on each piece of property to be evaluated for CITES tag issuance. Until recently this has been done "by hand", an extremely labor intensive process considering the magnitude of the alligator habitat and number of commercial hunters in Louisiana.

A computer based GIS/ArcView system was initiated around the year 2000 to develop digital files of each landowner's property, with superimposed vegetative type delineations. Once finalized, this program will allow LDWF biologists to automatically incorporate the new marsh types/vegetative changes when new surveys are flown.

Farming/Ranching Program

Early alligator farms in Louisiana were generally small, family-owned operations; and often run more as a hobby/curiosity than a commercial enterprise. Extensive studies done by LDWF biologists showed alligators could be efficiently cultured and grown in captivity (see review by Joanen and McNease 1987).

To encourage a possible new industry, the initial few farmers were supplied hatchlings from eggs collected from state-owned lands, and incubated and hatched by department personnel. A program was established wherein farmers would receive hatchlings from the LDWF for ten years; by which time some of their first hatchlings received would be sexually mature and the farmer would then obtain eggs from his own captive breeders. As time passed, the captive breeding proved to be less economical than ranching of wild eggs, and the requirement to maintain captive breeders was eliminated.

Hatchling alligators fared well in heated "controlled environmental chambers" or sheds in captivity and could reach market size in one-two years. Soon the demand for hatchlings for this new industry could not be met from agency resources. The LDWF then developed guidelines and strict quotas (similar to how wild harvest quotas are determined) whereby potential ranchers might obtain eggs from suitable private wetlands, which historically have been shown to support substantial populations of alligators.

Louisiana's alligator ranching program increased dramatically between 1986 and 1990 and has been described in detail (Elsey *et al*. 2001). To ensure wild alligators were not depleted as a result of egg collections, and to ensure future recruitment of sub-adult alligators to the breeding population, the LDWF initially required a quantity of juvenile alligators equal to 17% of the eggs hatched by the rancher be returned to the wild within two years of hatching. This program has been described in detail (Elsey *et al*. 2001). In the first three years of the release program (1988-1990) returns were limited to fewer than 15,000 alligators. Sizes at release were generally small, and averaged 91-97 cm.

In 1991, a variable return rate was established based on the estimated 17% survival from hatching to 122 cm predicted for wild juvenile alligators. Using the relationship of survival between size classes as specified in Taylor and Neal (1984), we extrapolated return rates based on expected survival rates for alligators from 91.4 cm to 152.4 cm. More alligators must be returned if the average total length is smaller, and fewer animals are required if the average length is larger. Alligators must be at least 91.4 cm and are usually less than 152.4 cm total length at release and must be free of disease or deformities to be acceptable for release (Elsey *et al*. 1998, 2001).

Releases were initially made from 15 March to 30 September, if the weather was suitably warm. Due to conflicts with administration of the September harvest and field staff scheduling limitations, in 2003 the ending date for releases was changed to August 25 of each year (2001 egg collection permits; releases due in 2003). The tagging, marking, data collection and release procedure have been documented in detail (Elsey *et al*. 2001).

Enormous effort has been made by the LDWF to monitor the fate of the alligators released to the wild. We were very concerned that we document any failings or successes of the program, as it is costly to the ranchers to fulfill the "returns to the wild" obligation. However, it is an integral necessity of the program, considering the large number of eggs collected. In recent years, up to 350,000-375,000 eggs have been collected when weather conditions/water levels led to excellent nesting efforts (Table 4).

The number of alligator farms in Louisiana peaked during 1990-1992, when some 123-134 farms were licensed at any time (although not all were actively raising alligators). Some of this growth was undoubtedly a result of exceptionally high prices for wild alligator hides in the September harvests of 1988-1990, which ranged from approximately $48 per foot to $57 per foot (thus a single "average" sized alligator of 7 feet was worth some $400 for the hide alone).

Over time, many of the new, less experienced, and smaller farms were unable to compete with the more established farms, whose larger inventories and other factors led to their ability to maintain successful operations in years of more modest prices. The number of farmers/ranchers in Louisiana gradually dropped until around 1999, when it

Table 4. Louisiana's ranching program.

Year	Total Eggs Permitted	Number Collected	Percent Collected	Number Hatched	Alligators Returned to Wild
1986	2,903	2,903	100.0%	1,985	none
1987	19,641	18,041	91.9%	13,782	none
1988	90,305	64,887	71.9%	50,394	1,680
1989	265,051	181,819	68.6%	137,323	7,078
1990	366,055	293,412	80.2%	231,434	6,088
1991	333,451	198,089	59.4%	165,054	44,405
1992	297,125	164,892	55.5%	133,463	35,531
1993	279,405	155,891	55.8%	123,666	28,512
1994	362,835	266,408	73.4%	223,011	21,633
1995	402,830	314,371	78.0%	261,428	20,749
1996	467,545	279,237	59.7%	233,076	40,919
1997	476,115	377,636	79.3%	321,641	48,171
1998	539,216	280,870	52.1%	240,118	36,733
1999	574,731	382,611	66.6%	332,428	44,169
2000	593,625	279,217	47.0%	236,313	39,559
2001	616,465	357,440	58.0%	295,498	48,225
2002	639,145	354,711	55.5%	304,604	32,627
2003	651,207	356,634	54.8%	306,761	50,542

leveled off at around 60-65 farms (Table 5). Again, many of these are small "hobbyists", or others who simply maintain a farming license in order to ranch eggs, and transfer the eggs or new hatchlings to other farmers. However, the inventory on farms is far higher now (530,000 in December 2003) than when there were over 120 farms (318,000 in December 1991).

With time, farmers experimented and have developed many techniques to improve efficiency and minimize costs of alligator production. Development of pelletized dry feeds with vitamin supplementation can avoid storage/freezer costs needed with frozen meat diets. Floating feed trays help minimize wastage. Sheds sometimes are constructed with multiple stacked levels to allow for housing of more alligators and more efficient use of heat. The use of heated refill water also encourages better feeding by maintaining constant warm temperature.

Our research and review of the ranching program documented that the released alligators are able to forage for food in the wild, grow well, have high survival rates, and successfully nest in the wild (Elsey *et al*. 2001). Thus, we decreased the return percentage to 14% of the eggs hatched, starting with the 2000 egg permit collection year (returns "due" in 2002; some done one year after collection in 2001). Thus, our management program was adapted when available data warranted less demanding return requirements; although very close monitoring of the effects of this change will continue.

As farm inventories increased, buyers and dealers were able to be more selective in choosing the highest grade/quality hides with which to prepare lots of hides to enter commercial trade. Increasingly stringent demands for near-perfect hides has been problematic for some farmers, as some portion of the hides produced will have damages due to scarring, bites, etc. Efforts are in place to find ways to continue to maintain excellent quality of skins produced on farms, such as use of deeper water (to avoid piling/scratching), hide boards (to limit stress and interaction with other alligators), vinyl liners (to avoid rough/abrasive surfaces), and filtered water (avoid possible infectious agents in standing water).

