Japan Bekko Association

Tokyo office : Rm. No. 0407, W.T.C.Bldg. 4-1, 2-chome, Hamamatsu-cho, Minato-ku, Tokyo 105

TEL : 03-3435-7097 FAX : 03-3435-7428

Dr. George Balazs
National Marine Fisheries Service,
Honolulu, Hawaii 96822-2396
U.S.A.
(+1-808-9431290)

24 January, 1997

- Proceedings
- Photo
-

Dear Dr. Balazs,

We have sent you a copy of the document which will be used at the Bali Workshop by EMS. If you have received the document before leaving for Bali, please inform us by return FAX.

Descriptive VS Informative

Sincerely yours,

H. Sekiguchi
Hidenori Sekiguchi
JBA

See P. 4, 6, 7, 11, 16, 20, 22, 24, 25, 27, 30 sat., 31

35 Campus

P. 52 DNA Samples

ANNEX I
P. 31 Doce leguas
32
34
35 [13 Billion]

Growth rings 36

P. 48 Tag recoveries

[P. 56 IN-OUT DNA]

P. 56 SAT. TRACK

Japan Bekko Association

Tokyo office : Rm. No. 0407, W.T.C.Bldg. 4-1, 2-chome, Hamamatsu-cho, Minato-ku, Tokyo 105

TEL : 03-3435-7097 FAX : 03-3435-7428

To the participant to the marine turtle workshop in Bali

Tokyo, 22 January 1997

Dear Sir/Madame,

Japan Bekko Association was asked to send you a copy of the proposal to downlist the Cuban population of hawksbill turtles. Since this proposal is a subject of discussions in Bali, I hope that you will bring the copy to Bali and that you manage to read on the way to Bali.

I look forward to seeing you in Bali.

Yours faithfully,

Hidenori Sekiguchi

A. PROPOSAL

1. Title

An annotated transfer of the Cuban population of Hawksbill Turtles (*Eretmochelys imbricata*) from Appendix I to Appendix II, submitted in accordance with Resolution Conf. 9.24, but also in compliance with Resolution Conf. 9.20, in order to allow trade in current registered stocks of shell with one trading partner that will not re-export, together with the continued export in one shipment per year, to the same trading partner, of shell marked in compliance with Resolution Conf. 5.16, which allows definitive identification of origin from the traditional harvest (harvest limit 500 individuals per year) or experimental ranching program (anticipated: 50 individuals in year 1; 100 in year 2; and, 300 in year 3).

2. Format

This proposal follows the format of Resolution Conf. 9.24 Annex 6, but additional information has been added to meet information needs specific to the conservation and sustainable use of sea turtles, and the management of *E. imbricata* shell stocks.

B. PROPONENT

Republic of Cuba

C. SUPPORTING STATEMENT

1. Taxonomy

1.1. Class	Reptilia
1.2. Order	Testudinata
1.3. Family	Cheloniidae
1.4. Species	*Eretmochelys imbricata* (Linnaeus, 1766)
1.5. Scientific synonyms	none
1.6. Common Names	Tortuga de carey (Spanish) Hawksbill Turtle (English) Tortue caret (French) [see Márquez (1990) for local names]
1.7. Code number	A-301.003.003.001

2. Summary

2.1. Cuban people have traditionally harvested sea turtles for food since the first recorded history. The shell of *E. imbricata* is a valuable byproduct, exported since the 1500's. The traditional *E. imbricata* fishery was expanded significantly in 1968, with a systematic increase in regulation and the introduction of conservation and research initiatives.

2.2. By 1976 the world population of *E. imbricata* was listed on Appendix I of CITES. The status of *E. imbricata* in Cuba was not known to the Parties at that time.

2.3. Cuba acceded to CITES 14 years later (1990), and lodged a reservation for *E. imbricata* as provided for under Article XXIII of the Convention. Between 1976 and 1990 an average of 4720 *E. imbricata* had been harvested each year. By 1990, the size structure of the annual harvest had stabilised in some harvest areas and remained unstable in others.

2.4. Recent estimates of the size of the *E. imbricata* population in Cuban waters (Doi *et al.* 1992; Heppell *et al.* 1995; this proposal) indicate a population in excess of 100,000 non-hatchlings. The degree to which the historical harvest could have been sustained indefinitely depends on many factors (Congdon *et al.* 1993; JBA 1994, 1995; Heppell *et al.* 1995; Mortimer 1995; Resolution Conf. 9.20).

2.5. In 1990, as part of a fisheries rationalisation program, Cuba phased down its harvest of sea turtles so that the fishing effort could be diverted to primarily export fisheries. The remaining traditional harvest now represents 10% of previous harvest levels, and occurs at two fishing communities. Cuba has no intention of expanding the harvest or number of harvest sites in the short- to medium-term future. International trade in *E. imbricata* shell ceased in 1992.

2.6. Since then Cuba has implemented many conservation initiatives. Today, *E. imbricata* is subject to permanent closed seasons and is thus totally protected in over 99% of Cuban waters. The exceptions are the two traditional harvest sites where the limited traditional utilisation is strictly managed and controlled. Management procedures have been refined and additional legal protection implemented. More stringent monitoring has been introduced, and incidental catch is under investigation. At present, Government is devoting significant resources to current research on population dynamics, ranching, shell chemistry, DNA, feeding, reproduction and movement.

2.7. Shell produced since 1992 (<6 tonnes), has been stockpiled. A stringent method of marking shell for export has been introduced, that exceeds the requirements of Resolution Conf. 3.15, 5.16, 6.22 and 9.20. Stocks will be registered with the CITES Secretariat, who could be invited to observe the shipment at the time of export.

2.8. Despite recognised gaps in the knowledge of *E. imbricata* biology everywhere, the information accompanying this proposal is consistent with the population in Cuban waters meeting the criteria for Appendix II (Annex 2a of Resolution Conf. 9.24) rather than Appendix I (Annex 1 of Resolution Conf. 9.24), taking into account the "Precautionary Measures" (Annex 4 of Resolution Conf. 9.24), and the additional safeguards in Resolution Conf. 9.20.

2.9. Cuba is requesting the transfer of the population of *E. imbricata* found in Cuban waters from Appendix I to Appendix II, so that a new conservation and management program, based on adaptive management and sustainable use, can be fully implemented. The program involves significant conservation benefits for the species and maintains traditional links between sea turtles and people in local communities.

2.10. Given acceptance of the proposal by the Parties, Cuba will:

2.10.1. Withdraw its reservation on *E. imbricata* within 90 days in accordance with Annex 4, Para. B3 of Resolution Conf. 9.24.

2.10.2. Organise for the immediate export of stocks of shell in Cuba accumulated since 1992, in one shipment to Japan, where equally strict controls are in place, and where no reexport will take place.

2.10.3. Dependent on the sale of the current stockpile and such stocks that may be exported over the next three years, ensure an appropriate budget is available to meet conservation and management obligations made in this proposal.

2.10.4. Limit the traditional harvest of *E. imbricata* to a maximum of 500 individuals per year over the next three years, when this limit will be reassessed on the basis of the measured impact of the harvest as revealed by monitoring.

2.10.5. Expand its experimental ranching program over the next three years, on the basis of research results, with limited exports: 50 in year 1, 100 in year 2 and 300 in year 3.

2.10.6. Export all shell produced from the traditional harvest and the experimental ranching program over the next three years, in one shipment each year to Japan, which will not reexport.

2.10.7. Provide the CITES Secretariat with an annual report on conservation, management and research of *E. imbricata* in Cuba which includes details of the extent of the harvest and exports, and of progress made with the experimental ranching program.

2.10.8. Provide the 11th Conference of Parties with a comprehensive report on the conservation and management of *E. imbricata* in Cuba, and specifically information pertaining to Article IV2 (a) of the Convention, which requires that the utilisation "is not detrimental to the survival of the species".

3. Biological Parameters

3.1. Distribution

3.1.1. Global

Eretmochelys imbricata has a global distribution (Fig. 1). It occurs within the territorial waters of at least 112 nations, and is known to nest in at least 60 (Witzell 1983; Groombridge and Luxmoore 1989; Márquez 1990). Despite historical utilisation and probable reductions of density in most nations, the range of *E. imbricata* does not appear to have contracted (Groombridge and Luxmoore 1989). The species is generally considered the least migratory of sea turtles (Witzell 1983), although some significant movements of marked individuals have been reported (Parmenter 1983; Groshens 1993; Groshens and Vaughan 1994; Hillis 1995). The species appears to favour shallow, warmer waters, and feeds primarily on sponges (eg. Witzell 1983; Meylan 1988; Bjorndal 1990; Anderes 1994, 1996; Anderes and Uchida 1994).

The status of feeding habitats varies greatly from country to country, due to a variety of factors which impact on tropical marine ecosystems (eg. fishing with nets, poisons and explosives; overfishing generally; use of coral for building; effects of siltation, coastal development, etc.). However, there are large areas of habitat (eg. northern Australia) where *E. imbricata* are both abundant and secure (eg. Limpus *et al.* 1983; Broderick *et al.* 1984; Loop *et al.* 1995; Miller 1994; Limpus and Miller 1996). In the Caribbean region, a number of nesting and feeding populations of *E. imbricata* appear stable or are increasing [eg Antigua (Hoyle and Richardson 1993); Mexico (Hernández *et al.* 1995; Garduño and Márquez 1994, 1996), Puerto Rico (Diez *et al.* 1994; Diez and Van Dam 1995), Virgin Islands (Hillis 1995)]. In addition, over the last 20 years controls on utilisation have been greatly strengthened throughout the region (Groombridge and Luxmoore 1989; see Section 5.1.2c).

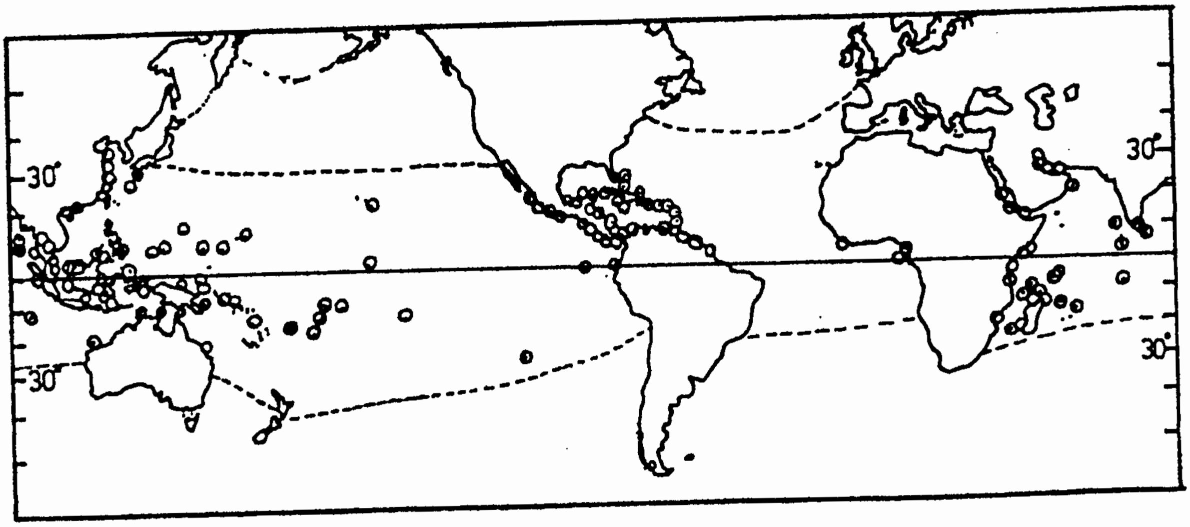

Figure 1. Global distribution of *E. imbricata* showing known nesting sites [modified after Witzell (1983) and Márquez (1990)].

Nesting (Fig. 1) is both colonial (many individuals nesting in a restricted area) and solitary (the odd individual nesting alone), but does not involve highly synchronised mass nesting. Nesting habitats are typically sandy beaches with a ridge of vegetation extending back from the beachfront (Witzell 1983; Hoyle and Richardson 1993; Pérez 1994; Loop *et al.* 1995; Limpus and Miller 1996). The status of nesting habitats probably varies greatly from country to country due to a variety of factors affecting beachfront development (Groombridge and Luxmoore 1989).

The degree to which known concentrations of *E. imbricata* around the world are continuous or fragmented is difficult to determine (Groombridge and Luxmoore 1989). In some countries the status of the local population of *E. imbricata* appears to highly dependent on local management (Hernández *et al.* 1995), whereas in others, this may not be the case (Bjorndal *et al.* 1993). New insights may be provided through: the examination of mitochondrial DNA (Broderick *et al.* 1994; Espinosa *et al.* 1994, 1996; Bass *et al.* 1996; Bowen *et al.* 1996; Koike 1995a; Koike *et al.* 1996); the recovery of tags (Parmenter 1983; Marcovaldi and Filippini 1991; Bjorndal *et al.* 1993; Moncada 1994a, 1996a, 1996b; Hillis 1995); and, the use of tracking transmitters (Starbird 1992; Groshens 1993; Groshens and Vaughan 1994; Balazs *et al.* 1996).

3.1.2. Cuba

Eretmochelys imbricata and other species of sea turtle (Annex 1) occur throughout Cuban territorial waters (Fig. 2), and there is no evidence indicating that their historical range has contracted. Natural history and population dynamic parameters for *E. imbricata* in Cuba are summarised on Table 1.

Eretmochelys imbricata are most abundant in shallow, interior, reef waters (Fig. 2), where they feed primarily on sponges (Anderes 1994, 1996; Anderes and Uchida 1994). The status of feeding and nesting habitats in Cuba is particularly good, with limited development (Annex 2) and a variety of legislation (with effective enforcement mechanisms) now protecting marine and shoreline habitats (Annex 3). Significant *E. imbricata* nesting occurs in the Doce Leguas area, which is sheltered from strong currents (>25 cm/sec see Annex 2), and has higher water temperatures (<30°C see Annex 2) than are found elsewhere in Cuba. However, *E. imbricata* in Cuba nest throughout the year (Annex 6), and at various locations around the island (Annex 6).

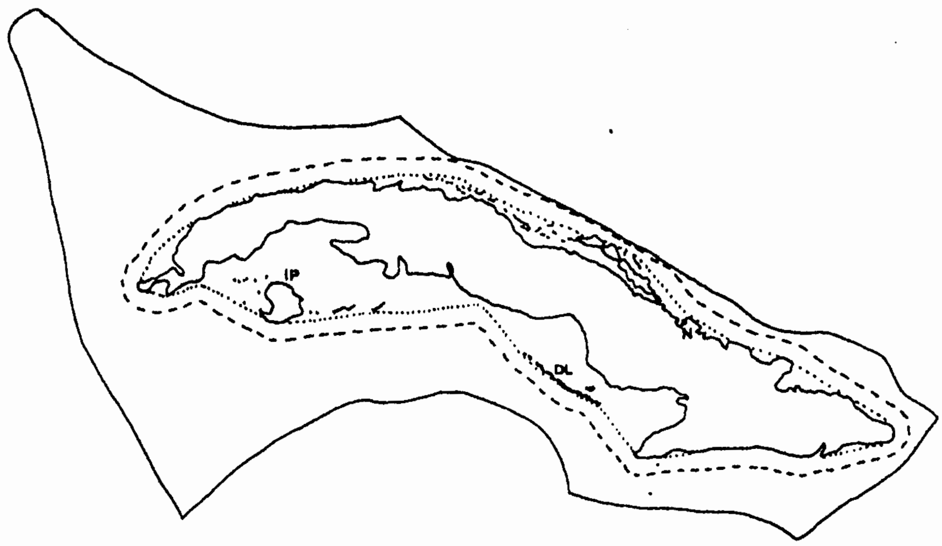

Figure 2. Cuba and its interior waters (dotted line), territorial waters (dashed line) and economic zone (solid line). Many areas within the interior waters zone are shallow and contain coral reefs. DL = Doce Leguas; IP = Isle of Pines; N = Nuevitas). Scale: 1mm = 10 km.

Table 1. Summary of natural history traits and mean population dynamic parameters measured, estimated or assumed for Cuban *E. imbricata*.

Parameter/Trait		Reference
Feeding	Mainly sponges	Section 3.1.2
Maturity (females)		
Minimum size	53 cm SCL	Annex 6
Minimum age	8 years	Annex 7
Average size (50% mature)	80-81 cm SCL	Annex 6
Minimum age (50% mature)	12 years	Annex 7
Mean age (50% mature)	15 years	Annex 7
Population Sex Ratio (proportion female)	0.77	Annex 5
Reproductive Rates		
Time of Nesting	All year	Annex 6
Peak of Nesting (Southeast)	December	Annex 6
Peak of Nesting (Northwest)	September	Annex 6
Mean Clutch Size (Southeast)	136 eggs	Annex 6
Mean Clutch Size (Northwest)	132 eggs	Annex 6
Clutches/season	2.36	Annex 7
Nesting interval	2.42 years	Annex 6
Annual Survival Rates		
Eggs to hatching	0.69	Annex 6
Hatchlings to 1-year-old	0.04 to 0.11	Annex 7
After 1 year of age	0.95 to 0.90	Annex 7

As elsewhere (Witzell 1983), *E. imbricata* nesting in Cuba occurs at both colonial and solitary nest sites, but does not involve mass highly synchronised nesting at any site. They usually nest on narrow beaches with a ridge of vegetation extending back from the beachfront, typically positioning their nests under vegetation (Pérez 1994). The main *E. imbricata* nesting area that has been studied (Doce Leguas; Fig. 2) is in a near virgin condition, with no development (Annex 2). Human activities carried out there are limited and have not caused any significant impacts or changes in the physical environment.

Evidence from a variety of sources (Annex 8) is consistent with *E. imbricata* having a high degree of site fidelity relative to other highly migratory species of sea turtles (Moncada 1994a, 1996a, 1996b). For example, of 607 *E. imbricata* so far tagged in Cuban waters, there have been 46 recoveries, and all (100%) were from Cuban waters. In contrast, of 432 *Chelonia mydas* tagged in Cuban waters, there have been 28 recoveries, and 14 (50%) of these were from outside Cuban waters. Foreign tag recoveries in Cuba are consistent with these trends. Of all the *E. imbricata* marked in the Caribbean region, only 2 tagged specimens (both from Mexico) have been recovered in Cuban waters (see Annex 8).

As with most marine vertebrates, including fish and marine crocodilians, precise rates of immigration and emigration for *E, imbricata* are impossible to quantify with known technology. A variety of techniques have been used to shed more light on movement patterns (eg. Broderick *et al.* 1994; Groshens 1993; Groshens and Vaughan 1994; Espinosa *et al.* 1994, 1996; Koike 1995a; Koike *et al.* 1996; Bass *et al.* 1996; Bowen *et al.* 1996), but they are seldom conclusive. In Cuba, a considerable research effort has and will continue to be directed at this problem, through tagging, DNA assessments, shell chemistry and satellite tracking (see Annex 8), so that a more precise understanding will develop over time.

3.2. Habitat Availability and Status

Cuba's extensive marine and coastal habitats (Annex 2) provide a secure environment for *E. imbricata*. Actions over the last 30 years (Annex 3) have further improved the security of marine environments in general. There has been: strict management of commercial fishing activities (Annex 3); prohibition on habitat-destructive fishing methods such as explosives and poisons; restrictions on the consumptive or destructive use of corals (for example in building activities); and, increasingly strict controls on pollution, soil erosion and adverse coastal development implemented by the National Fishery Inspection Bureau and other environmental inspection bodies (Annex 3). Some 84% of mainland coastline, and over 95% of keys remain undeveloped (Annex 2). At present major coastal development is subject to environmental impact assessment under a series of Acts and Resolutions (see Section 5.1.1) in force to minimise environmental impacts generally and protect biodiversity (see also Annex 3).

3.3. Population Data

3.3.1. General

In assessing the significance of *E. imbricata* population estimates to the reduced utilisation continuing in Cuba, it is important to recognise:

a. Cuba is not attempting to achieve a *maximum sustainable yield* (MSY) of *E. imbricata*. It is undertaking a conservative *sustainable harvest* well below MSY.

b. The current traditional harvest represents 10% of the harvest levels prior to 1990, and avoids nesting areas.

c. Improved monitoring programs are now in place to assess population trends more precisely, and the results will be made available to the CITES Secretariat annually.

3.3.2. Population Size

The most conservative estimate of the size of the wild population is 100,000+ non-hatchlings. This was derived from the size structure of animals taken in the historical harvest, assuming annual survival rate was 0.95 and errors involved in converting size to age from growth rings (see Annex 7) were within 3 years. That is, it does not account for animals that never enter the harvest and nor does it account for increases in the population since 1990, when the extent of the harvest was phased down. As shown on Table 2, total population estimates increase to 230,000 if annual survival is 0.90 (rather than 0.95) and the errors in the aging method are <5 years (rather than <3 years). The maximum age of *E. imbricata* in the population at that time was around 20 years (hatched in 1970).

Table 2. Minimum estimates for the size of the Cuban *E. imbricata* population derived from harvest data (1988 to 1990), assuming different rates of survival and errors in converting size to age (see Annex 7 for details).

Maximum aging error	<3y	<3y	<5y	<5y
Annual survival rate (1-20 y)	0.95	0.90	0.95	0.90
Non-hatchling population	102,521	161,024	134,298	233,374
Percentage mature adults	3.5%	2.6%	2.6%	1.7%
Percentage mature females	2.7%	2.0%	2.0%	1.3%
Nesting females per year	1,106	1,260	1,061	1,204
Hatchlings per year	243,062	276,913	233,320	264,621

The smallest individuals known to carry oviducal eggs (53 cm SCL: Annex 6) are about 8 years of age, with some 50% of females reaching maturity (78-80 cm SCL) by about 15 years of age. The reproductive capacity of the population is estimated at 300,000 to 400,000 eggs annually, producing some 250,000 hatchlings (Table 2; see Annex 7).

3.3.3. Population Status and Trends

"Status" is interpreted as a relative term relating aspects of the current population [eg distribution, abundance (density), size structure, age structure, sex ratio] to the situation that existed at some unspecified time, usually in the past. "Trends" on the other hand is interpreted to mean current rates of change in the same parameters.

a. Distribution

In Cuba *E. imbricata* occupy their complete historical range, and nesting occurs in the same, known, historical nesting sites (Annex 6).

b. Abundance

That the *numerical* abundance (density) of *E. imbricata* remained relatively constant during the period of historical harvest (which was much greater than the current harvest), is suggested by:

i. Harvest levels were maintained without any significant increase in fishing effort (Table 3; see Annex 4) until the fishery started to be phased down in 1990. This phase down was the result of a fisheries rationalisation program, where the fishing effort devoted to sea turtles was diverted to primarily export fisheries.

Table 3. Total annual catch of *E. imbricata* (in tonnes live weight) and catch per unit boat, between 1979 and 1990, when the harvest started to be phased down, and since 1990 (see Annex 4 for details). "*" = for 1994 and 1995, only data from the traditional harvest sites are available for the 12 month period, and in neither case were boats fully utilised.

Year	Total Catch (t)	Catch (t) per Boat
1979	202.9	2.21
1980	263.1	2.92
1981	253.1	2.98
1982	285.2	3.91
1983	263.3	3.61
1984	253.0	3.42
1985	321.6	4.80
1986	241.5	3.66
1987	277.4	4.55
1988	247.3	4.19
1989	244.9	4.15
1990	229.0	4.58
1991	175.0	3.80
1992	192.8	5.21
1993	117.0	3.66
1994	17.6	*2.20
1995	18.9	*2.36

ii. Turtle fishermen with up to 50 years experience (1945-95) indicate that the catch per unit effort for *E. imbricata* has remained similar (Annex 5).

iii. Data are available for the numbers of *E. imbricata* caught at the first of the two remaining traditional harvest areas (Isle of Pines), where similar methods and effort have been expended, largely by the same people. The results indicate no significant change in the numbers of *E. imbricata* caught each year, over the period 1983 to 1995 [mean = 34.2 ± 3.90 (SD); see Annex 5].

iv. Data are also available for the numbers of *E. imbricata* caught at the other remaining traditional harvest area (Nuevitas). For the years 1980 to 1993, the same harvest sites were included (the number of sites was reduced in 1994), and there was no significant change in the numbers of *E. imbricata* caught per year [mean = 299.0 ± 49.37 (SD); see Annex 5].

c. Size Structure

The historical harvest was increased significantly in the early 1980's. Monitoring data from the 1980's were based on four Zones (A-D) around Cuba (Annex 2). They indicate the increased harvest caused a reduction in the mean size of individual caught in most parts of Cuba (Annex 5), after which the size structure stabilised in some Zones and continued to decline in others. The decline was most apparent in Zone A (now fully protected), and least apparent in Zone D (which includes one of the two remaining traditional harvest areas). In interpreting these trends it is noted that:

i. On the basis of the annual probability of escaping capture in long-lived, slow-growing reptiles, it is to be expected that older, larger animals should gradually be removed from any population subject to annual harvest.

ii. If sustainability was reached in the 1980's harvest, it involved a different population structure than existed prior to the 1980's.

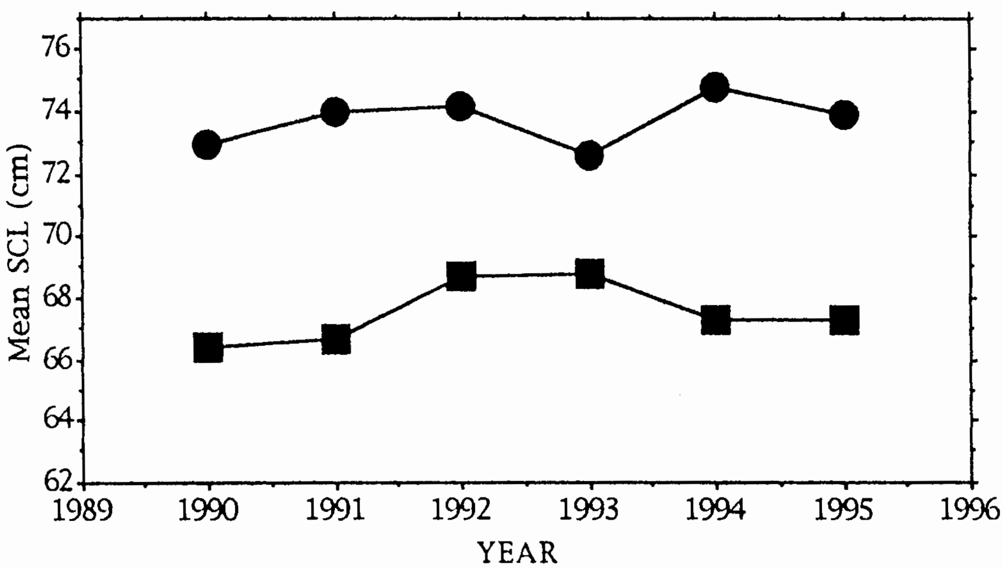

Figure 3. Mean size (SCL) of *E. imbricata* caught in the traditional fishery at the Isle of Pines (squares) and Nuevitas (Circles) between 1990 and 1995.

iii. *Eretmochelys imbricata* is now protected in 99% of Cuban waters.

iv. The stability of mean clutch size in Zone A over the last eight years [mean = 135.3 ± 2.4 (SD); see Annex 6] is consistent with mean adult female size being stable.

v. Within the traditional harvest areas, the mean size of *E. imbricata* caught over the last 6 years has remained stable or is increasing (Figure 3; see Annex 5).

d. Sex Ratio

In the two Zones for which sufficient sample data are available (Zones A and D), the sex ratio of the harvested population has varied from year to year, but shown no significant increase or decrease over time: 1984-1993 and 1989-1995 respectively (Table 4; see Annex 5).

Table 4. The proportion of female *E. imbricata* harvested from Zone A and Zone D over the period 1985 to 1995 (see Annex 5). Animals were sexed by direct examination of the gonads and reproductive tracts.

Zone	Mean	SD	Range	N
A	0.88	0.052	0.76-0.92	8
D	0.84	0.040	0.80-0.90	5

3.3.4. Captive Population

Details of the captive population of *E. imbricata* in Cuba are summarised in Table 5.

Table 5. Numbers of *E. imbricata* maintained in captivity in Cuba, at 30 June 1996.

Age Class (years)	Isle of Pines	Displays	Total
1<2	41	0	41
2<3	45	0	45
3<4	57	0	57
4<5	9	0	9
>5	0	13	13
Totals	152	13	165

3.4. Role in the Ecosystem

There is no evidence suggesting a reduction in *E. imbricata* numbers would have a significant adverse effect on other species. The main food of *E. imbricata* in Cuba is sponges (Anderes 1994, 1996; Anderes and Uchida 1994), and the impact of *E. imbricata* feeding on them is unknown.

Predators of wild non-hatchling *E. imbricata* appear to be large fish and sharks (Witzell 1983). Hatchlings are probably eaten by a variety of predators including birds, crabs and fish (Witzell 1983). On the southern shore of the Isle of Pines some predation of eggs by wild pigs has been recorded. However, the extensive predation on *E. imbricata* eggs attributed to racoons in Belize (Smith 1992), does not appear to have a parallel in Cuba. It is considered unlikely that any predator populations would be adversely affected by a reduction of *E. imbricata* numbers, as none are known to rely solely on *E. imbricata* for food.

3.5. Threats

In the longer-term, the Cuban population of *E. imbricata* could be threatened by uncontrolled exploitation and/or coastal development of beachfront nesting areas, but under current legislation and development planning, neither are significant threats. Placing a value on eggs and turtles harvested sustainably from particular habitats can only help to maintain strong incentives for habitat conservation. Illegal subsistance use by coastal people occurs from time to time, but at low levels. It seldom involves eggs, which are laid mainly on uninhabited keys. Since 1961 the taking of eggs and turtles by private persons has been prohibited (see Section 5.1.1 and Annex 3), and the laws are actively enforced: they involve heavy fines and penalties (see Section 4.7.2) which remain an effective deterrent. The management programs proposed here provide ample safeguards to ensure that future harvesting will be sustainable.

During surveys of incidental catch associated with shrimp trawling operations in Cuba, no *E. imbricata* have been recorded, although some are probably caught from time to time: it does not constitute a significant threat. *Eretmochelys imbricata* are caught occasionally in trawl nets in other countries [eg. Australia (Heppell *et al.* 1996)].

Because *E. imbricata* in Cuban inshore waters are both widespread and abundant, incidental catch has always occured in commercial inshore fisheries that use fixed nets. It is estimated to involve 100-200 individuals of varying sizes per year. Under Decree Law 164 (1996), fishermen are now not allowed to sell the meat or shell of marine turtles, and this Law is enforced by inspectors of the National Bureau for Fisheries Inspections. Actions taken to contain and minimise incidental catch are described in Section 4.3.

4. Utilisation and Trade

4.1. General

The history of exploitation of *E. imbricata* in Cuba is detailed in Annexes 3, 4 and 5. The extent of the harvest from before and after the phase down in 1990 (see Section 3.3.3.b.i above) is depicted in Fig. 4. This phase down occurred as part of an economic rationalisation of fishing priorities, despite the species being abundant and catch per unit effort remaining constant (Table 3). In 1994-95, all waters were permanently closed to harvesting, with the exception of the two remaining traditional harvest sites, where catch effort is restricted (Table 6): the current traditional harvest is about 10% (400 to 500 animals per year) of the harvest prior to 1990. It is carried out using traditional, hand-made turtle netsand targets animals >65 cm SCL.

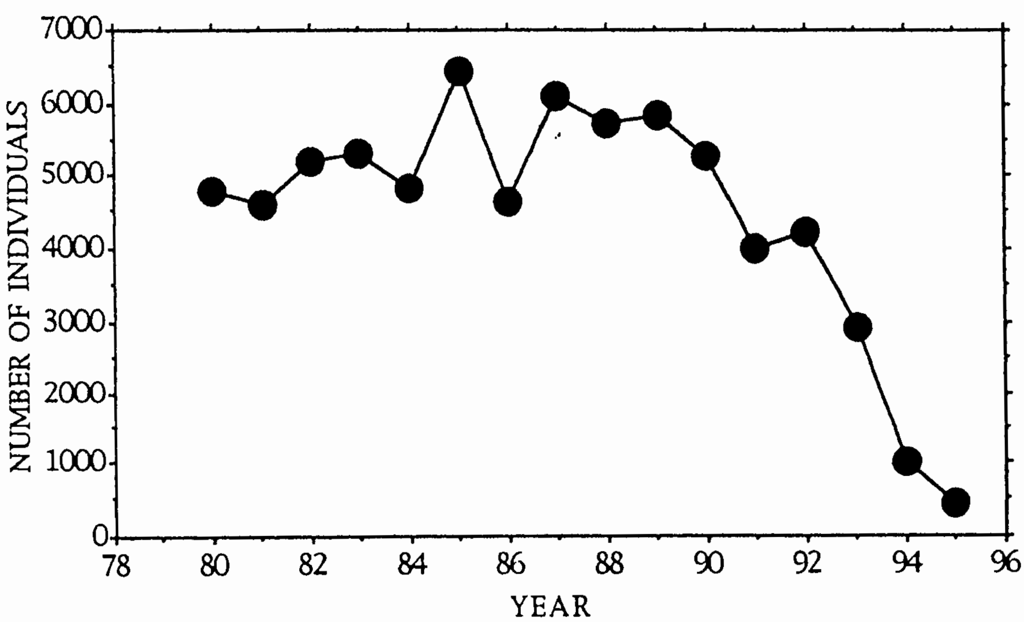

Figure 4. The extent of the reduction in the *E. imbricata* harvest brought about by the deliberate phasing down of the effort allocated to the fishery (see Annex 4).

Table 6. Current catch effort in the two remaining traditional harvest sites.

Traditional Harvest Area	No. of boats	Number and length of nets
Nuevitas	4	400 m long; 1 net per boat.
Isle of Pines	4	60-80 m long; <15 nets per boat.

The turtles are transported to processing facilities for the preparation of meat and shell, and data recording (Annex 9). Shell emanating from the traditional wild harvest is specifically identified on the CITES labels (Section 8.2; Annex 9).

Shell produced for each individual turtle is recorded and stockpiled, and all such stocks will be registered with the CITES Secretariat annually. Cuba intends to export current stocks (1993-96), in one shipment, under the direction of the CITES Secretariat, using the protocol outlined in Section 4.4 Over the next three years, shell produced from the traditional harvest and experimental ranching program will also be exported in one shipment per year, using the protocol outlined in Section 4.4. All *E. imbricata* meat and byproducts produced in Cuba will continue to be used for domestic consumption.

The numbers of eggs and hatchlings collected to date for the experimental ranching program (Table 7) represents the egg production of one female per year, and are biologically insignificant. Any shell produced from the ranching program will be identified as having come from "ranching" on the CITES labels (see Section 8.2 and Annex 10), but will otherwise be treated identically to the shell from the traditional wild harvest.

Table 7. Numbers of *E. imbricata* hatchlings collected from wild nests for the experimental ranching program.

Year	Location	Number
1991	Doce Leguas	218
1992	Doce Leguas	270
1993	Doce Leguas	328
1994	Doce Leguas	216
1995	Doce Leguas	0
Total		1032

On the basis of current research on controlled-environment raising (Annex 10), the experimental ranching program will be expanded in terms of both capacity and technology, over the next three years. To test the quality of the shell and ensure its acceptability in the market place, limited exports will be required. Depending on research results, the hatchling harvest may be switched to an egg harvest. It is anticipated that the extent of the harvest will increase steadily over the next three years, but the rate of increase will be dictated by research. It will not exceed 6000 hatchlings or their equivalent in viable eggs (8,700 eggs; see Annex 10). Egg equivalents are based on the mean survival rate of eggs in the wild (0.69; see Table 1 and Annex 6). Exports from the experimental ranching program over the next three years will be limited:

50 in year 1; 100 in year 2 and 300 in year three. There is currently no captive breeding of *E. imbricata* in Cuba.

4.2. Domestic Trade

A small domestic artesan industry has always existed within Cuba. When shell was being regularly exported, the industry used shell from the stores for which no export market existed (due to colour and grade). With the inability to export any *E. imbricata* shell (since 1992), domestic use increased, and some shell has been provided to the Ministry of Light Industries for this purpose. No CITES Export Permits are or will be issued for any products other than raw shell from the stockpile (see Section 4.4).

4.3. Incidental Catch.

The following initiatives have been started or are proposed by the Ministry of Fisheries.

4.3.1. Review.

A review of incidental catch in all fisheries operations has been initiated, with the goal of developing a more accurate understanding of the extent and size structure of the catch, and the circumstances under which *E. imbricata* are caught. In some cases (eg the stingray fishery) the feasibility of converting the fishery from a net to a line fishery is under investigation.

4.3.2. MIP Resolution

Depending on the results of the review, consideration is being given to an MIP Resolution to formalise actions, some of which occur now, namely:

i. Turtles caught alive in commercial fishing nets must be released.

ii. Turtles drowned in commercial fishing nets may be used for food but cannot be purchased or sold.

iii. The shell derived from such incidental catch to be submitted without payment to Fisheries enterprises (regional commercial entities operated by the State).

iv. The shell to be duly recorded and accumulated for research assessment, and ultimate release by Government to the low-value domestic market.

4.3.3. Trade Restrictions

Shell derived from incidental catch will not be available for export. It is readily identifiable from shell derived from the traditional harvest and ranching program, because it is not individually packed nor accompanied by individual numbered data sheets. These are needed to process the shell for export (see Section 8.2 and Annex 9).

4.3.4. Disincentives

Over the next three years shell derived from incidental catch will be released for the domestic market where its value is much reduced, and does not establish a commercial incentive to harvest. Any remaining shell will be stockpiled, and if necessary, an appropriate method of dealing with it will be derived in consultation with the CITES Secretariat.

4.4. Stockpile

4.4.1. Extent of Stockpile

Since December 1992, none of the *E. imbricata* shell produced through the wild harvest or experimental ranching program has been exported. Some has been used domestically and some for research, but the majority has been stockpiled after grading, pending the acceptance of a protocol for legal trade by the Parties to CITES.

Table 8. Details of *E. imbricata* shell stockpiled in Cuba.

Held at	As of	Stock (kg)
Cojimar	9 January 1996	5298.6
Isle of Pines	9 January 1996	99.0
Nuevitas	9 January 1996	43.0
Total		5440.6

4.4.2. Management of Stockpile

The main stockpile of *E. imbricata* shell in Cuba is in a secure store in Habana (Cojimar) (Table 8), controlled and managed by the Ministry of Fisheries. All shell into and out of the store is subject to inventory. Shell is accumulated at Fisheries Enterprises prior to shipment to Cojimar. The current stockpile contains accumulated shell already sorted and graded. Only recent shell is identifiable to individual animals.

