

7.0 RECOVERY STRATEGY: GOAL AND OBJECTIVES

The long-term (50-year) goal of this plan is to maintain and enhance existing genetic stocks of tuatara. Within the short-term (five years) the major aims are:

AIM 1: TO MAINTAIN, WITH ONE POSSIBLE EXCEPTION, ALL POPULATIONS OF TUATARA ON ISLANDS ON WHICH THEY CURRENTLY EXIST.

Explanation: The one possible exception is the Little Barrier Island population. If further surveys confirm that only a few adults remain there, it is considered likely that a tuatara population cannot be sustained on the island in the foreseeable future. The eradication of kiore from the island is considered the single management initiative that would be most likely to alter this position, but it is not feasible at present. This population will have to be maintained on another island or in captivity.

AIM 2: TO ENHANCE THE SECURITY OF ALL TUATARA POPULATIONS.

Explanation: Tuatara survival depends on the security of the islands on which they occur. The greatest threats they face are the arrival of predatory mammals, loss of vegetation (e.g. due to fire), or widespread poaching.

AIM 3: TO ENHANCE THE NUMBER OF TUATARA IN ALL POPULATIONS REDUCED OR THREATENED BY INTRODUCED MAMMALS.

Explanation: This aim is to move tuatara numbers back towards former levels.

AIM 4: TO HAVE ALL GENETIC STOCKS REPRESENTED BY AT LEAST TWO WILD POPULATIONS ON ISLANDS THAT ARE EACH CAPABLE OF SUPPORTING AT LEAST 1000 TUATARA.

Explanation: The figure of 1000 is arbitrary. It should ensure that the islands are large enough to offer a reasonable degree of geological stability and the tuatara populations large enough to contain sufficient genetic variation for survival in the long-term.

AIM 5: TO ESTABLISH AT LEAST ONE LONG-TERM, SELF-SUSTAINING CAPTIVE POPULATION OF EACH SPECIES FOUND ON FEWER THAN FOUR ISLANDS IN THE WILD.

Explanation: At present this applies only to the Brothers Island tuatara. A captive population based on groups held at several institutions is to be maintained until the species is established on four islands, two of which have the potential to support 1000 individuals.

AIM 6: TO ESTABLISH NEW WILD POPULATIONS OF TUATARA ON ISLANDS ON WHICH CONTROLLED PUBLIC ACCESS IS PERMITTED.

Explanation: This will result in an increase in tuatara numbers towards their former level and provide increased opportunities for public education and advocacy. It also provides an opportunity for research into tuatara reintroduction techniques.

AIM 7: TO MAINTAIN CAPTIVE POPULATIONS OF BOTH SPECIES OF TUATARA.

Explanation: Captive populations are to be used primarily to build up stocks of depleted populations, for research that will assist the conservation of the species in the wild, and for education and advocacy. Only a few individuals are likely to see tuatara in the wild because of restrictions of access to the vulnerable islands on which they occur and because of the largely nocturnal habits of tuatara, so captive animals are important to allow many more people to appreciate this animal, which is very special to New Zealand.

These aims are summarised in Table 1 below for each type of tuatara:

TABLE 1 Objectives for tuatara recovery

Type of tuatara	Islands inhabited now	Islands to be inhabited by mid-1997	Present population (approx.)	Potential population ¹	Present independently managed captive populations ² now	Independently managed captive populations long-term
Brothers tuatara	1	3	300	at least 2300	0	1
Northern tuatara	25	26	10,000	77,000	4 ³	0
Cook Strait tuatara	4	5	45,000	at least 46,000	1	1

¹ Number potentially supported after many generations on habitats established by mid-1997

² A captive population is defined here as one containing adults of both sexes in reproductive condition. It may consist of several sub-populations held at different institutions.

³ Populations from Little Barrier, Stanley, Cuvier and Red Mercury Islands are currently managed independently.

8.0 RECOVERY STRATEGY: WORK PLAN

Actions required urgently for tuatara in general are first listed. Actions required for specific taxa are then listed in approximate chronological sequence for that taxon.

ALL TUATARA POPULATIONS

OBJECTIVE 1: PROCEDURES FOR INCREASING THE SECURITY OF ALL POPULATIONS

Purpose: Stringent procedures are essential to minimise the possibility of predator introduction or fires on all tuatara islands, and to minimise the impact if either does occur.

Comments: 1. Signs should be posted on all landing locations on all tuatara islands to explain to the public that access is restricted, and the reasons why. (This recommendation is subject to DoC policy on the placement of signs.)

2. Procedures for preventing marijuana cultivation on northern islands (especially the Poor Knights and Hen and Chickens) are required.