Similar efforts are underway to maintain high quality wild harvested hides. Some problems (such as scars from fighting due to drought-imposed crowding) are unavoidable, but efforts have been directed to improving processing procedures (transport of carcass in refrigerated trucks to avoid "slip" of scales, careful use of pressure washers to remove tissue remnants from hides, use of compressed air to assist in separation of the hide from the carcass and avoid knife/cuts to the hide, etc.).

Table 5. Farm alligator harvest in Louisiana, 1972-2002. * = tag year extends from September of the year designated to the next September (eg 1997 = 9/97 to 8/98). ** = sale of meat not permitted; La. Health Department regulations first allowed meat sales in 1979.

Year *	No. Farms		No. Skins	Avg Length	Value of Skins		Deboned Meat	
	Licensed	Sold Skins	Sold	(feet)	Avg/foot	Total $US	Amount (lbs)	Value ($US)
1972	8	3	35	5	$8.10	$1,418	**	**
1973	8	5	103	6.33	$13.13	$8,561	**	**
1975	8	3	83	5.5	$7.88	$3,597	**	**
1976	8	3	360	5.75	$16.55	$34,259	**	**
1977	8	4	376	5.25	$12.23	$24,142	**	**
1980	8	1	191	4.67	$13.00	$11,596	957	$3,342
1981	8	3	360	4.67	$17.50	$29,421	1,801	$6,300
1982	8	1	113	4	$13.50	$6,102	452	$1,582
1983	14	6	1,449	4.58	$13.00	$86,273	7,253	$25,357
1984	12	7	2,836	4.25	$21.00	$253,113	11,354	$39,704
1985	15	12	4,430	4.25	$21.00	$395,378	17,736	$79,740
1986	22	15	5,925	4.5	$23.00	$613,238	26,687	$119,983
1987	30	23	10,670	4.42	$24.00	$1,131,874	48,060	$216,067
1988	47	38	27,749	4.25	$36.00	$4,245,597	111,094	$554,980
1989	83	68	66,737	3.98	$32.00	$8,499,624	300,877	$1,202,362
1990	123	80	88,424	4.03	$24.00	$8,552,369	397,732	$1,786,059
1991	134	91	118,976	4.13	$15.00	$7,370,563	536,379	$2,380,000
1992	125	85	128,026	4.04	$12.00	$6,206,700	578,289	$2,566,000
1993	101	70	121,700	3.87	$17.00	$8,006,643	388,010	$1,720,000
1994	89	62	136,126	3.67	$20.00	$9,991,648	277,780	$1,197,000
1995	83	50	125,460	3.88	$20.00	$9,735,696	331,395	$1,323,000
1996	81	51	161,845	3.91	$15.50	$9,808,616	511,668	$2,297,900
1997	75	36	169,988	3.74	$16.75	$10,648,898	542,332	$2,435,700
1998	73	38	154,399	3.79	$17.00	$9,947,928	490,990	$2,209,455
1999	64	35	187,570	3.64	$17.00	$11,606,832	552,693	$2,487,119
2000	66	35	219,827	3.81	$20.50	$17,169,588	659,481	$2,967,665
2001	63	32	180,391	3.79	$20.50	$14,015,479	541,173	$2,435,279
2002	62	35	240,143	3.73	$23.50	$21,049,735	720,429	$3,241,931

(___ Subject to change, numbers updated April 12, 2004).

Accelerated Experimental Wild Harvests

Although Louisiana's alligator harvests have expanded with time as indicated by population trends seen on nesting surveys, the harvest remains tightly regulated and conservative, to ensure over-harvest does not occur. More liberal, very aggressive experimental harvests were conducted in the mid-1980s, to determine if additional alligators could be safely harvested, and to collect numerous female alligators in spring/early summer, to gather additional reproductive data (questions remain as to exactly what portion of the adult female population nests each year, and subsequently, how many alligators does one nest represent when trying to extrapolate population figures from nest counts).

A very aggressive experimental harvest was conducted on Marsh Island Refuge, a 68,000 acre brackish marsh remote island off Iberia and St. Mary parishes. An experimental quota of 3500 alligators was established for the area, which is a tag allocation of 1 tag per 20 acres, far higer than quotas generally used statewide (Table 2). The harvest was held from April 4, 1986 to July 16, 1986, and 2930 alligators were taken. Harvest was heavily skewed to old, large males. Seven hundred twenty-nine alligator over 9 feet in total length (274 cm) were taken, 723 were males and 6 were females. In the more common adult size classes (6'0" to 8'11"; 183-272 cm) 1701 alligators were harvested, 62.9% of which were females. The experiment clearly documented that spring/summer harvests target more females than the standard fall harvest, and many of the largest, oldest alligators were taken (Kinler *et al*. 1987).

The next year the quota was decreased to 2000 alligators which is nearly one tag per 35 acres, and although less aggressive then in 1986, still an extensive harvest. The overall average total length taken dropped to 6'0" (183 cm) in 1987, down from 8'0" in 1986 (244 cm). Quotas were decreased to approximately 1000 alligators per year for the next four years, and average sizes remained around 183 cm total length (LDWF data). The experiment clearly

documented that limitations on harvest levels must be in place, and despite the abundance of alligators in Louisiana, unregulated overharvest could occur.

A similar (but more modest) accelerated harvest was conducted on Salvador WMA from 1986-1990, with a quota of 1 alligator per 32 acres. At the accelerated harvest levels the average size taken was smaller than the statewide harvest, but populations appeared to remain stable (Kinler and Taylor 1992).

Problems

During the 30 years over which Louisiana's alligator programs have evolved, some segments have proven to be ineffective or problematic to administer, and were discontinued. For the wild harvest, in the early years "special skinning instructions" were used each year, to ensure no poaching would occur. In addition to the use of CITES tags, alligator carcasses had to be skinned in a certain fashion each year, and these instructions were not made known to trappers until the day before the season opened. This prevented prior harvest and storage of large alligators before the season opened. As centralized processing sheds for alligator carcasses were developed, the special skinning instructions proved burdensome. A legally taken, CITES tagged carcass might be improperly skinned by an inexperienced employee at a processing shed, and thus technically creates an "illegal" hide. Thus, the rule requiring special skinning instructions was discontinued. Starting in 1991 every wild or farm hide produced in Louisiana is inspected by a LDWF employee, to ensure the CITES tag is properly attached and all hides in the lot are listed on the shipping manifest.

The experimental spring/summer harvest at Marsh Island clearly showed that high numbers of adult females are harvested at this time; providing further data to reinforce the decision to have the adult alligator harvest in autumn, to select for adult males or immatures of either sex. It also clearly showed that conservative quotas must be set to avoid overharvest.

The development of the egg ranching program led to most farmers discontinuing captive breeding efforts, which have been less successful (Elsey *et al*. 1994) and less cost efficient. Captive breeding is still underway at some farms, one advantage being that the "14% returns to the wild" are not required for egg/hatchlings produced by captive breeders.

The wild ranching program also initially allowed for the collection of hatchlings, if ranchers preferred this option (to avoid construction and maintenance of egg incubators). A much higher percentage "return rate" was due (30% at 123 cm). Problems developed with the temptation for farmers to catch "hatchlings" that were older/larger than specified, and this program was discontinued.