The shell is packed in sealed plastic bags, each of which contains a uniquely numbered CITES label as described in Section 8.2 (see also Annex 9). The origin of all shell is specified as: "STOCKPILE" on the CITES labels, which meet the requirements of Resolution Conf. 5.16. The label contains information on the number, weight, and type of shell plate (Section 8.2). The individual pieces of shell in each bag have been photographed with a digital camera, along with the identification number of the CITES label for the bag. The digitised images are transferred to computer disc, and these can be used to confirm precisely the identification of plates within a particular bag at any time.

Under the new management program, the shell from all individual *E. imbricata* (identified by a field identification number) is packed, sealed and labelled at Cojimar, under the supervision of the CITES Management Authority (Section 8.2.6).

4.4.3. Disposal of Current Stockpile

Cuba will export the current stockpile (Table 8) in one shipment to a Japanese consortium of private companies, who must comply with the strict Japanese control requirements (Annex 11).

4.4.4. Management in the Importing Country

Within Japan, The *Foreign Exchange and Foreign Trade Control Law* is the law governing export and import in compliance with CITES. A Cabinet Order issued under this law currently prohibits the export and import of *E. imbricata* shell with the exception of preconvention stocks. Should the Parties to CITES agree to the Cuban proposal, the import restrictions (but not the export restrictions) would be altered to allow the importation.

Domestic management of *E. imbricata* shell is subject to strict new amendments to the *Law for the Conservation of Endangered Species of Wild Fauna and Flora*, which came into force on 28 June 1995 (Annex 11). The CITES Management Authority of Japan will be fully briefed on the packaging and labelling system in use by Cuba, and will be provided with the computerised security images (Section 4.4.2), which will allow spot checks to ensure compliance with their management procedures.

4.5. Legal International Trade

International trade in *E. imbricata* from Cuba has been restricted to shell, and the trade has been primarily for commercial purposes (Annex 4). The current proposal is not expected to alter the nature of the trade in any way.

4.6. Illegal International Trade

Despite their reservation, in 1992 Cuban authorities apprehended an international visitor to Cuba in connection with a shipment of *E. imbricata* shell he was attempting to import into Cuba for transit purposes. The shipment was seized before it could be reexported and all details were reported to the CITES Secretariat (CITES Doc. 9.22. Review of alleged infractions and other problems of implementation of the Convention. Summary number 3.17). This is the only attempt to engage in commercial-scale illegal international trade detected by Cuba since joining CITES in 1990.

4.7. Potential Trade Threats

4.7.1. General

Harvesting and trade of *E. imbricata* in Cuba is and will continue to be strictly controlled by the Cuban Government: there are no private entrepreneurs involved. There will be no new trade impacts created, as the market is highly restricted and with Cuba's reservation lifted, all such trade will be between Parties to CITES and will comply with CITES requirements.

4.7.2. Stimulation of Illegal Trade

The notion that legal trade from Cuba will stimulate illegal trade from Cuba or other nations lacks supportive evidence and is rejected as a potential threat. This concern was originally raised with crocodilians, and proved unfounded. With crocodilians the creation of legal trade under CITES led to many countries adopting proactive conservation-management programs, and to major trading nations restricting intake of illegal products in favour of legal ones. The encouragement of legal trade in crocodilian products has resulted in illegal trade reaching the lowest levels ever known, and the same outcomes are to be expected for *E. imbricata*.

Trade from Cuba will not stimulate excessive harvesting within Cuban waters. Cuba's harvest was subject to responsible management before CITES came into being, and before Cuba became a Party to CITES. The traditional harvest of sea turtles in Cuba is undertaken primarily to provide a traditional food - it is a domestic rather that export-oriented harvest: the shell of *E. imbricata* is the only product exported. Existing laws have recently been strengthened by Decree Law 164 (1996), which imposes heavy penalties (fine = 400<5000 Cuban pesos) relative to monthly wages (203 pesos), for unlicensed taking of sea turtles and/or their eggs, in addition to confiscation of equipment and suspension of fishing licences if appropriate.

4.7.3. Benefits of Trade

The proposed listing on Appendix II will enhance the conservation of *E. imbricata* in many ways. These are detailed in Section 8.4, but of prime importance:

a. Export of the shell requires management of the whole *E. imbricata* resource to meet the stringent requirements of CITES. This will clearly not be the case if the use of *E. imbricata* shell is restricted to domestic use. Of the many regional countries which use *E. imbricata* (Groombridge and Luxmoore 1989), Cuba will be the only one whose use is subject to detailed international reporting.

b. The increased levels of monitoring, reporting and research associated with Cuba's current program are directly linked to trade. They will continue to provide new and definitive data on *E. imbricata* populations, which will assist in objectively determining the degree of threat posed by the various forms of domestic use occurring in many nations today (Groombridge and Luxmoore 1989).

c. The experimental ranching program generates new information on the captive raising of *E. imbricata* for conservation [should scientific evidence ever endorse restocking (Donnelly 1994)], cultural or commercial purposes.

4.8. Captive Breeding Outside Countries of Origin

No significant captive breeding of *E. imbricata*, for commercial purposes, is known to occur within or outside range states.

4.9. Future Plans

Cuba's current management goals with the traditional harvest are to consolidate the program and new monitoring procedures, which are now based on data from all individuals caught (not samples). There are no plans to expand the harvest, or the number of harvest sites.

With the experimental ranching program, Cuba intends to continue research into production efficiency. It will expand the program cautiously in accordance with the results obtained, which will be fully disclosed to the CITES Secretariat. Any such expansion will be in stages that are biologically and economically sustainable, and will provide conservation benefits to the species.

5. Conservation and Management

5.1. Legal Status

5.1.1. National

The history of development of legal controls in Cuba over *E. imbricata* management is summarised in Annex 3. Of particular significance:

a. Decree Law No. 704 (1936) called "General Law of Fisheries" establishes closed season for marine chelonians during reproductive period.

b. Decree No. 2724 (1956) establishes regulations dealing with the utilisation of marine resources.

c. Ministry of Fisheries Resolution 31-V (1960) establishes closed seasons for sea turtles: 15 June to 10 August.

d. Ministry of Fisheries Resolution 16-VI (1961) establishes permanent prohibition on taking and consuming sea turtle eggs and disturbing females at night.

e. Ministry of Fisheries Resolution 117 (1968) establishes State control on the accumulation and distribution of sea turtle products and byproducts.

f. Ministry of Fisheries Resolution 10 (1973) prohibits capture of sea turtles by private persons.

g. Article 27 of Cuban Constitution (1976) establishes policy for sustainable use of natural resources.

h. Ministry of Fisheries Resolution 34 (1976) authorises capture of sea turtles for research purposes.

i. Decree Law No. 1 (1977) establishes limits of Cuban territorial waters.

j. Decree Law No. 2 (1977) establishes limits of marine economic zone.

k. Ministry of Fisheries Resolution 317 (1977) prohibits the destruction of sea turtle nests.

l. Ministry of Fisheries Resolution 134 prohibits the capture of female sea turtles before nesting.

m. Act No. 33 (1981) establishes in detail Cuba's policy concerning the environment and rational use of natural resources.

n. Decree No. 103 (1982) regulates the taking of sea turtles by non-commercial interests, specifically restricting such use to State instrumentalities and requiring catching and keeping for research to be subject to permits issued by the Fisheries Regulation Directorate within the Ministry of Fisheries.

o. Ministry of Fisheries Resolution 298 (1994) permanently closes all seasons for taking marine turtles.

p. Ministry of Fisheries Resolutions 300 (1994) and 3 (1995) permits harvesting of turtles in the traditional harvesting sites at the Isle of Pines and Nuevitas.

q. Ministry of Science, Technology and Environment Resolution 168 (1995) establishes procedures for undertaking and approving environmental impact evaluations.

r. Ministry of Science, Technology and Environment Resolution 130 (1995) establishes regulations for appropriate inspections of environmental issues.

s. Decree Law 164 (1996) updates fisheries legislation, creates an advisory commission for fisheries, and further strengthens restrictions on the taking of *E. imbricata* and their eggs by unauthorised persons.

t. Ministry of Science, Technology and Environment Resolution 29 (1996) designates the Centre for Environmental Management of the Environmental Agency as the Management Authority for CITES.

u. Ministry of Science, Technology and Environment Resolution 87 (1996), establishes Regulations for compliance of Cuba's obligations under CITES.

v. Ministry of Science, Technology and Environment Resolution 111 (1996) establishes regulations about biological diversity.

w. Agreement 2994 (1996) of Executive Committee of the Cuban Council of Ministers creates the National Office for Fishing Inspections.

x. Ministry of Fisheries Resolution 562 (1996) declares Doce Leguas Keys, as a special use and protected area, which restricts commercial fishing operations in the area (makes it subject to consent) and prohibits sport-recreation fishing activities unless carried out under a special permit.

Cuba's legislation has proved effective in maintaining protected areas and in controlling and regulating the harvests. There is no significant illegal trade in *E. imbricata* within Cuba

5.1.2. International

a. Intergovernmental Organisations

According to the CITES Secretariat there are no intergovernmental organisations responsible for coordinating international utilisation of sea turtles.

Through CITES, illegal international trade in *E. imbricata* products has all but ceased. Cuba has complied with CITES in restructuring its management program and has sought and followed advice from the CITES Secretariat and Fauna Committee. It is significant that CITES Resolution Conf. 8.3 recognises the value of sustainable use programs.

From a conservation perspective CITES is limited, because its stringent requirements for sustainable management only become effective if there *is* international trade. It does not apply to the many nations that use sea turtles for traditional and/or domestic trade purposes (Groombridge and Luxmoore 1989).

b. International Instruments

Groombridge and Luxmoore (1989) provide a nation by nation review of *E. imbricata* status and management, which includes information on legal protection and its effectiveness.

Cuba is unaware of any evidence indicating large-scale international trade from producer countries. Locally-made products from *E. imbricata* shell can be purchased at markets in many developing countries (Groombridge and Luxmoore 1989), and through tourism, some of these products may cross international borders. The conservation significance of this trade is unclear, as it appears many coastal peoples, particularly in developing countries, use turtles for food when the opportunity presents itself: the same number of turtles may be used even if no trade in shell occurs.

Within the nations which have imported *E. imbricata* shell from Cuba in the past [Argentina, Austria, Bahamas, Belgium, Canada, France, Germany, Holland, Hong Kong, Italy, Jamaica, Japan, Switzerland, Great Britain, United States of America (Annex 4)], there has been a steady increase in the effectiveness of import restrictions. Since Japan lifted its reservation on *E. imbricata* in 1992, no imports of *E. imbricata* shell into Japan have been reported.

c. Regional Instruments

Of the 38 nations in the Cuban region reviewed by Groombridge and Luxmoore (1989), 36 were known to have had legislation aimed at regulating utilisation and trade in *E. imbricata*. New legislation had been passed during the 1970's and 1980's in 31 of those 36 countries, indicating a more active, regional consideration of *E. imbricata* conservation and sustainable use.

Utilisation of *E. imbricata* is common in the region, and by the late 1980's, occurred legally in 23 of the 38 nations, with varying degrees of control. Of the 36 nations with legislation, it provided for controls over use in 21, and blanket prohibition in 15. Of the nations which had blanket prohibition, various forms of subsistence use and domestic trade were common, particularly among coastal fishing communities.

d. Regional Meeting

In March (14-15th) 1996, Cuba hosted a regional meeting to discuss regional co-operation in the conservation and sustainable use of *E. imbricata* (see summary in Annex 12). The meeting was attended by representatives from: Colombia, Cuba, Dominica, Cayman Islands, Guatemala, Honduras, Jamaica, Mexico, Nicaragua, Panama, St. Vincent and Venezuela. There were also observers from the CITES Secretariat, CITES Fauna Committee, OLDEPESCA, IUCN and IWMC. There was unanimous agreement that all nations had much to gain from regional co-operation and the objective assessment of how different national management programs were working. The main conclusions were:

i. Cuba's initiative with the regional meeting was welcomed and further meetings to discuss management would be of great benefit.

ii. Research in the region on sea turtle biology and conservation threats were constrained by lack of resources.

iii. The Cuban *E. imbricata* program had particular significance and value in the region, as use and trade at the local community level was widespread and linked directly to the survival and well-being of many coastal peoples.

iv. The status of some sea turtle species in the region made it highly unlikely that they met the criteria for Appendix I of CITES, and in such cases transfer to Appendix II should be sought.

v. There was no single philosophy or approach to management that could or should be applied universally to sea turtles in the region. In contrast, there was much to gain by different nations experimenting with different combinations of protection and use, and sharing the results in a true spirit of regional co-operation.

It was noted that current attempts to draft a Convention on sea turtles in the region were inconsistent with CITES, and were equally inconsistent with international directions about conservation and sustainable use from the IUCN and the Convention on Biological Diversity.

e. International Forums

In co-operation with Japan, a series of international workshops were held (1992, 1994 and 1995) at which sea turtle biologists discussed freely and openly Cuba's management goals and program for *E. imbricata*. Recommendation from these meetings have been followed.

5.2. Species Management

Groombridge and Luxmoore (1989) summarise information on the management of *E. imbricata* throughout their global distribution.

5.2.1. Population Monitoring

a. General

In most nations where *E. imbricata* are utilised, for subsistence or domestic trade purposes, control mechanisms at best rely on closed seasons or the restriction of harvesting to limited groups of people (Groombridge and Luxmoore 1989). There appears to be no regular collection or assessment of harvest data, and as a consequence, there are no direct indices of the status of the population/s involved, nor reliable measures of the sustainability of harvests.

Some studies of *E. imbricata* nesting (eg. Hoyle and Richardson 1993) provide excellent indices of the population of nesting females over time, and allow some estimates of mortality rate to be derived. However, the logistics and costs of such studies limit their widespread application, and none appear to be carried out in populations subject to harvesting. For the purposes of sustaining use, they are clearly limited to a particular segment of the population (nesting females), at one brief window in time (when they are laying eggs).

Within specific study areas (eg. Limpus 1992), *E. imbricata* population estimates have been derived through mark-recapture results, and some minimum population densities have been measured by surveys. However, there remains no precise or accurate method of independently surveying *E. imbricata* populations subject to use. As with most marine resources, assessment of harvest data remains the most cost-effective and accurate method of monitoring populations.

b. Cuba

Under the management proposed, monitoring is intimately linked to the harvest programs. Detailed information on all animals captured (rather than on samples) is now collected at the harvest sites (Annex 9), and this includes: carapace length, carapace width, body weight, sex, reproductive status, and shell production.

i. Traditional Wild Harvest

The prime management questions are: whether the wild population is increasing, decreasing or stable; whether the reproductively mature segment of the population is increasing decreasing or stable; and, whether the mean age of animals caught is increasing, decreasing or stable. In the two traditional harvest areas, catch effort is maintained reasonably constant through restrictions on boats numbers and net lengths (see Table 6 in Section 4.1). The harvest data thus provide an annual index of the abundance, size structure, sex structure and age structure of *E. imbricata* in two well-separated sites.

ii. Ranching

Monitoring of nesting in the Doce Leguas area is linked to the collection of hatchlings/eggs for the ranching program. As the program develops, it will involve collections at the same time and locations each year. Clutch sizes and the sizes of females encountered during the collections will provide secondary indices. It is neither logistically nor economically feasible to maintain an intense annual nest beach study [eg. Hoyle and Richardson (1993)] in the remote Doce Leguas region, unless sound economic incentives through the ranching program are in place.

5.2.2. Habitat Conservation

a. General

Eretmochelys imbricata has a global range encompassing over 150 million square kilometres of marine environment (Fig. 1):

i. Marine habitats are unlikely to be limiting at a species level, although local populations in some countries may be affected by habitat degradation.

ii. Over the last 25 years many nations have implemented legislation aimed at protecting *E. imbricata* eggs, nests and nesting beaches (Groombridge and Luxmoore 1989).

iii. There is increased international awareness (IUCN 1995) of the need to integrate beachfront development with responsible management of sea turtle nesting, although it remains a widespread problem.

iv. At an international level large tracts of *E. imbricata* marine habitat now lie within marine protected areas (eg. Great Barrier Reef Marine Park in Australia).

b. Cuba

Within Cuba, marine and coastal habitats are in generally good condition (see Section 3.1.2 and Annex 2). Harvest methods have no known detrimental impact on the habitats, and harvest areas have now been restricted to an area of some 2 km^2; less than 0.005% of the 44,076 km^2 of shallow (<20 m deep) territorial waters (Annexes 2 and 9), through which animals move. The Doce Leguas nesting area is remote and in a near virgin condition, and no known significant *E. imbricata* nesting areas have been developed for tourism or other purposes. Nesting areas located in Zones B and C (Annex 6) are also remote and largely free of development threats (Annex 2).

5.2.3. Management Measures

The levels of management applied to *E. imbricata* within range states varies greatly (Groombridge and Luxmoore 1989). In most cases, there has been a history of traditional subsistence use, and domestic and international commercial use, typically with minimal controls, at some time in the past. Most legislative protection aims to control or restrict commercial use (domestic and/or international).

Subsistence use of eggs and meat remains common amongst coastal indigenous and coastal fishing people in developing countries. There is a minor domestic trade in shell products in many countries (Groombridge and Luxmoore 1989).

Management in Cuba varies from that in most other countries in that:

a. The wild harvest is strictly controlled and a legislative institutional framework exists for implementing corrective actions should they be necessary.

b. Cuba's use of *E. imbricata* is part of a management regime committed to the conservation and sustainable use of the species.

c. Data collection and monitoring are integral parts of the management regime.

d. The harvest is carried out on behalf of the State.

e. The program is associated with a considerable research effort.

f. Ranching remains experimental, and the expansion of the program will be based on research results.

5.3. Control Measures

5.3.1. International Trade

International trade in *E. imbricata* products from Cuba is capable of being strictly controlled, because of a unique set of circumstances:

a. Cuba is an island nation without common borders with other countries.

b. Under CITES, there are no countries that could serve as a viable market for shell exported illegally.

c. The only existing viable market is Japan, which has stringent import regulations and enforcement capability.

d. The Cuban traditional harvest is controlled by Government, and the shell is owned by Government.

e. The marking system for shell (Section 8.2) is highly secure.

f. There are no avenues through which *E. imbricata* shell produced elsewhere can enter Cuba and be exported as a Cuban product, with CITES certification.

g. The only CITES Export Permits issued for *E. imbricata* shell will be those pertaining to the current shell stockpile, and the annual shipment of shell from the traditional harvest and experimental ranching program.

5.3.2. Domestic Measures

Various forms of utilisation of *E. imbricata* are permitted in different nations for research, traditional, subsistence and commercial purposes. Accordingly, the domestic controls [decribed by Groombridge and Luxmoore (1989)] vary greatly between nations. Education programs appear to have increased generally in the last 25 years due to the actions of both Non-Government Organisations and responsible Governments (IUCN 1995).

Within Cuba, domestic controls (Section 5.1.1) on the use of *E. imbricata* have been in place for many years:

a. Fishing enterprises are subject to systematic control by inspectors from the National Bureau for Fisheries Inspections.

b. New legislation in force (Section 5.1.1; Annex 3), particularly Decree Law No 164 (1996), further strengthen the control kept by Government on domestic trade.

6. Similar Species

The shell plates of *E. imbricata* are unlike those of any other species, and can be distinguished on the basis of shape, thickness and colour.

The marking system (Section 8.2) for Cuban *E. imbricata* shell plates adds additional security. It allows identification to an individual turtle, and each plate with its unique colour pattern is individually photographed. Chemical analyses of shell material provide a further tier of security. The trace element concentrations reflect the environment in which the animal lives and the food it eats, which allows *E. imbricata* living in different areas to be differentiated (Annex 8).

There is no evidence indicating that trade from Cuba will stimulate illegal utilisation within Cuba or elsewhere (see Section 4.6.2). In fact it may actively encourage more effective management in other nations. At the regional meeting (see Section 5.1.2.d) neighbouring countries were keen to learn about Cuba's management program and access the research results, so that they could be used to improve the effectiveness of conservation and management efforts elsewhere.

Cuba will co-operate fully with any nation that considers that their populations of *E. imbricata* are placed at risk through international trade in *E. imbricata* shell from Cuba.

7. Other Comments

In preparing this proposal, Cuba has consulted continually with a wide range of regional representatives and technical experts. At the regional meeting hosted in Cuba (14-15 March, 1996), the scientific basis for Cuba's management program, and the philosophy upon which it is based (adaptive management and sustainable use), was presented and discussed openly (see Section 5.1.2d; details in Annex 12). Technical concerns expressed at that meeting have been taken into account when preparing the proposal.

Similarly, Cuba has attempted to comply with the technical advice received from a series of technical sea turtle meetings (see Section 5.1.2e), and the consultative meetings that led to the final text of Resolution Conf. 9.20 (see Section 8.10.6; Annex 13). An advanced draft of the proposal was reviewed by 23 international scientists, experienced with sea turtle biology, wildlife and fisheries management, and/or sustainable use (December 1996). This group included members of the IUCN Marine Turtle Specialist Group and the IUCN Sustainable Use Specialist Group. The advice received from these experts was incorporated into the proposal and annexes, but it did mean that the annexes were being edited up until the submission date.

Aware that the proposal would not be complete until just before the submission date, a summary of the proposal was sent by fax to the CITES Management Authorities or other appropriate or related regulatory authorities, for regional range states. It was successfully transmitted to the following nations: Antigua, Aruba, Bahamas, Barbados, Belize, Bermuda, Cayman Islands, Colombia, Costa Rica, Dominica, France, Great Britain, Guatemala, Guyana, Honduras, Jamaica, Mexico, Netherlands, Nicaragua, Panama, Dominican Republic, St. Vincent, Suriname, Trinidad and Tobago, Turks and Caicos, United States of America, and Venezuela.

In the accompanying letter, Cuba requested that information on concerns be returned by fax, as expediently as possible, so they could be addressed before the submission date (if they had not already been dealt with). The offer was also made to send a complete copy of the proposal and Annexes, by international courier, if required before submission date. For nations from which no response was forthcoming, attempts were made to contact the relevant authorities by telephone, to determine whether the summary had been received and whether there were any significant concerns.

By the time of submission, six formal, written responses were received from regional range states. Most of them had analysed the summary and offered criticisms and constructive ideas. Of the concerns raised, all been addressed to varying degrees within the proposal and annexes.

In one case, Cuba was urged to ensure that the studies of *E. imbricata* movement were continued over the next three years while the program was operating (see Annex 8). In another, it was assumed that the speculation of Bowen *et al.* (1996), about extensive mixing of *E. imbricata* within the Caribbean Region, was established fact [which is not the case (Annex 8)], and concerns were expressed that the Cuban harvest would impact significantly on the population within the jurisdiction of other range states.

One nation provided "preliminary" comments pending receipt of the complete proposal and annexes, after which a detailed review will be undertaken by technical experts. The general concerns identified were:

1. The need to use genetic analyses to clarify the extent of isolation of the Cuban population (see Annex 8).

2. The need to be cautious about using a particular harvest assessment model (the model has never been used for management of the resource in Cuba; see Annex 7).

3. The need to improve life history parameters used for any harvest model (see Annex 7).

4. The possibility that Cuba's proposal would encourage other Parties to harvest and stockpile Appendix I populations of *E. imbricata* in anticipation of obtaining CITES permission to export at some later date (see Section 4.7.2).

5. The need to collect information on the size, age and sex structure of the harvested population (see Annex 7; Section 5.2.1.b.ii)

6. Concern that legal trade will stimulate illegal trade generally (see Section 4.7.2).

7. The need to clarify the role of experimental ranching and the extent to which Resolution Conf. 9.20 had been complied with (see Section 4.1, Annex 10 and Annex 13).

It is reassuring that all major concerns so far identified had been addressed within the proposal, although not necessarily to the satisfaction of those with the concerns. A final copy of the proposal and annexes, as submitted to the CITES Secretariat, will be sent by Cuba to all regional range states to facilitate more extensive review prior to the 10th COP.

Cuba will continue to solicit comment from its regional neighbours on the completed proposal, and will attempt to address any remaining concerns. If changes in management procedures are merited, then appropriate ammendements will be prepared for the 10th COP. A complete assessment of concerns raised by range states, on the complete proposal, will be prepared for the 10th COP.

8. Additional Remarks

Resolution Conf. 9.20 requires Parties submitting a proposal for ranching (Resolution Conf. 3.15) to provide a range of information over and above that specified in Resolution Conf. 3.15 or 9.24. Because the Cuban program involves the export of products derived from a traditional wild harvest, this proposal has been prepared under Resolution Conf. 9.24. However, ranching remains a key future priority, and so the additional information required for Resolution Conf. 9.20 is provided here. Overall compliance with Resolution Conf. 9.20 is summarised in Annex 13.

Resolution Conf. 9.24 also requires information not provided for in the suggested format of proposals (Annex 6 of Resolution Conf. 9.24). Accordingly, these additional data are provided here.

8.1. Precautionary Measures

As detailed throughout the proposal and specifically in Annex 13, the Cuban population of *E. imbricata* meets the criteria for Appendix II (Annex 2a and 2b of Resolution Conf. 9.24), and does not meet the "Biological Criteria for Appendix I" (Annex 1 of Resolution Conf. 9.24).

The "Precautionary Measures" (Annex 4 of Resolution Conf. 9.24) apply additional safeguards, and they are addressed in Annex 13. There are no obvious or compelling reasons why they should be applied here. Cuba has demonstrated unequivocally that it has a responsible management record, and that it has the capacity to detect and respond to any unforseen conservation needs that may arise from time to time (see Section 8.5).

8.2. Products and Marking System

Resolution Conf. 9.20 requires compliance with Resolution Conf. 5.16: the adoption of a uniform marking system, associated with appropriate security and record-keeping to assist Parties in identifying products in trade that are legally derived. The system adopted by Cuba meets those requirements.

8.2.1. Product of Operation [Resolution Conf. 5.16(a)]

Any piece of *E. imbricata* shell, including whole or broken parts, from the plastron or carapace (plates, marginals, hoof).

8.2.2. Product Unit [Resolution Conf. 5.16(b)]

A standardised, double heat-sealed, heavy duty, plastic bag containing shell of *E. imbricata* is the smallest single item that will be individually marked and enter international trade. It is the Product Unit. [The uniquely numbered, non-reusable label on the bag is the equivalent of a Tag]. That part of the stockpiled material not identifiable to individual animals (which was already graded and sorted; Section 4.4.2), is packed in the bags according to size and grade. Stockpile shell identifiable to individual animals is packed with all the shell of one individual in the one bag. Each bag may contain up to 4 kg of shell. All individual plates within a bag are photographed digitally and the images transferrred to computer files. Copies of the identification photographs will be made available to the CITES Secretariat or to the Management Authority of any importing nation on request.

8.2.3. Uniform Marking System [Resolution Conf. 5.16(c)]

Applies to a bag of shell, not an individual piece or broken piece of shell.

8.2.4. Primary Container [Resolution Conf. 5.16(d)]

Each product unit (bag) serves as its own primary container and as such both primary containers and product units conform with the uniform marking system [Resolution Conf. 5.16(e)].

8.2.5. Labels

The CITES labels affixed to each bag (Annex 9) are uniquely numbered, non-reusable, high security (cannot be duplicated by photographic means), are clearly identified to Cuba, contain individual field identity numbers, information on the origin of the shell within Cuba, date of production, the number of pieces and weight of shell in each bag, and photograph number. The labels are glued to the bag and cannot be removed without destroying them.

8.2.6. Supervision/CITES Permits

Packaging of the stockpile is carried out under supervision of the Cuban CITES Management Authority. All exports of shell will be subject to supervision and issuance of CITES export permits by the Management Authority.

8.2.7. Additional Safeguards

New information being gained on DNA haplotypes, Nitrogen and Carbon isotope concentrations, and trace element concentrations, in the shell of Cuban *E. imbricata* (Annex 8) provide additional safeguards against illegal trade.

8.3. Reporting

As detailed in Resolution Conf. 6.22, an annual report will be submitted to the CITES Secretariat that provides information on the status of the wild population, the number of specimens taken from the wild, the estimated percentage of the population, the number of individuals released, any information on survival rates provided through tagging programs, mortality rate in captivity with probable causes, production, sales and exports, and conservation programs and scientific experiments in relation to the ranching program and the wild population. The Secretariat will at all times be welcome to review the program.

At or before the 11th Conference of Parties Cuba will provide the CITES Secretariat with a review detailing the results of monitoring and research over the past three years, and such additional information that may be available on the impact of the traditional harvest and egg harvest on the wild population. This report will contain, with appropriate scientific justification, details of any proposed changes in management, harvest levels or export levels for the three years following COP 11.

8.4. Conservation Benefits

The new Cuban management program proposed here has been designed specifically to allow an "increase in the wild" of the local population of *E. imbricata* (recommendation b) i) of Resolution Conf. 3.15) while the population is being used sustainably. Conservation benefits are:

i. The proposed wild harvest represents about 10% of the previous harvest maintained for many years.

ii. *Eretmochelys imbricata* is effectively protected throughout Cuba. The two traditional harvest sites, where utilisation is strictly controlled, together make up less that 0.005% of available habitat (Section 5.2.2.b).

iii. Ranching has stimulated new research on sea turtles within Cuba, and has increased co-operation and collaborative research with other international agencies.

iv. Upgraded record-keeping at the harvest sites provides more accurate and precise monitoring of trends in the wild population.

v. With the introduction of ranching based on wild eggs and/or hatchlings, new information on reproductive rates of the population can be collected as a byproduct, with little extra cost, which can be used for monitoring purposes.

vi. Ranching links the conservation of nesting females and habitats to the economic welfare of local fishing communities, providing tangible incentives for conservation.

By ? who? vii. The traditional harvest provides unique opportunities for research into the ecology and biology of *E. imbricata*.

viii. The management program provides unique opportunities to quantify the impacts of controlled use and allows objective testing of theoretical predictions.

ix. The program will provide a legal source of *E. imbricata* shell, thereby lessening incentives to trade illegally.

x. The program creates sound, tangible, economic reasons to maintain a budget commitment to the conservation and management of sea turtles when other pressing needs exist.

xi. The program has already led to regional co-operation and discussion, and this is expected to continue and expand.

xii. The program creates opportunities for economic development that are consistent with culture and tradition in remote, coastal regions.

xiii. Captive raising techniques developed in Cuba for *E. imbricata* could be important if the weight of scientific opinion decides that objective experimenation with restocking ("head-starting") *E. imbricata* has conservation value.

xiv. Having a significant captive population of *E. imbricata* at all times will mean that animals are always available for experimentation, and depending on 8.4.xiii above, for restocking should it be deemed necessary..

xv. Cuba's reservation on *E. imbricata* will be lifted.

8.5. Response Capability and Commitments (Safeguards)

Sustainability depends on two factors: effective monitoring and the ability to alter management regimes on the basis of monitoring results (response capability). Cuba's past management indicates unequivocally its commitment to both. Further, in this proposal the following specific commitments are made:

8.5.1. In the event that annual monitoring over 3 years indicates a decline of 20% in the total population (or the reproductively active segment of the population), that cannot be attributed to survey biases, the traditional wild harvest will be reduced by 50% as a first stage response.

8.5.2. In the event that the annual monitoring indicates a decline of 20% in the subadult population over 3 years or more that cannot be attributed to survey biases, the harvest of hatchlings/eggs will be reduced by 50% as a first stage response.

8.5.3. In the event that monitoring indicates a drastic short-term decline in the total population (50% in one year), that is not explicable by survey biases, all harvesting will cease.

8.6. Financial Viability

Captive rearing of sea turtles has been undertaken in many countries (see Donnelly 1994), for commercial (mainly meat production), conservation (head-starting or restocking) and display purposes. However, in most cases it has involved a "low-technology" approach to animal husbandry, in which little attention was paid to the physiological needs of the animals. This led to many problems, criticisms and lingering doubts (Donnelly 1994). A similar situation prevailed when crocodile ranching began. Many operations were simple ("low technology"), there was a general lack of understanding of the physiological needs of the animals, survival and growth rates were generally low, and commercial viability was often marginal. With crocodiles, this situation changed completely with increased research by crocodilian biologists around the world. A similar research effort is dramatically changing the efficiency with which *E. imbricata* can be raised in Cuba (Annex 10), and will continue to do so in the future.

Financial viability of "ranching" will ultimately depend on the efficiency of production, the market demand for the product/s, and the extent of competition that exists for those markets (export and domestic). However, equally important from a commercial viewpoint, is the diversity of income streams that can be integrated into the project. For example, a project with one income stream (production), may not be as profitable, [nor commercially sustainable amidst risk and uncertainty] as an operation that includes tourism, research and education.Serious consideration is now being given to incorporating the expanded Cuban ranching program within a significant education centre devoted to the conservation, management and sustainable use of sea turtles generally. Such a facility would allow a significant tourist income stream to be developed (50,000+ visitors in year 1), hand in hand with the ranching program.

From a purely production point of view, the main biological variables (Annex 10) affecting the economics of *E. imbricata* ranching are: incubation survival (80% of viable eggs), early hatchling survival (0-6 months of age: 90% is considered attainable), later survival (6 months to culling (95%+ is attainable); culling size (40 cm SCL; 6-8 kg); growth rates to culling size (2 years using controlled-environment facilities), nutrition (an adequate diet is provided from fish or pellets), food conversion rates (with fish 25% wet weight). A number of other factors, of lesser importance are involved (eg. effects of incubation environment on post-hatching growth and survival).

Table 9. Annual estimated cost and income ($US) for one model of *E. imbricata* production which relys on ranching 10,000 viable eggs per year and producing 6000 raised animals per year in 2 years. This model does not include income from other sources, such as tourism.

Expense/Income		$US/turtle
Expense	Egg collection/incubation (10,000)	$50,000
	Food (40 kg/animal/2 yr at $0.50/kg)	$120,000
	Salaries/consultants	$70,000
	Electricity (pumps, heating, general)	$30,000
	Repairs, maintenance, administration, etc.	$30,000
	Processing costs	$50,000
	Research costs	$25,000
	Miscellaneous	$25,000
	Total	$400,000
Income	Shell (350 gm/individual; 6000 animals)	$840,000
	Meat (2.0 kg/individual)	$12,000
	Byproducts (calipee/fat)	$10,000
	Total	$862,000

Capital costs depend on whether the commercial-scale raising facility is created by expanding the existing facility, building a new facility for increased production, or building a new facility for increased production that is integrated with tourism: an investment ranging from $US 0.5 million to $ 2 + million. The main variables associated with raising and production are summarised in Table 9, which does not include any income from tourism.

8.7. Research

Cuba's commitment of resources to research has been extensive and will continue. It involves a core group of Cuban research staff, and increasingly, international researchers working in collaboration. Current research programs include: population dynamics; movement patterns; DNA studies; shell chemistry; nesting ecology; incubation; sex determination; diet; nutrition (wild and in captivity); maturation and sexual differentiation; and, captive husbandry generally. Cuba has promoted and fostered international co-operation with research and will continue to do so in the future.

8.8. Movement and Population Integrity

NOT SO

The degree to which the Cuban population of *E. imbricata* is restricted to Cuban territorial waters is impossible to quantify precisely with known technology. However, a considerable amount of direct and indirect evidence has been accumulated and reviewed, and it is consistent with there being a significant resident population in Cuba, particularly along the southern shoreline (Zone A). This evidence is discussed in depth in Annex 8.

The main conclusion is that the status of the wild population in Cuban waters, like that in Mexican waters (Hernández *et al.* 1995; Márquez *et al.* 1996), will primarily reflect local management in Cuban waters. No evidence supports the speculation by Bowen *et al.* (1996), that the Caribbean population may be a single randomly distributed one. Nor is there evidence to support the view that Cuba's limited utilisation will impact significantly on other populations. Indeed, different management programs within Mexico and Cuba have established unequivocally that local populations in the northern parts of the Caribbean can increase and decrease in response to local management, with minimal impact on each other.

In the area within Cuba from which eggs are collected for ranching (Zone A), tagging studies (Annex 8) and DNA analyses (Annex 8) have confirmed respectively: a higher degree of site fidelity than found at other sites in Cuba so far investigated; and, a significant level of genetic isolation relative to other sites so far investigated in Cuba and neighbouring countries (see Annex 8). Haplotypes frequencies of non-nesting and nesting samples in Zone A, although limited, are very similar and support the view that animals nesting and living in the region come from the same population. Research on tagging and DNA haplotypes from nesting and non-nesting animals from different parts of Cuba are continuing. In addition, new insights are expected from satellite tracking, trace element concentrations in the shell, and Carbon and Nitrogen isotope levels in the shell, all of which are under investigation (see Annex 8).

With the continuation of Cuba's management program, and the research programs linked to it, a greater understanding of movement patterns and population integrity will emerge over time. If appropriate, Cuba will adapt its management program to meet any new conservation needs revealed by the research. All significant findings will be reported to the CITES Secretariat and distributed to regional neighbours where they may assist local and co-operative efforts to conserve and wisely manage *E. imbricata* populations.

8.9. Restocking ("Head-Starting") - A Conservation Option

Mortality between hatching and the minimum age at which any females could reach maturity (about 8 years) is almost certainly high (98-99%: Annex 7), and probably does occur mainly between hatching and one-year of age. If so, depleted wild populations may be able to be boosted by restocking or "head-starting" programs, although the merits of such programs are currently subject to debate (Donnelly 1994). Cuba's proposed ranching program will ensure that the technology needed for raising large numbers of *E. imbricata* efficiently will be available, if it is needed. It provides a sound form of conservation insurance. If required, the Cuban Government has the legal right to take animals from the ranching operation for release to the wild.

8.10. Regional Leadership

Within the limits of available resources, Cuba has and will continue to promote initiatives aimed at enhancing regional co-operation in the conservation and sustainable use of sea turtles. In this regard, Cuba has:

8.10.1. Hosted a regional workshop on *E. imbricata* bycatch in shrimp fisheries (1992).

8.10.2. Hosted a regional meeting on sea turtle DNA research (1994).

8.10.3. Hosted a regional workshop on fisheries DNA research which included sea turtles (1995).

8.10.4. Hosted a regional meeting on sea turtle management (1996) (Annex 12).

8.10.5. Consulted broadly with regional and non-regional states in preparing this proposal (Section 7).

8.10.6. Participated actively in appropriate CITES forums, including the meetings aimed at formulating CITES Resolution Conf. 9.20 ("Guidelines for Evaluating Marine Turtle Ranching Proposals Pursuant to Resolution Conf. 3.15").

8.10.7. Participated actively in meetings evaluating the merits of a regional convention on sea turtle conservation.

8.10.8. Been responsible for increasing international research efforts on sea turtles within the region, particularly in collaboration with researchers from Australia, Japan and Mexico.