3. Owners of charter or fishing boats known to approach tuatara islands within 300 m should be required to maintain their boats in a rodent-free state.
4. Illegal landings of helicopters with fishing parties on islands need to be prevented.
5. Any legal visitors to the islands must be given a stringent, written list of instructions stating that fires and smoking are not permitted and that stores are to be packed in a rodent-free manner.
6. All rodent-free tuatara islands should be visited at least once a year if possible to confirm the presence of tuatara, the absence of rats, and to maintain the legibility and visibility of landing warning signs.
7. Staffed islands with frequent visitors (e.g., Stephens) must have formal procedures for monitoring the rat-free status of the island and of incoming stores and luggage on a continuous basis. The Stephens Island Rodent Contingency Plan written by Derek Brown (DoC Nelson/Marlborough) provides a useful model for other islands.

Key Personnel: All DoC conservancies managing tuatara islands (Northland, Auckland, Waikato, Bay of Plenty, Nelson-Marlborough) to implement. Consultation with MoT, Maori owners, other visitors, and local boatowners is necessary to explain and obtain support for these measures.

BROTHERS TUATARA

OBJECTIVE 2. INCREASED SECURITY OF THE NORTH BROTHER ISLAND POPULATION

Purpose: To increase the security of the tuatara population on North Brother Island.

Comments: A high level of surveillance and frequent monitoring is required while this island remains the only site where the Brothers tuatara is found. Landing warning notices and rodent contingency plans, which are required for all tuatara islands (see above), are of extreme importance for this population. Improved liaison with MoT is required to obtain support for and compliance with rodent contingency plans. The feasibility and benefits of staffing the island over summer (at least December-February) when recreational boating in Cook Strait is frequent should be investigated. The population should be censused at at least six-monthly intervals (preferably including the months of November or January, when previous censuses have been carried out) until further wild populations of this species have been established. Locals who are regularly on boats within sight of North Brother Island should be encouraged to watch for and report any suspicious activities on the island.

Progress: Permanent bait stations were set up on the island in May 1992.

Key Personnel: DoC Nelson-Marlborough to implement rodent contingency plans in conjunction with MoT, to establish surveillance and monitoring schedules in consultation with MoT, local boatowners and other suitable parties, and to investigate the feasibility of

staffing over summer. Dr C.H. Daugherty (VUW) and DoC S&R to provide advice regarding census techniques.

OBJECTIVE 3. ESTABLISH TWO NEW WILD POPULATIONS PLUS ONE CAPTIVE POPULATION OF THE BROTHERS TUATARA

Purpose: To establish Brothers tuatara in the wild on at least two islands capable of supporting at least 1000 tuatara each, and to establish one long-term, self-maintaining population of Brothers tuatara in captivity.

Comments: The security of this species of tuatara should be increased by having it represented on at least two further islands. The first two islands chosen should be within the Cook Strait-Marlborough Sounds region to ensure climatic similarities with North Brother Island, and should not be available for public access. Several islands have been suggested as possible sites (Appendix 7); those with the greatest potential need to be investigated further and others considered. The first island chosen should be ready to receive tuatara within the next two years and the second within the next four years. South Brother Island is close to North Brother (Appendix 7), but should not be considered for a transfer attempt because its more or less pristine condition qualifies it as a "minimum impact" island on which transfers should not normally take place (Atkinson, 1990). However, it could already possess a population of tuatara and should be surveyed to establish this point.

The feasibility of establishing the first new population with adults (e.g., about 10 males and 10 gravid females) from North Brother Island should be examined. The population on North Brother should be large enough to sustain this level of removal. The second island should be stocked using juveniles from eggs incubated in captivity.

Some eggs will need to be collected from North Brother Island during 1989, 1990 and 1991 to obtain sufficient numbers of juveniles for all predicted uses (15 juveniles to a captive breeding facility; plus at least 50-100 juveniles to one or more new islands).

Captive populations need to be maintained at least until Brothers Island tuatara are established on sufficient islands for their status to change to 'rare' (Red Data Book category). Brothers Island tuatara could eventually replace Cook Strait tuatara as the taxon used for display for education and advocacy purposes.

A transfer proposal will need to be prepared according to the Transfer Guidelines For Indigenous Terrestrial Fauna and Flora (DoC Policy 17 September 1990) and a monitoring to judge the success of the transfer will have to be set up. (Such a programme might take the form of that proposed to evaluate a Somes Island transfer of Cook Strait tuatara (Objective 13)).

Progress: 208 eggs were collected in total from North Brother Island in 1989-91; 94 hatchlings survive and 73 eggs are still incubating (December 1991). The hatchlings are currently spread among three captive facilities. Two further captive facilities are developing sites to hold these remaining expected hatchlings.