Another problematic area which developed gradually as farmers tried to minimize costs was that less effort may be given to maintaining strict hygiene and husbandry. Obviously costs increase (heating water, labor, feed losses) the more often the alligator sheds are washed. We strongly encourage our farmers/ ranchers to maintain aggressive husbandry efforts. Most have learned that costs saved with lack of attention to husbandry might be offset by lower quality hides being produced, which are less valuable. Occasional "disease" outbreaks are often rectified by resuming stricter hygiene/husbandry practices. Similar problems occur in other species of intensively cultured livestock such as pigs, poultry, etc.

Future

The current level of harvest in Louisiana is clearly sustainable, as nesting counts are stable in southwest Louisiana and still gradually increasing in southeast Louisiana (Fig. 1). Despite the harvest of wild adults and eggs in the ranching program, populations remain sufficiently healthy as to require a "nuisance" alligator program. Thousands of calls from citizens are answered yearly, and some 2000 nuisance alligators are harvested by licensed trappers each year.

Habitat Concerns

One threat or potential limiting factor to Louisiana's alligator population is habitat loss. Because the vast majority of Louisiana's alligators are in the coastal parishes, saltwater intrusion and wetlands/marsh deterioration from numerous causes are very real threats. Some 20,000 acres (31 square miles) of coastal marshes are lost annually.

Vast resources by numerous state and federal agencies have been expended to attempt to limit these losses. Projects

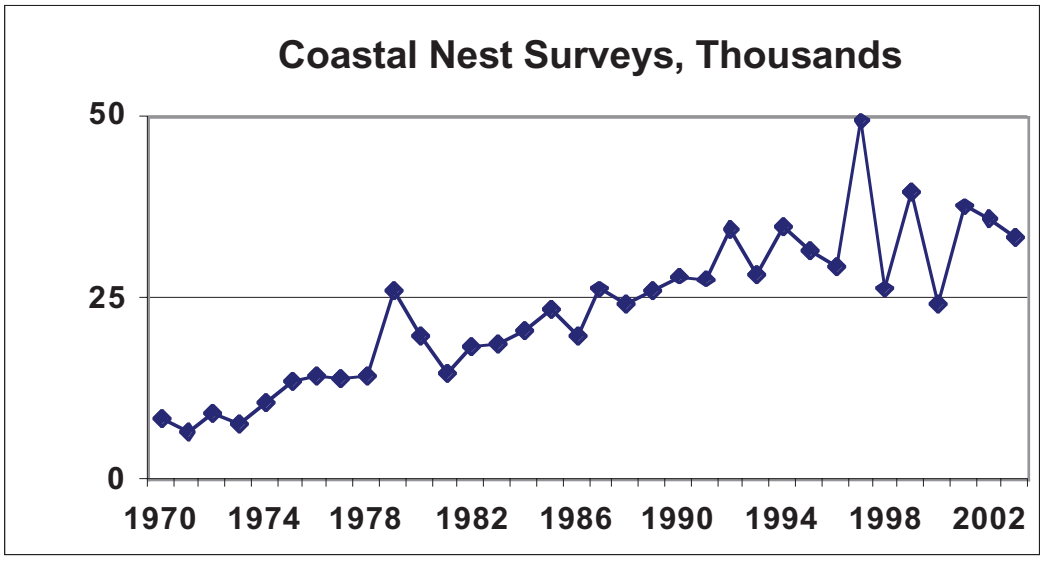


Figure 1. Numbers of alligator nests sighted in coastal surveys.

to restore/enhance marshes include construction of earthen terraces (to reduce wave action and turbidity), "breakwaters" and protection levees along coastlines, and freshwater diversions. The alligator benefits indirectly from these efforts to maintain/enhance wetlands. The freshwater diversion projects (Davis Pond and Caernarvon) shift water from the Mississippi River in hopes of re-establishing more favorable salinity conditions for numerous fish and wildlife species. Some preliminary data suggests alligator nesting has improved in the areas enhanced by lower marsh salinity levels (LDWF, unpublished data).

Summary

Louisiana's alligator management programs have clearly illustrated that controlled sustained use of the species is feasible. The wild harvest has been in place over 30 years, and the egg ranching program for nearly 20 years and may appear to operate unchanged every year. However, constant adaptations are made to try to improve both programs. The annual surveys lead to review of harvest quotas and possible changes for each parish as marsh types change and nesting efforts are affected. Constant requests by user groups (farmers, egg ranchers, trappers, landowners, buyers, dealers and other industry personnel) are received and considered as the LDWF tries to safely manage the resource to the benefit of many user groups with varied interests.

Literature

Chabreck, R.H., Joanen, T. and Palmisano, A.W. (1968). Vegetative type map of the Louisiana coastal marshes. La. Wildl. and Fish. Comm.: New Orleans.

Elsey, R.M., Joanen, T. and McNease, L. (1994). Captive breeding of alligators and other crocodilians. Proc. 2nd Regional Meeting of the Crocodile Specialist Group. Darwin, Australia, 12-19 March 1993. 41pp.

Elsey, R.M., Moser, E.B., McNease, L. and Frederick, R.G. (1998). Preliminary analysis of survival of farm-released alligators in southwest Louisiana. Proc. Ann. Conf. Southeast. Assoc. Fish and Wildl. Agencies 52: 249-259.

Elsey, R.M., McNease, L. and Joanen, T. (2001). Louisiana's alligator ranching program: a review and analysis of releases of captive-raised juveniles. Pp. 426-441 *in* Crocodilian Biology and Evolution, ed. by G. Grigg, F. Seebacher, and C.E. Franklin. Surrey Beatty and Sons: Chipping Norton.

Joanen, T. (1969). Nesting ecology of alligators in Louisiana. Proc. Southeastern Assoc. Game and Fish Commissioners Conf. 23: 141-151.

Joanen, T. and McNease, L. (1970). A telemetric study of nesting female alligators on Rockefeller Refuge, Louisiana. Proc. Southeastern Assoc. Game and Fish Commissioners Conf. 24: 175-193.

Joanen, T. and McNease, L. (1972). A telemetric study of adult male alligators on Rockefeller Refuge, Louisiana. Proc. Southeastern Assoc. Game and Fish Commissioners Conf. 26: 252-275.

Joanen, T. and McNease, L. (1987). Alligator farming research in Louisiana, USA. Pp. 329-340 *in* Wildlife Management: Crocodiles and Alligators, ed. by G.J.W. Webb, S.C. Manolis and P.J. Whitehead. Surrey Beatty and Sons: Chipping Norton.

Joanen, T. and McNease, L. (1991). The development of the American alligator industry. *In* Proceedings of the Intensive Tropical Animal Production Seminar, Townsville, Australia.

Joanen, T., McNease, L., Elsey, R. and Staton, M. (1997). The commercial consumptive use of the American alligator (*Alligator mississippiensis*) in Louisiana: Its effect on conservation. Pp. 465-506 *in* Harvesting Wild Species - Implications for Biodiversity, ed. by C.H. Freese. The Johns Hopkins University Press: USA.

Kinler, N.W., Taylor, D. and Linscombe, G. (1987). 1986 Experimental alligator harvest program on Marsh Island Refuge. Mimeograph Report. 27 pp.