9. References

Alcala, A. (1980). Observations on the ecology of the Pacific hawksbill turtle in the central Visayas, Philippines. Report to Division of Research, Silliman University, Philippines.

Anderes, B.L. (1996). Feeding habits of the hawksbill turtle in the Cuban shelf. (unpublished manuscript).

Anderes, B.L. (1994). Study of the stomach contents. *In* Proceedings of the International Workshop on the Management of Marine Turtles '94. 28-30 March 1994, Tokyo.

Anderes, B.L. and Uchida, I. (1994). Study of hawksbill turtle (*Eretmochelys imbricata*) stomach content in Cuban waters. Pp. 27-40 *in* "Study of the Hawksbill Turtle in Cuba (I)". Ministry of Fishing Industry, Cuba: Havana.

Baisre, J.A. (1987). La pesca en Cuba: apuntes para su historia (I). Mar y Pesca 1987: 39-43.

Balazs, G.H., Katahira, L.K. and Ellis, D. (1996). Satellite tracking of hawksbill turtles nesting in the Hawaiian Islands. *In* Proceedings of the 16th Annual Sea Turtle Symposium. Hilton Head Island, South Carolina, U.S.A., 28 February-2 March 1996.

Bass, A.L., Good, D.A., Bjorndal, K.A., Richardson, J.I., Hillis, Z., Horrocks, J.A. and Bowen, B.W. (1996). Testing models of female reproductive migratory behaviour and population structure in the Caribbean hawksbill turtle, *Eretmochelys imbricata*, with mtDNA sequences. Molec. Ecol. 5: 321-328.

Bjorndal, K.A. and Bolten, A.B. (1988). Growth rates of immature geen turtles, *Chelonia mydas*, on feeding grounds in the southern Bahamas. Copeia 1988: 555-565.

Bjorndal, K.A., Bolten, A.B. and Lageux, C.J. (1993). Decline of the nesting population of Hawksbill turtles at Tortuguero, Costa Rica. Conserv. Biol. 7(4): 925-927.

Bjorndal, K.A. (1990). Digestibility of the sponge *Chondrilla nucula* in the green turtle, *Chelonia mydas*. Bull. Mar. Sci. 47(2): 567-570.

Boulon, R.H. (1994). Growth rates of wild juvenile hawksbill turtles, *Eretmochelys imbricata*, in St. Thomas, United States Virgin Islands. Copeia 1994: 811-814.

Bowen, B.W., Bass, A.L., Garciá-Rodriguez, A., Diez, C.E., Van Dam, R., Bolten, A., Bjorndal, K.A., Miyamoto, M.M. and Ferl, R.J. (1996). Origin of Hawksbill Turtles in a Caribbean feeding area as indicated by mitochondrial DNA sequence analysis. Ecol. Appl. 6(2): 566-572.

Broderick, D., Moritz, C., Miller, J.D., Guinea, M., Prince, R.I.T. and Limpus, C. (1994). Genetic studies of the Hawksbill Turtle *Eretmochelys imbricata*: evidence for multiple stocks in Australian waters. Pp. 123-131 *in* "Pacific Conservation Biology". Surrey Beatty and Sons: Sydney.

Caughley, G. and Sinclair, A.R.E. (1994). Wildlife Ecology and Management. Blackwell Science: Victoria, Australia.

Congdon, J.D., Dunham, R.C. and Van Loben Sels, R.C. (1993). Delayed sexual maturity and demographics of Blanding's turtles (*Emydoidea blandingii*): implications for conservation and management of long-lived organisms. Conserv. Biol. 7: 826-833.

Courtney, A.J., Die, D.J. and Holmes, M.J. (1994). Discriminating populations of the eastern King Prawn *Penaeus plebejus*, from different estuaries using ICP-MS trace element analysis. Atomic Spectroscopy Jan/Feb 1994: 1-6.

Depeñalver Angulo, D.D. (1635). "Derechos Que Se Percibían Para El Sostenimiento De La Armada De Barlovento En El Puerto De La Habana". Doc. XXXI (pp 182-86) in "Documentos Para La Historia Colonial De Cuba", edited by C. Garciá Del Pino and A. Melis Cappa. 1988 (Editorial De Ciencias Sociales: La Habana)

Deriniyagala, P.E.P. (1939). The tetrapod reptiles of Ceylon. Colombo Museum: Colombo.

Diez, C.E. and Van Dam, R. (1995). Foraging ecology and population dynamics of the Hawksbill (*Eretmochelys imbricata*) at Mona Island, Puerto Rico. Summary Report for 1992-94; National marine Fisheries Service and the Puerto Rico Department of Natural Resources, Miami, Florida, USA.

Diez, C.E., Van Dam, R., Koyama-Diez, H. and Bustamante, M. (1994). Growth, foraging and sex ratio of immature Hawksbills at Mona Island, Puerto Rico. *In* Proceedings of the International Workshop on the Management of Marine Turtles '94. 28-30 March 1994, Tokyo.

Direccion Politica De Las F.A.R. (1967). "Historia De Cuba". (Direccion Politica De Las F.A.R.: La Habana).

Doi, T., Márquez, R., Kimoto, H. and Azeno, N. (1992). Diagnosis and conservation of the hawksbill turtle population in the Cuban Archipelago. Tech. Rep., Japan Bekko Association, Japan.

Donnelly, M. (1994). Sea Turtle Mariculture. A Review of Relevant Information for Conservation and Commerce. Centre for Marine Conservation: Washington.

Espinosa, G.L., Gavilan, F.M., Cardenas, E.C., Nodarse, G.A., Hernández, R.D. and Gorita, N.V. (1994). Electrophoretic comparison in Hawksbill turtles from three fishing areas of the Cuban shelf. *In* Proceedings of the International Workshop on the Management of Marine Turtles '94. 28-30 March 1994, Tokyo.

Espinosa, G.L., Diaz, R., Garciá, E., Robainas, A., Ramos, M., Elizalde, S., Nodarse, G., Pérez, C., Moncada, F., Meneses, A. and Garduño, M. (1996). Mitochondrial DNA as a molecular marker in hawksbill *Eretmochelys imbricata* population studies. *In* Proceedings of the Regional Meeting on Conservation and Sustainable Use of the Hawksbill Turtle in Cuba. Habana, 14-15 March 1996.

Fosdick, P. and Fosdick, S. (1994). Last Chance Lost? I.S. Naylor: York, Pennsylvania.

Garciá, C. (1981). Temperatura de las aguas oceanicas de Cuba: I. Aguas superficiales. Rev. Cub. Inv. Pesq. 6(2): 1-15.

Garduño, M.A. and Márquez, R. (1994). Tagging and returns of hawksbill sea turtle in Las Coloradas, Yucatan, Mexico. *In* Proceedings of the International Workshop on the Management of Marine Turtles '94. 28-30 March 1994, Tokyo.

Garduño, M.A. and Márquez, R. (1996). Evaluacion de la poblacion anidadora de tortuga de Carey (*Eretmochelys imbricata*) en Los Coloradas, Yucatan, Mexico. (in prep.).

Groombridge, B. and Luxmoore, R. (1989). The Green Turtle and Hawksbill (Reptilia: Cheloniidae): World Status, Exploitation and Trade. CITES: Switzerland.

Groshens, E.B. (1993). Internesting and Post-Nesting Movement and Behaviour of Hawksbill Sea Turtles, *Eretmochelys imbricata*, at Buck Island Reef National Monument, St. Croix, USVI. Unpubl. MSc Thesis, Virginia Polytechnic Institute and State University, Virginia.

Groshens, E.B. and Vaughan, M.R. (1994). Post-nesting movements of hawksbill sea turtles from Buck Island Reef National Monument, St. Croix, USVI. *In* Proceedings of the 13th Annual Symposium on Sea Turtle Biology and Conservation. NOAA Tech. Mem. NMFS-SEFSC-341.

Heppell, S., Crowder, L. and Priddy, J. (1995). Evaluation of a fisheries model for the harvest of hawksbill sea turtles, *Eretmochelys imbricata* in Cuba. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-5, 48pp.

Heppell, S.S. and Crowder, L.B. (1996). Analysis of a fisheries model for harvest of Hawksbill Sea Turtles (*Eretmochelys imbricata*). Conserv. Biol. 10(3): 874-880.

Heppell, S., Limpus, C.J., Crouse, D.T., Frazer, N.B. and Crowder, L.B. (1996). Population model analysis for the loggerhead turtle (*Caretta caretta*) in Queensland. Wildl. Res. 23: 143-159.

Hernández, V.G., Puch, J.C.R., Gómez, R.G. and Sánchez, J.S. (1995). Informe final del programa de investigacion y proteccion de las tortugas marinas del estado de Campeche, Mexico., Temporada 1994. Situacion actual. Boletin Tecnico No. 1, Instituto Nacional de la Pesca.

Hillis, Z. (1995). Characteristic breeding biology of the hawksbill turtle (*Eretmochelys imbricata*) at Buck Island Reef National Monument, St. Croix, U.S. Virgin Islands. Proceedings of the International Workshop on the Management of Marine Turtles '95. 8-10 March 1995, Tokyo.

Hoyle, M. and Richardson, J.I. (1993). The Jumby Bay Hawksbill Project: Survivorship, Mortality, Recruitment and Reproductive Biology and Behaviour of Adult Female Hawksbill Sea Turtles (*Eretmochelys imbricata*) Nesting at Pasture Bay, Long Island, Antigua, 1987-1992. Technical Report. The Georgia Sea Turtle Cooperative, Institute of Ecology, University of Georgia, Athens. 76pp.

IUCN (1995). A Global Strategy for the Conservation of Marine Turtles. IUCN: Gland.

JBA (1994). Proceedings of the International Workshop on the Management of Marine Turtles. 28-30 March, 1994 Tokyo.

JBA (1995). Proceedings of the International Workshop on the Management of Marine Turtles '95. 8-10 March 1995, Tokyo.

Koike, H. (1995a). Mitochondrial DNA analysis using the turtleshell of the Hawksbill, *Eretmochelys imbricata*. *In* Proceedings of the International Workshop on the Management of Marine Turtles '95. 8-10 March 1995, Tokyo.

Koike, H. (1995b). Isotope analysis using bekko samples. Unpublished report to Japan Bekko Association, Tokyo.

Koike, H., and Chisolm, B. (1991). Paleo-diet of hunter-gatherers in Japan estimated by ^{13}C and ^{15}N and lipid analyses. Daiyonki-kenkyu (The Quarterly Research) 30: 231-238

Koike, H., Okayama, T., Baba, Y., Diaz, R., Diez, C.E., Márquez, R.M. and Espinosa, G. (1996). Conservation genetics for the CITES-listed animals - mitochondrial DNA analysis using the scutes of hawksbill turtles. International Symposium on Network and Evolution of Molecular Information, 20-22 April 1996, Tokyo. Abstract.

Kowarsky, J. and Capelle, M. (1979). Returns of pond-reared juvenile green sea turtles tagged and released in Torres Strait, northern Australia. Biol. Conserv. 15:207-14.

Lageaux, C.J. (1996). Demography of marine turtles harvested by Miskito Indians of Atlantic Nicaragua. *In* Proceedings of the 16th Annual Sea Turtle Symposium. Hilton Head Island, South Carolina, U.S.A., 28 February-2 March 1996.

Le Riverend, J. (1971). Historia Economica de Cuba. Instituto Cubano del Libro: Habana.

Limpus, C.J. (1992). The hawksbill turtle, *Eretmochelys imbricata*, in Queensland: population structure within a southern Great Barrier Reef feeding ground. Wildl. Res. 19: 489-506.

Limpus, C.J. and Miller, J.D. (1996). Australian Hawksbill Turtle Population Dynamics Project. Unpublished Project Report for Year 1, Queensland Department of Environment.

Limpus, C.J., Miller, J.D., Baker, V. and McLachlan, E. (1983). The Hawksbill Turtle, *Eretmochelys imbricata* (L.), in north-eastern Australia: the Campbell Island rookery. Aust. Wildl. Res. 10: 185-197.

Loop, K.A., Miller, J.D. and Limpus, C.J. (1995). Nesting by the Hawksbill Turtle (*Eretmochelys imbricata*) on Milman Island, Great Barrier Reef, Australia. Wildl. Res. 22: 241-252.

Marcovaldi, M.A. and Filippini, A. (1991). Trans-Atlantic movement by a juvenile hawksbill turtle. Marine Turtle Newsletter 52: 3.

Márquez, R. (1990). FAO Species Catalogue Volume II. Sea Turtles of the World. FAO Fisheries Synopsis No. 125. FAO: Rome.

Márquez, R., Peñaflores, C. and Vasconcelos, J. (1996). Olive ridley turtles (*Lepidochelys olivacea*) show signs of recovery at La Escobilla, Oaxaca. Marine Turtle Newsletter 73: 5-7.

McConnaughy, T. and Mcroy, C.P. (1979). Food structure and the fractionation of carbon isotopes in the Bering Sea. Mar. Biol. 53: 257-262.

Meylan, A. (1982). Estimation of population size in sea turtles. *In* The biology and Conservation of Sea Turtles. Smithsonian Institution Press: Washington, D.C.

Meylan, A. (1988). Spongivory in hawksbill turtles: a diet of glass. Science 239: 393-395.

Miller, J. (1985). Embryology of marine turtles. Pp. 269-328 *in* Biology of the Reptilia, ed. by C. Gans, F. Billett and P.F.A. Maderson. Vol. 14. Academic Press: New York.

Miller, J.D. (1994). The hawksbill turtle, *Eretmochelys imbricata*: a perspective on the species. Pp. 25-38 *in* Proceedings of the Australian Marine Turtle Conservation Workshop. ANCA: Canberra.

Milliken, T. and Tokunaga, H. (1987). The Japanese sea turtle trade 1970-1986. TRAFFIC (Japan) report.

Minagawa, M. and Wada, E. (1984). Stepwise enrichment of 15N along food chains; further evidence and relation between 15N and animalage. Geochem. Cosmochem. Acta. 48: 1135-1140.

Moncada, F.G. (1994a). Migration of Hawksbill Turtle (*Eretmochelys imbricata*) in the Cuban platform. Pp. 1-8 *in* "Study of the Hawksbill Turtle in Cuba (I)". Ministry of Fishing Industry, Cuba: Havana.

Moncada, F.G. (1994b). Methodologies for maturation and sexual differentiation studies of the Hawksbill Turtle in Cuba. Pp. 9-18 *in* "Study of the Hawksbill Turtle in Cuba (I)". Ministry of Fishing Industry, Cuba: Havana.

Moncada, F.G. and Nodarse, G.A. (1994). Length composition and size of sexual maturation of hawksbill turtle in the Cuban platform. Pp. 19-25 *in* "Study of the Hawksbill Turtle in Cuba (I)". Ministry of Fishing Industry, Cuba: Havana.

Moncada, F.G. (1996a). Migration of hawksbill turtle. *In* Proceedings of the 16th Annual Sea Turtle Symposium. Hilton Head Island, South Carolina, U.S.A., 28 February-2 March 1996.

Moncada, F.G. (1996b). Movements of sea turtles in Cuba. Tagging. *In* Proceedings of the Regional Meeting on Conservation and Sustainable Use of the Hawksbill Turtle in Cuba. Habana, 14-15 March 1996.

Mortimer, J. (1995). Teaching critical concepts for the conservation of sea turtles. Marine Turtle Newsletter 71: 1-4.

Mrosovsky, N., Bass, A., Corliss, L.A., Richardson, J.I. and Richardson, T.H. (1992). Pivotal and beach temperatures for hawksbill turtles nesting in Antigua. Can. J. Zool. 70: 1920-1925.

Mrosovsky, N. (1994). Sex ratios of sea turtles. J. Exptal. Zool. 270: 16-27.

Nodarse, G.A. (1996). Experimental rearing of hawksbill turtle (*Eretmochelys* imbricata) in Cuba. *In* Proceedings of the Regional Meeting on Conservation and Sustainable Use of the Hawksbill Turtle in Cuba. Habana, 14-15 March 1996.

Ohtaishi, N., Kobayashii, M., Pérez, C., Diez, C.E., Kamezaki, N. and Miyawaki, I. (1996). Age determination of Hawksbill turtle (*Eretmochelys imbricata*) by annual layers of the scute. *In* Proceedings of the 16th Annual Sea Turtle Symposium. Hilton Head Island, South Carolina, U.S.A., 28 February-2 March 1996.

Ohtaishi, N., Puentes, C.P., Kamezaki, N., Miyawaki, I. and Koike, H. (1995). Preliminary report on the age determination of Hawksbill turtle (*Eretmochelys imbricata*) by annual layers of the scute. *In* Proceedings of the International Workshop on the Management of Marine Turtles '95. 8-10 March 1995, Tokyo.

Okayama, T., Diaz, R., Koike, H., Diez, C.E., Márquez, R.M. and Espinosa, G. (1996). Mitochondrial DNA analysis of the hawksbill turtle. I. Haplotype detection among samples in the Pacific and Atlantic Oceans. Absract. International Symposium on Network and Evolution of Molecular Information, 20-22 April 1996, Tokyo.

Parmenter, C.J. (1983). Reproductive migration in the hawksbill turtle (*Eretmochelys imbricata*). Copeia 1983: 271-273.

Parsons, J.J. (1972). Etudes de geographie tropicale offertes a Pierre Gourou. Ecole Pratique des Hautes Etudes, Sorbonne, Paris.

Pearson, C.E. (compiler)(1981). El Nuevo Constante: Investigation of an Eighteenth Century Spanish Shipwreck off the Louisiana Coast. Div. Admin., Admin. Serv.: Baton Rouge, Louisiana.

Pelegrin, E., Fraga, I. and Varea, J.A. (1994). Artificial feeding as an alternative in Hawksbill Turtle (*Eretmochelys imbricata*) rearing. Pp. 41-47 *in* "Study of the Hawksbill Turtle in Cuba (I)". Ministry of Fishing Industry, Cuba: Havana.

Pérez, C. (1994). Caracterizacion de la cayeria de las Doce Leguas. *In* Proceedings of the International Workshop on the Management of Marine Turtles. 28-30 March 1994, Tokyo.

Pérez de Oliva, H. (1528). "Historia de la Invencion de las Indias".

Sakai, H., Ichihashi, H., Suganuma, H. and Tatsukawa, R. (1995). Heavy metal monitoring in sea turtles using eggs. Mar. Poll. Bull. 30(5). 347-353.

Sakai, H. and Tanabe, S. (1995). Discriminating the original areas of tortoise-shell (Bekkou) using ICP-MS trace element analysis. Unpublished report to Japan Bekko Association, Tokyo.

Smith, A.M.A. and Webb, G.J.W. (1985). *Crocodylus johnstoni* in the McKinlay River area, N.T. VII. A population simulation model. Aust. Wildl. Res. 12: 541-554.

Smith, G.W. (1992). Hawksbill turtle nesting at manatee Bar, Belize, 1991. Marine Turtle Newsletter 57: 1-5.

Starbird, C.H. (1992). Internesting movements and behaviour of hawksbill sea turtles (*Eretmochelys imbricata*) around Buck Island Reef Island National Monument, St. Croix, United States Virgin Islands. Unpublished MSc Thesis, San Jose State University.

Tanabe, S. and Sakai, H. (1996). Trace element analysis of tortoise-shell (Bekkou) using ICP-MS and AAS. Unpublished report to Japan Bekko Association, Tokyo.

Webb, G.J.W. and Smith, A.M.A. (1987). Life history parameters, population dynamics and the management of crocodilians. Pp. 199-210 *in* Wildlife Management: Crocodiles and Alligators, ed. by G.J.W. Webb, S.C. Manolis and P.J. Whitehead. Surrey Beatty & Sons: Sydney.

Witzell, W.N. (1980). Growth of captive Hawksbill turtles, *Eretmochelys imbricata*, in western Samoa. Bull. Mar. Sci. 30(4): 909-912.

Witzell, W.N. (1983). Synopsis of Biological Data on the Hawksbill Turtle *Eretmochelys imbricata* (Linnaeus, 1766). FAO Fisheries Synopsis No. 137. FAO: Rome.

Wood, F. and Wood, J. (1993). Release and recapture of captive-reared green sea turtles, *Chelonia mydas*, in the waters surrounding the Cayman Islands. Herp. J. 3: 84-89.

Yamamuro, M., Minagawa, M. and Kayanne, H. (1992). Preliminary observation on food webs in Shiraho coral reef as determined from carbon and nitrogen stable isotopes. Pp. 358-361 *in* Proc. 7th Int. Coral Reef Symp., Guam 1992.

Yntema, C. and Mrosovsky, N. (1980). Sexual differentiation in hatchling loggerheads (*Caretta caretta*) incubated at different controlled temperatures. Herpetologica 36: 33-36.

ANNEX 1. Cuban Sea Turtles

Carrillo, E.C. and F.G. Moncada,

Of the seven species of world sea turtles, five inhabit Cuban territorial waters. There are six species known from the Carribean region (Table A1.1). Some nest and feed regularly in Cuban waters (*Chelonia mydas, Caretta caretta, Eretmochelys imbricata*), whereas others are encountered rarely (*Dermochelys coriacea, Lepidochelys olivacea*) (Table A1.1).

Table A1.1. Sea turtles encountered in Cuban waters. NR= not recorded.

Species	Presence	Nesting	Feeding
Green Turtle (*Chelonia mydas*)	Continual	Common	Common
Loggerhead (*Caretta caretta*)	Continual	Common	Common
Hawksbill (*Eretmochelys imbricata*)	Continual	Common	Common
Leatherback (*Dermochelys coriacea*)	Uncommon	Possible (2 records)	Probable
Olive Ridley (*Lepidochelys olivacea*)	Rare (2 records)	NR	Rare
Kemp's Ridley (*Lepidochelys kempi*)	NR	NR	NR

Common = ?

ANNEX 2. Cuba and its Marine Environments

Carrillo, E.C. and J. Contreras

Cuba and its associated islands and atolls (Fig. A2.1) represent the largest island complex in the Caribbean (110,860 km^2). Marine resources, including sea turtles, are a major source of food and export trade for Cuba's near stable population of 10.96 million people (0.21% annual rate of increase in 1994).

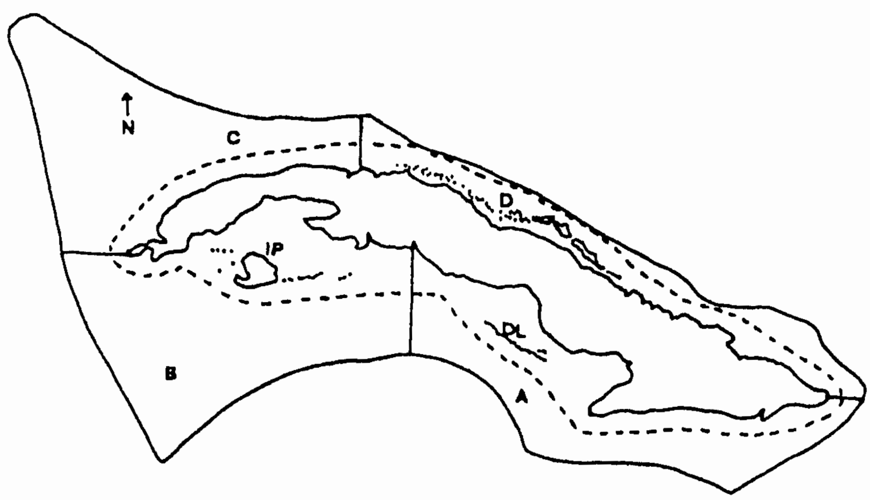

Figure A2.1. Cuba's territorial waters (broken line) and economic zone (solid line) subdivided into 4 Fisheries Zones (A, B, C, D). The extent of available habitat was quantified from 1:100,000 topographical maps and nautical charts. IP = Isle of Pines; DL = Doce Leguas.

The extensive mainland coastline (5120 km) and island coastline (3000+ km) with relatively little coastal development (Table A2.1) provides a vast mosaic of shallow-water habitats, that *E. imbricata* can and does occupy. It also appears to provide extensive potential nesting areas.

Table A2.1. Quantification of the extent of Cuba's mainland coastline, number of islands, island coastline and developed coastline, based on the regions defined in Figure A2.1. A-D represent categories of small islands: A = <0.04 km^2; B = 0.04<0.25 km^2; C = 0.25<1.0 km^2; D = 1.0<4.0 km^2.

Zone	Mainland		Large Islands			Small Islands (N)					
	km	%Dev	N	km	%Dev	A	B	C	D	Total	%Dev
A	1170	25.1	24	159	0.0	242	308	50	0	600	<5
B	1089	7.4	63	650	11.1	220	118	45	0	383	<5
C	726	14.9	18	119	10.1	52	37	15	0	104	<5
D	2135	15.9	149	1152	0.1	550	145	91	1	787	<5
All	5120	16.0	254	2080	3.8	1064	608	201	1	1874	<5

Table A2.2. Quantification of the extent of Cuban territorial waters (subdivided into interior and exterior waters) and the extent of the economic zone outside of territorial waters, for each of the 4 Fisheries Zones (see Fig. A2.1). All measurements are square kilometres.

Zone	Interior Waters	Exterior Waters	Economic Zone	Totals
A	18,793	14,061	49,675	82,529
B	30,595	10,625	101,237	142,457
C	2,784	9,362	91,209	103,355
D	10,698	14,554	17,037	42,289
All	62,870	48,602	259,158	370,630

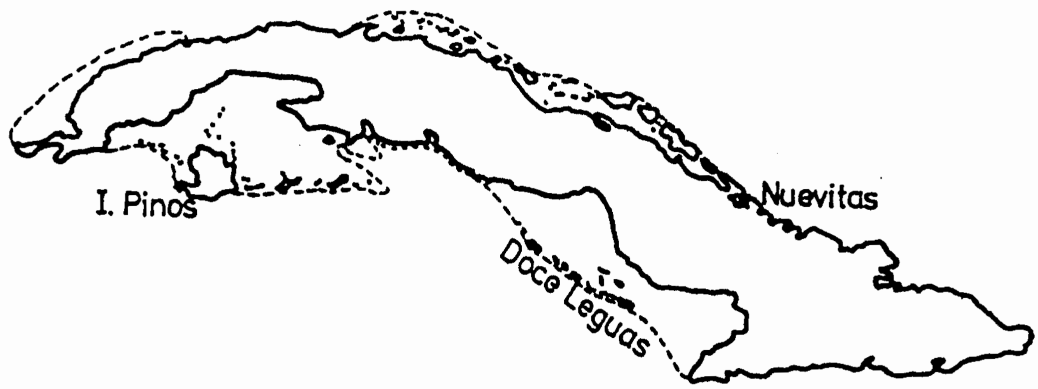

Figure A2.2. Location of shallow water areas around Cuba. Broken line is the 20 m depth contour.

Territorial waters (Fig. A2.1) comprise about 111,400 km^2 and the economic zone an additional 259,200 km^2. On the southern side of Cuba, there are extensive areas of shallow water (Fig. A2.2; Table A2.2), with large numbers of islands (Table A2.1) that are outside of and protected from, the strongest ocean currents to the south (Figs. A2.3 and A2.4). In contrast, the northern side of Cuba has more limited shallow waters (Table A2.2). Sea depths drop off sharply to over 2 km deep.

Table A2.3. Quantification of areas (km^2) of marine habitat greater and less than 20 m in depth within Cuban waters (interior waters, exterior waters and economic zone), and maximum and minimum surface water temperatures. Zones are those defined on Figure A2.1.

Zone	Areas of Different Depths <20m	>20m	Islands (N)	Temperatures (°C) Max.	Min.
A	15,550	68,806	624	29.8	25.9
B	18,155	123,194	446	29.8	25.9
C	2,942	101,289	122	28.9	24.9
D	7,429	33,265	936	28.8	24.9
All	44,076	326,554	2128	(mean) 29.3	25.4

The ocean currents surrounding Cuba are complex and change during the year. In May-June (Fig. A2.3), there are strong currents (>25 cm/sec) sweeping around the western end of Cuba and heading in a northerly direction. In contrast, the dominant currents across the north-east of Cuba flow from west to east, are not as strong (<25 cm/sec), and flow around the eastern extremity. The dominant flow is from east to west across the southern side, with numerous countercurrents and reduced flow in the shallow interior waters around Doce Leguas and the Isle of Pines.

Figure A2.3. Direction of major ocean currents around Cuba, in May-June [C. Garcia (MIP), unpublished data].

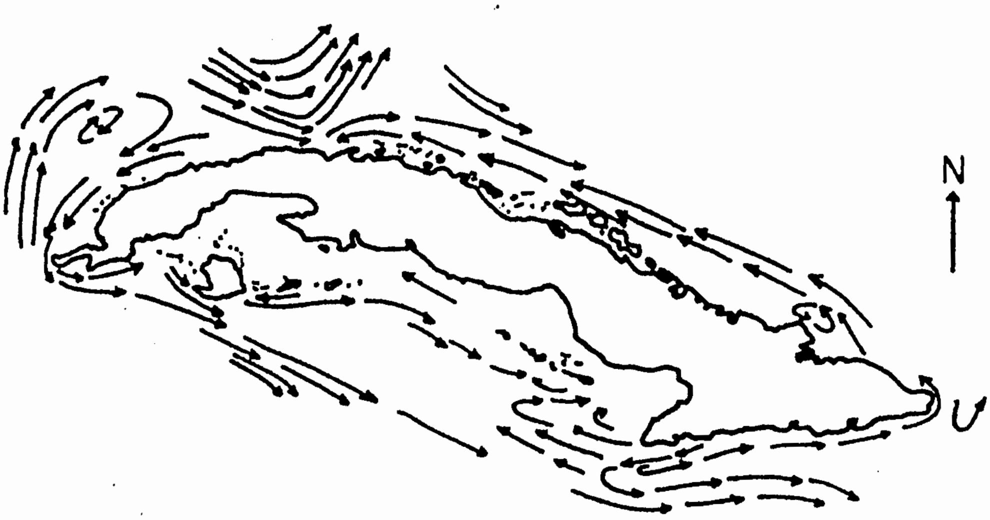

Figure A2.4. Direction of major ocean currents around Cuba, in November [C. Garcia (MIP), unpublished data].

By November (Fig. A2.4), the dominant current across the south of Cuba is from west to east (i.e. reversed), again with countercurrent complexes around Doce Leguas. These southeastern water currents flow around the eastern extremity of Cuba (west to east) and then form a near-shore east to west flow across the northeastern shoreline.

Surface sea temperatures are generally around 1°C lower across the north coast than they are on the south coast, at all times of year (Table A2.2; Fig. A2.5). The waters in and around Doces Leguas reach a maximum of around 30°C in the summer and drop to around 26°C in the winter (Garcia 1981).

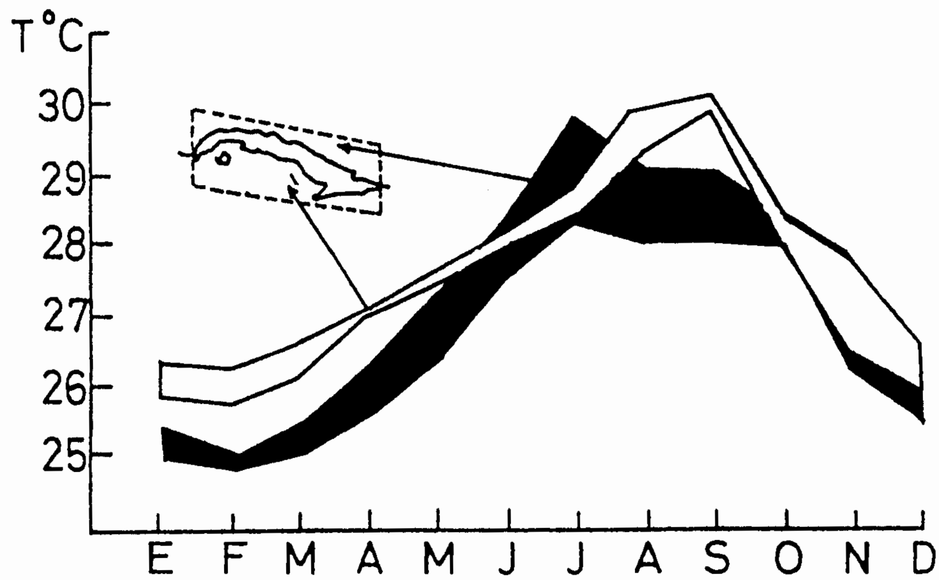

Figure A2.5. Surface sea temperatures from the north and south of Cuba (after Garcia 1981).

ANNEX 3. Regulation of *E. imbricata* Use in Cuba.

Carrillo, E.C., Machado, A. and P. Sanchez

Table A3.1. Chronology of major events associated with the abundance, management and use of *E. imbricata* in Cuba.

Period	Event
Pre-1500	Use of meat and eggs for food by indigineous Indians. Sea turtles caught by Indians using Remora (suckerfish)(Balsre 1987). Indians rely heavily on sea turtle meat and use handmade nets to catch them in addition to Remora (Direccion Politica De Las F.A.R. 1967).
1525	Doce Leguas area specifically identified as being "good" for turtles [Fray Bartolome de las Casas, in "Historia de las Indias" (1525), quoted in Balsre 1987].
1528	Turtles recorded as being abundant in Cuban seas, particularly to the south of the island (Pérez de Oliva 1528).
1635	Turtles and turtle products identified as important items available to be purchased from Cuba, at stated prices, in an assessment of products available in the region (Depeñalver Angulo 1635).
1700-1800	Increased demand for shell in Europe met by increased trade (Pearson 1981; Fosdick and Fosdick 1994); Doce Leguas Keys region identified as one of the earliest commercial harvest areas [Parsons (1972) from Groombridge and Luxmoore (1989)]; Turtle catch used to supply food for poor people, particularly slaves. Turtles transported live by coastal trade ships from north-west Cuba to markets in Habana (Le Riverend 1971).
1936	Decree Law No. 704 called "General Law of Fisheries" establishes closed season for marine chelonians during reproductive period.
1956	Decree No. 2724 establishes regulations dealing with the utilisation of marine resources.
1960	Ministry of Fisheries Resolution 31-V establishes closed seasons for sea turtles: 15 June to 10 August.
1961	Ministry of Fisheries Resolution 16-VI establishes permanent prohibition on taking and consuming of sea turtle eggs and disturbing nesting females at night.
1968	Formal, managed sea turtle fishery established. Ministry of Fisheries Resolution 117 establishes State control on accumulation and distribution of sea turtle products and byproducts.
1973	Ministry of Fisheries Resolution 10 prohibits capture of sea turtles by private persons.
1975	Closed seasons (breeding) introduced for all species of sea turtle.

Table A3.1. continued.

Period	Event
1976	Article 27 of Cuban Constitution establishes policy to be followed regarding utilisation of natural resources.
	Ministry of Fisheries Resolution 34 authorises capture of sea turtles for research purposes.
1977	Decree Law No. 1 establishes limits of Cuban territorial waters.
	Decree Law No. 2 establishes limits of marine economic zone.
	Ministry of Fisheries Resolution 317 prohibits the destruction of sea turtle nests on nesting beaches.
1978	Ministry of Fisheries Resolution 134 prohibits the capture of female sea turtles before nesting.
1980	Fisheries Regulation Directorate is created under the central direction of the Ministry of Fisheries, and assumes control of enforcement and compliance with Ministry of Fisheries regulations and policies.
1981	Act No. 33 specifically establishes environmental policy for different types of natural resources including marine resources.
1982	Monitoring of sea turtle harvest upgraded with a sampling program.
	Decree No. 103 regulates the taking of sea turtles by non-commercial interests, specifically restricting such use to State instrumentalities and requiring catching and keeping for research to be subject to permits issued by the Fisheries Regulation Directorate within the Ministry of Fisheries.
1984	Fishery Management Committee is created within the Ministry of Fisheries and placed in charge of analysing and approving the annual plan for specific fisheries.
1987	Preliminary experiments with ranching *E. imbricata*. Closed seasons altered on basis of new reproductive data.
1990	Cuba accedes to CITES and lodges reservation with *E. imbricata*. Ministry of Fisheries is authorised as CITES Management Authority and Institute of Oceanography as CITES Scientific Authority.
	As part of a fisheries rationalisation program, the sea turtle fishery starts to be phased down so that the fishing effort could be diverted to primarily export fisheries.
1992	Last exports of *E. imbricata* shell from Cuba.
1994	Ministry of Fisheries Resolution 298 permanently closes all seasons for the taking of marine turtles.
	Ministry of Fisheries Resolution 300 regulates marine turtle harvesting at the traditional harvest site at Isle of Pines.

Table A3.1. continued.

Period	Event
1995	Ministry of Fisheries Resolution 3 regulates marine turtle harvesting at the traditional harvest site at Nuevitas.
	Ministry of Science, Technology and Environment Resolution 168 (1995) establishes procedures for undertaking and approving environmental impact evaluations
	Ministry of Science, Technology and Environment Resolution 130 (1995) establishes regulations for appropriate State inspections of environmental issues.
1996	Decree Law 164, consolidates aspects of Decree Law 704 (1936), Decree No. 2724 (1956) and Decree No. 103 (1982). It updates fisheries legislation, creates an advisory commission for fisheries, and further strengthens restrictions on the taking of *E. imbricata* and their eggs by establishing severe penalties for those who violate the law (fines, fishing gear confiscations, boat confiscations, suspension of licences, etc.).
	New monitoring, reporting and regulatory systems introduced, including marking of shell stocks.
	Ministry of Science, Technology and Environment Resolution 29 designates the Centre for Environmental Management of the Environmental Agency as the Management Authority for CITES.
	Ministry of Science, Technology and Environment Resolution 87 (1996), establishes Regulations for compliance of Cuba's obligations under CITES.
	Ministry of Science, Technology and Environment Resolution 111 (1996) establishes regulations about biological diversity.
	Agreement 2994 of Executive Committee of the Cuban Council of Ministers creates the National Office for Fishing Inspections.
	Ministry of Fisheries Resolution 562 declares Doce Leguas Keys, as a special use and protected area, which restricts commercial fishing operations in the area (makes it subject to consent) and prohibits sport-recreation fishing activities unless carried out under a special permit.

ANNEX 4. Historical Harvest, Trade and Sampling Data

Carrillo, E.C., Moncada, F.G., Elizalde, S.R., Nodarse, G.A., Perez, C.P. and A.M. Rodriguez.

A4.1. Levels of Historical Harvest and Trade

The earliest trade statistics available (Cuban Customs Records) cover the period 1935-58 (Table A4.1). Between 1935 and 1945, 14,745 kg of shell was traded to: United Kingdom (60.3%); United States of America (12.9%); France (10.9%); Germany (5.5%); Canada (4.2%); Bahamas (2.8%); Italy (1.1%); Jamaica (1.0%); Switzerland (1.0%); and, Argentina (0.3%).

Trade was reduced during the War Years, and no data are available for the immediate post-war period (1946-49). Exports increased during the 1950's, with a peak export of 8543 kg in 1958. During the period 1950-59, to total of 18,451 kg of shell was traded to: Holland (40.7%); Bahamas (12.5%); United Kingdom (12.3%); Hong Kong (7.7%); France (7.1%); United States of America (6.6%); Italy (6.5%); Japan (4.4%); Germany (1.6%); Belgium (0.5%); and, Austria (0.2%).

From 1959-92, Cuban shell exports (154 tonnes) are recorded to the nearest tonne. The majority went to Japan (90.3%), with smaller amounts going to Holland (7.8%: 1959-68), Bahamas (0.7%), Hong Kong (0.7%) and France (0.7%). Shipments less than 1 tonne (amount not stipulated) were made to Italy, England, France and Switzerland. Japan was virtually the sole importer of Cuban *E. imbricata* shell between 1973 and 1992.

On the basis that Cuban trade represented almost totally Hawksbills harvested in Cuba, the trade data can be used to approximate the minimum levels of harvest. To do so, it was assumed that the average *E. imbricata* harvested before 1983 produced 1.6 kg of shell (Milligan and Tokunaga 1987), the shell represented around 3% of body weight (MIP, unpublished data), and the average turtle was 55 kg body weight. The results (Table A4.1) indicate a minimum harvest of some 165,148 individuals (8589 tonnes) between 1935 and 1995.

Table A4.1. Trade and harvest data for Cuban *E. imbricata*. In the early years, harvest data were incomplete relative to later years, where the primary measure was tonnes live weight of *E. imbricata* harvested. * measured or reported values (primary data). Numbers in brackets are those used to estimate the "Numbers Harvested" (see text for correction factors). BWt = body weight.

Year	Harvest (tonnes)	Mean BWt (kg)	Numbers Harvested	Japanese Imports (kg)	Cuban Exports (kg)	Eggs	Hatch.
[1935-67: "Numbers Harvested" estimated by assuming 1.6 kg of shell per average animal harvested. Data for 1935-39 are annual means over 5 years.]							
1935	80.2	55	1459	0	(*2334)	0	0
1936	80.2	55	1459	0	(*2334)	0	0
1937	80.2	55	1459	0	(*2334)	0	0
1938	80.2	55	1459	0	(*2334)	0	0
1939	80.2	55	1459	0	(*2334)	0	0
1940	11.3	55	205	0	(*328)	0	0
1941	12.8	55	233	0	(*373)	0	0
1942	13.7	55	249	0	(*398)	0	0
1943	4.5	55	81	0	(*130)	0	0
1944	33.5	55	609	0	(*974)	0	0
1945	30.0	55	545	0	(*872)	0	0

Table A4.1. continued.

Year	Harvest (tonnes)	Mean BWt (kg)	Numbers Harvested	Japanese Imports (kg)	Cuban Exports (kg)	Eggs	Hatch.
1950	10.8	55	196	0	(*313)	0	0
1951	17.1	55	311	0	(*497)	0	0
1952	30.3	55	551	*299	(*881)	0	0
1953	35.0	55	636	*231	(*1018)	0	0
1954	52.0	55	945	0	(*1512)	0	0
1955	66.7	55	1213	0	(*1941)	0	0
1956	25.7	55	467	0	(*747)	0	0
1957	103.1	55	1874	*225	(*2999)	0	0
1958	293.7	55	5339	*749	(*8543)	0	0
1959	309.4	55	5625	*1034	(*9000)	0	0
1960	171.9	55	3125	*3131	(*5000)	0	0
1961	171.9	55	3125	*3292	(*5000)	0	0
1962	68.8	55	1250	*2825	(*2000)	0	0
1963	137.5	55	2500	*1533	(*4000)	0	0
1964	44.8	55	814	(*1303)	-	0	0
1965	137.5	55	2500	*2054	(*4000)	0	0
1966	103.1	55	1875	*3013	(*3000)	0	0
1967	103.1	55	1875	*2146	(*3000)	0	0

[1968-82: "Numbers Harvested" derived from reported tonnes of harvest divided by the estimated mean body weight of 55 kg.]

1968	(*300.0)	55	5455	*6819	*9000	0	0
1969	(*225.4)	55	4098	*7632	-	0	0
1970	(*175.9)	55	3198	*5435	-	0	0
1971	(*205.9)	55	3744	*5946	-	0	0
1972	(*221.8)	55	4033	*5100	-	0	0
1973	(*279.1)	55	5075	*8100	*8000	0	0
1974	(*273.0)	55	4964	*6245	*6000	0	0
1975	(*278.9)	55	5071	*6100	*6000	0	0
1976	(*204.9)	55	3725	*6975	*5000	0	0
1977	(*202.2)	55	3676	*3984	*6000	0	0
1978	(*202.0)	55	3673	*6600	*4000	0	0
1979	(*202.9)	55	3689	*3725	*5000	0	0
1980	(*263.1)	55	4784	*7338	*5000	0	0
1981	(*253.1)	55	4602	*2050	*6000	0	0
1982	(*285.2)	55	5185	*6933	*4000	0	0

[1983-95: "Numbers Harvested" derived by dividing the reported tonnes of harvest by mean bodyweights derived by sampling (see text Table A4.6).]

1983	(*263.3)	(*49.6)	5309	*5017	*3000	0	0
1984	(*253.0)	(*52.5)	4819	*4200	*7000	0	0
1985	(*321.6)	(*49.9)	6445	*7816	*6000	0	0
1986	(*241.5)	(*52.2)	4626	*5688	*4000	0	0
1987	(*277.4)	(*45.4)	6110	*5640	*9000	0	0
1988	(*247.3)	(*43.2)	5725	*9533	*7000	0	0
1989	(*244.9)	(*42.0)	5831	*5176	*2700	0	237
1990	(*229.0)	(*43.4)	5277	*5385	*5900	800	0
1991	(*175.0)	(*43.6)	4014	*4894	*4400	0	367
1992	(*192.8)	(*45.4)	4247	*5969	*6000	0	218
1993	(*117.0)	(*40.2)	2910	0	0	0	270
1994	(*45.2)	(*45.4)	996	0	0	0	328
1995	(*18.9)	(*43.7)	432	0	0	0	216
							0

A4.2. Management of Historical Harvest

Between 1968 and 1992, the sea turtle fishery was managed and regulated as a commercial fishery, and was subject to many of the general management directives applied to other fisheries.

Each year, annual catch targets were set by the Committee of Fisheries Management, comprising representatives from different Directorates within the Ministry of Fisheries. In formulating targets, factors taken into account included: the extent of the previous year's catch; any obvious changes in the harvest; and, such new research results as may have been gained. As research effort increased in the 1980's, so too did the information taken into account when setting targets and allocating resources to achieve them.

When targets were established, these were subdivided among the State's Fisheries Enterprises according to local production levels. The Fisheries Enterprises did and continue to co-ordinate the activities of a range of Fisheries Establishments (Co-operatives). Only two are now licenced specifically to fish for turtles on behalf of the State. The allocation of resources by the State, to the Fisheries Establishments, through the Fisheries Enterprises, was and remains based on the estimated minimum needs to meet the target production. The boats and equipment belong to the State.

A4.3. Fisheries Zones

From 1968 to 1995 the Cuban sea turtle fishery has been managed on the basis of four fisheries zones (Fig. A4.1).

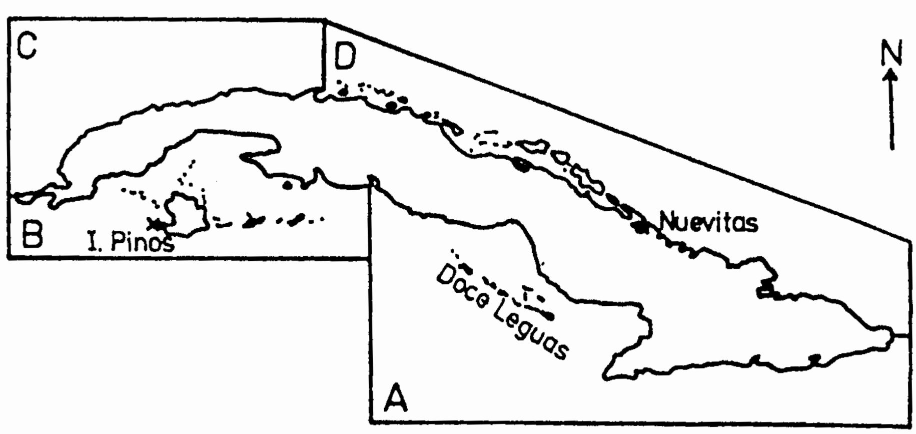

Figure A4.1. Fishery Zones used for regulating and reporting of *E. imbricata* harvests.

A4.4. Boats

Five (5) main types of boat were used in the historical sea turtle fishery.

A4.4.1 *Ferrocemento* - Three-man; 12.9 m long; beam 4.05 m; 95 HP inboard.

A4.4.2. *Cayo Largo* - Three-man; 18.3 m long; beam 4.56 m; 150 HP inboard.

A4.4.3. *Criollos* - Three-man; old boats from before the revolution; beam not taken into account; seven categories recognised based largely on length:

A	5.79 m
B	7.32 m
C	7.32 < 8 m
Cm	8-10 m
D_1	10.06 < 18.28 m
D_2	18.28 < 21.34 m
D_3	21.34 < 21.43 m

A4.4.4. *Sigmas* - Two-man; 10 m long; beam 3.2 m; 25 HP inboard.

A4.4.5. *Cherneras* (Grouper Fishing Boat) - Two-man; 5 m long; beam 1.78 m; 11 HP inboard.

Boats in the fishery were mainly larger boats, which were steadily scaled down through the 1980's (Table A4.2) to increase economic efficiency. The current fishing effort consists of 8 *Cherneras* boats: 4 at Isle of Pines and 4 at Nuevitas.

Table A4.2. Numbers of boats operating in the Cuban sea turtle fishery (1980-95) and *E. imbricata* catch per unit boat per year. Between 1979 and 1993 catch per boat increased significantly, with the average trend being an increase of 0.12 t per boat per year (simple regression, $r^2 = 0.47$; $p = 0.005$). In 1994 and 1995, catch effort data for the full 12 month period are only available for the traditional harvest sites, and in neither case were the 4 boats at each site used to capacity.

Year	Zone A	Zone B	Zone C	Zone D	Total Boats	Total Catch (t)	Catch (t) per Boat
1979	21	15	24	32	92	202.9	2.21
1980	21	13	24	32	90	263.1	2.92
1981	18	14	24	29	85	253.1	2.98
1982	18	13	18	24	73	285.2	3.91
1983	16	12	18	25	71	263.3	3.61
1984	20	10	18	26	74	253.0	3.42
1985	16	10	16	25	67	321.6	4.80
1986	16	10	16	24	66	241.5	3.66
1987	13	10	16	24	61	277.4	4.55
1988	11	10	15	23	59	247.3	4.19
1989	12	8	15	22	59	244.9	4.15
1990	12	6	16	16	50	229.0	4.58
1991	10	7	16	13	46	175.0	3.80
1992	10	7	10	10	37	192.8	5.21
1993	7	4	9	12	32	117.0	3.66
1994	0	4	0	4	8	17.6	2.20
1995	0	4	0	4	8	18.9	2.36

A4.5. Nets

Three types of net were used:

A4.5.1. *Superficie* (top net). 50-60 fathoms long, 12-15 meshes deep, 46-53 cm mesh size, floats but no lead line.

A4.5.2. *Calamento* ("set" net). 120-235 fathoms, 12-40 meshes deep, 38-48 cm mesh size. Set in areas from shallow to deep.

A4.5.3. *Fondo* (bottom net). 50-60 fathoms long, 12-15 meshes deep, 43-53 cm mesh size. Has heavy lead line to sink to the bottom, such that the floats are submerged and the net fishes the bottom layers.

In 1991, the Ministry of Fisheries undertook research aimed at standardising the effectiveness of different nets, so as to better quantify fishing effort. The results were:

1 *Calamento* = 5.03 *Superficie*
1 *Fondo* = 2.5 *Superficie*

Therefore total fishing effort (in terms of *Superficie* nets) was:

Total *Superficie* = No. of *Superficie* + 2.5*Fondo* + 5.06 *Calamentos*.

A4.6. Fishing Effort over Time

For the years 1988 to 1992, information on the total number of nets being used in the sea turtle fishery was gathered, standardised and analysed. Despite limitations of sample size (only 5 years), the results (Table A4.3) are consistent with catch per unit effort not declining during the period 1988 to 1992. The only Zone in which any change was statistically significant was Zone D, in which catch per unit net increased consistently.

Table A4.3. Catch per unit effort assessed for five years in which detailed information on the numbers and types of nets in the fishery were gathered. "Nets" refers to "*Superficie* net equivalents" (see Section A4.5 above). WT = tonnes of *E. imbricata* caught; CN = Catch per net. Regression statistics include direction of trend and significance.

Year	Zone A			Zone B			Zone C			Zone D			Total		
	Nets	WT	CN	Nets	WT	CN	Nets	WT	CN	Nets	WT	CN	Nets	WT	CN
1988	513	96.5	.19	440	51.2	.12	750	30.9	.04	296	69.3	.23	1999	247.9	.12
1989	580	92.5	.16	513	52.4	.10	750	25.8	.03	296	75.2	.25	2139	244.9	.11
1990	543	98.6	.18	350	24.2	.07	750	35.0	.05	286	71.2	.25	1929	229.0	.12
1991	468	66.1	.14	350	24.7	.07	750	25.8	.03	211	58.5	.28	1779	175.1	.10
1992	388	84.6	.21	350	30.4	.09	750	21.1	.03	195	56.8	.29	1683	192.9	.11
Slope			+			-			-			+			-
r^2			0.05			0.49			0.35			0.90			0.31
p			0.71			0.19			0.30			0.01			0.33

A4.7. Zone-Specific Harvest Levels

Up to 1990, when the industry was scaled down, Zones A and D accounted for 64% and Zones B and C for 36% of the mean annual harvest (260 tonnes; Table A4.4).

Table A4.4. Percentage of total harvest from each Fisheries Zone for 1983-95. The harvest was deliberately scaled down from 1990 onwards.

Year	Zone A (%)	Zone B (%)	Zone C (%)	Zone D (%)	Total Harvest (tonnes)
1983	27.4	25.8	16.1	30.7	263.3
1984	31.7	19.4	21.4	27.5	253.0
1985	36.7	12.9	23.1	27.4	321.6
1986	34.8	15.6	26.7	22.9	241.5
1987	43.7	18.7	15.7	21.9	277.4
1988	38.9	20.7	12.5	28.0	247.3
1989	37.6	21.3	10.5	30.6	244.9
1990	43.1	10.6	15.3	31.1	229.0
Mean	36.7	18.1	17.7	27.5	259.8
1991	37.8	14.1	14.7	33.4	175.0
1992	43.9	15.8	10.9	29.5	192.8
1993	47.9	12.0	7.7	32.5	117.0
1994	24.3	19.7	17.0	38.9	45.2
1995	-	71.4	-	28.6	18.9

A4.8. Sample Data

From 1983, samples of *E. imbricata* caught during the harvest, from each Zone, were measured and had their reproductive status determined by direct examination of gonads and reproductive tracts (Moncada and Nodarse 1994; see Annex 6). The sample data were extensive for Zone A, less so for Zone D (Table A4.5), and more incomplete again for Zones B and C.

Table A4.5. Samples of *E. imbricata* measured from each Zone from 1983-95. Those taken in 1985 and 1986 (bold) came from throughout each Zone, rather than from a single sampling area, and were taken in all months and not just the open season: that is, they are not directly comparable with data from other years.

Year	Zone A	Zone B	Zone C	Zone D	Total
1983	94	179	26	0	299
1984	400	287	238	0	925
1985	**457**	**408**	**693**	**259**	**1817**
1986	**637**	**364**	**398**	**335**	**1734**
1987	1041	0	0	186	1227
1988	355	28	0	110	493
1989	395	57	0	113	565
1990	326	0	0	164	490
1991	315	0	0	111	426
1992	133	22	0	54	209
1993	259	0	0	87	346
1994	0	0	0	38	38
1995	0	0	0	42	42
All	4412	1345	1355	1499	8711

A4.9. Sample Data - Zone-Specific Differences in Size

The sample data indicate significant differences in the size structure of the *E. imbricata* caught in each zone: these trends are best exemplified by the extensive 1985-86 data (Table A4.4).

Table A4.6. Variation in the mean size of *E. imbricata* from the four Fisheries Zones, as determined by sampling in 1985-86.

	Straight Carapace Length (cm)			Body Weight (kg)		
	1985	1986	Mean	1985	1986	Mean
Zone A	65.2	64.8	65.0	38.5	37.8	38.2
Zone B	68.6	67.6	68.1	44.1	43.1	43.6
Zone C	72.7	76.7	74.7	54.0	64.7	59.4
Zone D	78.5	78.9	78.7	64.3	65.7	65.0

The biological significance of these differences is unclear, although it is consistent with Zones A and B, with extensive areas of water under 20 m deep (Table A2.3), being the major areas within Cuba where younger, smaller *E. imbricata* live and grow.

A4.10. Sample Data - Mean Size of *E. imbricata* Harvested

To estimate the mean size of *E. imbricata* harvested each year for the period 1983-94 (for Table A4.1), the percentage of the total harvest from each Zone (Table A4.4) was combined with Zone-specific mean body weights. This required a number of correction factors and estimates, because after 1985-86: not all Zones were sampled annually; the areas that were sampled were from a more restricted area in a particular Zone; sample sizes were sometimes small; closed seasons were introduced; closed seasons were changed; and, there were changes in fishing effort. The approach taken was:

- where Zone-specific sample data (Table A4.5) provided a mean-sized turtle for a particular Zone, in a particular year, the value was accepted (Table A4.8).

- where no sample was available for a particular month in a zone, an estimate was derived using Table A4.7. This involved correcting the mean 1985-86 weights by the mean changes for the years before and after.

The results are summarised in Table A4.8.

Table A4.7. Relationship between the mean body weight (BWt, in kg) of *E. imbricata* caught in the intensive 1985-86 sampling period, and that caught in samples from the same Zones before and after that period.

	Zone A	Zone B	Zone C	Zone D	All
1985/86					
Mean BWt	38.2	43.6	59.4	65.0	51.6
N	1094	772	1091	594	4
1983/84					
% Change	+21.5	+12.8	-34.9	-	+4.1
N	494	466	264	-	3
1987/94					
% Change	-6.5	-19.3	-	-15.5	-13.8
N	2824	107	-	853	3

Table A4.8. Mean body weight (BWt) of animals harvested from each Zone in each year. Values in brackets are where there were missing data and the values are those predicted from Table A4.7. "Mean BWt" is that calculated from the mean weight adjusted for Zone-specific harvest levels (Table A4.4). *values derived from the mean weight of all individuals caught. [The mean BWt values in this Table are the ones included in Table A4.1 (1983-95)].

Year	Zone A (kg)	Zone B (kg)	Zone C (kg)	Zone D (kg)	Mean BWt (kg)
1983	45.56	45.87	33.17	(64.88)	49.58
1984	47.25	52.47	44.28	(64.88)	52.48
1985	38.45	44.06	53.99	64.27	49.88
1986	37.77	43.10	64.69	65.73	52.19
1987	38.82	(37.61)	(51.24)	60.92	45.38
1988	36.83	33.44	(51.24)	55.48	43.19
1989	34.56	32.06	(51.24)	54.87	41.99
1990	35.86	(37.61)	(51.24)	51.92	43.43
1991	33.32	(37.61)	(51.24)	54.32	43.57
1992	38.96	40.23	(51.24)	55.44	45.40
1993	31.48	(37.61)	(51.24)	51.14	40.16
1994	32.92*	36.10*	(51.24)	55.50	45.41
1995	-	39.64*	-	53.75	43.69

Clearly, shifts in the total annual harvest towards Zones A and B (Table A4.4) result in a smaller mean size of turtle caught (Fig. A4.2), whereas shifts towards Zones C and D do the opposite. The analysis of trends in the population size structure over time are addressed separately in Annex 5.

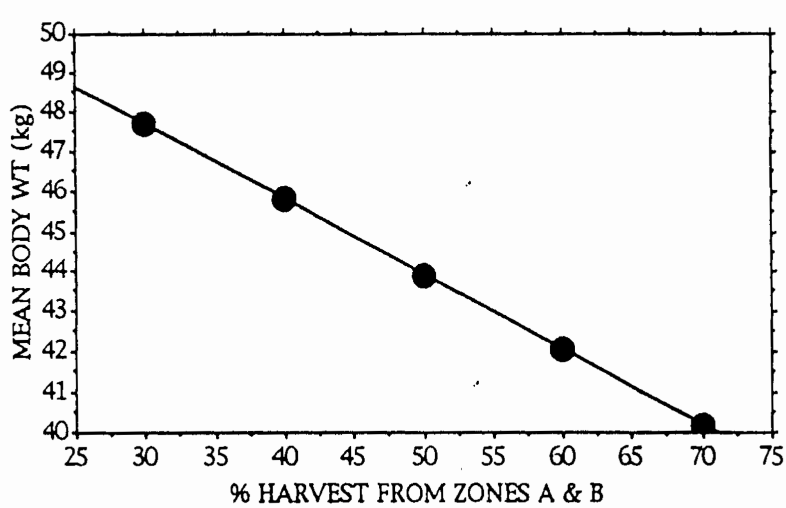

Figure A4.2. The theoretical relationship between the mean size of *E. imbricata* harvested in Cuba, and the percentage of the harvest taken in Zones A and B, where average size is smaller than in Zones C and D (based on 1994 Zone-specific body weights in Table A4.8).

ANNEX 5. Trends in the Harvest Data over Time

Carrillo, E.C., Moncada, F.G., Nodarse, G.A., Perez, C.P. and A.M. Rodriguez.

The sampling data taken from each Zone during the historical harvest of *E. imbricata* in Cuba (Annex 4), although sometimes incomplete, provide insights into the impacts of harvesting on the size structure and sex ratio of the population harvested. The results are important to any assessment of the likely impacts of the much reduced traditional harvest now in place.

If a harvest was sustainable over time, it would be expected that the size structure would change significantly when harvest pressures increased, and gradually stabilise as density-dependent factors came into play. That is, that older larger adults would be systematically removed, with the population becoming more dependent on younger adults, quite probably with a different set of age-specific survival values and other population dynamic parameters. Stability of size structure does not prove a harvest is sustainable in the long-term, as many other factors are involved (Congdon *et al.* 1994; JBA 1994, 1995; Heppell *et al.* 1995; Heppell and Crowder 1996; Mortimer 1995). However, if a harvest was clearly unsustainable, the population size structure would remain unstable, and management actions would need to be implemented to reduce or change the harvest.

A5.1. Sample Data

Making direct comparisons over time is complicated by: the non-random nature of sampling; the small numbers of animals sampled in some months in some Zones (Annex 4); changes in the mean size of animals caught in different months; and, alterations to closed seasons. To reduce variation, subsets of sample data were chosen for each Zone which included *E. imbricata* sampled in the same months, over succeeding years. Years were lumped, as appropriate to increase sample sizes. Contingency table analyses were applied to the raw data (with 80<90 and >90 cm SCL categories lumped), to determine whether the changes in size structure were significant. Some additional harvest records (rather than sampling data) are available for some sites within a Zone, providing further insights into the changes in size structure that have occurred.

The intensive sampling program carried out in 1985-86 (Annex 4), to quantify the reproductive status of *E. imbricata* throughout the year, is a further bias that cannot be adequately accounted for. The samples examined in that year, in some Zones, were not from the normal harvest areas from which *E. imbricata* were sampled. There are of course other biases associated with exactly how the harvest was carried out from year to year, in each Zone, although these cannot be quantified precisely.

A5.2. Zone-specific Trends

Zone A

By 1986 (Table A5.1), there had been a decrease in the proportion of larger (80<90 cm SCL) *E. imbricata* in the Zone A harvest samples. Despite various management actions (changes in closed-seasons; size limits), the size structure did not stabilise over time, and less larger animals were recorded each year. Zone A was fully protected in 1994. The same trend is apparent from examining the mean size of all animals sampled in Zone A from all years (Fig. A5.1). There is a decline in the mean size between 1983 and 1993 (linear regression: $r^2 = 0.60, p = 0.005; N = 11$). This is comprised of a decline between 1984 and 1985, after which the trend continues, although at a lesser rate, which does not reach statistical significance (1985-93: linear regression: $r^2 = 0.32, p = 0.12; N = 7$). The increase in mean size in

1992 reflects in part increased harvesting effort in new areas, prior to the cessation of exports from Cuba.

Table A5.1. Size distribution (percentages) of *E. imbricata* >60 cm SCL sampled in Zone A for the months February to May, 1984 to 1993. Years have been lumped to increase sample sizes. $\chi^2 = 32.9$; p = <0.001. SCL = straight carapace length.

SCL (cm)	60<70 (%)	70<80 (%)	80<90 (%)	>90 (%)	N
1984-85	49.3	37.9	10.7	2.1	140
1986	58.3	36.2	5.0	0.5	218
1987	53.3	42.6	3.8	0.3	345
1988-89	60.3	34.0	5.1	0.6	156
1990-91	65.6	30.3	4.1	0.0	122
1992-93	77.3	24.3	1.4	0.0	70

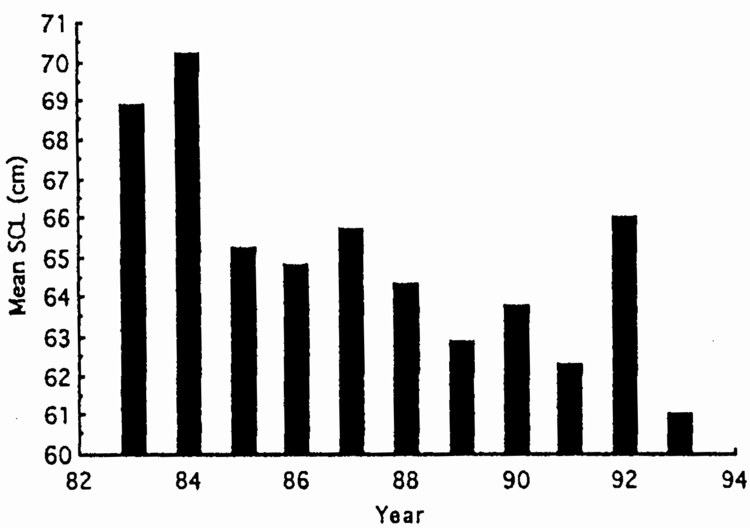

Figure A5.1. The mean size (cm SCL) of *E. imbricata* in Zone A as revealed by all available sample data for all months and years (N = 4412).

Zone B

The limited sample data available indicate a significant change in the size structure between 1984-86 and 1988-89 (Table A5.2). However, whether the size structure continued to decline or stabilised cannot be determined for the Zone as a whole.

Table A5.2. Size distribution (percentages) of *E. imbricata* >60 cm SCL sampled in Zone B for the months February and March, 1984 to 1989. Years are lumped to increase sample sizes. $\chi^2 = 20.0$; p = <0.001. SCL = straight carapace length.

CL (cm)	60<70 (%)	70<80 (%)	80<90 (%)	>90 (%)	N
1984-86	15.4	49.2	32.3	3.1	65
1988-89	62.5	29.2	8.3	0.0	24

Better insights into long-term trends in Zone B can be obtained from the more complete set of raw harvest data available for the traditional harvest site at the Isle of Pines (within Zone B). These data reflect similar catch effort, largely by the same people, using similar catch equipment, over a longer period of time (Table A5.3; Fig. A5.2).

Table A5.3. Harvest data from the Isle of Pines, 1983 to 1995. MCL = mean SCL in cm derived from Mean Weight. Data for 1987 and 1988 are incomplete.

	January		February		October		November		December		Total	Mean
Year	N	MCL	N	MCL	N	MCL	N	MCL	N	MCL	N	MCL
1983	8	73.9	10	76.8	69	70.0	52	68.8	24	68.5	163	70.0
1984	24	70.5	22	73.5	72	70.3	25	66.7	23	67.4	166	69.8
1985	12	70.4	18	77.1	36	70.4	45	67.4	16	67.9	127	70.0
1986	15	71.5	11	79.2	55	69.6	52	66.2	48	66.9	181	68.7
1989	18	64.9	19	70.9	103	67.0	27	68.5	23	64.6	190	67.1
1990	15	68.6	16	70.8	83	64.6	40	66.3	25	68.7	179	66.4
1991	20	68.6	39	66.9	70	64.7	33	65.7	20	72.8	182	66.7
1992	5	63.7	21	72.8	73	67.9	58	67.7	38	70.3	195	68.7
1993	9	67.0	26	70.4	44	69.1	54	68.3	25	68.0	158	68.8
1994	5	66.2	22	71.6	16	61.0	38	67.1	49	67.7	130	67.3
1995	17	64.3	28	72.2	58	65.1	48	67.3	22	68.8	173	67.3

There are no consistent trends over time in the numbers of *E. imbricata* caught, which is consistent with the observations of traditional fishermen operating from this site for over 50 years. The rates of catch for *E. imbricata* are much the same now as they were in the past. They vary up and down from year to year and are influenced by the weather.

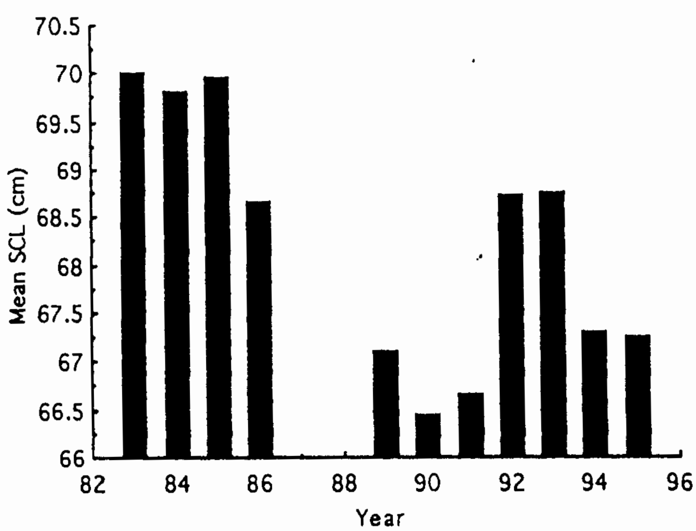

Figure A5.2. The mean size of *E. imbricata* harvested at the Isle of Pines, within Zone B.

Mean size of the 637 animals caught within the same 5 months between 1983 and 1986 (69.6 cm SCL), was higher than that of 1207 animals caught in the same months between 1989 and 1995 (67.5 cm SCL). However, between 1989 and 1995 no significant change in mean size has occurred (linear regression: $r^2 = 0.12$, $p = 0.44$; $N = 7$). Continued monitoring at this traditional harvest site will provide insights into the impacts of reducing the total Cuban harvest. With the exception of this one traditional harvest site on the Isle of Pines, *E. imbricata* are now protected throughout Zone B.

Zone C

In Zone C, which contributed 17.7% to the total harvest up to 1990, limited sample data are available (Annex 4). Those data indicate that between 1984 and 1986 there was a significant increase in the number of large animals taken in the harvest. To some extent this may be biased by the increased sampling, in new areas, that took place in 1985-86. *E. imbricata* are now protected throughout Zone C.

Table A5.4. Size distribution (percentages) of *E. imbricata* >60 cm SCL sampled in Zone C for the months January to May, July, September, November and December 1984 to 1986. $\chi^2 = 62.5$; $p = <0.001$.

CL (cm)	60<70 (%)	70<80 (%)	80<90 (%)	>90 (%)	N
1984	28.1	50.0	22.0	0.0	164
1985	32.4	39.3	23.3	5.0	377
1986	18.5	24.2	33.7	23.6	178

Zone D

In Zone D, a change in the size structure of the harvested population occurred between 1985 and 1995. This was mainly a change between 1985-86 and 1987-88, perhaps partly attributable to the reproductive sampling undertaken in 1985 and 1986. In the 8 years since 1988, the size structure has remained reasonably stable (with 1985-86 removed: $\chi^2 = 3.0$; $p = <0.81$). This trend is also apparent when all available sample data for Zone D are examined (Fig. A5.3): there was no significant change in the mean size of *E. imbricata* caught between 1988 and 1995 (linear regression: $r^2 = 0.01$, $p = 0.78$; $N = 8$).

Table A5.5. Size distribution (percentages) of *E. imbricata* >60 cm SCL sampled in Zone D for the months March, April, September and October, 1985 to 1994. Years have been lumped to increase sample sizes. $\chi^2 = 34.9$; $p = <0.0001$. SCL = straight carapace length.

SCL (cm)	60<70 (%)	70<80 (%)	80<90 (%)	>90 (%)	N
1985-86	14.1	32.2	40.3	13.4	149
1987-88	26.1	42.0	24.2	7.6	157
1989-90	27.5	47.7	22.9	2.0	153
1991-92	23.9	45.7	30.4	0.0	92
1993-95	22.4	50.0	26.3	1.3	76

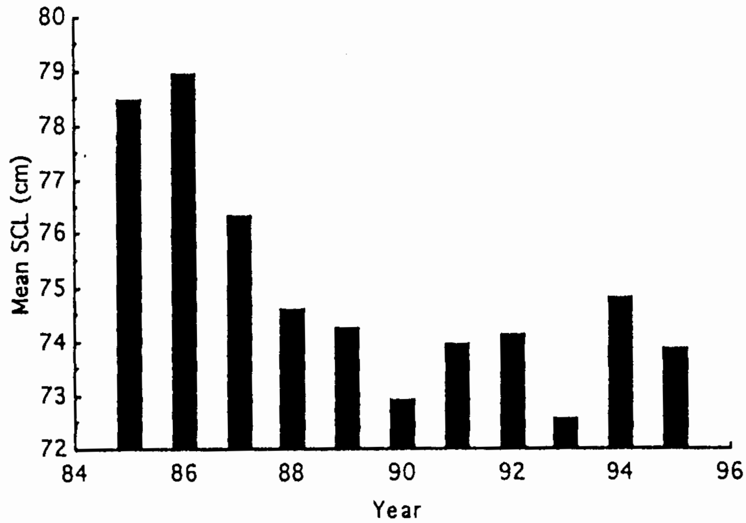

Figure A5.3. The mean size (cm SCL) of *E. imbricata* caught in Zone D, as revealed by all available sample data for all months (N = 1447).

Table A5.6. Harvest data (tonnes body weight) for *E. imbricata* from Nuevitas between 1980 and 1995. Trends are simple regressions indicating slope over time and significance. "*" indicates a significantly better fit with a negative polynomial: that is, harvests declined in the early years and increased in later years (-/+) or vice versa (+/-). Data for 1994 and 1995 were excluded because they refer only to the main traditional harvest site at Nuevitas (Punta Ganado). Estimated numbers (Est. No.) derived from mean values for Zone D (Annex 4).

Year	J	F	M	A	M	J	J	A	S	O	N	D	Total	Est. No.
1980	0.6	0.6	0.9	1.8	3.9	-	-	-	3.0	3.3	1.3	0.1	15.5	239
1981	0.5	1.1	0.5	2.7	2.4	0.7	-	-	5.3	3.6	1.1	1.4	19.3	298
1982	-	-	1.1	3.6	3.2	1.9	-	-	3.4	3.2	1.5	2.6	20.5	316
1983	-	0.2	1.2	1.9	2.1	0.6	-	-	5.7	3.3	0.9	5.2	21.1	325
1984	-	-	0.7	2.0	3.2	0.5	-	-	3.4	2.5	0.9	8.5	21.7	335
1985	-	-	0.8	2.0	1.9	4.2	4.0	2.0	2.5	1.7	0.4	-	19.5	303
1986	0.1	0.1	1.3	1.2	2.6	3.7	6.6	4.3	2.4	1.9	0.2	0.3	24.7	376
1987	-	0.4	0.5	1.1	2.4	0.3	-	-	3.7	3.1	0.9	-	12.4	304
1988	-	-	0.2	0.9	0.1	-	-	2.7	3.2	2.0	0.7	0.4	10.2	184
1989	-	0.4	1.2	1.1	0.5	-	-	4.7	3.0	-	-	-	10.9	259
1990	0.4	0.3	0.7	1.5	-	0.1	-	5.5	3.8	1.8	0.2	0.1	14.4	277
1991	-	0.2	1.3	1.3	0.5	0.1	-	4.2	3.2	3.1	1.3	-	15.2	280
1992	0.6	0.5	0.6	1.8	0.7	-	0.7	6.7	4.0	3.0	1.0	0.1	19.7	355
1993	-	0.7	0.1	1.2	0.4	0.1	0.2	5.4	3.9	2.9	-	-	14.9	291
1994	-	0.5	1.2	1.0	0.7	0.3	0.2	1.1	-	-	-	-	5.0	98
1995	-	0.4	-	-	0.1	-	-	1.0	1.0	0.3	0.3	-	3.1	62
	*	*						*				*		
Slope	-/+	-/+	-	-	-	-	-	+/-	-	-	-	+/-	-	-
r^2	.97	.35	.01	.42	.75	.14	.83	.52	.16	.28	.20	.30	.16	.002
p	.03	.15	.70	.01	.0001	.25	.03	.08	.14	.05	.12	.34	.15	.88

For Nuevitas, within Zone D, harvest effort and methods have been similar and data in terms of the total weight of *E. imbricata* caught are available (Table A5.6). The decline in May reflects a reduction in harvesting due to altered closed seasons. Harvests from some months were reported in the next months totals, and some harvesting in closed seasons was allowed in some years for various reasons.

The results indicate that the total harvest has not changed significantly in terms of total weight or numbers caught over the harvest period. With the exception the traditional harvest area at Nuevitas (Annex 9), *E. imbricata* throughout Zone D are now protected. Improved monitoring of the harvest has now been implemented.

Summary

The historical harvest clearly resulted in changes to the size structure of the *E. imbricata* population. The general trend was a marked decline in the early 1980's in all Zones.

In Zone A, which is largely comprised of warm, shallow waters with reefs, the structure of any one year's harvest varied greatly and was highly dependent on where fishermen fished. For example in 1992, before the export ban, the fishing extended into parts of the Zone not normally fished, and this was reflected in an increased mean size (Fig. A5.1). It is consistent with the distribution and abundance of *E. imbricata* being more patchy in this Zone than in others, and with the harvest effecting some patches more than others. Based on the general decline in mean size, the harvest was considered unsustainable and Zone A was fully protected in 1994.