Kinler, N.W. and Taylor, D. (1992). Intensive alligator harvest on Salvador Wildlife Management Area, Louisiana, 1986-1990. Proc. Southeast. Assoc. Fish and Wildl. Agencies 46: 88-96.

McNease, L. and Joanen, T. (1974). A telemetric study of immature alligators on Rockefeller Refuge, Louisiana. Proc. Southeastern Assoc. Game and Fish Commissioners Conf. 28: 482-500.

McNease, L. and Joanen, T. (1978). Distribution and relative abundance of the alligator in Louisiana coastal marshes. Proc. Southeastern Assoc. Fish and Wildl. Agencies 32: 182-186.

McNease, L., Kinler, N., Joanen, T., Richard, D.M. and Richard, D.S. (1994). Distribution and relative abundance of alligator nests in Louisiana coastal marshes. Pp. 108-120 *in* Crocodiles. Proceedings of the 12th Working Meeting of the IUCN-SSC Crocodile Specialist Group. Pattaya, Thailand, 2-6 May 1994. IUCN: Gland.

Palmisano, A.W., Joanen, T. and McNease, L. (1973). An analysis of Louisiana's 1972 experimental alligator harvest program. Proc. Southeastern Assoc. Game and Fish Commissioners Conf. 27: 184-206.

Stevenson, O.H. (1904). Utilisation of the skins of aquatic animals. U. S. Comm. Fish and Fisheries Report 1902: 281-352.

Taylor, D. and Neal, W. (1984). Management implications of size-class frequency distributions in Louisiana alligator populations. Wildl. Soc. Bull. 12: 312-319.

International Trade and CITES - Tags, Permits and Stricter Domestic Measures

Cindy Steensby

Australian Government, Department of the Environment and Heritage, GPO Box 787, Canberra, ACT 2601, Australia (cindy.steensby@deh.gov.au)

Abstract

CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora) is an international treaty to ensure that international trade in specimens of wild animals and plants does not threaten their survival. CITES requires member countries to control the import and export of an agreed list of species that are endangered, or at risk of becoming endangered, due to inadequate controls over trade in those species or their products. CITES allows countries to adopt 'stricter domestic measures' (controls that are stricter than those required by CITES). This paper provides a brief description of CITES, explains permitting and tagging requirements and discusses the use of stricter domestic measures using Australia as an example.

CITES

In 1975, an international treaty was agreed to prevent international trade threatening species with extinction. This treaty is known as the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Australia is one of more than 160 countries that are a Party to CITES. Each member country controls the import and export of an agreed list of species that are endangered, or at risk of becoming endangered, due to inadequate controls over trade in those species or their products.

How CITES Works

Although CITES is legally binding on the Parties that have ratified the Convention, it does not take the place of national laws. Rather, it provides a framework that must be implemented by each Party through the administration of domestic legislation at the national level.

CITES lists four criteria that Parties must meet in order to enforce the provisions of the Convention (Conf Res 8.4):

i) designate at least one Management Authority and one Scientific Authority; and
ii) prohibit trade in specimens in violation of the Convention; and,
iii) penalise such trade; or,
iv) confiscate specimens illegally traded or possessed.

While Parties may trade with non-Parties, non-Parties must still meet the same documentary standards as Parties in order to trade in CITES-listed specimens. Accordingly, non-Parties need to nominate a domestic authority that is competent to issue such documents.

CITES has established a worldwide system of controls on international trade in threatened wildlife and wildlife products by stipulating that Government permits are required for such trade. Security paper and stamps are often used for these permits to prevent forgery.

CITES documentation consists of a number of different types of documents. The main ones that are relevant to implementation include the actual text of the Convention (made up of Articles), Resolutions and Notifications. Note that CITES resolutions are not mandatory and not binding upon Parties. Resolutions are often used to interpret or provide guidance on implementing the Articles of CITES.

CITES Appendices

CITES places species into three categories based on their conservation status and the risk from trade. Lists of species in each category are compiled as three separate appendices to the Convention.

CITES Appendix I

These are species threatened with extinction and that are, or may be, affected by trade. Among the species listed are apes, lemurs, the giant panda, many South American monkeys, great whales, cheetah, leopards, tigers, elephants, all rhinoceroses, many birds of prey, cranes, pheasants, parrots, all sea turtles, some crocodiles and lizards, giant salamanders, some mussels, orchids, cycads and cacti.

CITES Appendix II

These are species that, although not presently threatened with extinction, might become so unless trade in those species is strictly controlled and monitored. CITES Appendix II also includes some non-threatened species, in order to prevent threatened species from being traded under the guise of non-threatened species that are similar in appearance.

CITES Appendix III

These are species that any CITES Party identifies as being subject to regulation within its jurisdiction for the purpose of preventing or restricting exploitation and that require the cooperation of other countries in the control of trade.

Authorities

Each Party is obliged to designate Management and Scientific Authorities.

Management Authorities are responsible for:

- authorising and issuing permits and certificates of approval;
- communicating information to other Parties and the Secretariat; and,
- reporting on compliance matters and contributing to CITES Annual Reports.

Scientific Authorities are responsible for providing scientific advice and recommendations to the Management Authorities, for example:

- biological and trade information on species proposed for listing in the Appendices;
- suitable measures to limit export of specimens on Appendix I;
- the suitability of recipients of live specimens listed on Appendix I to house and care for them;
- whether a scientific institution meets the criteria for registration to exchange CITES-listed specimens;
- whether a facility meets the criteria for captive breeding or artificial propagation in accordance with CITES; and,
- whether a management program for commercial harvested species from the wild is sustainable in accordance with CITES.

Stricter Domestic Measures

CITES allows Parties to adopt a stronger position on certain listed species than is required under the Convention. Australia recognises and uses this provision in its wildlife trade legislation – the Environment Protection and Biodiversity Conservation Act 1999 (the EPBC Act).

CITES does not prohibit the export or import of live CITES II specimens for commercial purposes. However, Australia does not permit the export of live native mammals, amphibians, reptiles or birds for commercial purposes. This is a stricter domestic measure.

Another stricter domestic measure applied by Australia is in regard to animal welfare. CITES specifies the need for animal welfare to be considered in relation to transport of live animals. The EPBC Act expands this to include welfare of animals when they are taken and/or held.

Other examples of Australia's stricter domestic measures are provided throughout this paper.

Permits

CITES I

Article III of CITES states that trade in CITES Appendix I specimens requires the issue of both import and export permits, and that an import permit must be issued first. This Article states also that CITES I species cannot be imported for primarily commercial purposes. However, Article VII, Paragraph 4 states that a captive-bred CITES I animal shall be regarded as if it were a CITES II specimen and hence it may be traded for commercial purposes. Resolution Conf. 12.10 interprets 'captive bred animal' to mean an animal sourced from a CITES Secretariat Registered Captive Breeding Program. In the case of crocodilians, there are currently seven such registered programs.

Through stricter domestic measures, Australia considers all specimens of *Loxodonta africana* (African Elephant) as Appendix-I specimens, although CITES lists some populations under Appendix II for specific purposes, specified in the Appendix.