The sample data available for Zone C are not sufficient to determine what happened after 1986. However, for Zones B and D, the results are consistent with an initial decrease in mean size, followed by a period of stability in the size structure - that is, annual fluctuations around a stable mean. This is consistent with a higher level of sustainability being achieved, although many other factors are involved (Mortimer 1995).

With the exception of the traditional harvest sites in Zones B and D (Annex 9), *E. imbricata* are now fully protected throughout Cuba. Continued monitoring at the traditional harvest sites will provide definitive information on the effectiveness of the reduction in harvest pressure.

A5.3. Sex Ratio

The harvested population is strongly biased towards females (Table A5.7). This could be a result of temperature-dependent sex determination (i.e. the wild population could be biased towards females from hatching), or it could be the result of a variety of sex-specific natural history traits resulting in increased capture of females. That Limpus (1992) reports 72% of wild *E. imbricata* caught in and around Heron Island to also be females, is consistent with the results from Cuba, and strongly suggests a biased sex ratio through all age classes due to temperature-dependent sex determination (Mrosovsky 1994; Mrosovsky *et al.* 1992).

The degree to which sex ratios have changed during the period of harvest can be examined through the sample data, using the Zones (A and D) and months for which samples spanned a number of years (Table A5.8). All animals were sexed by autopsy and direct examination of the gonads and reproductive tracts. In neither Zones A nor D has the sex ratio shown any significant change over time, despite changes in the sex ratio of sampled animals from year to year.

These results are consistent with the historical harvest causing no significant alteration to the sex ratio of the population.

Table A5.7. Variation in *E. imbricata* sex ratio (SR; proportion of females) as a function of Zone and period of capture. Data from the 1985 and 1986 samples, using animals greater than 60 cm SCL, where sex can be more reliably determined. Ratios in bold type are the highest for each Zone and those underlined are the lowest.

Period	Jan-Mar		Apr-Jun		Jul-Sep		Oct-Dec		Mean
	SR	N	SR	N	SR	N	SR	N	SR
Zone A	**0.80**	145	0.79	200	0.70	137	0.66	240	0.74
Zone B	0.82	59	0.85	163	**0.87**	249	0.80	128	0.84
Zone C	0.79	81	0.65	400	0.66	286	**0.81**	146	0.73
Zone D	0.63	34	0.83	208	**0.85**	308	0.82	34	0.78
Means	0.76	4	0.78	4	0.77	4	0.77	4	0.77

Table A5.8. Variation over time in the sex ratio (SR; proportion of females) of *E. imbricata* examined in samples from Zones A (February to May) and D (March, April, September and October) for equivalent months. N = number of animals sexed. Years have been lumped to increase sample sizes.

	Zone A			Zone D	
Year	N	SR	Year	N	SR
1984-85	205	0.87	1985-86	152	0.80
1986	354	0.92	1987	103	0.83
1987	473	0.76	1988-89	136	0.82
1988	178	0.89	1990-91	162	0.90
1989	103	0.92	1992-95	132	0.87
1990	119	0.89			
1991	105	0.91			
1992-93	118	0.90			

ANNEX 6. Reproduction and Nesting of *E. imbricata* in Cuba

Moncada, F.G., Perez, C.P., Nodarse, G.A., Elizalde, S.R., Rodriguez, A.M., and A. Meneses.

Information on *E. imbricata* reproduction within Cuban waters is available from the animals sampled during the historical harvest (Annex 4), and from nesting research.

A6.1. Size at Maturity

Female *E. imbricata* in the 51-55 cm SCL range may be mature, although the size at which most females mature is >76 cm SCL(Table A6.1). The smallest mature females in the samples were three individuals at 53 cm SCL with enlarged follicles and three at 54 cm SCL with enlarged follicles, one of which also had oviducal eggs.

Table A6.1. The relationship between size (SCL) and reproductive activity in a sample of 6789 female *E. imbricata* examined in Cuban waters between 1983 and 1993. Values are percentages and numbers in brackets are sample sizes. "Estimated Percentage Mature" is based on a 2.42 correction (see text) for animals <81 cm SCL, and assumes all (100%) females 81 cm SCL or greater are mature. "Follicles" = enlarged ovarian follicles, but no oviducal eggs; "Eggs" = oviducal eggs (in most cases these individuals also had enlarged follicles).

SCL (cm)	31-40	41-50	51-55	56-60	61-65	66-70	71-75	76-80	81-85	86-90	>90
Sample Sizes	(32)	(395)	(643)	(849)	(973)	(1091)	(1022)	(896)	(481)	(271)	(136)
Follicles	0	0	1.2	1.3	1.9	3.0	5.9	13.7	30.6	40.2	36.8
Follicles and Eggs	0	0	0.3	0.4	0.9	1.5	2.1	5.0	5.6	8.9	6.6
Eggs (no Follicles)	0	0	0	0	0.1	0	0	0.3	0.4	0	0
Total Reproductively Active	0 (0)	0 (0)	1.6 (10)	1.7 (14)	2.9 (28)	4.5 (49)	7.9 (81)	19.1 (171)	36.6 (176)	49.1 (133)	43.4 (59)
Estimated % Mature	0	0	3.9	4.1	7.0	10.9	19.1	46.2	100	100	100

If it is assumed that:

- all females >81 cm SCL are mature;
- the 41.4% (368/888) with enlarged follicles or eggs represent an expected result from mature females nesting each 2-3 years (Hoyle and Richardson 1993; Garduno and Marquez 1996); and,
- the same proportion of reproductively active:inactive females in any one year applies to both small and large mature females,

then a correction of 2.42 (100/41.4) can be applied to reproductively active individuals in all size classes, to obtain a first estimate of the likely proportion of mature (rather than simply reproductively active) females in each size class (Table A6.1)[Hoyle and Richardson (1993) estimate females in Antigua return to nest each 2.53 years, and Garduno and Marquez (1996) estimate females in Mexico to return to nest each 2.36 years].

Few data are available on the sizes at which males mature, although individuals of 68 cm SCL have been recorded with enlarged testes. This aspect of reproduction in *E. imbricata* is currently being studied in Cuba (Moncada 1994b).

A6.2. The Seasonal Reproductive Cycle

To quantify general trends in Cuba, monthly results for all females over 75 cm SCL with oviducal eggs, from all areas, for all years, were lumped (Table A6.2).

Table A6.2. Percentage of female *E. imbricata* >75 cm SCL which contained oviducal eggs, as a function of month of capture. Data from all areas and years are lumped. Numbers in brackets are numbers of females examined.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All
7.1	1.6	0.9	3.4	2.4	6.2	4.9	4.5	10.6	9.0	9.9	16.0	6.1
(42)	(63)	(117)	(148)	(208)	(227)	(223)	(201)	(263)	(145)	(81)	(75)	(1793)

From these data (Table A6.2) it is apparent that:

1. *E. imbricata* in Cuban waters contain oviducal eggs in all months of the year.
2. Females with oviducal eggs are least common in March (0.9%).
3. The percentage of females with oviducal eggs increases in June (6.2%)
4. A major increase in the percentage of females with oviducal eggs occurs in September (10.6%).
5. The percentage of females with oviducal eggs remains high in October and November, reaching its maximum level in December (16.0% of animals examined).

The general pattern above needs to be interpreted cautiously, because there are significant Zone-specific trends (Table A6.3).

Table A6.3. Samples of female *E. imbricata* >75 cm SCL examined from each Fisheries Zone (A-D). "Follicles" refers to animals with enlarged ovarian follicles but no oviducal eggs, and "Eggs" refers to animals with oviducal eggs, and usually a complement of enlarged follicles (5 individuals had oviducal eggs but no enlarged ovarian follicles).

Month	Sample Size				Follicles				Eggs			
	A	B	C	D	A	B	C	D	A	B	C	D
Jan	20	11	4	7	3	1	0	1	2	0	1	0
Feb	22	17	12	12	2	10	2	5	1	0	0	0
Mar	33	27	22	35	2	6	4	13	0	0	0	1
Apr	43	21	28	56	1	14	11	13	2	0	3	0
May	56	36	60	56	13	15	21	18	3	1	0	1
Jun	34	38	91	64	3	10	32	8	3	2	8	1
Jul	38	18	86	81	4	8	21	4	1	0	10	0
Aug	27	24	29	121	5	7	4	26	4	3	2	0
Sep	76	53	16	118	25	10	2	32	16	4	3	5
Oct	39	48	1	57	14	6	0	13	7	2	1	3
Nov	37	26	7	11	17	3	0	6	5	0	3	0
Dec	45	8	20	2	13	1	0	0	11	1	0	0

Excluding monthly samples in which less than 10 individuals were examined, the information in Table A6.3 is expressed in terms of the percentage of females with FOLLICLES (%F), EGGS (%E) and FOLLICLES AND EGGS (%FE) for each month in each Zone (Figs. A6.1 to A6.4).

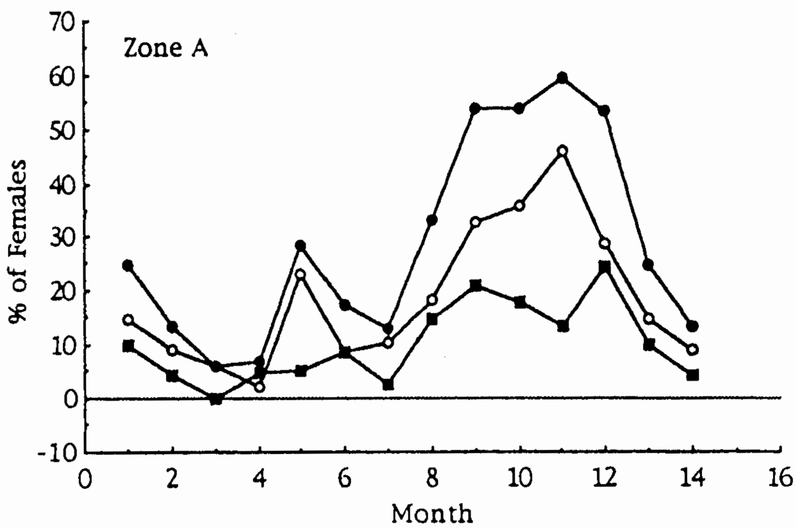

Figure A6.1. Monthly variation in Zone A in the percentage of female *E. imbricata* >75 cm SCL recorded as having FOLLICLES (open circles), EGGS (closed squares) and FOLLICLES AND EGGS (closed circles). Month: 1 = January, 2 = February, etc. Months 13 and 14 are the same data as Months 1 and 2.

In Zone A (Fig. A6.1) in May, there is a small increase in the percentage of females captured that have enlarged follicles, but not in the percentage of females with oviducal eggs. That this is a real, annual occurrence is confirmed by the fishermen. It corresponds with the period of increased nesting by *Chelonia mydas* and *Caretta caretta*, and may represent reproductive activity within some *E. imbricata* being triggered by reproductive activity in the other species.

The main period of reproductive activity extends from August to January. The peak of animals containing eggs is in December, which is consistent with the results of nest surveys (Table A6.7). December is also the time when *E. imbricata* with eggs are rarely found in Zone D, which would be consistent with increased movement of animals into Zone A for nesting.

Regardless of the situation in May (see above), which is clearly an exception, when all months are considered the percentage of animals with oviducal eggs in any month is highly and positively correlated with (and can be predicted from), the percentage of animals with enlarged follicles (%F) in the same month, or the month before (%F-1) [%E = 2.5 + 0.41%F; r^2 = 0:53; p = 0.008 (by chance the exact same formula applies to %F-1)]. This suggests that in Zone A, the animals with enlarged follicles are the ones that nest in Zone A. In none of the other Zones is this correlation anywhere near significant (r^2's = 0.005 to 0.05). This suggests that a significant proportion of females caught with enlarged follicles in the other Zones may move out of their capture Zone to nest (which does not appear to be the case in Zone A).

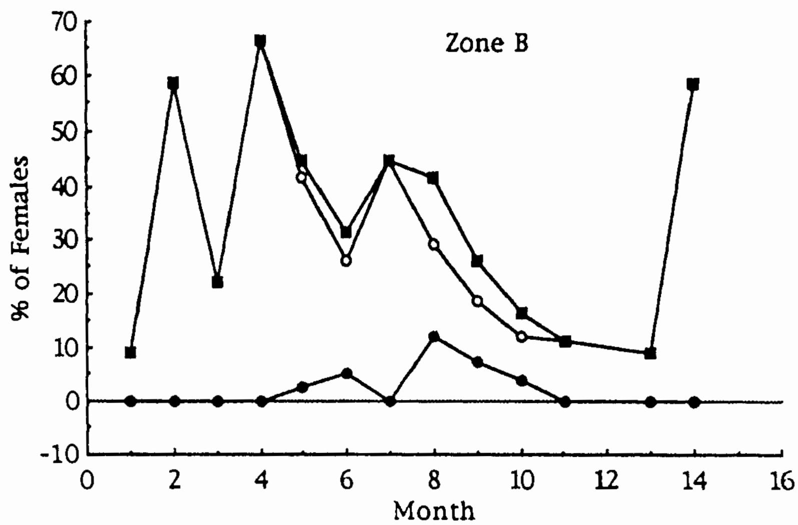

Figure A6.2. Monthly variation in Zone B in the percentage of female *E. imbricata* >75 cm SCL recorded as having FOLLICLES (open circles), EGGS (closed circles) and FOLLICLES AND EGGS (closed squares). Month: 1 = January, 2 = February, etc. Months 13 and 14 are the same data as Months 1 and 2.

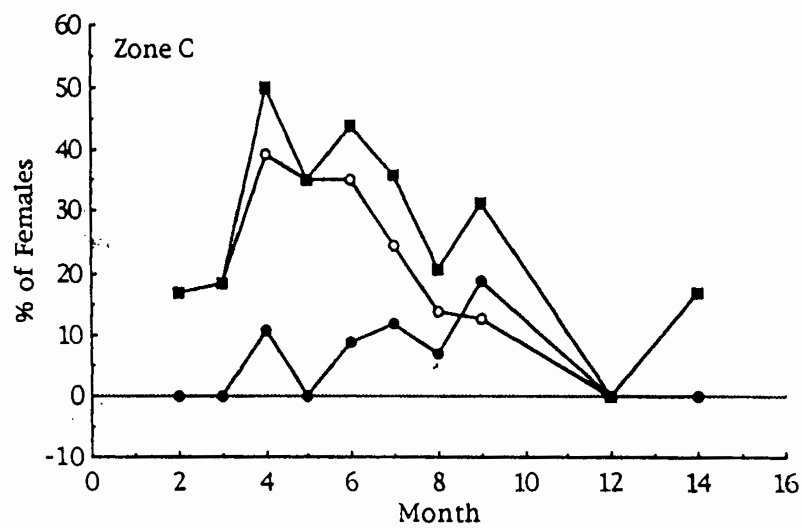

Figure A6.3. Monthly variation in Zone C in the percentage of female *E. imbricata* >75 cm SCL recorded as having FOLLICLES (open circles), EGGS (closed circles) and FOLLICLES AND EGGS (closed squares) in Zone C. Month: 1 = January, 2 = February, etc. Month 14 is the same data as Month 2.

In contrast to Zone A (Fig. A6.1), where the peak of animals with enlarged follicles occurs late in the year, within Zones B, C and D (Figs. A6.2 to A6.4) the highest percentages of *E. imbricata* with enlarged follicles occur early in the year. The early peak in Zones B,C and D is correlated with an increase in %F in Zone A in May (Fig. A6.1), but there is no corresponding increase in %E. That is, the general increase in follicular development in Cuba early in the year does not appear to be reflected in an increase in nesting in Zone A. However, it does correlate with an increase in %E in Zone C [0% to 10.7% (April)], which has recently been identified as a significant nesting site within Cuba (see Section A6.4).

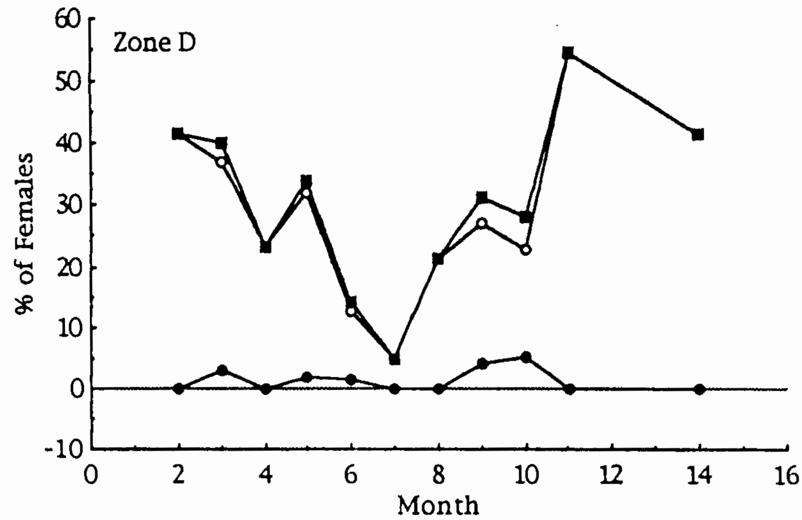

Figure A6.4. Monthly variation in Zone D in the percentage of female *E. imbricata* >75 cm SCL recorded as having FOLLICLES (open circles), EGGS (closed circles) and FOLLICLES AND EGGS (closed squares). Month: 1 = January, 2 = February, etc. Month 14 is the same data as Month 2.

When comparing all data from all Zones, it is clear that regardless of significant numbers of animals being found with enlarged follicles in Zones B and D ("Follicles" and "Follicles+Eggs" in Table A6.4), few are found with oviducal eggs but no enlarged follicles: that is, animals thought to be completing their last clutch.

Table A6.4. Zone-specific mean monthly percentages of female *E. imbricata* with enlarged ovarian follicles and oviducal eggs. SE = standard error.

Zone	Category	N	Mean	SE	Maximum	Minimum
A	Follicles	12	19.8	3.9	45.9	2.3
B	Follicles	11	31.0	5.9	66.6	9.0
C	Follicles	9	21.6	4.3	39.3	0.0
D	Follicles	10	27.7	4.5	54.5	4.9
A	Eggs	12	10.6	2.2	24.4	0.0
B	Eggs	11	2.9	1.2	12.5	0.0
C	Eggs	9	6.3	2.3	18.7	0.0
D	Eggs	10	1.6	0.6	5.2	0.0
A	Follicles+Eggs	12	30.4	5.7	59.4	6.0
B	Follicles+Eggs	11	33.9	5.7	66.6	9.0
C	Follicles+Eggs	9	27.9	5.1	50.0	0.0
D	Follicles+Eggs	10	29.3	4.5	54.5	4.9

The data used to construct Figs. A6.1 to A6.4 are clearly subject to a number of biases and inconsistencies in sampling, and so the degree of biological significance that can be attributed to any specific monthly peak or trough remains unclear.

Given such potential sampling biases, polynomial regressions were used as a means of demonstrating what appears to be the major general trends in each Zone (Figs. A6.5 to A6.7).

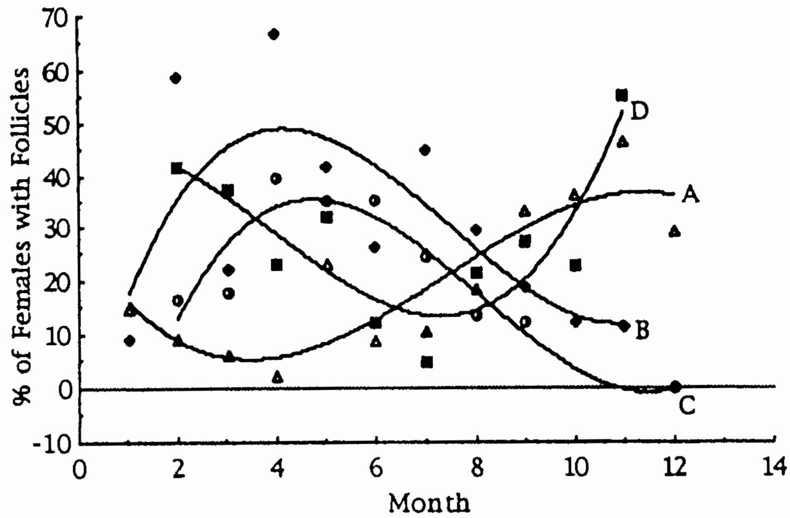

Figure A6.5. Major monthly trends in the percentage of female *E. imbricata* recorded as containing FOLLICLES in Zones A (closed circles), B (closed squares), C (open circles) and D (open squares).

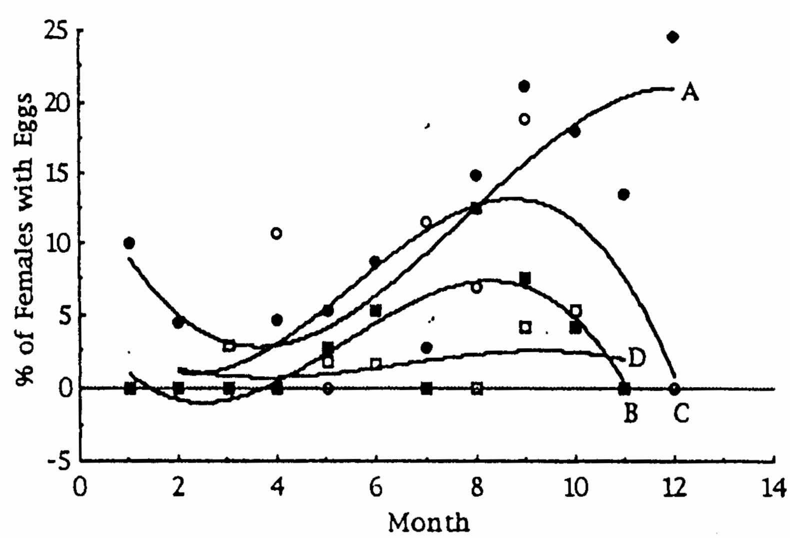

Figure A6.6. Major monthly trends in the percentage of female *E. imbricata* recorded as containing EGGS in Zones A (closed circles), B (closed squares), C (open circles) and D (open squares).

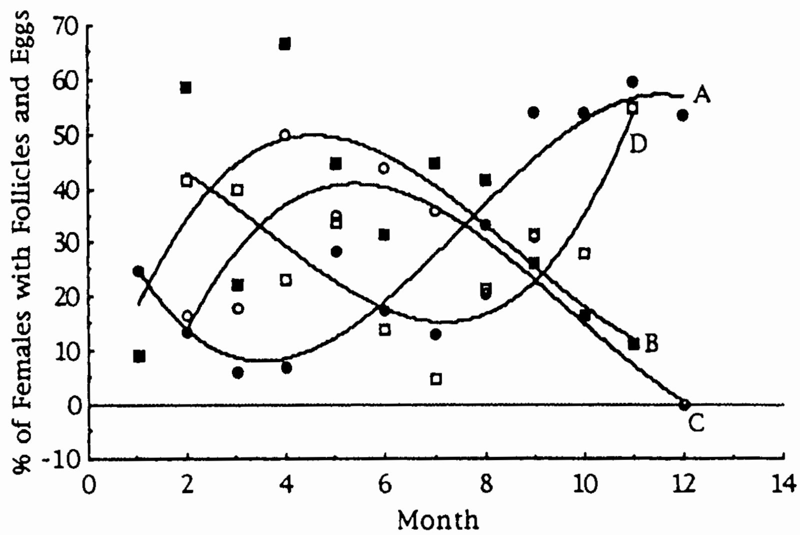

Figure A6.7. Major monthly trends in the percentage of female *E. imbricata* recorded as containing FOLLICLES and EGGS in Zones A (closed circles), B (closed squares), C (open circles) and D (open squares).

A6.3. Zone-Specific Reproductive Effort

The differences in the timing of reproductive events described above do not take account of the extent of the total population found in each Zone. That is, they do not reflect the proportion of the total population undergoing various activities in each Zone, at the same time. As we have no precise zone-specific estimates of population size, then any such adjustments are subject to wide errors. However, if the extent of the harvest from each Zone (Annex 4), is an index of the population in each Zone, then there are clearly striking differences in the numbers of reproductively active females in each Zone (Table A6.5).

Table A6.5. Estimates of the Zone-specific distribution of reproductively active *E. imbricata* in Cuba. "Mean" = the mean monthly % of mature female *E. imbricata* in a particular category (from Table A6.4). "%Hv" = the percentage of the total harvest from each Zone (Annex 4), used here as an index of population size. N = number of monthly samples available. "Adjusted %" estimates the percentage of Cuba's total population of reproductively active females in each Zone.

Zone	Category	N	Mean	%Hv	Adjusted %
A	Follicles	12	19.8	36.7	29.9
B	Follicles	11	31.0	18.1	23.1
C	Follicles	9	21.6	17.7	15.7
D	Follicles	10	27.7	27.5	31.3
A	Eggs	12	10.6	36.7	65.1
B	Eggs	11	2.9	18.1	8.9
C	Eggs	9	6.3	17.7	18.7
D	Eggs	10	1.6	27.5	7.4

how do they know that all turtles with developing follicles will nest IN Cuba?

Female *E. imbricata* with enlarged follicles in Cuba appear to be distributed throughout Cuba. Zones D and A each contain about 30% of the total population. However, 65.1% of animals with eggs are found in Zone A, and 18.7% in Zone C, both of which are now totally protected. If *E. imbricata* females tend to adopt small home ranges close to their nesting site between clutches, as occurs in the Virgin Islands (Starbird 1992), then these percentages may provide an index of the extent of the total nests in each Zone, regardless of whether they are laid in colonial or solitary sites.

A6.4. Nesting

The general nesting strategy of *E. imbricata* in Cuba and elsewhere involves both colonial and solitary nesting (but not highly synchronised mass nesting), with low density nesting throughout the year, and a peak of nesting activity at different times, in different regions (Witzell 1983; Marquez 1990; Bjorndal *et al.* 1993; Hoyle and Richardson 1993; Loop *et al.* 1995; Hernandez *et al.* 1995; Limpus and Miller 1996). The extent of solitary nesting, and the ability to nest all year round are unusual amongst sea turtles (Witzell 1983), and suggest selective advantages, most likely in hatchling survival. Most research has concentrated on colonial nesting sites for obvious logistic reasons, but as a consequence, the extent to which solitary nesting (both in and out of the main nesting season) may contribute to population recruitment has been largely ignored. In some crocodilians, solitary nesting can result in markedly higher hatchling survival rates than colonial nesting in the same area (Smith and Webb 1985).

Within Cuba, the full extent of *E. imbricata* nesting is unknown. The locations of all *E. imbricata* nesting sites so far identified are on Figure A6.8, although only a small proportion of the potential nesting areas have been investigated. Surveys amongst fishermen indicate nesting is more widespread amongst the islands, keys and beaches of Cuba, and a survey program aimed broadly at identifying more of those areas is now underway.

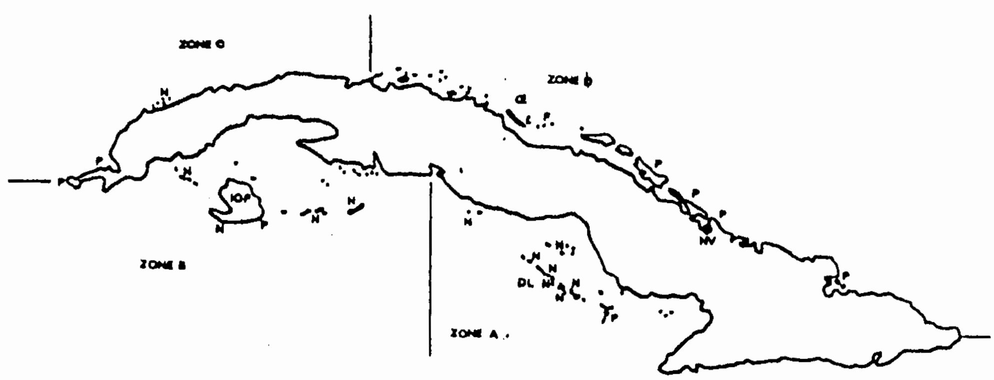

Figure A6.8. Sites (single or multiple) in Cuba where *E. imbricata* nests have been located (N), in relation to Fisheries Zones. Information collected during surveys of turtle fishermen indicate additional (unverified) nesting areas (P). IOP = Isle of Pines; DL = Doce Leguas; NV = Nuevitas.

Zone A

Attempts to locate nests within Zone A have so far been restricted to the Doce Leguas keys, with sporadic visits between 1987 and 1993, and more extensive surveys in the 1994/95 and 1995/96 seasons (October to March 1995). To date, 36 separate nesting sites have been identified (Table A6.6).

No systematic annual surveys of the same nest sites, throughout the nesting period (eg Bjorndal *et al.* 1993; Hoyle and Richardson 1993; Loop *et al.* 1995; Hernandez *et al.* 1995; Garduno and Marquez 1996; Limpus and Miller 1996) have yet been undertaken, partly because the Doce Leguas Keys are isolated, small in size, lack freshwater and facilities, and are logististically difficult and expensive to survey. With the approval of the expanded ranching program search effort will be standardised for a series of nest sites so that the egg collection program can be intimately linked to a monitoring program.

Table A6.6. Results of *E. imbricata* nest surveys in Cuba (1987/88 to 1995/96 nesting seasons). Search effort and timing has not been consistent from year to year. Year: '88 = 1988/89, '89 = 1989/90 season, etc.

Key/Beach	'87	'88	'89	'90	'91	'92	'93	'94	'95
Isle of Pines									
Playa Larga	2	3	1	0	0	0	0	1	0
Doce Leguas									
Alcatracito									
Alcatracito	-	1	-	-	-	1	-	-	3
Alcatraz									
Alcatraz	-	-	-	1	-	2	-	17	5
Anclitas	-	4	-	7	3	-	-	-	-
Caballones Este	-	7	5	-	-	2	1	-	-
El Datiri	-	-	-	-	-	-	-	4	5
El Manchao	-	-	-	-	-	-	-	1	-
Los Pinos	-	-	-	-	-	-	-	5	1
La Cana	-	-	-	-	-	-	-	-	3
Ballenas									
Ballenas	-	-	-	-	-	9	-	-	2
Bartolo									
Bartula	-	-	-	-	-	-	-	1	6
Boca Piedra Chiquita									
Boca Piedra Chiquita	-	-	-	-	3	-	-	4	-
Boca de Piedra	-	-	-	2	-	-	-	-	1
Boca Seca									
Boca Seca	-	-	-	3	2	-	-	30	15
Campo Santo	-	-	-	-	-	-	-	-	3
Caballones	-	-	-	-	2	-	-	-	-
Caballones Oeste	-	-	-	-	-	3	3	11	8
Playa Bonita	-	-	-	-	-	-	-	9	1
El Guinchos	-	-	-	-	-	-	9	13	-
La Llana	-	-	-	-	-	-	-	-	1
Carabineros									
Carabineros	-	2	4	1	-	1	-	11	-
Cachiboca									
Barrabas	-	-	-	-	-	2	-	8	-
Chaciboca	-	-	-	-	1	-	-	-	2
El Faro	-	-	-	-	-	-	-	7	-
Indios Chiquitos	-	-	-	-	-	-	-	4	-
Cayo Grande	-	2	1	-	-	-	-	-	-
Ballameses	-	-	-	-	-	3	-	5	2
Almendron	-	-	-	-	-	-	-	13	-
Los Cocos	-	-	-	-	-	-	-	12	-
Boca de Guano	-	-	-	2	-	1	3	44	-
Caleta Blanca	-	-	-	-	-	-	-	6	1
Boca Grande	-	-	-	3	-	6	-	-	-
Piedra Grande	-	1	-	-	-	-	-	-	2

Table A6.6. continued.

Key/Beach	'87	'88	'89	'90	'91	'92	'93	'94	'95
Doce Leguas cont'd									
Cinco Balas									
Cinco Balas	-	-	-	3	-	-	-	1	3
Indios Grande									
Indios Grande	-	-	-	-	-	-	-	3	-
Juan Grin									
Juan Grin	-	-	-	-	8	-	-	11	13
Las Cruces									
Crucesitas	-	-	1	-	1	3	-	3	2
Las Cruces	-	-	-	-	-	-	-	13	2
Los Hierros									
Los Hierros	-	-	-	-	-	-	-	15	13
Palomo									
Palomo	-	-	-	-	-	-	-	-	1
Algodones									
Algodones	-	-	-	-	-	-	-	-	8
Algodoncito									
Algodoncito	-	-	-	-	-	-	-	-	2
Cayo Ines de Soto									
Cayo Ines de Soto	-	-	-	-	-	-	-	-	20
Cayo Canarreos									
Cayo Canarreos	-	-	-	-	-	-	-	-	8
Cayo San Felipe									
Cayo San Felipe	-	-	-	-	-	-	-	-	22

Zone B

The reproductive data (Table A6.5) suggest that some 8.9% of nesting may occur in Zone B (compared with 65.1% in Zone A). Zone B also contains a large number of islands and keys. To date, no major surveys have yet been conducted in Zone B, although some nests have been located at Isle of Pines, San Felipe Keys and Canarreos Keys (Fig. A6.8; Table A6.6).

Zone C

The reproductive data suggest that Zone C is the second most important nesting area in Cuba, and could account for 18.7% of nests (Table A6.5). Interviews with fishermen indicated nesting occurs in the Zone, and preliminary surveys (1995) have resulted in nests being located at Ines de Soto Keys (Table A6.6).

Zone D

The reproductive data suggest Zone D could be responsible for 7.4% of the total nesting effort (Table A6.5) and may be the least important Zone for nesting. To date interviews with fishermen at Nuevitas indicate that no nesting is known from the immediate area in which *E. imbricata* are caught, but the status of nesting elsewhere in the Zone is unknown.

A6.5. Time of Nesting

During the 1994/95 nesting season at Doce Leguas, survey effort was not uniform throughout the season. However, the approximate day of laying was predicted for most nests from the known day of laying, of hatching, or from embryo stages. These data indicated a peak of nesting activity in December (Table A6.7) which is consistent with the peak of females with oviducal eggs (Fig. A6.1 and A6.6).

Table A6.7. Estimated month of laying for 214 of 251 *E. imbricata* nests located in Doce Leguas during the 1994/95 nesting season.

Month	Oct'94	Nov '94	Dec '94	Jan '95	Feb '95	Mar '95
Number	4	22	167	12	8	1
Percentage	1.9	10.3	78.0	5.6	3.7	0.5

Clutch Characteristics

The available data on clutch sizes, egg infertility (which includes possible early embryonic deaths), embryo mortality and hatching success are summarised in Table A6.8. Mean clutch size within the annual samples has varied a little from year to year, but shown no significant increase or decrease over the 8 years (r^2 = 0.004, p = 0.87). The mean characteristics of all nests so far examined in Zones A, B, and C are summarised in Table A6.9.

Table A6.8. Mean clutch sizes and hatching success for *E. imbricata* nests at Doce Leguas, 1988/89-1995/96 seasons. "N" refers to the sample sizes.

Season	N	Mean Clutch Size	Infertile (%)	Dead in Nest (%)	Hatched (%)
1988/89	17	137.3	11.4	13.5	75.1
1989/90	11	132.2	15.3	18.9	65.8
1990/91	22	137.4	11.7	17.5	70.8
1991/92	20	133.4	18.9	15.2	65.9
1992/93	33	136.8	14.6	19.0	66.4
1993/94	17	131.8	-	-	-
1994/95	106	136.4	13.7	16.1	70.2
1995/96	105	137.0	-	-	-
Mean	8	135.3	14.3	16.7	69.0

Table A6.9. Mean clutch characteristics (for all nests sampled) for *E. imbricata* nests from different Zones within Cuba. "N" refers to the sample sizes.

Area	N	Mean	SE	Minimum	Maximum
Zone A	371	136.0	1.15	69	197
Zone B	30	132.3	3.38	98	168
Zone C	20	132.1	5.63	74	180

ANNEX 7. Population Size

Carrillo, E.C., Perez, C.P., Ohtaishi, N., Kobayashii, M., Moncada, F.G., Manolis, S.C., Tsubouchi, T. and G.J.W. Webb.

A7.1. General

Resolution Conf. 9.24 requires information on trends in the population (see Annex 5). However, it also requires an estimate of the size of the total population, which is virtually impossible to do with any degree of confidence for any sea turtle species (Meylan 1982). It is for this reason that management decisions are usually based on trends in population indices (i.e. the number of nests is increasing, decreasing or stable; the harvest is going up, down or stable).

There have been two serious efforts to develop a mathematical model to simulate the dynamics of the Cuban *E. imbricata* population (Doi *et al.* 1992; Heppell *et al.* 1995). Both predict significant populations (20,000+ adults), but little confidence can be attached to those estimates. As in all long-lived reptiles (Webb and Smith 1987; Heppell *et al.* 1995), estimating age-specific survival rates and mean age of adults creates significant problems. For example, if you had 10,000 adults at say 20 years of age, and age-specific survival was constant at 0.9 (which is a common assumption not supported by data), then there would be 11,111 19-year olds, 12,345 18-year olds etc., and a total population between 1 and 20 years of age would be about 650,274. But if it were argued growth was slower, and the 20 year olds were really 40 years olds, then the total population would be 6 million. If age-specific survival was 0.72 (Limpus 1992) rather than 0.90, it would be 13 billion! The estimates are largely a product of the assumptions used to derive them and have little management significance.

In addition, when populations are reduced below carrying capacity, things change (Caughley and Sinclair 1995). If you do not account for density-dependent changes, then any harvest of adults will be predicted as having a dramatic irreversible impact on the population. Yet in reality, populations of many long-lived reptiles (eg. *Chelodina rugosa* in Australia; *Alligator mississippiensis* in the USA) are harvested sustainably.

In any overview, estimates of total population size need to be treated cautiously, as does the relationship between population size, structure and the sustainability of harvests. In this Annex we examine some of the key variables involved in estimating population size, and derive a conservative minimum estimate of the size of the Cuban *E. imbricata* population. Like all estimates, it depends on a series of assumptions.

A7.2. Is the harvested population a random sample of the total population?

The *E. imbricata* measured during the historical harvests in Cuba are not a random sample of all age classes: the nets used to catch *E. imbricata* generally target animals over 50 cm SCL.

A7.3. Growth, Age and Size

A7.3.1. Growth Rings

Reliable information on the age structure of the harvested population can be used to estimate total population size. The normal approach to developing an age-structure, in the absence of definitive morphological age indicators, has been to use information on growth rates to describe a mean size-age curve, and then use that relationship to predict age from size. However, whereas Doi *et al.* (1992) assumed fast growth rates on limited data, Heppell *et al.* (1995) applied fast and slow growth rates, and got vastly different population estimates. Both studies assumed that the size-age relationship followed a negative exponential (Von Bertalanffy Curve).

To shed new light on the relationship between age and size we reviewed the available information on growth, and are undertaking a detailed study of growth rings in the shell plates (Ohtaishi *et al.* 1995, 1996). That growth rings are laid down annually has been demonstrated in captivity (Ohtaishi *et al.* 1995, 1996) and in the wild (Limpus and Miller 1996). However, the extent to which total age can be predicted accurately from the total count of growth rings remains unclear. Within the first year, 3 bands may be laid down, after which annual rings are formed. Ohtaishi *et al.* (1995, 1996) have confirmed that captive-raised animals up to 4 years of age have 4 annual growth rings, and 22 annual growth rings were counted in one individual captured from the wild as a small juvenile and maintained in captivity for 18 years since. On the other hand, large mature adults may essentially cease growing (Limpus 1992), which raises questions about the continued build up of growth rings. In some habitats excessive erosion of parts of the shell plate occurs, which may remove some rings (Limpus and Miller 1996).

Notwithstanding these uncertainties, growth rings are intimately related to age. They have now been examined in the costal shell plates of 2788 different Cuban *E. imbricata*: 2780 (1993-95) from animals taken in the traditional harvest (shell plates currently stored in the stockpile in Cuba), and the remainder from 8 smaller animals hand caught in Cuba (1995), from which sections of shell plate were excised.

Table A7.1. The mean size (SCL in cm) of *E. imbricata* with different numbers of growth rings. For rings 8, 9 and 10, the mean size from the animals harvested overestimates the population mean, because small animals with 8 to 10 rings are below the size range captured. * = the "population mean" for animals with different numbers of rings have been corrected (see text). The size with no annual growth rings is the mean SCL at hatching.

	Harvest Sample					Population
No. of Rings	Sample Size	Mean	SE	Minimum	Maximum	Mean (cm)
0	-	-	-	-	-	4.0
1	-	-	-	-	-	14.0*
2	3	22.63	0.29	22.1	23.1	22.6
3	5	29.50	0.68	27.6	31.7	29.5
4	-	-	-	-	-	34.0*
5	-	-	-	-	-	38.6*
6	-	-	-	-	-	42.5*
7	-	-	-	-	-	46.3*
8	33	54.87	0.44	50.6	62.0	50.0*
9	164	56.88	0.23	49.9	66.4	54.0*
10	296	59.03	0.16	51.3	67.4	57.5*
11	251	61.92	0.18	52.3	73.4	61.9
12	438	65.94	0.18	56.3	83.4	65.9
13	704	69.17	0.14	56.8	87.9	69.2
14	484	72.77	0.21	58.4	92.8	72.8
15	281	77.32	0.27	62.9	90.8	77.3
16	62	80.51	0.66	65.7	96.2	80.5
17	9	81.48	1.67	75.7	87.9	81.5

Of the 2780 larger animals examined, growth rings could not be discerned in 58 individuals with excessive black pigmentation. Growth rings proved discernable in most other individuals, but became increasingly difficult to identify in some slow-growing individuals (regardless of size) where the lines were close together, and in some fast-growing, larger animals, where the pigmentation creating the lines tended to be diffuse. The maximum number of growth rings counted in any Cuban *E. imbricata* was 17 (N = 9). The mean sizes of *E. imbricata*, with different numbers of growth rings are summarised on Table A7.1. The number of growth rings found in different size classes of *E. imbricata* are in Table A7.2.

Table A7.2. The percentage of different size classes of *E. imbricata* (SCL in cm) containing different numbers of growth rings (Ohtaishi, unpublished data). N = sample size.

Size Class	N	Numbers of Growth Rings 8	9	10	11	12	13	14	15	16	17
45-50	1	-	100.0	-	-	-	-	-	-	-	
50-55	86	23.3	48.8	25.6	2.3	-	-	-	-	-	-
55-60	352	3.4	28.4	48.0	16.2	2.3	1.1	0.6	-	-	-
60-65	555	0.2	3.6	18.2	29.0	33.9	12.3	2.0	0.9	-	-
65-70	737	-	0.1	0.5	3.9	27.1	50.2	15.7	2.2	0.1	-
70-75	522	-	-	-	0.4	5.7	42.9	42.3	7.7	1.0	-
75-80	308	-	-	-	-	1.3	8.8	34.4	46.4	7.5	1.6
80-85	128	-	-	-	-	6.3	7.0	17.2	50.8	18.8	-
85-90	28	-	-	-	-	-	7.1	14.3	39.3	25.0	14.3
90-95	4	-	-	-	-	-	-	50.0	25.0	25.0	-
95-100	1	-	-	-	-	-	-	-	-	100.0	-

From the information in Table A7.2, it is apparent that the harvest data overestimate the real mean size of animals with 8, 9 and 10 growth rings in the population. There should be a complement of animals smaller than 50 cm SCL with 8, 9 and 10 rings, but these are not captured in the harvest. After examining the distribution of recorded sizes with different numbers of rings, and the extent of skewness of the means, we estimate the real population mean sizes for animals with 8, 9 and 10 rings to be approximately 50, 54 and 57.5 cm SCL respectively. These values are used as an estimate of the "population mean size" on Table A7.1, and they required an adjustment to the measured harvest mean sizes of -4.9 cm, -2.9 cm and -1.5 cm SCL respectively.

In animals with 11 to 16 growth rings, sample sizes are large (N = 2220) and no corrections were necessary. The increase in mean size with additional rings is strongly linear (linear regression: $r^2 = 0.998$; $p = 0.0001$; $N = 6$). With the independently adjusted mean values for 8, 9 and 10 rings, that linear trend extends from 8 to 16 years (linear regression: $r^2 = 0.999$; $p = 0.0001$; $N = 9$), and if it is extrapolated back to 3 growth rings, it predicts a mean size of 31.0 cm SCL: 1.5 cm SCL above the measured mean size (29.5 cm SCL) of animals with three rings. If the number of rings does approximate real age, it indicates that growth is linear rather than exponential over a wide range of sizes.

Growth between zero (hatching) and 3 rings appears exponential, as is growth between 16 and 17 rings. On the assumption of exponential growth to 4.5 rings, linear growth to 16 rings and exponential growth after 16 rings, the approximate mean relationship between size and growth rings is depicted on Figure A7.1.

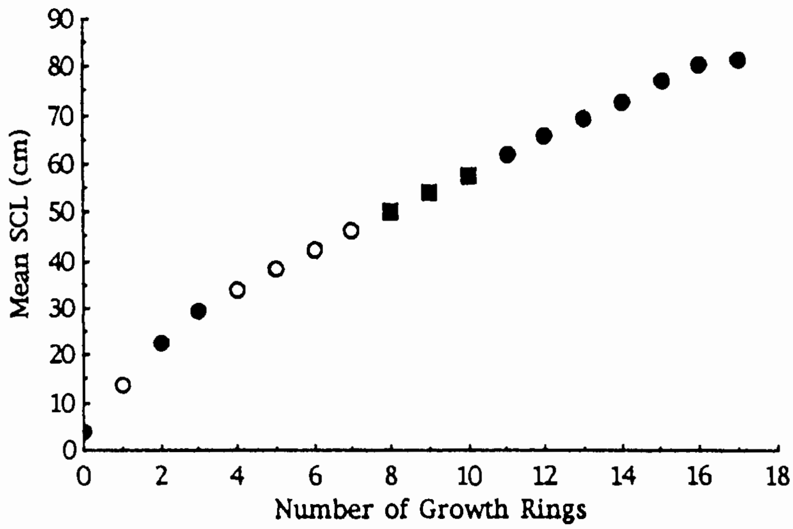

Figure A7.1. Approximate relationship between size and number of growth rings for Cuban *E. imbricata*. Closed circles = measured values; closed squares = adjusted from measured values; open squares = predicted values (raw data are in Table A7.1).

The extent to which the growth rings underestimate real age is unclear, although during the process of counting them, and comparing the results with the larger known-aged captive animal, it was felt that the maximum error would be 3 years, and that with younger animals, errors were generally within 1 year. If so, the results are probably a reasonable approximation of the size-age relationship in younger animals, but may underestimate the extent of negative exponential growth in the older ones (15+ years). That is, if the number of rings in older animals tended to stabilise in the 15-16 ring class, it would give the impression that linear growth extended further that it may do in reality. Overall, the results suggest:

1. Many large *E. imbricata* can be quite young, a consequence of the extreme variability in individual growth rates.

2. During the historical harvest, the probability of avoiding capture until 20 years of age was close to zero.

3. If nesting *E. imbricata* from areas outside Cuba are old (e.g. Hoyle and Richardson 1993), and have more than 17 growth rings, then they are seldom caught in Cuban waters, despite their ability to move considerable distances (Groshens 1993; Groshens and Vaughan 1994; Hillis 1996) from island nesting sites.

4. The mean relationship between size and age is exponential in the smaller animals and then linear over a wide range of ages. The limited data on older animals (17 growth rings) suggest that the growth rates in older *E. imbricata* (greater than 17 growth rings) will also be exponential, but they are not represented in Cuba. The relationship between age and size does not fit a negative exponential (Von Bertalanffy Curve).

A7.3.2. Measured Growth Rates of Wild *E. imbricata*

The relationship between growth rate and mean size derived for *E. imbricata* from different parts of the world are summarised on Table A7.3 and Figure A7.2. The data for Cuba come from two sources: firstly, two recapture records were obtained from the tagging study; secondly, it was assumed that growth rings were annual, and that the difference in the mean sizes of animals with different numbers of growth rings reflected mean annual growth for different sized animals. [The mean age at which growth ceases in Cuba cannot be estimated from the growth ring data, because the probability of individuals escaping capture until growth ceases appears low].

Table A7.3. A summary of reported mean growth rates (cm SCL per year) of different sized wild *E. imbricata*. Numbers in brackets are sample sizes. Raw data from: Limpus (1992) and Limpus and Miller (1996)[1], Kowarsky and Capelle (1979)[2], Bjorndal and Bolton (1988)[3], Boulon (1994)[4], Garduno and Marquez (1994, 1996)[5], MIP, unpublished[6], Ohtaishi, unpublished[7] (derived from Table A7.1), Diez and van Dam (1995)[8], and Wood and Wood (1993)[9]. "*" indicates values from captive-raised *E. imbricata* recaught after release in the wild. Where necessary, raw data were converted to units of SCL using the formula in Limpus (1992).

CL (cm)	Australia (Sth[1])	Australia (Nth[2])	Bahamas[3]	Virgin Is.[4]	Mexico[5]	Cuba (Wild[6])	Cuba (Ring[7])	Puerto Rico[8]	Cayman Is.[9]	
4<20	-	-	-	-	-	-	9.5	-	-	
20<30	-	8.5* (2)	-	-	-	-	7.1	2.7 (10)	-	
30<40	-	-	15.7 (1)	4.8 (3)	8.9 (4)	-	4.4	2.8 (11)	-	
40<50	1.4 (11)	-	5.9 (1)	3.3 (5)	6.9 (6)	6.6 (1)	3.8	2.7 (13)	11.3* (1)	
50<60	1.9 (15)	-	-	2.8 (3)	8.2 (2)	-	3.6	1.5 (5)	-	
60<70	1.6 (19)	-	2.6 (3)	2.6 (1)	-	-	3.8	-	-	-
70<80	0.5 (8)	-	-	-	-	2.3 (1)	3.4	-	-	-
80<90	0.5 (3)	-	-	-	0.4 (8)	-	-	-	-	-
90<100	-	-	-	-	0.5 (4)	-	-	-	-	-

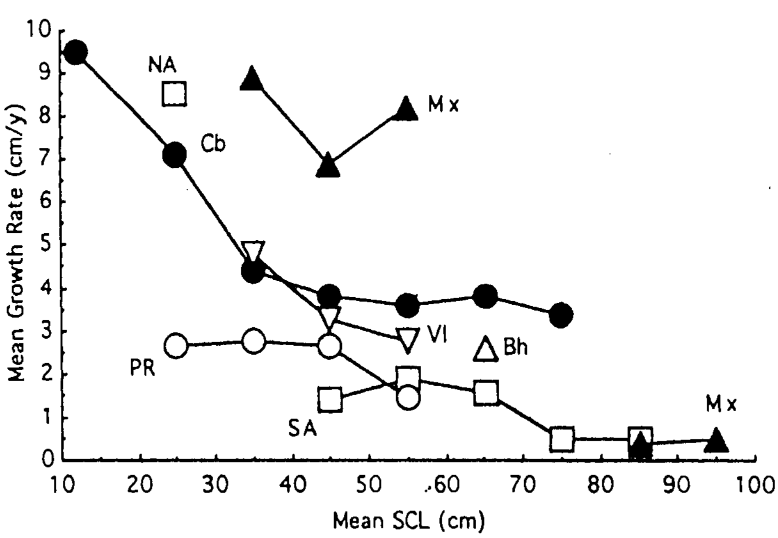

Figure A7.2. The mean relationship between growth rate (cm SCL per year) and size (cm SCL) measured in wild *E. imbricata* from different areas, compared with the mean relationship derived for Cuba from the growth rings. Bh- Bahamas; VI- Virgin Islands; NA- northern Australia; SA- southern Australia; PR- Puerto Rico; Mx- Mexico; Cb- Cuba). Only means with at least 2 values are included (data from Table A7.3).

A7.3.3. Individual Variation in Growth Rates

Growth rates of wild *E. imbricata* show extreme individual variation, which is common in chelonians and crocodilians, and indicates that within any one area there are fast and slow growing individuals. Variation in the size of *E. imbricata* with the same number of growth rings (Tables A7.1 and A7.2) in Cuba is consistent with the extreme individual variation in growth rates reported elsewhere.

A7.3.4. Effects of Temperature on Growth Rates

Over and above individual variation, there are marked differences in the reported growth rates of *E. imbricata* from different parts of the world. This could be due to many factors, but given the profound effects that water temperature has on growth rates in captivity (see Annex 10), it seems likely that sea temperature, particularly at the microhabitat level (sheltered bays etc.), is involved,

To examine general trends, monthly sea surface temperatures (mean, maximum, minimum) were obtained [Australian Bureau of Meteorology (Oceanography Department)] for the regions in which *E. imbricata* growth rates in the wild had been reported. Multiple regression analysis was then used to predict individual growth rates (dependent variable) from size (independent variable) and various combinations of mean, maximum and minimum surface temperatures (additional independent variables). [The mean growth data predicted from the growth rings, and the data from captive-raised animals released to the wild were not included.]

With all data, from all study sites included ($N = 138$ growth records), the linear relationship between growth rate and size was improved significantly (r^2 increased from 0.24 to 0.43) with an ln transformation of growth rate. With maximum monthly temperature added to size, 50% of the total variation in growth rates was explained (r^2 addition due to maximum monthly sea temperature $= 0.07$; $p = 0.0001$).

When only data from the Caribbean region were analysed ($N = 82$), 65% of the variation in growth rates was explained by size ($r^2 = 0.50$; $p = 0.0001$) and maximum monthly temperature (r^2 addition due to maximum temperature $= 0.15$; $p = 0.0001$). On this basis, *E. imbricata* in Cuba (maximum monthly sea surface temperature in the global data matrix provided by the above source = 30.5°C), could be expected to have faster mean growth rates than *E. imbricata* in Puerto Rico (maximum monthly sea surface temperature = 29.5°C), as has been found (Table A7.3; Fig. A7.2).

A7.3.5. Growth Rates derived from Growth Rings

If sea temperature does exert a significant influence on *E. imbricata* growth rates, then the growth rates derived from any one study site within a region may in part reflect the temperature characteristics of that site. Mean growth rates of a population, using a range of different sites, with different thermal environments, could be higher or lower than those recorded at any one study site selected because it was suitable for catching and recatching *E. imbricata* for research.

Table A7.4. Results of comparing growth rates recorded from wild *E. imbricata* in different areas to the mean growth rates applicable to Cuba (paired t-test).

Area	Size Range (cm SCL)	t	df	p	Difference (cm)	Conclusion
Mexico	31-55	10.72	11	0.0001	+3.81	Significantly higher
Virgin Islands	31-62	1.31	12	0.215	-0.61	Similar
Puerto Rico	25-53	8.05	38	0.0001	-2.08	Significantly lower
South'n. Australia	41-80	21.04	52	0.0001	-2.34	Significantly lower

The mean relationship between growth rate and size computed from the growth rings (Table A7.3; Fig. A7.2), are derived from very large samples, and reflect the full extent of variation in growth rates within Cuba. Paired t-tests were used to compare the raw growth data from each region with more than 10 records, against predicted mean growth rates for the same sized individuals in Cuba. In the case of Mexico, only the juveniles could be compared (Table A7.4), and they grow faster than the mean Cuban animals. In the Virgin Islands growth is similar to the mean Cuban result, but in Puerto Rico and southern Australia growth rates are appreciably lower than the mean Cuban rates.

A7.3.6. The Size-Age Relationship

Despite known biases associated with underestimating age, the analysis of growth rings indicated that the size-age relationship involved exponential growth in small and large animals, and linear growth over a wide range of intermediate sizes. Of significance here, the relationship could not be described by a negative exponential (Von Bertalanffy Curve). This general conclusion is supported by the measured growth data from *E. imbricata* in Puerto Rico and southern Australia. The relationship between the growth rate and size is significantly better modelled with a parabolic curve than with a straight line! This indicates the size-age relationship is a positive exponential, followed by a period of linear growth, followed by a negative exponential. The situation in Mexico is unclear, because there are no growth data for intermediate sized animals.

A7.3.7. Conclusions

1. Analysis of growth rings in large samples of *E. imbricata* may shed new light on both the growth rate to size relationship and the size to age relationship. The underestimating bias is clearly a problem, which in the growth rate to size relationship would result in the predicted growth rates for 60-70 cm and 70-80 cm SCL sized animals (Fig. A7.2) being higher than the real mean growth rates for this sized individual.

2. Regional variation in growth rates is real and sea temperature appears to be involved. There may be little utility in using growth rates derived from *E. imbricata* in a cool area, to simulate the population dynamics of *E. imbricata* in a warm area.

3. The relationship between size and age does not follow a negative exponential curve and significant errors and inconsistencies could be introduced by assuming that it does.

A7.4. The Size Structure of the Historical Harvest

During the period of the historical harvest in which sample data were collected, changes in the size-structure of the harvested population occurred (Annex 5). In some Zones the changes appeared to stabilise, whereas in others they did not. In the years 1988 to 1990, before the *E. imbricata* fishery was phased down, an average of 240.4 tonnes per year (5611 individuals) were being harvested (Annex 4). The harvest was more from Zones A (39.9%) and D (29.9%), than from Zones B (17.5%) and C (12.8%), and was restricted to an open season of 9 months each year, which varied between Zones to avoid the peak of reproductive activity.

Sample data from that period allow the size structure of the harvest (Annex 5) in Zones A, B and D to be estimated: that in Zone C was assumed to be the mean of the other Zones. The average annual size structure of harvested *E. imbricata* in Cuba, in the period 1988-90, can accordingly be estimated (Fig. A7.3).

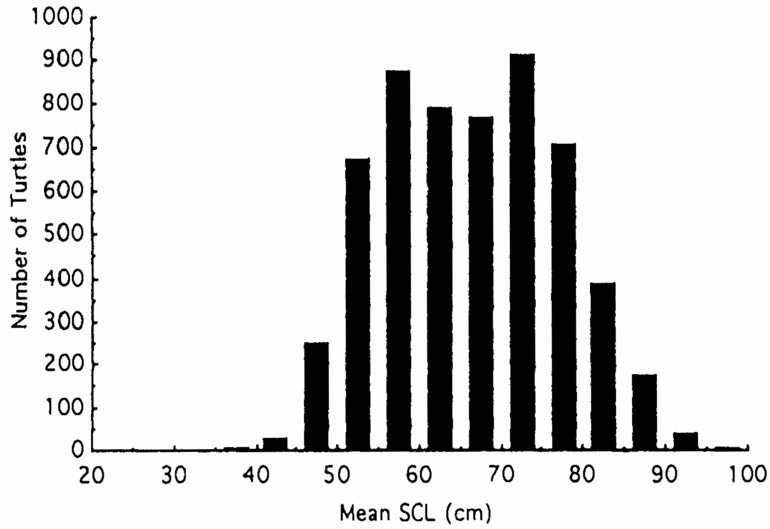

Figure A7.3. The mean annual size structure of *E. imbricata* harvested (1988-90) at the end of the historical harvest.

Based on sex ratios of the harvested population (Annex 5) and the relationship between size and the proportion of mature females (Annex 6)), 18% of the harvested sample (N = 1006) were mature females. If males mature at approximately the same size as females, the historical harvest would have comprised 23% adults (N = 1310).

A7.5. Growth Ring Structure in the Historical Harvest

To describe the harvested population in terms of growth rings, the results in Table A7.2 were used. For animals below 50 cm SCL (N = 281) the data in Table A7.2 were extrapolated backwards taking into account the mean relationship on Figure A7.1. Size classes were subdivided as follows: 45-50 cm SCL, 5% 10 rings, 10% 9 rings, 30% 8 rings, 50% 7 rings, 5% 6 rings; 40-45 cm SCL, 10% 8 rings, 30% 7 rings, 50% 6 rings, 10% 5 rings; 35-40 cm SCL, 25% 6 rings, 50% 5 rings, 25% 4 rings (Fig. A7.4).

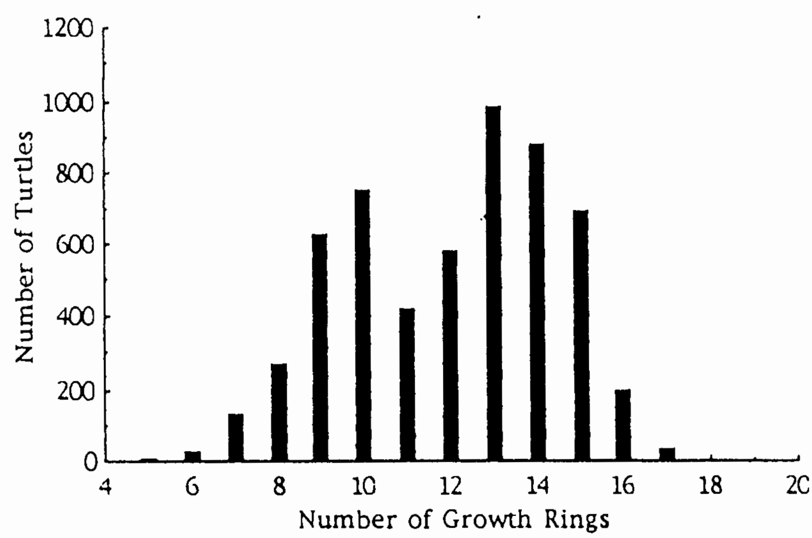

Figure A7.4. The predicted annual structure of the harvested *E. imbricata* population (1988-90) in terms of growth rings.

A7.6. The Age Structure of the Historical Harvest

The relationship between growth rings and absolute age is impossible to determine accurately at this time (see Section A7.3). The method underestimates age, and it is highly likely that the degree of underestimate increases with increasing size, age and the slowing of growth rates.

While accepting that errors in the larger animals may prove to be substantial (Limpus and Miller 1996; Ross, pers. comm.), we have as yet no evidence to indicate that errors exceed 3 years. We tested two hypothetical levels of bias. The first assumes that the levels of underestimate are minor, with a small number of animals being underestimated by up to 3 years. The second assumes a more significant underestimating bias, but still sets the maximum error at 5 years (Table A7.5). The predicted age structure of the harvested population, according to both sets of corrections, is on Figures A7.5 and A7.6 respectively.

Table A7.5. Corrections for relating counts of growth rings to real age in years (see text). Percentages refer to the estimated percentage of animals with different numbers of growth rings whose age would be underestimated by 0 to 5 years.

	CORRECTION 1 Bias (y)				CORRECTION 2 Bias (y)					
Growth Rings	0	-1	-2	-3	0	-1	-2	-3	-4	-5
1-8	90%	5%	5%	0%	10%	30%	40%	10%	5%	5%
9-11	80%	10%	5%	5%	0%	10%	30%	30%	20%	10%
12-14	70%	15%	10%	5%	0%	5%	20%	30%	35%	10%
15-17	60%	20%	10%	10%	0%	0%	10%	30%	40%	20%

Figure A7.5. The predicted annual age structure of *E. imbricata* harvested (1988-90) assuming that the underestimating bias for predicting age from growth rings is reasonably minor and does not exceed 3 years (Correction 1 on Table A7.7)

Figure A7.6. The predicted annual age structure of *E. imbricata* harvested (1988-90) assuming that the underestimating bias for predicting age from growth rings is within 5 years (Correction 2 on Table A7.7)

A7.8. Population Size during the Historical Harvest

The extent to which the historical harvest was sustainable, or could have been sustained indefinitely in the future, is a matter of speculation: the historical harvest level exists no longer. However, to obtain a minimum estimate of the population, sustainability is assumed, which accepts that the population dynamics had reached a stable state. It is also assumed that immigration equals emigration, which may or may not be the case, and that such density-dependent mechanisms that may have operated, have stabilised. The analysis clearly only considers the population subject to harvest at sometime during its lifetime, within Cuba.

We ignored animals between hatching and year 1 ("hatchlings"), and thus concentrated only on "non-hatchlings" (greater than 1 year of age). We used a simple matrix model to apply different age-specific survival rates to each year class, with both age structures (Figs. A7.5 and A7.6), thereby reconstructing the size of the population associated with an annual harvest of 5611 individuals.

As pointed out above (Section A7.1), the final population estimates are largely a function of the age-specific survival rates used. Limpus (1992) estimates age-specific survival amongst immature wild *E. imbricata* to be 0.72, but this is really a minimum estimate. Hoyle and Richardson (1993) derive minimum annual survival estimates for nesting females of between 0.89 and 0.98. Doi *et al.* (1992) used a constant rate of 0.90 for all age classes, and Heppel *et al.* (1995) use 0.90 and 0.95 for different purposes. Given the sensitivity of models of long-lived reptiles to survival estimates (Webb and Smith 1987; Heppel *et al.* 1996), and our desire to compare results with those derived by others, we applied constant age-specific survival rates of 0.90 and 0.95 for all years. Estimates of the total non-hatchling population size, using both age-structures, are on Table A7.7.

Table A7.7. Minimum estimates of the total population of non-hatchling *E. imbricata* assuming constant age-specific survival rates. The two age structures (Figs. A7.5 and A7.6) reflect different levels of potential underestimating bias in the aging method (Table A7.5).

Age Structure	Aging Bias	Age-specific Survival Rate	Estimated Population of Non-hatchlings
Figure A7.5	<3 years	0.90	161,024
		0.95	102,521
Figure A7.6	<5 years	0.90	233,374
		0.95	134,298

A7.9. Population Dynamics during the Historical Harvest

Of the 5611 animals harvested per year, it was estimated on the basis of size that 1310 were mature. For the age structures, we allocated maturity according to Table A7.8.

Table A7.8. Estimated relationship between predicted age and percentage maturity of females, for the age structures depicted on Figures A7.5 and A7.6. "na" = not applicable.

Estimated Age (y)	Percentage of Females Mature Age Structure 1 (Fig. A7.5)	Age Structure 2 (Fig. A7.6)
10	1.6	0.0
11	5.0	0.0
12	10.0	0.0
13	15.0	1.4
14	25.0	5.0
15	50.0	10.0
16	75.0	15.0
17	75.0	25.0
18	100.0	50.0
19	100.0	75.0
20	100.0	100.0
21	na	100.0
22	na	100.0

This assumed that both age structures, each with 5611 individuals, would have the same complement of mature animals. It also assumed that there would be a transition between age and maturity similar to that described for size, and that the age at first maturity would be later with the second age structure than with the first.

Using these maturity percentages, the reproductive output of the population was predicted using the following estimates: a constant sex ratio of 0.768 biased to females (Annex 5); females nest each 2.42 years (Annex 6); a mean clutch size of 135 eggs (Zone A; Annex 6); hatch rate of 0.69 (Annex 6); and, females lay 2.36 clutches per year (Garduno and Marquez 1996). Although 4.52 clutches per year has been recorded at Antigua (Hoyle and Richardson 1993), the *E. imbricata* there are not harvested and their large clutch size and clutch mass suggests they are older and larger females. The value we used (2.36) is more conservative: it comes from Mexico, where *E. imbricata* and *Lepidochelys olivacea* are both increasing exponentially in response to new management procedures (Hernandez *et al.* 1995; Marquez *et al.* 1996). The *E.*

imbricata are probably younger and with higher water temperatures, are more likely to reflect the situation in Cuba. The results of the simulations are in Table A7.9.

Table A7.9. Estimated reproduction potential of the *E. imbricata* population in Cuba (1988 to 1990).

Age Structure	<3y	<3y	<5y	<5y
Annual survival rate (1-20 y)	0.95	0.90	0.95	0.90
Non-hatchling population	102,521	161,024	134,298	233,374
Mature adults	3,628	4,133	3,483	3,950
Percentage mature adults	3.5%	2.6%	2.6%	1.7%
Mature females	2,786	3,174	2,675	3,033
Percentage mature females	2.7%	2.0%	2.0%	1.3%
Nesting females per year	1,106	1,260	1,061	1,204
Nests per year	2,609	2,973	2,505	2,841
Eggs per year	352,264	401,323	338,145	383,509
Hatchlings per year	243,062	276,913	233,320	264,621
Estimated hatchling survival to 1 y	4.4%	7.8%	5.3%	10.9%

A7.10. Population Size at the End of the Historical Harvest

Estimates of sea turtle population size clearly need to be treated cautiously, because they involve assumptions that are difficult to verify. However, the estimates for the size of the population at the end of the historical harvest derived here are considered very conservative, relative to those derived by Doi *et al.* (1992) and Heppell *et al.* (1995). The estimates derived here indicate a minimum population of 100,000 to 230,000 non-hatchlings, comprised of some 3,500 to 4,100 mature adults. For the historical harvest to be sustainable, 4.4% to 10.9% of hatchlings would have needed to survive until they were one year of age (Table A7.9).

A7.11. Population Size in 1996

Between 1990 and 1996, the harvest was reduced substantially (by 90%), although the effects on population size cannot yet be estimated with any reliability. Erring on the side of caution, we consider it best to assume that the current population approximates that at the end of the historical harvest. If so, the population could be expected to produce some 2500 to 3000 nests annually. The number of nests so far located during searches at the Doce Leguás nesting sites (Annex 6: 251 nests in one year) represent 8-10% of the total nests in Cuba. Given the incomplete nature of nest searches at Doce Leguas (Zone A) to date, the colonial and solitary nesting habits of the species, the fact that low density nesting occurs throughout the year, and that nesting also occurs in Zones B and C (Annex 6), where surveys have been limite [a brief survey in Zone C in 1995 located an additional 50 nests (Annex 6)]. We consider the estimate of total nest numbers to be reasonably consistent with the known situation.

Cuban territorial waters (interior and exterior) encompass some 111,472 square kilometres, of which 62,870 square kilometres are interior waters (44,076 under 20 metres). Limpus (1992) estimated the density of *E. imbricata* within his study site to be about 3.34 individuals older than 4-5 years per square kilometre. If the complete population greater than or equal to 4 years of age was spread evenly throughout the internal waters, it would indicate densities of 1.1 to 2.5 per square kilometre, which are not unrealistic.

The manner in which the population responds to the reduced harvest can and will be quantified over the next four years through the nest monitoring program implemented in 1996, and through the monitoring of size, sex and growth rings in the animals taken during the reduced traditional harvest.

ANNEX 8. Movement and Population Integrity

Moncada, F.G., Koike, H., Espinosa, G., Manolis, S.C., Pérez, C., Nodarse, G.A., Tanabe, S., Sakai, H., Webb, G.J.W., Carrillo, E.C., Diaz, R. and T. Tsubouchi.

A8.1. Introduction

Eretmochelys imbricata is generally considered the least migratory of sea turtles (Witzell 1983; Groombridge and Luxmoore 1989). This is partly because individuals are known to inhabit particular coral reef areas for long periods of time (Bjorndal and Bolton 1988; Limpus 1992; Boulon 1994; Diez *et al.* 1994; Diez and van Dam 1995; Garduno and Marquez 1996; Limpus and Miller 1996), and partly because there are few records of major ocean crossings comparable with those known for some other sea turtle species (Marquez 1990). Nevertheless, long-distance movements have been documented from tag recoveries [Parmenter 1983; Marcovaldi and Filippini 1991; Bjorndal *et al.* 1993; Hillis 1996] and from limited radio and satellite tracking (Groshens 1993; Groshens and Vaughan 1994). New insights into the integrity of local populations are being gained through the examination of mitochondrial DNA (Broderick *et al.* 1994; Espinosa *et al.* 1996; Koike 1995; Bass *et al.* 1996; Bowen *et al.* 1996; Koike *et al.* 1996; Okayama *et al.* 1996). *Eretmochelys imbricata* inhabit some areas well-distanced from known nesting sites (Limpus 1992; Starbird 1992; Bjorndal *et al.* 1993; Hillis 1996; Limpus and Miller 1996), which implies that they move considerable distances to reach them.

However, the degree to which these "insights" into *E. imbricata* movement apply to all *E. imbricata* populations is impossible to determine at this time. One confounding factor may be the degree to which different study sites represent optimal habitat for given life stages, particularly with regard to sea temperature. For example, the relationship between growth rate and body size at Mona Island (Puerto Rico) and Heron Island (Australia), suggests that very small turtles could not grow at such sites (Annex 7). In the case of Mona Island (Diez and van Dam 1995), turtles also reach zero growth at about 55 cm SCL. It should thus not be surprising if hatchlings eminating from nests in the area disperse from it, and that larger adults do not become permanent residents there, as suggested by Bowen *et al.* (1996). However, there is no evidence indicating these situation characterise the species throughout its range.

A8.2. The Signifance of "Movement"

Cuban waters contain extensive areas of warm, shallow coral reef, and as such, appear to provide extensive areas of optimal habitat for *E. imbricata* and many other marine resources. Marine resources eminating from Cuban waters move into the territorial waters of other nations, where they are exploited commercially in a variety of consumptive and non-consumptive ways, just as the reverse situation is obviously true. However, there is no evidence indicating that the Cuban *E. imbricata* population is highly migratory, in the sense that a large portion of the Caribbean population is simply moving through Cuban waters at any one time of year. Regardless, regional co-operation is important.

Cuba has initiated and is committed to, a regional forum (see Section 5.1.2.d) to share information about the management of sea turtles, and particularly the extent of their uses by people. The use of sea turtles by people is widespread in the region, although it is poorly documented. International convention regarding ownership of such marine resources within territorial waters is well established.

Because of its general importance to long-term management and regional co-operation, Cuba has devoted considerable resources to the issue of movement. The results obtained to date are summarised below. They are consistent with the species having a high degree of site fidelity within Cuban waters.

A8.3. Cuban Tag Recovery Rates

Between May 1989 and December 1995, 607 different *E. imbricata* were caught, tagged and released in Cuban waters. By 1996, there had been 46 recoveries, all (100%) from within Cuban waters. That is, no *E. imbricata* tagged in Cuban waters has yet been detected in other nations despite mark-recapture programs in non-nesting areas in Puerto Rico (Diaz and van Dam 1995) and Mexico (Garduno and Marquez 1994, 1996), and beach nesting studies in various Caribbean nations [e.g. Antigua (Hoyle and Richardson 1993); Puerto Rico (Diaz and van Dam 1995); Virgin Islands (Hillis 1996); Costa Rica (Bjorndal *et al.* 1993); Mexico (Garduno and Marquez 1996)]. The species is traditionally harvested in Nicaragua (Lagueux 1996; Castro pers. comm.), which has resulted in tag returns of *E. imbricata* marked in Costa Rica (Bjorndal *et al.* 1993) and the Virgin Islands (Hillis 1996); but none have been recovered from Cuba.

In contrast, 432 different *Chelonia mydas* were tagged and released in Cuban waters between 1989 and 1995. By the end of 1995, there had been 28 recoveries: 14 (50.0%) from within Cuban waters and 14 (50.0%) from other countries [USA (1), Costa Rica (1), Honduras (1), Nicaragua (10), Panama (1)]. Of the 143 different *Caretta caretta* tagged and released in Cuba during the same period, 10 (91%) were recovered in Cuban waters, and 1 (9%) from Nicaragua. Although these results are subject to many potential biases, they are consistent with some general conclusions:

1. That *E. imbricata* move less than some other species of sea turtles (Witzell 1983; Groombridge and Luxmoore 1989); and,
2. That *E. imbricata* caught in Cuban waters seem to show a reasonably high degree of site fidelity to Cuban waters (Moncada 1994a, 1996a, 1996b).

A8.4. Foreign Tag Recovery Rates from within Cuba

The total number of *E. imbricata* tagged within the Caribbean region is small relative to some other species (Groombridge and Luxmoore 1989), but is probably a few thousand individuals. During the period 1983 to 1995, some 58,000 *E. imbricata* were caught in Cuban waters for research or during harvests; two had tags from another country (Mexico).

By way of contrast there have been 'confirmed' recoveries in Cuban waters of 124 *C. mydas* and 35 *C. caretta* tagged in other regional countries (e.g. USA, Mexico, Venezuela, Cayman Islands). Precise comparisons are confounded by many potential biases, but the results are consistent with *E. imbricata* moving less than the other species.

A8.5. The Direction of Movements

A8.5.1. Fishermen's Observations

At the two traditional harvest areas (Isle of Pines and Nuevitas), there is an unbroken chain of harvesting *E. imbricata*, in the same coastal capture sites, for up to 100 years. The fishermen involved consider both sites to be located in areas that intercept near coastal movement past where they set their nets. At Nuevitas (Zone D), the nets are always set at 90° to the shoreline, and all *E. imbricata* caught are moving from west to east. When the nets at Nuevitas are used to capture *E. imbricata* for tagging, the tagged animals are always released on the east side of the net - none have been recaught in the nets, indicating a strong tendency to move from west to east with the prevailing inshore currents (Annex 2).

A8.5.2. Tag Recoveries

Recoveries of *E. imbricata* tagged in the Nuevitas region (Table A8.1; Fig. A8.1) are consistent with near coastal west to east movement along the north coast, of a significant number of marked animals.

Table A8.1. Data from *E. imbricata* tagged on the northern coast (Nuevitas and Las Tunas; see Fig. A8.1) and at Doce Leguas, and recaptured after various periods of time. * = include turtles recaught at the same keys (1-10 km) of the original tag site. "90/2030" refers to animals recaught 90 km west of their release site; that is, they had moved 90 km in the opposite direction to movement trends (see Section A8.5.1), or had moved a minimum of 2030 km around Cuba.