CITES II

Article IV of CITES states that export permits must be issued for the export of CITES Appendix II specimens, but does not require import permits.

Through a stricter domestic measure, Australia requires import permits for all Appendix-II specimens, except in the case of certain specimens imported as personal baggage. An export permit is required unless the specimen is covered by a personal effect exemption (see discussion under *Personal effects: Australian example*). The EPBC Act provides a list of taxa that always require an import permit.

Where imported CITES II specimens are not captive-bred, the wild harvest or ranching program (commercial import program) from which they are sourced must be approved by the Australian Department of the Environment and Heritage before an import permit will be issued. Overseas captive breeding operations do not need to be approved, but the CITES permit issued by the CITES Management Authority of the exporting country must list a source code of 'C' (Captive Bred).

Currently the only approved commercial import program is for ranched *Crocodylus porosus* and *C. novaeguineae* from Papua New Guinea.

CITES III

Article V of CITES states that an export permit is required for the export of Appendix III specimens. This relates only to those specimens from the countries listed on the Appendix. Import of specimens from the same species sourced from other countries requires a certificate of origin issued by the exporting country.

Permit Exemptions

CITES Article VII lists a number of circumstances in which a specimen is exempt from normal trade provisions (permits). These include:

- Where a specimen is being transhipped.
- Where a specimen was acquired before the provisions of CITES applied to that specimen (in many cases 1975). In this situation, specimens must be accompanied by a certificate from the exporting country certifying that they were obtained before the species was listed on CITES.
- Personal or household effects (detailed below).
- Captive bred specimens if exported with a certificate stating that it is captive bred (Article VII, paragraph 5). Resolution Conf. 12.10 limits this exemption for CITES I animals to animals bred for non-commercial purposes.
- Non-commercial loan, donation or exchange between scientific institutions registered by their country. These must be preserved specimens and labelled, as required by Resolution Conf. 11.15.
- Specimens that are part of a travelling zoo or exhibition - the requirement for a permit or certificate may be waived provided the exporter or importer registers full details of such specimens with that Management Authority. (Details of requirements can be found in Resolution Conf. 12.3).

Personal Effects: CITES Requirements

Article VII, paragraph 3, and Resolution Conf. 12.9 states that personal and household effects are exempt from permitting. These are specimens that are personally owned or possessed for non-commercial purposes and legally acquired. Personal effects are either worn or carried or included in personal baggage at the time of import or export. Household effects are part of a household move. This exemption does not apply to:

- Specimens of Appendix-I species that are souvenirs being imported by a person returning to his State of usual residence; and,
- Specimens of Appendix-II species that are souvenirs and the exporting State requires the granting of export permits.

CITES Resolution Conf. 12.9 recommends that Parties do not require export or import permits for personal effects of crocodilian species (up to four specimens per person). Once this resolution is fully implemented internationally, there should be no need to issue personal baggage permits.

Personal Effects: Australian Example

Australia does not recognise the household effects exemption but recognises the personal effects exemption in cases such as crocodile products. Australia does not require permits for crocodile products (up to 4 specimens) if imported or exported as accompanying baggage and for personal purposes.

However, not all countries recognise personal effects exemptions and therefore Australia still issues personal effect permits (one dollar crocodile permits). These permits are issued in bulk to manufacturers of Australian crocodile products.

The personal effects permits may be attached to manufactured products such as handbags, belts and wallets that are derived from animals bred under an approved Captive Breeding Program or sourced from an approved Wildlife Trade Management Plan or Wildlife Trade Operation.

A CITES personal effects permit may be used only when the product is leaving the country as hand luggage or luggage accompanying a person on the same flight or ship.

Items exported via post or courier require an individual export permit. The personal effects permits issued to the manufacturers of the products are not valid for export in these cases.

Tagging

Little significant illegal trade in crocodilians has been recorded globally in the last few years due primarily to the successful introduction of a universal tagging system for crocodilian skins exported from range States (COP12 Doc. 54.2). This system was introduced at COP6, approximately 14 years ago. The most recent amendment relating to this provision is Resolution Conf. 11.12.

The CITES Secretariat is responsible for establishing and maintaining a list of approved sources capable of manufacturing tags that meet the minimum tagging requirements. The Management Authority of each Party is responsible for ordering and distributing the tags. In addition, the Management Authority must notify the Secretariat of the details of each order for tags. If requested by the Secretariat, the Management Authority may need to provide further details on tags issued.

Crocodile skins or body parts must be individually tagged before export. The tags are non-reusable and must include the ISO two-letter code for the country of origin; a unique serial identification number; a standard species code; and, where appropriate, the year of production or harvest. The tags must have the following characteristics: a self-locking mechanism, heat resistance, inertia to chemical and mechanical processing, and alphanumeric information applied by permanent stamping.

Enforcement of CITES Regulations

Enforcement of CITES is the responsibility of each Party. In most countries, customs officers are given the task of

enforcing CITES regulations. Governments also are required to submit reports, including trade records, to the CITES Secretariat in Switzerland. To ensure effective enforcement at the international level, the CITES Secretariat acts as a clearinghouse for the exchange of information and liaison between the Parties and with other authorities and organisations.

In order to enforce compliance with CITES obligations, the CITES Standing Committee may recommend suspension of trade with non-complying Parties (either for all CITES specimens or for particular species). These recommendations would be included in Notifications to the Parties, which the CITES Secretariat distributes, usually on a monthly basis. As there are very few countries that are non-CITES Parties, this would severely restrict trade for the suspended Party.

Literature

CITES (1992). National laws for implementation of the Convention, CITES Resolution Conf. 8.4, Eighth Meeting of the Conference of the Parties, Kyoto, Japan.

CITES (2000). Universal tagging system for the identification of crocodilian skins, Resolution Conf. 11.12, Eleventh Meeting of the Conference of the Parties, Gigiri, Kenya.

CITES (2000). Non-commercial loan, donation or exchange of museum and herbarium specimens CITES Resolution Conf. 11.15, Eleventh Meeting of the Conference of the Parties, Gigiri, Kenya.

CITES (2002) Personal effects made of crocodilian leather, COP12 Doc.54.2, Twelfth Meeting of the Conference of the Parties, Santiago, Chile.

CITES (2002). Permits and certificates, Resolution Conf. 12.3, Twelfth meeting of the Conference of the Parties, Santiago, Chile.

CITES (2002). Personal and household effects Resolution, Conf. 12.9, Twelfth Meeting of the Conference of the Parties, Santiago, Chile.

CITES (2002). Guidelines for a procedure to register and monitor operations that breed Appendix-I animal species for commercial purposes, Resolution Conf. 12.10, Twelfth Meeting of the Conference of the Parties, Santiago, Chile.

Lessons We Are Still Learning: Bioeconomic Models of Crocodile Conservation

Brendan Moyle

Massey University (Albany), AL154, Auckland, New Zealand 1311 (b.j.moyle@massey.ac.nz)

Sustainable use is a conservation strategy where the benefits of harvest motivates the recovery of wild populations. Early bioeconomic models failed to identify the drivers that generated conservation outcomes. Such models ignored the effects of age-structure and improvements in product quality. They also omitted investments in habitat or increases in growth rates. The treatment of uncertainty was also poorly modelled. This continues to hamper assessment of conservation risks. This is currently manifested in the promulgation of the sub-optimal precautionary principle as a tool for dealing with uncertainty.