	No. of Turtles	No. of Recapt.	------ Months since Tagging ------ 0-1	2-6	7-12	13-24	25-36
<u>Marked at Nuevitas/Las Tunas</u>							
Recaught at Nuevitas	0	0	-	-	-	-	-
Recaught elsewhere	26	27	20	5	-	2	-
Mean distance from tagging site (km)	-	-	115	332	-	90/2030	-
Minimum distance from tagging site (km)	-	-	21	74	-	90/2020	-
Maximum distance from tagging site (km)	-	-	372	744	-	90/2030	-
<u>Marked at Doce Leguas</u>							
Recaught at Doce Leguas	15	15	1	3	6	3	2
Recaught elsewhere	0	0	-	-	-	-	-
Mean distance from tagging site (km)	-	-	*<10	27	26	*<10	17
Minimum distance from tagging site (km)	-	-	*<10	*<10	*<10	*<10	10
Maximum distance from tagging site (km)	-	-	*<10	66	132	*<10	24

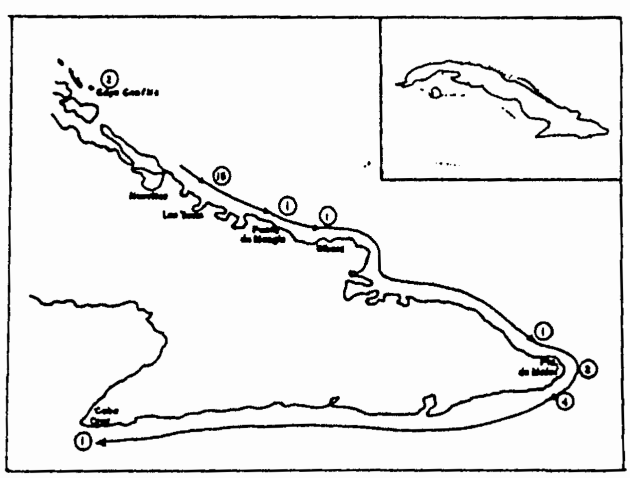

Figure A8.1. Locations (circles) of 27 recaptured *E. imbricata* originally marked at Punta Ganado (Nuevitas; N = 25) and Cobarrubia (Las Tunas; N = 2). Modified from Moncada (1996a, 1996b). Numbers in circles are sample sizes.

If this is the case, the most plausible explanation of the longer term recoveries of animals marked on the north coast, is that they result from movement around the eastern end of the island, as suggested by Moncada (1994a, 1996a, 1996b). In contrast to the animals marked on the north coast, those marked at Doce Leguas (Zone A), where waters are shallow and warm, show a higher degree of site fidelity (Table A8.1; Fig. A8.2).

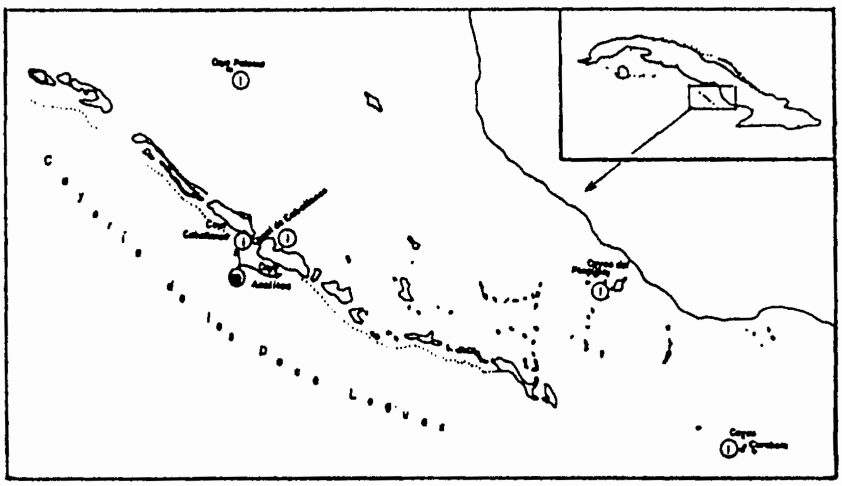

Figure A8.2. Locations (circles) of 15 recaptured *E. imbricata* originally marked at Doce Leguas. Modified from Moncada (1996a, 1996b).

A8.5.3. Indications from Reproductive Data

The reproductive cycles of *E. imbricata* within the four different Zones (Annex 6), are not synchronised with each other. But they do have a consistent relationship with each other.. For example, in the western part of Cuba, the reproductive cycle in Zone C (northwest) is highly predictable from that in adjoining Zone B (southwest) the month before (Annex 6). In the eastern part of Cuba, the peak of females with enlarged follicles occurs at the same time of year in Zones D (northeast) and A (southeast) (Annex 6). However, animals with oviducal eggs at that time of year are largely restricted to Zone A. These results are consistent with some level of movement of reproductively mature animals between adjacent Zones.

A8.6. DNA Analyses

Notwithstanding the limitations of using mitochondrial DNA to define population boundaries, it remains a useful tool for developing hypotheses on the origins and movements of *E. imbricata* (Broderick *et al.* 1994; Espinosa *et al.* 1994, 1996; Koike 1995; Bass *et al.* 1996; Bowen *et al.* 1996; Koike *et al.* 1996). Bass *et al.* (1996) and Bowen *et al.* (1996) describe haplotype frequencies in nesting animals from seven sites in the Caribbean. Bowen *et al.* (1996) also describe frequencies in a resident population of non-nesting animals at Puerto Rico. Koike (1995), Koike *et al.* (1996) and Espinosa *et al.* (1996) have examined additional samples from Puerto Rico, Mexico and Cuba. DNA studies of Cuban *E. imbricata* are continuing, and samples from throughout the Cuban shelf are now being collected and analysed.

Espinosa *et al.* (1996) derived comparative frequencies for 4 haplotypes based on total mitochondrial DNA that allowed specimens from Zones A, B and D to be compared with each other, and with a sample of animals from Yucatan (Mexico). The results (Table A8.2) indicate two common (I and II) and two uncommon (III and IV) haplotypes. Zones B and D contained the same haplotypes, in near identical proportions, suggesting common stocks. The Mexican sample contained similar proportions of the common haplotypes to Zones B and D, but contained one haplotype found in no other Cuban samples. The Zone A sample contained only the two common haplotypes, and in significantly different proportions to Zones B, D and Mexico ($\chi^2 = 10.74; p = 0.013$).

Table A8.2. Haplotype frequencies based on total mitochondrial DNA for *E. imbricata* from Zones A, B and C in Cuba, and Yucatan in Mexico.

Location	No. of Samples	Haplotype I	II	III	IV
Cuba (Zone A)	31	9	22	0	0
Cuba (Zone B)	23	14	8	1	0
Cuba (Zone D)	35	19	14	2	0
Mexico (Yucatan)	21	14	6	0	1

Espinosa *et al.* (1996) also examined haplotype frequencies in a fragment of the control region of the DNA strand (Table A8.3). Four haplotypes were identified, three common (A, B, C) and one rare (D). The three common haplotypes occurred in all three Cuban samples, at variable but not significantly different frequencies. In contrast, the Mexican sample had only two of the common haplotypes, at significantly different proportions to the Cuban animals ($\chi^2 = 11.37; p = 0.01$), and contained the fourth haplotype.

Table A8.3. Haplotype frequencies in a control region fragment of mitochondrial DNA for *E. imbricata* from Zones A, B and C in Cuba, and Yucatan in Mexico.

Location	No. of Samples	Haplotype A	B	C	D
Cuba (Zone A)	17	5	6	6	0
Cuba (Zone B)	13	6	5	2	0
Cuba (Zone D)	16	9	4	3	0
Mexico (Yucatan)	29	25	2	0	2

Taken together, these preliminary results suggest that Zones B and D contain animals of similar origins, that may not be homogeneous with animals from Zone A. The Mexican animals do not appear to be homogeneous with the Cuban animals, although they share some common haplotypes.

The results reported by Koike *et al.* (1996) and Okayama *et al.* (1996) are more comprehensive and can be directly compared with the data reported by Bowen *et al.* (1996) and Bass *et al.* (1996). Koike *et al.* (1996) examined a longer sequence in the control region, and were able to discern an important polymorphic site, which allowed some haplotypes described by Bowen *et al.* (1996) and Bass *et al.* (1996) to be subdivided into new haplotypes.

Notwithstanding the relatively small sample sizes examined to date, the results from Cuba indicate different haplotype frequences between Zones A and D (the only two Zones examined to date), and between different capture sites within each Zone (Table A8.4). The diversity of haplotypes in Zone D (12) is so far greater than that in Zone A (6). There are many possible explanations for this, not the least of which is that Zone A appears to contain more resident animals than Zone D, which appears to sample animals moving on the north coast, from west to east. The haplotypes so far identified from nesting areas at Doce Leguas, are all represented within the non-nesting population that exists there (Table A8.4). Comparable information on the haplotypes in Zones B and C are being gathered.

Table A8.4. Haplotype frequencies in a control region fragment of mitochondrial DNA for *E. imbricata* from different capture sites in Zones A and D in Cuba (Koike *et al.* 1996; Okayama *et al.* 1996). SC = Santa Cruz del Sur; DL = Doce Leguas; NV = Nuevitas; LT = Las Tunas. NDL refers to individuals in the ranching program which were collected from nests at Doce Leguas, although it is not known how many nests the individuals represent.

Zone/	No. of	Haplotype													
Site	Samples	Cb1	Cb2	Pr1	Pr3	Mx1	Mx2	a	e	g	i	m	n	o	p
Zone A															
SC	8	5	-	3	-	-	-	-	-	-	-	-	-	-	-
DL	23	18	1	1	-	-	1	-	-	-	-	-	-	1	1
NDL	12	9	2	1	-	-	-	-	-	-	-	-	-	-	-
Zone D															
NV	18	8	-	4	1	1		1	-	1	-	1		-	1
LT	14	3	1	4	1	-	1		1	1	1	-	1	-	-

To compare the preliminary results from Cuba with those described by Bowen *et al.* (1996) and Bass *et al.* (1996), the new polymorphic sites (Okayama *et al.* 1996) were ignored, and the Cuban results lumped into two groups: nesting and non-nesting (Table A8.5). The nesting sample at this stage represents only animals currently within the ranching program, which are known to have come from Doce Leguas (Zone A). However, the number of nests from which they were obtained is unknown, and thus siblings may be included. Samples from a range of nesting areas, throughout Cuba, are currently being collected and analysed, which should throw more light on the diversity of haplotypes involved.

From the data currently available, few conclusions about movement can be drawn with any confidence. The new data from Puerto Rico indicate that the most common haplotype in the nesting population is indeed the most common in the nearby resident population, which lessens the importance of the differences emphasized by Bowen *et al.* (1996), based on samples taken the previous year, from a different mix of nesting beaches on Mona Island. However, given both small and large *E. imbricata* resident in the Puerto Rican study area have severely constrained growth rates (Annex 7), perhaps due to low sea temperatures, there may be sound ecological reasons for both large and small *E. imbricata* to avoid that area. This may not be the case in Mexico and Cuba, where growth may not be compromised.

The limited data so far available from Cuban nesting animals also shows no major difference between nearby resident populations (Table A8.4). But even if it did, variation within a Zone would make it difficult to interpret. In overview, a great deal more information, from throughout the Cuban shelf, from both nesting and non-nesting animals, will be needed before the Cuban DNA results can be used to confidently shed new light on movements.

Table A8.5. Haplotype frequencies in a control region fragment of mitochondrial DNA for *E. imbricata* from the Caribbean region, as described by Bowen *et al.* (1996) and Bass *et al.* (1996). D1-D10 = additional haplotypes identified in the same control region by Okayama *et al.* (1996) and Koike *et al.* (1996). Haplotypes in brackets indicate those identified by Okayama *et al.* (1996) and Koike *et al.* (1996). * indicates data from Koike *et al.* (1996) and Okayama *et al.* (1996). The Cuban non-nesting sample comes from Zones A and D, and the nesting sample from Zone A. The Cuban nesting sample comes from animals in the ranching program, whose identity to nest of origin is no longer known. Bel = Belize; Mex = Mexico; PR = Puerto Rico; VI = Virgin Islands; Ant = Antigua; Bar = Barbados; Brz = Brazil; Cba = Cuba. Numbers in brackets indicate sample sizes.

	Nesting										Non-Nesting		
Haplotypes	Bel (14)	Mex (15)	Mex* (34)	PR (15)	PR* (20)	VI (15)	Ant (15)	Bar (15)	Brz (14)	Cba* (12)	Cba* (63)	PR (41)	PR* (106)
A (Cb1)	-	-	-	1	-	1	9	11	4	9	34	7	31
B (e)	-	-	-	-	-	-	4	-	-	-	1	1	1
C	-	-	-	-	-	-	2	-	-	-	-	-	-
D	-	-	-	-	-	-	-	1	-	-	-	-	-
E	-	-	-	-	-	-	-	3	-	-	-	-	-
F (Pr1, c, j)	11	-	-	1	12	14	-	-	-	1	12	18	44
G (i)	1	-	-	-	-	-	-	-	-	-	1	-	1
H	1	-	-	-	-	-	-	-	-	-	-	-	-
I	1	-	-	-	-	-	-	-	-	-	-	-	-
J	-	-	-	2	-	-	-	-	-	-	-	-	-
K	-	-	-	1	-	-	-	-	-	-	-	-	-
L (Pr3)	-	-	-	1	1	-	-	-	-	-	2	1	2
M	-	-	-	2	-	-	-	-	-	-	-	-	-
N (Pr2)	-	-	-	6	6	-	-	-	-	-	-	3	5
O (Pr4)	-	-	-	1	1	-	-	-	-	-	-	-	-
P	-	2	-	-	-	-	-	-	-	-	-	-	-
Q (Mx2, Mx1)	-	13	33	-	-	-	-	-	-	-	4	7	11
R	-	-	-	-	-	-	-	-	6	-	-	-	-
S	-	-	-	-	-	-	-	-	2	-	-	-	-
T	-	-	-	-	-	-	-	-	1	-	-	-	-
U	-	-	-	-	-	-	-	-	1	-	-	-	-
α (g)	-	-	-	-	-	-	-	-	-	-	2	2	3
β	-	-	-	-	-	-	-	-	-	-	-	1	-
γ (Cb2)	-	-	-	-	-	-	-	-	-	2	2	1	-
D1 (d)	-	-	-	-	-	-	-	-	-	-	-	-	1
D2 (f)	-	-	-	-	-	-	-	-	-	-	-	-	1
D3 (b)	-	-	-	-	-	-	-	-	-	-	-	-	4
D4 (a)	-	-	-	-	-	-	-	-	-	-	1	-	-
D5 (o)	-	-	-	-	-	-	-	-	-	-	1	-	-
D6 (h)	-	-	-	-	-	-	-	-	-	-	-	-	1
D7 (m)	-	-	-	-	-	-	-	-	-	-	1	-	-
D8 (n)	-	-	-	-	-	-	-	-	-	-	1	-	-
D9 (zz)	-	-	-	-	-	-	-	-	-	-	-	-	1
D10 (Mx1a)	-	-	1	-	-	-	-	-	-	-	-	-	-
D11 (p)	-	-	-	-	-	-	-	-	-	-	1	-	-

A8.7. Evidence from Chemical Analyses

Trace element concentrations within animals (Courtney *et al.* 1994; Sakai *et al.* 1995), reflect the environment in which they live and the foods they eat. Because of this, they can sometimes be used to differentiate animals of the same species which live in different geographical areas (Courtney *et al.* 1994). When these techniques were applied to small samples of *E. imbricata* shell from various parts of the world (Sakai and Tanabe 1995; Tanabe and Sakai 1996; Tanabe *et al.* unpublished), they indicated a high (100%) degree of discrimination (Fig. A8.3).

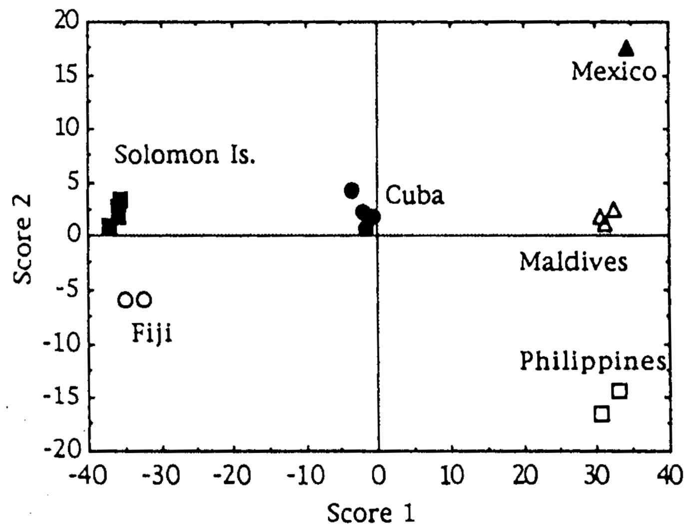

Figure A8.3. Relationship between scores calculated by discriminant analysis based on concentrations of V, Cr, Mn, Cu, Zn, Se, Sr, Cd, Ba, Pb, Th and U in the shell of *E. imbricata* from six countries. Modified from Tanabe *et al.* (unpublished).

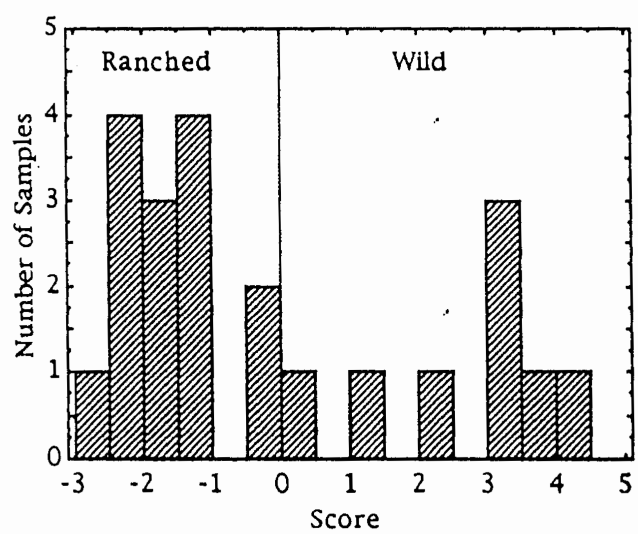

Figure A8.4. Scores calculated by discriminant analysis based on the concentrations of Mn, Cr and Se in the shell of ranched and wild *E. imbricata*. Modified from Tanabe *et al.* (unpublished).

They also allowed samples of wild and ranched *E. imbricata* from Cuba (Fig. A8.4) to be discriminated from each other. A broader-scale study is now underway to determine, with larger samples, the extent to which the technique can discriminate between between samples of *E. imbricata*, from different parts of Cuba and from other Caribbean locations. The results may allow independent testing of hypotheses about movement, particularly of nesting females, derived from other sources.

Relative concentrations of carbon and nitrogen isotopes in the shell of *E. imbricata* are also a reflection of an animal's diet (Koike 1995b). Carbon isotope ratios ($\delta^{13}C$; ratio of ^{13}C to ^{12}C compared to a standard) vary between oceanic and coral reef systems, with oceanic primary producers having $\delta^{13}C$ values of around -2.0 to -1.6%, and coral reef dwellers with values between -1.5 and -1.1% (McConnaughy and McRoy 1979; Yamamura *et al.* 1992). Nitrogen isotope ratios ($\delta^{15}N$; ratio of ^{15}N to ^{14}N compared to a standard) indicate the trophic level within the food web, with oceanic primary producers usually having values between 0 and 0.5% and secondary producers between 1.0 and 1.5+% (Minagawa and Wada 1984).

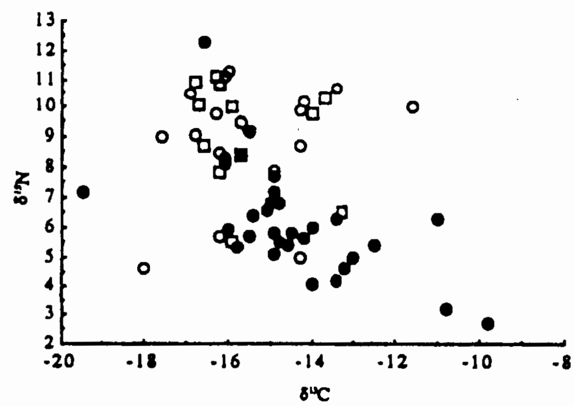

Figure A8.5. Relationship between $\delta^{15}N$ and $\delta^{13}C$ values for wild *E. imbricata* shell. Cuba (closed circles), Mexico (closed squares), Pacific Ocean (open circles), Indian Ocean (open squares). (Koike, unpublished data).

Isotope analysis (Koike and Chisolm 1991) has been carried out for wild *E. imbricata* shell from a number of countries (Cuba, Indonesia, Mexico, Philippines, Solomon Islands, Maldives, Fiji), and ranched shell from Cuba. Amongst wild samples, $\delta^{15}N$ values were generally higher for samples from the Pacific and Indian Oceans than they were for Cuba (Fig. A8.5), suggesting that *E. imbricata* from Cuba had relatively less dependence on animal protein. The $\delta^{13}C$ values from wild Cuban shell (Fig. A8.5) indicate a higher link to coral reef ecosystems.

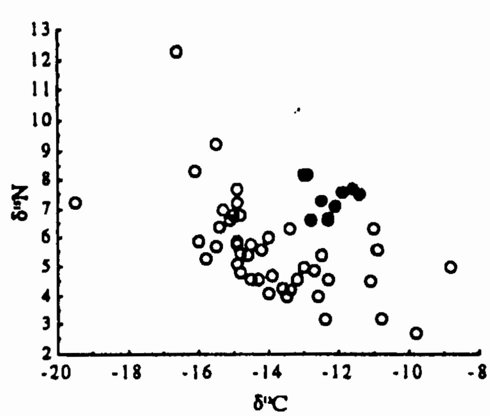

Figure A8.6. Relationship between $\delta^{15}N$ and $\delta^{13}C$ values for wild (open circles) and ranched (closed circles) Cuban *E. imbricata* shell. (Koike, unpublished data).

Wild and ranched shell from Cuba were different in terms of $\delta^{15}N$ values (Fig. A8.6). Ranched turtles were fed small fish, which may be at a higher trophic level than sponges in the coral reefs, the main diet of Cuban *E. imbricata* (Anderes 1994, 1996; Anderes and Uchida 1994). These preliminary data indicate that isotopic analysis may be a further useful tool for distiguishing ranched from wild shell, and Cuban shell from that from other countries.

A8.8. Satellite Tracking

Satellite tracking offers a further means of obtaining information on the movements of *E. imbricata* (Groshens 1993; Groshens and Vaughan 1994; Balazs *et al.* 1996), although the technique is inordinately expensive, and to date, has only been used with limited numbers of *E. imbricata* [11 (Groshens 1993; Groshens and Vaughan 1994); 2 (Balazs *et al.* 1996)]. The majority of transmitters used with this species have given no readings, which in part may reflect mechanical damage associated with the species' activities in and around coral reefs. An Australian research team is investigating different transmitter mounting methods and have indicated their willingness to attempt to track a sample of *E. imbricata* caught in Cuban waters. At the time of submission, the only test results available are that two individuals released at Nuevitas (Zone D) with a prototype mounting harness, were detected 55 and 70 km to the east, within 3 and 10 days respectively. This is consistent with the direction of movement indicated by fishermen's observations and the tagging results (Section A8.5).

A8.9. Evidence from the Harvest

The exact relationship between age and the total number of growth rings in the shell plates is still under investigation, but within the animals harvested between 1993-95, no individuals had more than 17 rings (Annex 7). If errors are generally within 3 years, as is thought to be the case (see Section A7.3.1 of Annex 8), it indicates that animals caught in Cuba are no more than 20 years of age (hatched 1973-75). This would be an expected result if the one population was harvested over a long period of time. It would not be the expected result if *E. imbricata* moved freely throughout the Caribbean (Bowen *et al.* 1996). That is, the large, old, females known to nest in other locations [eg. Antigua (Hoyle and Richardson 1993)], either have a maximum of 17 growth rings or do not frequent Cuban waters.

Trends in the size structure of *E. imbricata* caught during the historical harvest (Annex 5) are also inconsistent with a continual replacement of larger animals from other locations.

In response to changes in local management, the nesting populations of *E. imbricata* and *Lepidochelys olivacea* in Mexico, have increased dramatically and exponentially (Hernandez *et al.* 1995; Marquez *et al.* 1996), despite harvesting of *E. imbricata* (but not *L. olivacea*) in Cuba. Again, the result is inconsistent with totally random mixing of *E. imbricata* between Mexico and Cuba.

A8.10. Conclusions

There is little doubt that immigration and emigration of *E. imbricata* into and from Cuban waters occurs, but there is no evidence to support the speculation by Bowen *et al.* (1996) that a hawksbill turtle harvest on feeding grounds anywhere within the Caribbean will "reduce nesting populations throughout the Caribbean region".

Zone A, with its vast areas of shallow, warm protected waters (Annex 2), appears to contain resident populations of all-sized *E. imbricata*. Young animals in Zone A have grown rapidly (Annex 7), suggesting that they have lived in warm waters since hatching. It must be remembered that there is no direct evidence indicating that hatchling *E. imbricata* disperse from optimal conditions. The limited data on nesting animals indicates that nesting and non-nesting haplotypes within Zone A are similar, which is consistent with the population being more closed than may be the case in some other areas. DNA results indicate a degree of isolation of animals resident in Zone A from those in Zones B, C and D, and tagging results indicate a high degree of site fidelity in Zone A.

Nesting areas and resident populations are also known from Zone B, which has large areas of shallow warm waters, but the harvest is centred on a site where *E. imbricata* are moving. Based on the limited data currently available, the *E. imbricata* caught in Zone B are similiar to those caught in Zone C, where increased nesting occurs (Annex 6). Some data suggests that at least some *E. imbricata* from Zone B move to Zone C for nesting. In Zone D, the majority of animals caught are moving from west to east, and the tagging results suggest that some go around the eastern extremity of the island to the southern side.

Two *E. imbricata* tagged in Mexico have been caught in Cuban waters, and the populations share some haplotypes known from nesting *E. imbricata* from Mexico. However, these haplotypes may also be found in nesting animals within Cuba, as to date only a small sample of nesting animals, from one site in one Zone, have been examined. Caution needs to be exercised in drawing any firm conclusions about movement from the DNA data, without some form of independent check. Trace element concentrations in the shell plates may provide such a check.

In overview, information on movement of Cuban *E. imbricata* is continuing to be gathered, using a variety of different techniques and approaches. Most evidence suggests that the status of *E. imbricata* in Cuba, like that in Mexico, will largely reflect the effectiveness of Cuba's management of the population within Cuban waters. The general results are consistent with the existence of a significant resident population, that spends a great deal of its time within the warm coastal waters demarcated by the Cuban shelf.

Annex 9. Management Program and Procedures - Traditional Wild Harvest

Carrillo, E.C., Perez, C.P., Moncada, F.G., Nodarse, G.A., Rodriguez, A.M., Meneses, A., and S.C. Manolis.

A9.1. General

The traditional wild harvest conserves an important part of Cuba's cultural heritage, provides definitive data on population trends, allows the real impact of harvesting to be quantified, and provides the commercial incentives needed to continue a significant research effort on *E. imbricata*.

A9.2. Harvest Areas

Within Cuba, *E. imbricata* is protected in all waters. Under Ministry of Fisheries Resolutions 300/94 and 3/95, the traditional harvest is authorised at the settlement of "Cocodrilos" (formerly Jacksonville) on the southwest coast of the Isle of Pines, and at "Nuevitas", on the northeast coast of the mainland. These areas have a long unbroken history of turtle harvesting. For example, the remote settlement of Cocodrilos (1996 population = 332 people), was started by William Jackson and his family, turtle fishermen who immigrated to Cuba from the Cayman Islands in 1885. The Jacksons, their descendents, and the central economic activity of the community, has been turtle fishing for 112 years.

Harvesting takes place at two locations at the Isle of Pines (Punta Pedernales and El Diablo), and three locations at Nuevitas (Punta Ganado, Cayo Romano and Cayo Guajaba). The total area in Cuba where *E. imbricata* is subject to harvest is now less than 2 km^2; this represents 0.0045% of the 44,076 km^2 of Cuban waters under 20 m in depth.

A9.3. Harvest Limits

Under current management, the total traditional harvest will not exceed 500 individual *E. imbricata* per year, during the 9 month open season, over the next 3 years. Within this limit, the two harvest areas operate under a catch-plan rather than a quota, that takes into account varying ocean conditions, traditions of fishing in both areas, and annual variation in abundance.

At the Isle of Pines the catch-plan consists of: four cherneras boats (5 m long; see Annex 4) with <15 bottom and/or surface nets per boat (60-80 m per net; 46 cm minimum mesh size). For Nuevitas the catch-plan consists of: four boats (5 m long) and a total of <1600 m of calamento surface nets. The nets (mesh size 46 cm) are hand-made by the fishermen specifically for turtle fishing.

A9.4. Closed Seasons

The annual season is closed for three months, from 1 May to 31 July. In addition, when weather conditions are unsuitable during the open season, fishing ceases. That is, the open season sometimes extends for only 7 months.

A9.5. Size Limits

In the past, minimum size limits have been imposed on the basis of theoretical calculations. These required varying tolerance levels to account for incidental catch, and were generally impractical to implement. A minimum size limit of 65 cm SCL is now in force and any *E. imbricata* <65 cm SCL caught alive must be released. A tolerance level of 5% of total catch (included within the harvest limit of 500) has been established to account for incidental death of *E. imbricata* <65 cm SCL. These limits may be revised during the next three years.

A9.6. Harvest Procedures

At the Isle of Pines, the nets are laid from cherneras boats, in various patterns, within 400 m of the shoreline. Due to the distance from the settlement, nets are checked once daily. At Nuevitas, the longer calamento nets are laid perpendicular to the shoreline, adjacent to the settlements, and are within 1 km of the shoreline. Weather permitting, nets are checked 2-3 times daily.

A9.7. Processing Procedures and Distribution of Products

At Nuevitas, live turtles are measured and weighed at the harvest sites, and are then released into an ocean corral. They are picked up by a Ministry of Fisheries vehicle 2-3 times each week, and transported to the processing facility at Nuevitas, where they are re-measured and weighed. At the Isle of Pines, all animals are landed at the local processing facility, where they are measured and weighed.

All turtles are allocated a unique field identification number (FIN: Isle of Pines = IP; Nuevitas = PG, CR or CG), written onto the shell plates). The FIN bears a specific code for each harvest site (IP, PG, CR, CG), year and a unique number (e.g. IP/96/001), but this is not the CITES export label number (see below).

Turtles are killed by a blow to the brain, using a hammer and chisel. They are bled, hosed down, and an incision made around the edge of the plastron, which is then removed. The viscera are then removed, and edible parts (liver, heart, fat) separated. The anterior limbs and body meat are then removed, followed by the posterior limbs and body meat. The extremities of each limb and viscera are provided to the local fishing establishment for food. With the remainder, the skin is removed and dried (after salting). The meat is deboned, reweighed, and packed in plastic fish crates, which are placed in a chiller (<10°C).

The meat is collected and reweighed, once or twice per week by the local Fishing Enterprise, which in turn transfers the meat to the Ministry of Interior Trade which is responsible for its distribution within Cuba. The Fishing Enterprises themselves are subject to regular inspection by inspectors from the National Bureau of Fisheries Inspections.

Following the removal of the meat, the plastron and carapace of each turtle are placed into a fine mesh bag, and submerged in water for 5-10 days, to allow the shell plates to loosen. Excess bone is then removed and the plates are allowed to dry in their individual mesh bag. When dried, all shell parts (shell plates, marginals, hoof, plastron) from a particular individual are weighed and packed into a plastic bag, which is provisionally sealed with the FIN.

At Nuevitas, any turtles used for local consumption are numbered, measured and weighed at the harvest sites. The meat is either salted or eaten fresh, and only the dried shell, individually packed and numbered, is sent to the processing facility at Nuevitas, where it is re-measured and treated in the same way as freshly processed shell.

The bags of shell from Nuevitas and the Isle of Pines are sent by the Fishing Enterprises to Provincial stores at Camaguey and Nueva Gerona respectively, where the shell is weighed. Stores of shell are periodically sent to the central store at Cojimar, in Habana . Here, the shell in each bag, which comes from an individual *E. imbricata*, is laid out on a light table, graded, and photographed with a digital camera. The plates are counted and weighed (carapace, marginals, hoof, plastron), and repacked in a heat-sealed plastic bag. A non-reusable CITES label (issued by the Cuban CITES Management Authority; Fig. A9.1; Section 8.2), containing all relevant data, is included in each photograph and is later fixed to the bag. The digital images are then transferred to a computer which allows each individual plate, from each individual animal, to be identified from size, shape and colour pattern. The images are transferred to discs, which can be forwarded to the CITES Secretariat or the CITES Management Authority of the importing nation.

The skins are a minor byproduct that are used domestically for leather. When dried, they are packed in boxes or sacks, weighed, and are collected periodically by the Fishing Enterprise. From here they are forwarded to the Ministry of Light Industries, where they are manufactured into items for domestic consumption. When Cuba lifts its reservation, it will impose a total embargo on the exports of such products.

where to now?

CONVENCION SOBRE EL COMERCIO INTERNACIONAL DE ESPECIES AMENAZADAS DE FAUNA Y FLORA SILVESTRES

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

CONCHAS DE CAREY

(HAWKSBILL SEA TURTLE SHELL)

Eretmochelys imbricata (A-301.003.003.001)

PRODUCTO DE CUBA

PRODUCT OF CUBA

Número de etiqueta:CU ___/___/___
(Label Number)

(Año/Lugar/No. de Serie)

Código de campo : ___/___/___ (Year/Place/Serial No.)
(Field Code)

Origen de la Tortuga : ______
(Origin of Turtle)

Fecha de producción : ______
(Date of Production)

//IMPORTANTE//

(!! IMPORTANT !!)

No valido si no se abre a lo largo de esta linea.
(INVALID UNLESS OPENED ALONG THIS LINE)

Corte por aqui (cut here) — Corte por aqui (cut here)

Peso de las conchas : ______ kg
(Weight of Shell)

Número de las piezas : ______
(Number of Pieces)

Número de foto : ___/___ (Número de disco/marco)
(Photo Number) (Disk Number/Frame Number)

Figure A9.1. CITES Label (tag equivalent) attached to sealed bags of *E. imbricata* shell in Cuba.

A9.8. Record Keeping

Since September 1996, data has been recorded from all turtles caught in the traditional fishery. The unique field identification number (see A9.7) allocated to each turtle identifies the individual at any stage of processing and/or point of data collection. Data are now recorded in printed data books (individually numbered pages in triplicate) provided by the Ministry of Fisheries.

Data are collected at the harvest sites (Harvest Form), processing facilities and Provincial stores (Processing Form), and central store (Cojimar; Shell Form). Forms are submitted monthly to the Ministry of Fisheries in Habana, where they are assessed and data transposed to computerised databases. Copies are also held at the harvest sites, processing facilities and Provincial stores.

The data forms make provision for: species; field identification number (FIN); date of capture/processing; type of fishery; capture site/processing facility/Provincial store; straight carapace length; straight carapace width; curved carapace length; curved carapace width; condition; body weight; presence of tags; sex; presence and size of enlarged follicles and/or oviducal eggs; presence of corpora lutea in the ovary; number and weight of different shell plates; other products produced (meat, skins); age (see Annex 7); digital photograph number; and, CITES label number (Fig. A9.1).

A9.9. Supervision

At both traditional harvest sites, all operations are subject to spot checks by inspectors of the National Bureau for Fisheries Inspections. At the Isle of Pines, the Ministry of Fisheries has a permanent presence at the ranching research centre, and staff are responsible for ensuring compliance with the regulations and the accurate recording of harvest data. At Nuevitas, the Ministry of Fisheries has a small experimental station, with a permanent biologist on staff, who is responsible for compliance with regulations and accurate data collection.

Annex 10. Management Program and Procedures - Ranching Program

Nodarse, G.A., Meneses, A., Manolis, S.C., Webb, G.J.W., Carrillo, E.C., and E. Pelegrin

A10.1. General

Cuba's approach to ranching *E. imbricata* has and will continue to be a cautious one based on objective experimentation. Pilot studies have established unequivocally that hatchling *E. imbricata* from wild eggs can be raised in captivity to commercial size. They have also indicated a range of variables that affect survival, growth and the efficiency of production, all of which are the subject of ongoing research.

A10.2. Harvest Areas

Wild *E. imbricata* eggs/hatchlings are currently collected from the Doce Leguas area in Zone A. The exact collection sites in the future will be selected on the basis of access and suitability for long-term monitoring.

A10.3. Harvest Limits, Exports and Impacts

Harvests for experimental purposes have so far been limited (Proposal Table 7), and as such shell exports over the next 3 years will be limited (50 in year 1, 100 in year 2 and 300 in year 3). The harvests will increase steadily, but over the next four years will not exceed the limits in Table A10.1.

Table A10.1. Maximum limits of *E. imbricata* egg/hatchling harvesting for 1997-2000. The harvest will comprise hatchlings incubated in nests in the field, and hatchlings derived from eggs collected and artifically incubated. The total harvest will be the equivalent of "hatchlings" or "viable eggs". "%H/P" = the percentage of the minimum estimated wild hatchling production (233,320 hatchlings) harvested. [This is also the percentage of wild nesting females (3483; Annex 7) whose eggs will be collected].

Year	Hatchlings	Viable Eggs	%H/F
1997	1000	1450	0.4
1998	2000	2900	0.9
1999	4000	5800	1.7
2000	6000	8700	2.6

Given that the annual average harvest of *E. imbricata* from this Zone (Zone A) prior to total protection was around 95 tonnes (2700 individuals) per year (Annex 4), the impact of the ranching program relative to the historical harvest may be so small that it will be impossible to quantify. Nevertheless, long-term monitoring programs are being designed to accompany the egg/hatchling collection program.

A10.4. Harvest Procedures

Harvesting occurs mainly in December and January. At present, nests are left to incubate in the field and hatchlings are collected at the time of hatching. As harvesting switches from hatchlings to eggs, standard procedures will be followed: the orientation of eggs will be retained; they will be transported in insulated containers packed in nest sand; they will be shielded from extremes of temperature; prevented from dehydrating; and, provided with opportunities for embryonic gas exchange. One live egg will continue to be sacrificed where applicable to determine the approximate age of the nest and to predict hatching dates. All dead eggs will be opened to record (to the extent possible) the approximate stage (age) at death.

A10.5. Incubation

Artificial incubation techniques are well established for sea turtles (e.g. Miller 1985; Mrosovsky *et al.* 1992), as are the effects of incubation temperature on sex determination (eg. Yntema and Mrosovsky 1980; Mrosovsky 1994; Mrosovsky *et al.* 1992). The results of recent incubation trials on *E. imbricata* eggs within water-jacketed incubators are in Tables A10.2 and A10.3. One clutch (D1) was collected on the day of laying, but was also used for incubation trials at extreme temperatures.