This research presents several simple bioeconomic models. These models are motivated by the recovery of the Australian Saltwater Crocodile. The bioeconomic models demonstrate that slight improvements in their biological or economic realism reverses the pessimistic predictions (eg optimal extinction) of the earlier models.

The models show that from a policy perspective, sustainable use is either the most cost-effective or efficient conservation approach. Incentives to invest in habitat and age-cohort survival rates sustains and reinforces the recovery of crocodilian populations.

Conservation Implications of Harvesting Wild Adult Crocodilians

Allan R. Woodward

Florida Fish and Wildlife Conservation Commission, 4005 South Main Street, Gainesville, FL 32601, USA (Allan.woodward@fwc.state.fl.us)

Crocodilians have long generation times, high fecundity, and low egg and juvenile survival rates. Consequently, adult females have a high expected value to the population. Harvest of wild adult crocodilians has, therefore, been discouraged by conservation and wildlife trade organizations, such as the CSG and CITES. Ranching has been encouraged as the preferred low-risk option for commercial consumptive harvest of wild crocodilians. Many country and state harvest programs have embarked on capital-intensive ranching programs that have had difficulty maintaining profitability. Harvest programs of large wild crocodilians have lower potential production levels but also have lower capitalization and operational costs, and are usually profitable. Case studies of harvest programs in the United States, Venezuela and Papua New Guinea suggest that adult crocodilian harvests can be sustainable, economical for the primary harvester, implemented with manageable long-term risk to populations, and can have important conservation benefits. Each program has used a different mixture of regulations, monitoring, and enforcement strategies to achieve sustainable harvests. These successes suggest that harvest of adult crocodilians can be considered as a viable harvest option under the right conditions.

Sustainable Use: What Can Kangaroos Tell Us About Crocodiles?

Gordon C. Grigg

School of Life Sciences (Zoology), University of Queensland, Brisbane, QLD 4072, Australia (ggrigg@zen.uq.edu.au)

Two extensions of the current commercial use of crocodiles are under discussion in Australia, a proposal for trophy hunting of large crocodiles in the Northern Territory and a proposal to harvest eggs in Queensland. There are many similarities between kangaroo and crocodile harvesting issues. Both are a pest/problem to some, a resource to others, and iconic for everyone. Commercial use of both has been made possible only after extensive independent and objective scientific research and population monitoring, and extensive public discussion and international lobbying. Because individual States or Territories have responsibility for wildlife within their jurisdictions, harvests depend on research and monitoring at a regional level. This carries implications for the proposed harvest in Queensland where the background independent science remains to be done. Beyond science, however, safari hunting of crocodiles raises questions about humane treatment and stirs the personal distaste of many. This is true of kangaroo harvesting too, which now has community endorsement. Governments respond to community attitudes, and crocodile hunting is unlikely to be approved in Australia until community support grows. Experience with kangaroos suggests that this will follow substantial explanation and education about potential conservation and socioeconomic benefits.

National Progress Report on the Conservation of Chinese Alligator

Jiang Hongxing[1], Ruan Xiangdong[2], Gu Changming[3] and Wang Zhiping[4]

[1]National Research and Development Center of Wildlife, State Forestry Administration, PO Box 1928, Beijing, PC 100091, China (hxjiang@forestry.ac.cn); [2]Department of Wildlife Conservation, SFA, P. R. of China (ruan@forestry.gov.cn); [3]Station of Wildlife Conservation, Anhui Forestry Department (guchangming@ahly.gov.cn); [4]Changxing Nature Reserve and Breeding Research Center for Chinese Alligator, Zhejiang, China

This paper describes the implementation of National conservation project for Chinese Alligator in the recent two years especially since the Chinese Alligator conservation project issued one of 15 species conservation projects under the Master Plan on the National Wildlife Conservation and Nature Reserve Construction approved by the National Development and Planning Commission in June 2001. For Anhui Breeding and Research Center for Chinese Alligator (ABRCCA), about 1200 Chinese Alligator hatchlings were incubated and the survival rate of the young crocodiles reached 86% in the Year 2002 and 2003. Meanwhile, the ABRCCA established two new breeding areas, refurbished the fence with the length of 3500 metres and reconstructed the old breeding ponds with the area of 0.7 ha in the Year 2003. In addition, one released pond with the area of 1 ha was constructed and 3 alligators were released to the field (the site named Hongxing, where 4 individuals were counted in 1999 by Ding *et al*. in 2003). For Changxing Breeding and Research Center for Chinese Alligator (CBRCCA), 163 eggs were laid and 64 hatchlings were incubated in the semi-natural condition in 2003. The area of CBRCCA was enlarged to be 10 ha and 80% breeding habitat restoration was completed in 2003. In addition, the habitat evaluation project was also finished and the results would guide the released site selection and habitat restoration for Chinese Alligator. Finally the paper presents some thoughts on the next step.

Movement Patterns of Released Captive-reared Chinese Alligators (*Alligator sinensis*)

Ding Youzhong[1], Wang Xiaoming[1], John Thorbjarnarson[2], Wu Jiansheng[1], Wang Zhenghuan[1], Wu Wei[1], Gu Changming[3] and Nie Jishan[4]

[1]The School of Life Science, East China Normal University, No 3663, Zhongshan Road (N), Shanghai, 200062, P.R. China (yzding@kj.ecnu.edu.cn); [2]Wildlife Conservation Society, New York 10460, USA (jthorbjarnarson@wcs.org); [3]Anhui Forest Bureau, Hefei 230000, P.R. China; [4]Anhui Research Center for Chinese Alligator Reproduction, Xuancheng 242000, P.R. China

In April 2003, 3 adult captive-reared alligators (2 female F1, F2 and 1 male M1) were released at Hongxing conservation site, Xuancheng, Anhui Province. The home ranges of these alligators were studied through radio-tracking. From April to November 2003, a total of 2124 locations were recorded, comprising 1191 locations for F1, 32 locations for F2, and 901 locations for M1. Soon after release the signal from F2 was lost, but she was re-located while basking in May 2004, with a very weak signal as a result of a broken antenna. Treating these data with minimum convex polygon tells that the home ranges of each individual are: F1, 3.5117 ha; M1, 5.0348 ha. Beginning 3 to 14 days after the release, the three alligators stayed in three different stable areas which had the symbols of territory. The male's home range is relatively larger than the female's. Their activity areas were limited by the reservoir's area. They all tended to stay near the bank where the vegetation is dense. This study suggests that the release of captive-reared alligators can be an effective management technique for reintroductions or restocking this critically endangered species.

Siamese Crocodile (*Crocodylus siamensis*) Surveys in Cambodia

Boyd K. Simpson[1] and Sam Han[2]

[1]Fauna & Flora International - Cambodia, 8b Street 398, PO Box 1380, Phnom Penh, Cambodia (boyd1@ekit.com);
[2]Wildlife Protection Office, Forestry Administration, #40 Norodom Blvd, Phnom Penh, Cambodia (wildlifefa@online.com.kh)

Abstract

The Siamese Crocodile (*Crocodylus siamensis*) is critically endangered and Cambodia now seems to be the last stronghold of the species. Four years of surveys by the Cambodian Forestry Administration (FA) and Fauna & Flora International (FFI) have revealed that a population of less than 200 adults is widespread and highly fragmented. More than 850 km of rivers and wetlands have been surveyed since 2001, resulting in the discovery of 23 dry season crocodile sites in 6 provinces, most of which are in the southwest of the country. Only two of these sites contain significant numbers of crocodiles, with the majority of sites holding on a handful of individuals. The movement of crocodiles between these sites is poorly understood and research is continuing to elucidate population and distribution dynamics.

The Siamese Crocodiles of Cambodia continue to decline and current threats include habitat destruction, drowning in fishing nets, and the collection of live animals to stock crocodile farms. Evidence of at least 61 crocodiles being taken alive for crocodile farms has been gathered since 2001 but this is probably only a fraction of the real number. This collection continues to pose the single most serious threat to Siamese Crocodile recovery in Cambodia.

FA and FFI are continuing to work at all levels to conserve this critically endangered species, but animals continue to disappear from what is a very small and fragmented population. Unless there is a concerted effort from National and International agencies, this constant drain on the population will have irreversible and disastrous effects for the species.

Introduction

The Siamese Crocodile (*Crocodylus siamensis*) is classified as 'Critically Endangered' by the World Conservation Union (Hilton-Taylor 2000), and as such, is one of the most endangered of the world's 23 crocodilian species. It has been rated by the IUCN-SSC Crocodile Specialist Group as a species with the highest need for wild population recovery (Ross 1998).

Once widespread throughout the waterways of Southeast Asia, the Siamese Crocodile was historically found in Indonesia, Malaysia, Thailand, Laos PDR, Cambodia and Vietnam. Recent reports (Ross 1998) however, suggest that its distribution may have declined by at least 90% and populations in many of its former range states are extremely depleted or extinct. The species is now considered 'effectively extinct' throughout most of its former range. Cambodia is now viewed as the last stronghold of the species because several hundred crocodiles still remain, mostly in scattered locations in the Cardamom Mountains (Daltry *et al.* 2003). A small population exists in southern Laos (Thorbjarnarson 2003), while a small re-introduced population in Vietnam persists despite initial poaching pressure (Murphy and Cong Viet 2002). The status in Indonesia is unknown, but the population is thought to be very low or extinct.

Even within Cambodia where the largest populations of Siamese Crocodiles occur, their numbers have been severely depleted (Daltry *et al.* 2003). The initial decline was probably caused hundreds of years ago by the conversion and alteration of their wetland habitat for rice cultivation. The continued expansion and cultivation on these wetlands, and the associated development of villages and communities along the rivers and lakes have continued to reduce the suitable habitat for the species. More recently however, the collection of crocodiles to stock crocodile farms has caused a severe decline in their numbers. The first Cambodian crocodile farms were started in 1945 (Chea Peng and Ratanakorn 1993), and the collection of wild animals intensified through the 1980s and 1990s when skin prices were high (Thuok and Tana 1994). Cambodia now hosts over 900 crocodile farms (Thuok, pers. comm.) with most being small-scale village operations.

Although Siamese Crocodiles were first described over 200 years ago, very little is known of their ecology in the wild. Slow moving rivers and freshwater swamps were the preferred habitats described by Smith (1931), but they are also known from lakes and streams (Daltry *et al.* 2003; Thorbjarnarson 2003). Males may reach lengths of around 4 m, but most are generally less than this size, and they are not known to pose a threat to humans. The relatively broad snout suggests it is a generalist feeder, and Daltry *et al.* (2003) described a diet comprising fish, reptiles, amphibians, mammals, birds and invertebrates. Although several old nests have been located in Laos and Cambodia (Baird 2001; Daltry *et al.* 2003; Thorbjarnarson 2003), the majority of information regarding nesting has been gathered from captive animals in zoos or farms. Nesting occurs at the start of the wet season (April/May in Cambodia) where the female lays 20-50 eggs in a mound nest (Youngprapakorn *et al*. 1971). Incubation takes about 70-80 days but is dependent on nest temperature (Webb and Manolis 1998).

Goals and Objectives

The Cambodian Crocodile Conservation Programme (CCCP) was established in 2001 by the Cambodian Department of Forestry and Wildlife (now Forestry Administration) and Fauna & Flora International (FFI). The Programme was formed in response to the discovery in the year 2000 of a breeding population of Siamese Crocodiles in the Cardamom Mountains in Southwest Cambodia (Daltry and Chheang 2000). This discovery was significant because the species was considered to be effectively extinct in the wild prior to this (Messel *et al*. 1992). The overall programme objectives aim to conserve the Siamese crocodile through an integrated approach of surveys, research, education, law enforcement, capacity building, and community-based conservation.

This paper summarises the results of Siamese Crocodile field surveys carried out by the Cambodian Crocodile Conservation Programme in Cambodia for the period 2001-2004. The primary objectives of these surveys were to:

1. Confirm the presence, status and distribution of crocodiles in the various rivers systems and waterways.
2. Estimate the minimum number of crocodiles present, based on sightings and sign.
3. Gather baseline data on Siamese Crocodile ecology, including diet, habitat use and nesting.
4. Identify the historic and current threats to the Siamese Crocodiles in Cambodia.

Methods

Surveys were carried out during the 'dry season' of 2001-2004. Usually, the surveys started in December and finished when the rains began in April because of rapidly raising rivers and access difficulties. Crocodiles and their sign also became increasingly difficult to locate with increasing water levels. Rain in the mountainous regions in the southwest usually started earlier than in other areas in the country, so by late April and May, the survey team shifted their attention to lowland parts and the northeast. Survey teams usually comprised 2-4 trained CCCP staff, a guide and 1-2 security personnel from the police or military. Local rangers were also encouraged to participate, to help increase their knowledge of crocodiles.

Surveys initially focused on the Cardamom Mountains, in the southwest of Cambodia for the majority of 2001-2003, as this area appeared to be the last stronghold of the species. Towards the end of the dry season in 2003 (May 2003) and 2004 (March and April 2004), surveys were undertaken in other areas in the country (Table 1) after information was gathered through interviews and previous reports.

As many of the areas posed different survey problems, there was no standard technique used to find crocodiles. Often the rivers were shallow for many kilometres or contained numerous rapids or rock bars, resulting in boat drivers refusing to work at night. Or, when rivers were suitable for night surveys, they were often isolated and in uninhabited areas, and so boats were unavailable. The thick riparian evergreen forests found fringing many of the mountainous rivers and lakes made quiet nocturnal surveys by foot virtually impossible.

The majority of surveys were conducted by day on foot, and focused mainly on searching for crocodiles or their sign. Survey teams walked the banks of rivers, lakes and wetlands looking for crocodiles, their tracks, dung or other signs indicating the presence of crocodiles. Sometimes motorised boats or canoes were available for day and night work, and spotlight surveys were undertaken where possible. Standard nocturnal spotlighting techniques were used (see Messel *et al*. 1981), using torches (flashlights) or headlights to scan the waters surface to detect the red "eyeshine" of crocodiles. Crocodiles were then approached if possible, to obtain a size estimate. Small oxbow lakes were often spotlighted by foot where the vegetation allowed. The location of all sightings of crocodiles and their sign was recorded using Garmin™ global positioning systems (GPS) or 1:50,000 topographic maps.