Table A10.2. Incubation trials on *E. imbricata* eggs, transported 525 km from the nesting site, for artificial incubation at constant temperatures between 27°C and 33°C.

	No. of Eggs	% of all Eggs	% of Eggs Incubated
Eggs collected	826	-	-
Infertile	3	0.4	-
Dead before collection	165	20.0	-
Dead at collection	32	3.9	-
Probed	16	1.9	-
Live eggs	610	73.8	-
Opened for aging	10	1.2	-
Embryo series	45	5.4	-
Eggs incubated	555	67.2	-
Died during incubation	93	11.3	16.8
Normal hatchlings	455	55.1	82.0
Abnormal hatchlings	7	0.8	1.2

Table 10.3. Clutch-specific results for the incubation of *E. imbricata* at different constant temperatures (±0.2°C).

Clutch	Viable Eggs	Temp. Range (°C)	Normal Hatchlings		Abnormal Hatchlings		Died During Incubation	
			N	%	N	%	N	%
B1	97	29-30	87	89.7	4	4.1	6	6.2
D1	67	27-33	2	3.0	0	0.0	65	97.0
D2	93	29-31	87	93.5	1	1.1	5	5.4
D3	82	29-31	70	85.4	1	1.2	11	13.4
D4	83	29-32	82	98.8	0	0.0	1	1.2
D5	133	29-31	127	95.5	1	0.8	5	3.8
All	555	27-33	455	82.0	7	1.2	93	16.8

A10.6. Transportation of Hatchlings

To date, hatchlings have been held in plastic containers in the field and fed minced fish until they can be transported from Doce Leguas to the Isle of Pines facility, by boat, road or air.

A10.7. Transportation of Eggs

Where field incubation occurs, clutches are packed in moist sand in insulated boxes, and are moved to a central collection area where they are reburied, with the same orientation, in a section of beach that is secure, and where the nest environment meets the requirements for successful incubation. The same methods are used for transporting eggs for artificial incubation (see A10.4 above). Care is taken to minimise mechanical shock during transportation.

A10.8. Location of the Ranching Facility

Research on the raising of sea turtles has been largely carried out at the experimental raising facility located at the township of Cocodrilo, situated on the south-west coast of the Isle of Pines. Established in 1982, it covers an area of 32 hectares. This facility will continue to be used, but it is anticipated that on aceptance of this proposal by the Parties, new facilities will be constructed in Habana (see Proposal 8.6).

A10.9. Raising Facilities

Rearing facilities currently consist of 37 pens of various sizes (Table A10.4), comprising 546 m^2 of surface area and 255 m^3 of water. All pens are of concrete and brick construction, and, with the exception of the largest pen (20 m diameter), are situated beneath green, translucent roofing. Similar pens will be used for the expanded raising capacity, although these may be modified according to the results of ongoing experiments with controlled-environment raising facilities.

Table A10.4. Details of rearing pens at the Isle of Pines facility, at 31 December 1996.

Dimensions	Water Depth (m)	No. of Pens	Suitable For
2.0 x 2.0 m	0.30	24	Hatchlings-1 year olds
3.2 x 2.2 m	0.40	1	0.5 - 2 year olds
3.4 x 1.5 m	0.35	3	0.5 - 2 year olds
5.8 x 3.8 m	0.45	2	1 - 2 year olds
3.5-4.0 m diam.	0.40	5	1 - 2 year olds
5.8 x 2.1 m	0.50	1	2 - 3 year olds
20.0 m diam.	0.55	1	2 - >3 year olds

A10.10. Water

Water at the Isle of Pines facility is pumped directly from the sea and reticulated to all pens. Current pumping capacity is 300 m^3 per hour, with water changed completely at least once or twice per day, depending on the rates of feeding (see A10.18). The pH of the water varies between 7.5 and 8.1, salinity from 3.4 to 3.9%, oxygen 3.8 to 4.8 mg l^{-1} (Nodarse 1996). The temperature of water pumped into pens varies between 23.0 and 29.5°C (the highest temperature recorded is 29.7°C), and water in the rearing pens ranges between 18 and 30°C, depending on time of year (Nodarse 1996). This site is exposed to different water currents and temperatures (Annex 2) than the sheltered Doce Leguas Keys nesting sites.

A10.11. Controlled-Environment Raising

During 1996, hatchlings were raised experimentally in new plastic tanks (2 x 1 x 0.5 m high), with recirculated water filtered through a mechanical sieve, biofilter, protein skimmer and an ultraviolet screen. This allowed water temperature to be controlled, which had a pronounced effect on growth rates (Table A10.5).

Table A10.5. Effects of temperature on mean *E. imbricata* growth rates of hatchlings from 5 clutches raised in a controlled environment.

Clutch	Mean Age (days)	Sample Sizes		Body Weight (g)		Straight Carapace Length (mm)	
		26°C	29°C	26°C	29°C	26°C	29°C
D2	92	20	30	45.0	78.6	63.9	79.1
D3	87	22	30	74.5	116.7	76.9	89.1
D4	105	18	16	55.2	119.4	69.4	91.1
D5	85	41	60	54.3	76.3	69.4	77.8
B1	112	7	7	56.2	100.3	68.4	82.5
All	85-112	5	5	57.0	98.3	69.6	83.9
D2	177	15	30	115.0	335.2	91.3	124.7
D3	172	19	26	297.5	593.7	120.3	149.4
D4	190	14	16	133.0	551.2	96.8	150.6
D5	170	29	54	147.5	370.7	97.4	125.6
B1	197	2	5	226.0	455.1	116.2	136.5
All	170-197	5	5	183.8	461.2	104.4	137.4

A10.12. Waste Management

The major sources of waste in the pens are uneaten food and nitrogenous wastes in solution: solid wastes (faeces) are negligible. Waste management at the Isle of Pines involves dumping directly into the ocean. The nature of the currents ensure no contamination of intake water. Solid waste is rapidly eaten by fish. Dead animals are autopsied and parts of significant size, that are not preserved, are buried and used as fertiliser.

A10.13. Facilities

A10.13.1. Feed Storage

Frozen food (mainly fish) is stored within freezers capable of maintaining -10°C or colder when fully loaded. Artificial rations (pellets) are stored at room temperature within a storeroom.

A10.13.2. Quarantine

Pens are separated from each other, so that at any time, a pen can be used to isolate sick turtles.

A10.13.3. Processing

No processing of ranched animals has yet been undertaken. Design specifications for processing facilities attached to the facility will include:

- Exclusion of dust, insects, birds, rodents and other vermin.

- Floors, walls and ceiling to be constructed of impervious material (concrete), for cleaning.
- Drainage of all water through trapped floor drains, and effluent discharged in an approved manner.
- Processing tables to be constructed of smooth, impervious material.
- Stainless steel sinks to be equipped with hot and cold running water.
- Room temperature to be maintained at 15-20°C throughout processing of turtles.

A10.13.4. Other

Additional facilities include a laboratory, food preparation area, storeroom and office.

A10.14. Staff

Current staff include one full-time research biologist and 7 technical and support staff. Veterinarians and research biologists visit the facility regularly.

A10.15. Survival Rates

Despite a variety of experimental treatments so far tested, survivorship after one year of age is high (1-2 years of age, 95%; 2-3 years of age, 97-98%). In contrast, the health and well-being of hatchlings requires strict attention to all aspects of the raising environment, and possibly the incubation environment.

Seventy-one percent survival to one year of age (N= 193) was achieved with one batch of hatchlings, without temperature control, and despite them being used for various experimental manipulations. In the first trials involving controlled environment and recirculated water, increasingly sophisticated filtering was introduced during the trials, and it was highly effective in reducing mortality linked to bacterial contamination. In these separate experiments, 76.1% survival to six months was achieved without efficient filtering (26°C: N= 142). It is anticipated that 90+% survival rates between hatching and one year of age can be achieved with further research into the physiology and optimal environment for hatchlings.

A10.16. Growth Rates

The mean size of *E. imbricata* raised under varying experimental regimes at the Isle of Pines are in Table A10.6, although these do not represent the results of optimal raising conditions. Growth to 35-40 SCL in 1.5-2 years is readily achievable with basic husbandry (Deraniyagala 1939; Alcala 1980; Witzell 1980, 1983). The extent to which growth rates to one year of age can be increased under controlled temperature regimes is currently under investigation. At 29°C, faster growing individuals attain 24-25 cm SCL in 8 months.

Table A10.6. Mean size of *E. imbricata* of different ages, raised at the Isle of Pines ranching facility under a variety of experimental regimes, but without temperature control.

Age (y)	Mean Straight Carapace Length (cm)	Range (cm)
1	19.6	16.0-22.6
2	32.4	28.5-37.2
3	38.7	29.9-45.7
4	44.5	42.0-47.7

A10.17. Density

Density is reduced as turtles increase in size. Results to date indicate a range of stocking densities (expressed both as kilograms of turtle per cubic metre of water and turtles per square metre of water surface area) suitable for this type of pen (Table A10.7).

Table A10.7. Densities of different-sized *E. imbricata* at the Isle of Pines.

Straight Carapace Length (cm)	Density (m^{-2})	Density ($kg\ m^{-3}$)
4	75	10
12	14-19	10
20	4-7	10
35	1-2	15
40	1	20

A10.18. Foods and Feeding

A variety of foods and feeding regimes have been tested. Locally caught fish (mostly sardines), fed in a minced form, is a common diet. With *E. imbricata* less than 20 cm SCL feeding is twice per day, and those over 20 cm SCL it is once per day. Water levels are dropped (to approximately 10 cm for turtles <6 months old) before food is introduced, and the food is left for 30-60 minutes before pens are drained, hosed out, and refilled with fresh seawater.

Experiments with artificial rations (Pelegrin *et al.* 1994) indicated similar conversion rates with two dry, granulated rations (15 and 25% conversion; 40 and 45% protein respectively) to fresh fish (25%), although growth was higher in turtles fed the fish. Feeding trials are now being conducted with a new floating pelletised ration.

A10.19. Disease Control

Treatment of sick or injured turtles is under the control of a qualified veterinarian.

A10.20. Slaughter/Processing

No commercial processing of ranched animals has yet taken place. Future processing will be within dedicated processing facilities (see A10.13.3). Food will be witheld from turtles for 2-3 days prior to slaughter, and they will be killed rapidly and humanely using the method described in Annex 9. They will be processed and uniquely numbered according to the procedures described in Annex 9. Ranched shell will be identified as "Ranched Product" on the CITES label (Annex 9).

A10.21. Record Keeping

Details of all ranched turtles processed will be recorded on printed data sheets (Annex 9), and regularly transposed to computerised databases. All data relating to incubation success, survival and growth, and numbers of stock, are recorded and submitted on a monthly basis to the Ministry of Fisheries in Habana. These will be reported annually to the CITES Secretariat.

ANNEX 11. Management of Turtle Shell in Japan

The *Foreign Exchange and Foreign Trade Control Law* is the law governing export and import in compliance with CITES. A Cabinet Order issued under this law currently prohibits the export and import of *E. imbricata* shell with the exception of preconvention stocks. Should the Parties to CITES agree to the Cuban proposal, the import restrictions (but not the export restrictions) would be altered to allow the importation.

Domestic trade in *E. imbricata* shell is controlled by *the Law for the Conservation of Endangered Species of Wild Fauna and Flora* entered into force on June 28, 1995. It provides for the following 3 steps to be taken: (1) registration of any size of the whole turtle shell, (2) notification by those engaged in business dealing pieces of shell, (3) obligation imposed upon the producers having made the notification to compile records of their transactions.

1.Registration of any size of the whole shell.

Any size of the whole shell, may be bought or sold only, if they are accompanied by a registration card issued by the Director-General of the Environment Agency.

The method by which the registration is made is as follows:

1. Any size of the whole shell to be registered.

   The whole shell proven to have been acquired or imported legally under the scheme of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

2. Management of Registered shells.

   (1) Anyone having been given a registration card is required to be ready to present it at any time when he/she (or a corporation) displays the whole shell relating to the registration card for the purpose of trading in it either commercially or non-commercially.

   (2) When a whole shell thus registered, is delivered or transferred it must be accompanied by the registration card.

   (3) Anyone having received a registered shell is required to notify the Environment Agency within 30 days of receiving it.

   (4) Where anyone ceases to own a registered shell either by losing it (including theft) or cutting it up into pieces, he is required to return the registration card, within 30 days of the day the event took place.

* Those having violated 2. (1)-(4) may be fined an amount not exceeding ¥200,000.

* Those having made the registrations by falsification or other illegal means are liable to imprisonment for a period not exceeding 6 months or to a fine not exceeding ¥500,000.

3. Designated registration organisation.

   (1) The business of registering is conducted by a public organization designated by the Director-General of the Environment Agency. [Designated registering organisation: Japan Wildlife Research Centre (JWRC)].

   (2) All data of the registered shells are collected in the computerized database at JWRC.

2. Notification by those engaged in the business dealing with pieces of shells

Anyone who is to carry out any transaction involving the transfer or delivery of pieces of shell is required to notify the Director-General of the Environment Agency and the Minister of International Trade and Industry of the matters mentioned below.

The matters to be notified are:

(1) His/her own address and name.
(2) The name and location of the facilities to carry out the business.
(3) The quantity of stock.

* Anyone having carried out any transaction involving pieces of shell without the notification may be fined an amount not exceeding ¥500,000.

**The officials of the Environment Agency and the Ministry of the International Trade and Industry have randomly inspected the shell traders. The inspections have been done without the prior notice.

3. Obligation upon persons having made notification to compile a Ledger of Transactions

Anyone who carries out any transaction involving pieces of shell is required to compile and maintain a ledger recording all such transactions; and is required to preserve the ledger for five years, and to present it at the request of officials of the Environment Agency and the Ministry of International Trade and Industry.

1. More specifically, the obligation is as follows:

(1) The person responsible must enter in the ledger the name and address of the person (or corporation) from whom the transfer, etc. was carried out (this must be confirmed) as well as the date of the transaction, weight and quantity in stock.

(2) Each record in the ledger must be kept for five years, and the person responsible is required to present the ledger at the time of surprise inspection by officials of the Environment Agency and the Ministry of International Trade and Industry.

* Where anyone has failed to make the entry in the ledger, or has made a falsified entry, the Environment Agency and the Ministry of International Trade and Industry may issue necessary instructions; and, where anyone has violated the instructions, he or she may be ordered to suspend business for a period not exceeding 3 months. Those having violated the orders may be imprisoned for a period not exceeding 6 months or fined an amount not exceeding ¥500,000.

* Where the Environment Agency and the Ministry of International Trade and Industry seek to undertake an inspection of a business, the owner of the business is required to accept such an inspection. Anyone having refused such an inspection may be fined an amount not exceeding ¥200,000.

ANNEX 12. Summary of the Regional Meeting on the Conservation and Sustainable Use of Hawksbill Turtle in Cuba

A regional meeting on the conservation and sustainable use of the Hawksbill Turtle in Cuba, hosted by the Cuban Ministry of Fishing Industry (MIP), was held on 14-15 March 1996, in Habana. The aim of this meeting was to present Cuba's experiences with the conservation and management of *E. imbricata.*, and to foster and encourage understanding and co-operation with regional neighbours. Representatives from Colombia, Cuba, Dominica, Cayman Islands, Guatemala, Honduras, Jamaica, Mexico, Nicaragua, Panama, St. Vincent and Venezuela attended the meeting, together with observers from the CITES Secretariat, CITES Animal's Committee, OLDEPESCA, IUCN and IWMC.

This Annex summarises the meeting.

- The meeting was officially opened by the Deputy Minister of MIP, Enrique Oltuski Osacki, and chaired by Elvira Carrillo Cardenas, (Directoress of the Fishery Development Directorate of MIP).

- Grahame Webb (Australia) presented a paper on the concept of conservation through sustainable use, and discussed the importance of identifying the fundamental differences between conservation, animal rights and animal welfare when applying this concept. Conservation programs are likely to be more effective if they are tailored to the aspirations and needs of the people expected to implement them, and should be based on a philosophy of tolerance, respect and understanding of all peoples, cultures and religions.

- The case of the Miskito Indians of Nicaragua, with a long history of use of sea turtles, exemplified the importance of sea turtles as a source of food and an item of trade for coastal indigenous people in the Carribean region. Denis Castro (Nicaragua) emphasized that conservation measures should not be adopted without the participation of such communities, and consideration of their traditions. Henry Jackson (Cuba) explained that his family were sea turtle fishermen from the Cayman Islands, who established the township of Cocodrilo in Cuba in 1885, on the southern coast of the Isle of Pines. The tradition of sea turtle fishing has been maintained in Jackson's family for over 100 years, and his experiences at the one location over a long period of time (>50 years) provide valuable insights into the harvesting of *E. imbricata.* The Japanese craft associated with *E. imbricata* shell (bekko) was explained by Yoshio Ezaki (Japan), whose family has been involved with this tradition for some 300 years.

- Cuba's experiences with research and management of *E, imbricata* were addressed by various researchers:

  Legislation and fisheries regulations (Placido Sanchez).
  Movement of *E. imbricata* in the Cuban shelf (Felix Moncada).
  General Biology of *E. imbricata* (Felix Moncada).
  Sea turtle habitats and diet of wild *E. imbricata* in Cuba (Blanca Anderes).
  Population dynamics (Carlos Perez).
  Harvest trends (Carlos Perez).
  Reproduction and nesting (Silvio Elizalde).
  Experimental rearing of *E. imbricata* at the Isle of Pines (Gonzalo Nodarse).
  DNA studies of *E. imbricata* in Cuba (Georgina Espinosa).

- The theory and practice of harvesting and ranching were the the subject of a presentation by Grahame Webb. He noted the need to approach problems with sea turtle conservation and management in a positive and scientific manner. He cited the example of crocodilians, where potential problems with ranching were tested, and were either overcome by research, or simply did not eventuate. Like crocodilians, sea turtles appear to be good candidates for ranching, due to high egg production and low survival rates to maturity. Harvests below maximum sustainable yield should theoretically be sustainable, and compensatory mechanisms may allow the harvest of juveniles without significantly affecting recruitment to the adult population. Monitoring is essential to sustaining a harvest.

- Quantifying the relationship between age and size in turtles and crocodilians is complicated by highly variable growth rates. Growth data from Cuba indicate that *E. imbricata* grow faster and mature earlier there than populations living in cooler environments. Growth data from a number of studies were summarised by Charlie Manolis (Australia), indicating the extent of variation between different populations of *E. imbricata*. The warmer, more optimal sea temperature in the Cuban shelf probably account for the higher growth rates observed in Cuba). An assessment of the impact of a ranching program based on eggs and/or hatchlings, as proposed by Cuba, was also presented; the short- and long-term impacts would probably be biologically negligible compared to the historical harvest.

- Regional representatives presented summaries on the conservation and management of sea turtles in their respective countries (eg. population status, legislation, public education, research, incidental catch). Issues discussed included the need to adopt management programs which ensured sustainable use, and the need for regional co-operation in this regard. Cuba's initiative with the regional meeting was welcomed, and it was felt that further meetings to discuss management issues would be of great benefit.

- Carlos Mazal (OLDEPESCA) reported on progress being made with the "Draft Convention for the Protection and Conservation of Sea Turtles in the Western Hemisphere". Several participants expressed concerns about the draft document circulated at the meeting. In particular, it was felt that Convention contradicted the development of management programs for sea turtles in the region, as it dealt mainly with total prohibition of trade.

- The chronology of events involved with the listing of sea turtles on the CITES Appendices was presented by Hank Jenkins (CITES Animals Committee).

- Eugene Lapointe (IWMC, Switzerland) discussed changes in conservation generally over the last 55 years. He emphasised the need for regional co-operation, and the need to search for further innovative and creative solutions for conservation problems, outside of the conventional preservationist ones used to date. It was important that traditional and cultural uses of wildlife were respected. In the past, many potential solutions to conservation problems were rejected because they involved utilisation in one form or another. However, prohibition with conservation and many other aspects of human activity has often failed.

- Ichiro Kanemaki (IWMC, Japan) outlined Japan's registration system for *E. imbricata* shell. This system will allow Japan to fully comply with CITES regulations, and close possible loopholes for illegal shell entering Japan.

- Open discussion on Cuba's program, and the management of sea turtles in the Carribean region generally, was carried out throughout the meeting. In summary, there was unanimous agreement from all participants that all nations had much to gain from regional co-operation and discussion of how different management programs operated. From a regional perspective, it was concluded that:

  a. A lack of resources (funding) constrained research on sea turtle biology and conservation threats in the region.

  b. Although all countries had environmental policies and legal instruments in place, often there was little response on the part of local communities with regard to their traditional use and trade in sea turtles.

c. There was a need to design management programs for sea turtles, in particular *E. imbricata*, at the country level, and to include these into a regional co-operation plan.

d. There was no single approach to management that could be applied universally to sea turtles in the region. There was much to gain by different nations experimenting with different combinations of protection and use, and sharing the results in a true spirit of regional co-operation.

e. The Cuban *E. imbricata* program was acknowledged as having particular significance and value in the region.

f. There are no scientific or technical data to support the listing of all sea turtle species in Appendix I of CITES. In cases where Appendix I criteria are not met, transfer to Appendix II should be sought.

g. More co-ordination and co-operation between fisheries and wildlife authorities, at both a national and regional level, would be beneficial.

h. The "Draft Convention for the Protection and Conservation of Sea Turtles in the Western Hemisphere" be revised such that it is consistent with the direction of existing international agreements on conservation and sustainable use (eg. CITES, IUCN, CBD).

Annex 13. Compliance with CITES Resolutions.

Resolution Conf. 9.24

Annex 1. "Biological Criteria for Appendix I".

Neither the Cuban nor global population of *E. imbricata* meets the biological criteria for Appendix I, although some populations in some range states are and will continue to need conservation action, in some cases, perhaps urgently. International trade is no longer a key threatening process, and with CITES in place, is unlikely to be so in the future.

A. The global wild population is not "small". In Cuban waters the most conservative estimate of the population, derived here, is 100,000 to 230,000 non-hatchlings, with a minimum of 3500 to 4100 adults (Annex 7). In Mexico (Hernandez *et al.* 1995; Garduño, unpublished) some 2000 nests were located in 1995. The species nests around the world (Proposal 3.1.1), and the global population may involve millions of individuals, and tens of thousands of mature adults.

B. The wild population does not have a restricted distribution. It has a global distribution encompassing over 1 million square kilometres (Proposal 5.2.2).

C.i. In the past, the wild population has been reduced relative to the historical, virgin situation. However, with no significant international trade (Proposal 5.1.2.b), no potential for it to resume without compliance with CITES, and with *E. imbricata* protected in many areas (Proposal 5.1.2.b, c and d), including Cuba, the global population is unlikely to continue declining. [Some local populations will still decline due to subsistence/domestic use and other factors (Proposal 3.1.1; 5.1.2.; 5.2.1)]. Within Cuba, no evidence indicates an ongoing decline (Annex 5).

C.ii. On a global scale, and in Cuba, habitat is not limiting to the species (Proposal 3.1.2). Exploitation is reduced relative to historical levels and legal controls have increased greatly over the last 20 years (Proposal 5.1.2b, c). In Cuba the harvest has been scaled down by 90%. No significant extrinsic factors are involved in Cuba nor in many other parts of the range of *E. imbricata*. The reproductive potential of the population is not compromised in Cuba, where the main nesting areas are still intact (Annex 6). The reduced harvest is expected to alter the population structure in the direction of there being increased numbers of nesting females, as has occurred elsewhere (Annex 7).

D. There is no evidence indicating that the status of *E. imbricata* on a global scale and within Cuba will not steadily improve rather than deteriorate over the next 5 years.

Annex 2a "Criteria for the inclusion of Species in Appendix II in Accordance with Article II, Paragraph 2.(a).

The Cuban population of *E. imbricata* clearly meets the criteria for inclusion in Appendix II, in that if uncontrolled exploitation of wild stocks occurred, without any regulation, a population decline would be expected until it became economically not viable to continue harvesting them. That is, commercial extinction rather than biological extinction would be expected.

Annex 2b "Criteria for the inclusion of Species in Appendix II in Accordance with Article II, Paragraph 2.(b).

The Cuban population of *E. imbricata* meets this criteria. Despite the ability to distinguish *E. imbricata* shell from that of all other species of sea turtles (Proposal 6), distinguishing it from other populations of *E. imbricata*, which will remain on Appendix I, requires reference to the marking system and security photographs (Proposal 8.2; Annex 9). Chemical and biochemical analyses provide additional safeguards (Annex 8).

Annex 3. Special Cases - Split Listings.

The split listing is not requested on the basis of a sub-specific classification. The marking system and trade controls ensure effective management and control is possible.

Annex 4. Precautionary Measures.

The Cuban proposal does not meet the criteria for having the transfer from Appendix I to Appendix II rejected because of precautionary measures. Notwithstanding the ongoing results of research in Cuba and elsewhere, which will continue to provide new insights into the biology of sea turtles, and which will assist regional neighbours, Cuba has demonstrated unequivocally a record of responsible management, and an ability to both detect and react to any unforseen conservation needs that may arise from time to time.

In specific terms:

A. The Cuban proposal does not meet this criteria. In terms of distribution and abundance the status is stable or improving under current management and is not declining (Proposal 3.3.3). The results of the management program may have far reaching ramifications in the enhancement of the conservation of *E. imbricata* within and outside of Cuba (Proposal 8.4). The international trade proposed is highly regulated and creates very real incentives to prevent illegal trade.

B.1. The Cuban proposal does not meet this criteria. Cuba is proposing to transfer its population of *E. imbricata* from Appendix I to Appendix II, not to remove it from the Appendices.

B.2. The Cuban proposal does not meet the criteria. The population does not meet the biological criteria for inclusion in Appendix I (see above). In addition, the species satisfies more that one of the five precautionary criteria (a to e) that would override this situation:

a. The Cuban proposal meets this requirement. The shell is not in widespread international demand. It is in critical demand within Japan, where it is essential to the maintenance of long-established traditional uses. Japan has gone to considerable lengths to improve Governmental controls (Annex 11). Members of the

Japanese consortium receiving the shell have indicated their determination to comply fully with CITES. There is no evidence to suggest that stimulation of illegal trade is a significant factor in this case (Proposal 4.6.2).

b. The Cuban proposal also meets this requirement. There are no other range states exporting *E. imbricata* under Appendix I (captive breeding) or Appendix II, and thus Article IV applies only to Cuba, where a commitment to total compliance with CITES, in particular Article IV, has been made.

c. The Cuban proposal meets this requirement in some respects. The proposal is not based on quotas, but self-imposed limits are involved. There is a definitive stockpile (Proposal 4.3) to be moved, and the traditional harvest and ranching program are subject to definitive limits (Annex 9).

d. The Cuban proposal meets this requirement in some respects (see B.2.c above).

e. The Cuban proposal meets this requirement in some respects. The proposal is not restricted to ranching, but contains an experimental ranching component. To the degree possible it complies with Resolution Conf. 3.15 and 9.20.

B.3. The Cuban proposal meets this criteria. Cuba agrees to withdraw its reservation on *E. imbricata* within 90 days of the approval of its proposal.

B.4. The Cuban proposal meets this criteria. It is not requesting removal from Appendix II.

C.1 & 2 The Cuban proposal meets this criteria. Cuba supports the control measures indicated, although its proposal is not specifically based on a quota (B2.c or B2.d).

D. The Cuban proposal meets this criteria. Cuba intends to submit a comprehensive report to the 11th COP detailing progress and any amended management procedures based on scientific research (Proposal 2.10 and 8.3).

E. The Cuban proposal meets this criteria. No evidence indicates *E. imbricata* is or ever will be considered "possibly extinct" in Cuba.

Annex 6. "Format for Proposals to Amend the Appendices".

The proposal follows the format outlined in Annex 6 although various additional information has been required to meet other needs (Proposal A.2).

Other Relevant Resolutions

Although Cuba's proposal complies with Resolution Conf. 9.24, it involves ranching, and through Resolution Conf. 3.15 and Resolution Conf. 9.20 the Parties have identified a series of concerns related to ranching, and the ranching of sea turtles in particular. These concerns are addressed here, as they reflect concerns expressed by the Parties about the sustainable use of sea turtles in general.

Resolution Conf. 3.15

As recognised in the preamble of Resolution Conf. 3.15, Cuba wishes to maintain trade in a species that it has been managing in a responsible manner before it joined CITES. Cuba was actively implementing management procedures aimed at achieving sustainability before CITES came into being (Proposal 5.1.1.).

Compliance with specific recommendations:

a) The Cuban proposal complies. *Eretmochelys imbricata* is not in danger of extinction within Cuban waters, and nor does it meet the requirements for Appendix I (see above). The species will benefit from the new program in many ways (Proposal 8.4), and the results on sustainable use and the impacts of harvesting eggs will assist other nations attempting to conserve *E. imbricata* despite varying levels of unregulated traditional and subsistance use (Proposal 4.6.3; 5.1.2d; 8.4).

b) I) The Cuban proposal complies. The new program, which includes ranching, was developed specifically to reduce harvest pressures and encourage changes in the population structure in the direction of there being more adult animals (see Proposal 8.4).

b) ii) The Cuban proposal complies. The marking system and security photographs together provide a highly reliable means of identifying products from the Cuban program (Proposal 8.2; Annex 9). A further tier of security lies in DNA analyses and chemical analyses (Annex 8).

c) The Cuban proposal complies with each of the six criteria:

i) The harvest from Zone A has been reduced from 2700 wild individuals of all ages, per year, to a maximum within three years of 8700 viable eggs: the number of eggs laid in Zone A by 40 females annually. The program is accompanied by monitoring programs (Proposal 5.2.1; Annexes 9 and 10) and a response capability (Proposal 8.5) which will ensure no significant detrimental impact occurs or is undetected.

ii) Some thirty years of experience in the Cayman Islands provides unequivocal evidence that commercial-scale captive raising of sea turtles is biologically feasible, which is supported by all data so far collected in Cuba. The financial viability of the Cayman Island farm was severely constrained by the inability to export products, and by the relatively low market demand for the shell of *Chelonia mydas*. By integrating the operation with tourism, as occurs with many crocodile farms and ranches, commercial viability has now been achieved, even without exports (Fosdick and Fosdick 1994). With the ability to export *E. imbricata* from Cuba (see Proposal 8.6), there is a high probability of financial viability, which could be increased further through the inclusion of tourism.

iii) All aspects of the operation will be carried out in a humane manner (Annexes 9 and 10).

iv) The program will benefit the species in many ways (Proposal 8.4), including the possibility of reintroduction (Proposal 8.9) should it be necessary.

v) A method of product marking has been developed that exceeds the requirements of CITES (Proposal 8.2).

vi) A report detailing the status of the wild population as revealed through monitoring, and of the operation of all aspects of the program, will be submitted to the CITES Secretariat annually (Proposal 8.3). The Secretariat is and will continue to be welcome to review all aspects of the program at any time.

d) The proposal is submitted pursuant to Resolution Conf. 9.24. Information on ranching is provided so that Parties can fully appreciate the responsible approach being taken to the development of a ranching program as one part of its overall management plan for the species.

Resolution Conf. 9.20

In the preamble of Resolution Conf. 9.20 the Parties recognise that the sustainable use of sea turtles is achievable, but requires a serious ongoing commitment to management, which Cuba has and will continue to make. The Parties also accept that the sustainable use of sea turtles may have potential conservation benefits for marine turtles and their habitats.

Compliance with recommendations:

a) The Cuban proposal complies with the management requirements of Resolution Conf. 3.15 (see above) 5.16. (Proposal 8.2) and 6.22 (Proposal 8.3; Annexes 9 and 10).

b) Compliance with the Annex to Resolution Conf. 9.20 is detailed below.

c) Cuba is committed to annual reporting and the provision of information quantifying the impacts of its management on the wild population (Proposal 8.3).

GUIDELINES FOR EVALUATING MARINE TURTLE RANCHING PROPOSALS SUBMITTED PURSUANT TO RESOLUTION CONF. 3.15.

1. Resource Management

A. Biological Information

Information on the biology, management and geographic extent of *E. imbricata* is provided, using original data and published references, including the extensive reviews by Witzell (1983), Groombridge and Luxmoore (1989) and Márquez (1990).

a) Population distribution. Current nesting grounds are identified (Annex 6), and no known historical nesting grounds have been lost. Perez (1994) describes nesting habitats (Annex 6). Zones A and B contain extensive shallow water feeding grounds (Annex 2), but stomach contents analyses (Proposal 3.1.2) suggest feeding occurs throughout the Cuban shelf. Preliminary chemical analyses (Annex 8) indicate a heavy reliance coral reef habitats. Information on movement continues to be gathered using a variety of techniques (Annex 8). No results indicate that *E. imbricata* are migrating through Cuban waters. In contrast, a significant resident population exists, particularly in the southern inshore waters of Cuba (Proposal 8.8; Annex 8). As additional insights are gained, they will be reported to the CITES Secretariat.

b) Population status and trends. Information on the population size structure, age structure, and population trends is provided (Annexes 4, 5 and 7).

c) Reproduction. Estimates of reproductive rates and annual hatchling production are provided (Annexes 6 and 7).

d) Population mortality. Estimates of hatching success are provided through direct measurement (Annex 6), and population modelling (Annex 7). Levels of harvest are precisely recorded and incidental catch is under investigation. The CITES Secretariat will be informed about the results of that investigation.

B. National Management

The conservation and use of all sea turtles within Cuba has been subject to strict management protocols for many years (Proposal 5; Annex 3), as is demonstrated here for *E. imbricata*.

a) Monitoring. Harvest data are the primary tool for monitoring population trends (Annexes 4, 5 and 7). They provide the only practical approach to monitoring changes in the structure of the population (size, age and sex). For *E. imbricata* information on egg and hatchling mortality has (Annexes 6 and 7), and will continue to be gathered through the ranching program, which is linked to nest monitoring (Proposal 5.2.1).

b) Habitat protection. Nesting and feeding habitats within Cuba remain relatively free of disruption due to development, urbanisation and pollution (Proposal 3.2; Annexes 2 and 3).

c) Harvest regulation. Harvesting for ranching is restricted to eggs and hatchlings, and maximum levels have been expressed as a proportion of the estimated total production (Annex 10).

d) Protection of the population. All sea turtles are protected in Cuban waters. Exceptions are made specifically for the traditional harvest, which is strictly regulated, and the experimental ranching program. Incidental catch is the subject of a current investigation. No significant impact of pollution on sea turtles is known in Cuba.

e) Rules for stopping harvests. Cuba has established definitive response capability in terms of reduced and/or stopping harvests if the population status declines, regardless of whether this is due to the harvest or not (Proposal 8.5).

C. Regional Management

Cuba has demonstrated regional leadership, and is committed to regional co-operation and the sharing of information on the conservation, management and sustainable use of sea turtles within the Caribbean region (Proposal 5.1.2.d, e).

a) Activities to enhance regional co-operation are described (Proposal 5.1.2.d, e).

i-v. At the first regional meeting hosted by Cuba (Proposal 5.1.2.d; Annex 12) each representative reported on the conservation, management and use of sea turtles within their territorial waters. All aspects of *E. imbricata* management within Cuba, including the operation of Cuba's ranching program, were described in detail.

Although some countries (eg. Cuba and Mexico) had implemented significant management programs, the lack of funds and resources was a major impediment for many regional nations, faced with a great array of pressing problems.

Traditional and subsistence uses of sea turtles were and would continue to be widespread in the region. They were significant to the welfare of many impoverished coastal and indigenous peoples, despite being technically illegal in many countries. With the exception of Cuba, programs aimed at ensuring uses could be sustained, were largely lacking, yet they clearly were a high conservation priority within the region.

Cuba has and will continue to provide regional leadership if nations in the region request it, and funding mechanisms are identified by the Parties. Cuba will continue to make the results of its programs available to other regional nations. However, national management programs may never reach the expectations of the Parties (as expressed in Resolution Conf. 9.20) unless very significant funding is made available for this purpose.

2. Trade Controls

Cuba has introduced a highly secure and responsible set of trade controls, and will limit export to countries with equally strict controls (Proposal 4; Annexes 9 to 11).

a). Not applicable. Ranching remains an experimental component of a broader sustainable use program. However, maximum levels of harvest are already set (Annex 10), the importing nation has provided documentation on domestic laws and management (Annex 11), and stockpiles have been inventoried.

b) Laws, management protocols and enforcement capability have been documented (Proposal 5.1.1; 5.3.2, Annexes 3, 9 and 10).

c) The stockpile has been inventoried (Proposal 4.4.2), stringent marking systems have been introduced to distinguish ranched from wild shell (Proposal 8.2) and chemical means have been developed to distinguish between ranched and wild shell (Annex 8).

d) The only product exported from the ranching program will be unprocessed shell, and details of the stringent controls (Proposal 4.4.2; 8.2; Annex 9 and 10) and maximum levels of production have been provided (Annex 10).

3. The Ranching Operation

Compliance with Resolution Conf. 3.15 is detailed separately above.

a) Financial operation. The operation belongs to the State. Financial viability is addressed (Proposal 8.6).

b) Physical plant.

i-iv. Details of the experimental ranching site, facilities, water circulation systems and staff have been provided (Annex 10).

c) Operating procedures.

i. Details of stock and their collection methods, seasons, quotas, proportions of natural production, handling, transport and mortality have been provided (Proposal 4.1; Annexes 6 and 10).

ii. Stocking rates in terms of surface area and volume are provided (Annex 10).

iii. The CITES Secretariat will be informed of production schedules when the program advances beyond the experimental stage. Current information of growth rates, identification methods, culling procedures, mortality in captivity, disposal of carcases, and current stocks are provided (Proposal 3.3.4; 8.2; Annexes 8, 9 and 10).

iv. Information on food and nutrition is provided (Annex 10).

v. Information on care, maintenance and staff are provided (Annex 10).

vi. Information on slaughter procedures and record keeping are provided (Annexes 9 and 10).

d) Record Keeping.

Records from the ranching operation are kept and assessed by Government.

e) Benefits

Ranching is currently based at Cocodrilo, on the Isle of Pines, and involves the employment of traditional turtle fishermen in the remote community. The collection of hatchlings/eggs provides employment for coastal fishermen.

4. Summary Statement Describing Benefits to the Population

The ranching program is part of a sustainable use strategy implemented by Government and linked to a 90% reduction in historical harvest levels. Legal and control mechanisms are described (Proposal 5; Annex 10), as are conservation benefits (Proposal 8.4).

5. Reporting

The proposal contains a commitment to detailed annual reporting to the CITES Secretariat (Proposal 8.3).