To gain an understanding of the population size structure and to help determine the number of different individuals found (based on size) all sign were measured. The maximum dung diameter was measured and then collected for later examination and identification of undigested prey items (see Daltry *et al.* 2003). Tracks and footprints were measured to give estimates of crocodile size. Front and rear footprints were measured for width and length, as well as the stride and straddle of the tracks (see Daltry *et al.* 2003). Total length estimates of all crocodiles seen were made to the nearest 50 cm, or in 30 cm (1 foot) intervals.

Using a combination of all crocodile sightings and sign found, and based on their size and location, a conservative estimate of the minimum number of crocodiles was made for each area.

As surveys were undertaken in the dry season, crocodile locations could be described in terms of dry season sites. However, the term 'site' is a relative one, and two or more sites may in fact be a continuous area, especially during the wet season. For the sake of this paper we have defined a 'site' to include crocodiles (a group or a single animal) that are separated from others during the dry season by natural barriers such as mountains or hills, large waterfalls, tidal waters or at least 10 km of shallow (less than 1 m) river water. Areas along rivers are difficult to define in terms of 'sites' and so have been grouped unless there is some form of natural barrier, such as a waterfall. Ox-bow lakes have been classed as the same site as river populations unless individuals in that river are greater than 30km away (this 30 km limit has been arbitrarily chosen and has no real meaning).

Numerous informal interviews were carried out during the course of these surveys. Information gathered from local communities shed light on current and historical distributions and gave insight to current threats. Fishermen were often a wealth of knowledge regarding crocodile distribution, dispersal patterns, hunting pressures and trade, but such information was regarded as a mere "report" until it could be confirmed.

Information was also gathered on various ecological parameters, including the habitat descriptions on locations during the wet and dry seasons where crocodiles were found, and where they were not found. Information on the diet of this species was gleaned through the examination of crocodile dung and the identification of undigested prey items. Keratin (fur, feathers, scales and claws), chitin (arthropod exoskeletons) and enamel (mammalian teeth) pass through the digestive tract largely intact, while bone and soft tissues are completely digested. By examining the undigested remains of prey items, assumptions on diet can be made.

Data was also collected from nesting sites, and nests were examined where possible. Data on nest structure, habitat type and egg characteristics, including clutch age were recorded. Old nest sites were also assessed and notes taken on habitat type, even if the nest was no longer present.

2001: After rapid biodiversity surveys in 2000 had identified crocodiles in several localities in the Cardamom Mountains (Daltry and Momberg 2000), the FFI and FA team chiefly focused on surveying the crocodile population in Veal Veng Marsh, where a community-based management programme was under development (see Daltry 2002a; Hammond and Hor 2002). We also conducted rapid surveys of the nearby Krau and Koi Rivers, and the Phnom Aural Wildlife Sanctuary (Daltry 2002b).

2002: Rapid surveys by three CCCP field teams covered 12 major rivers and associated tributaries on the southern slopes of the Cardamom Mountains, flowing southwest to the Gulf of Thailand. Monitoring (repeat) surveys were undertaken in Veal Veng marsh and Anlong L'Ang on the Koi River (see Daltry *et al.* 2003).

2003: Numerous biodiversity surveys were conducted in partnership with WildAid (NGO) in central and southern Cardamoms, which included surveying for crocodiles (Chheang *et al*. 2003; Daltry and Traeholt 2003). Additional monitoring surveys were conducted in the Veal Veng marsh and Areng River populations, as well as a survey in Mondulkiri Province, in eastern Cambodia.

2004: Surveys were conducted in 8 major rivers in the central and southern Cardamoms, which again included monitoring Veal Veng marsh and Areng River populations. Surveys were also undertaken in rivers on Northeastern slopes of Cardamom Mountains, flowing to Tonle Sap Great Lake (Mekong River basin) and in other provinces in the North and East of Cambodia, including Mondulkiri, Ratanakiri, Stung Treng and Preah Vihear.

Results

Distribution and Abundance

Over 40 discrete surveys were carried out over the course of the 2001-2004 dry seasons, which covered more than 40 major rivers and streams (plus additional lakes and swamps). While some surveys may be incomplete, more than 850 km of waterways were examined, confirming at least 162 individuals in 23 discrete dry season sites (Table 1, Fig. 1). Most of these sites and crocodiles were found in the isolated Cardamom Mountains in southwest Cambodia.

Table 1. Confirmed dry season crocodile sites in Cambodia (2001-2004), with a conservative estimate of the minimum number of crocodiles found at each site.

Site No.	Site Area	Province	Estimated No. of Crocodiles (all areas)
1	Pursat River	Pursat	7+
2	Pim River	Pursat	1+
3	Veal Veng Marsh (O'Som)	Pursat	ca. 40
4	Koi and Krau Rivers	Pursat	14+
5	Russei Chrum	Koh Kong	1+
6	Kiew River (Upper)	Koh Kong	3+
7	Kiew River (Lower)	Koh Kong	1+
8	Kep River	Koh Kong	10+
9	Tatai River (Upper)	Koh Kong	2+
10	Tatai + Touch Rivers	Koh Kong	11+
11	Tatai River (Lower)	Koh Kong	5+
12	Areng River (Upper)	Koh Kong	1+
13	Areng River (Central)	Koh Kong	ca. 30
14	Trapeang River	Koh Kong	11+
15	Kompong Chey	Koh Kong	7+
16	Sre Ambel River	Koh Kong	2+
17	Kul River, Botum Sakor	Koh Kong	1+
18	O'Plai River (trib. of Srepok R.)	Mondulkiri	1+
19	O'Lieou River (trib. of Srepok R.)	Mondulkiri	1+
20	Sesan River	Ratanakiri	1+
21	Sekong/O'Chay/O'Kampa Rivers	Stung Treng	10+
22	O'Kandal River	Preah Vihear	1+
23	Sen River	Preah Vihear	1+
		TOTAL	162+

In the majority of sites, only a handful of individuals were found. Worrying, the crocodiles appear to be widely scattered and highly fragmented. Only 7 sites were confirmed to hold more than 10 individuals (Table 1), and several of these may in fact be continuous. Only two sites were found to have significant numbers of crocodiles; Veal Veng marsh (site #3) is estimated to contain about 40 crocodiles, while the Central Areng River (site #13) holds an estimated 30 crocodiles (Table 1).

Identifying individuals through spotlight surveys has proved to be difficult, not only because of the difficult river access and boat availability, but because of the wary nature of these crocodiles. Hunting has occurred in much of the country over the last several decades and so the remaining crocodiles have become extremely wary of noise and light, making spotlighting individuals difficult. This may have lead to us considerably underestimating the number of animals in a river or area, when based on spotlight data alone.

Repeat monitoring surveys of Veal Veng marsh, the Koi and Areng Rivers (Cardamom Mountains) were undertaken