Key Personnel: DoC Nelson-Marlborough to survey South Brother Island. DoC Nelson-Marlborough to investigate and decide on suitable translocation islands in consultation with Recovery Group and DoC Wellington.

NORTHERN TUATARA

OBJECTIVE 4. CAPTIVE BREEDING OF NORTHERN TUATARA FROM STANLEY ISLAND, RED MERCURY ISLAND AND CUVIER ISLAND

Purpose: To survey these islands, collect any tuatara found, establish them in a captive breeding facility on the mainland, and attempt to raise juveniles for re-introduction to the source island following kiore eradication.

Comments: Ideally, if resources allow, the tuatara re-introduced to each of these islands should come from the stock previously on the island. Although significant genetic differences have not been detected between the different stocks, this is not proof that they do not exist. However, a five-year time-frame should be imposed on this. If satisfactory progress is not being made with the captive populations of any of these stocks after this period, consideration should be given to using Northern tuatara from other islands for re-introduction.

Progress: During 1990/91 expeditions to Stanley, Red Mercury and Cuvier resulted in the removal of 15, 11 and 6 adult tuatara respectively to Auckland Zoo. One Stanley Island tuatara died from chronic disease soon after transfer. Three of the Red Mercury females collected were induced to lay eggs by injection of oxytocin in 1990. The eggs produced were incubated at VUW and 14 hatched successfully. Both Cuvier Island females were treated with oxytocin in November 1991 but failed to produce eggs. Blood samples were taken from all captive animals from the three islands in February-March 1991 and analysed for sex hormone concentrations. The results suggest that reproductive activity in these animals is reduced compared with wild Northern tuatara, but not non-existent (Cree and Daugherty, 1991, Crec et al., 1991a). There are at least two female tuatara known to remain on Red Mercury Island. Six animals known on Stanley Island in 1989 were not found during surveys before and after the recent poison drop there.

Actions to Follow: Each population is being housed separately so that with suitable screening procedures the adults as well as any juveniles produced could eventually be returned to their source island, if appropriate. A captive management plan will be developed to summarise a programme for monitoring and enhancing reproduction in the adults. In the years subsequent to 1990, egg incubation and rearing of juveniles should be carried out in appropriate quarantine conditions, either at the adult husbandry site or elsewhere. Work on restoring the islands is identified in objective 8.

Key Personnel: Institutions holding northern tuatara. Facilities chosen should have experience in maintaining tuatara and must be able to provide a large, outdoor enclosure in which animals can be maintained following recommended procedures (Appendix 4). They must be willing to work closely with scientists to monitor reproductive and nutritional condition and carry out artificial egg incubation. Quarantine facilities for rearing hatchlings

outdoors to 3-4 years of age will be required (this could be carried out at a location separate from the adults).

Drs A. Cree (Otago University) and C.H. Daugherty (VUW) and holding institutions to set up monitoring and reproduction enhancing programme for incorporation in captive management plan to be produced by Barbara Blanchard (Wellington Zoo).

OBJECTIVE 5: SURVEY TO ESTABLISH THE STATUS OF NORTHERN TUATARA ON LITTLE BARRIER ISLAND.

Purpose: To estimate the numbers and reproductive status of tuatara on Little Barrier Island to enable recommendations to be made for the management of this population (Objective 6 below).

Comment: The initial reconnaissance survey carried out in February 1991, during which four adults were found, needs following up with a further two surveys in late spring/early summer 1992 and late summer/early autumn 1993 (Whitaker and Daugherty, 1991). Search effort should be concentrated on the northern half of the island.

OBJECTIVE 6: MANAGE LITTLE BARRIER TUATARA ON THE ISLAND, EITHER THROUGH ISLAND TRANSFER OR CAPTIVE BREEDING.

Purpose: To ensure the long-term survival of the Little Barrier tuatara population as a distinct entity in its natural habitat.

Comment: The presence of a self-sustaining population of Northern tuatara on Little Barrier is the desired long-term aim. Ideally this should be achieved with the stock currently on the island. The Little Barrier population is particularly significant for the following reasons (Whitaker and Daugherty, 1991): The population is of scientific interest as it occurs in an 'inland' forest similar to those occupied by tuatara in the past on the mainland; Little Barrier has the most diverse reptile fauna of any island that includes tuatara; Little Barrier has the potential for a huge population of tuatara un-matched elsewhere; as the only northern island with a resident caretaker, Little Barrier has high security for a population and a potential for public education and tourism if tuatara numbers can be built up.

The results of the reconnaissance survey of Little Barrier Island in February 1991 suggest that, under present conditions, this population is unlikely to be self-sustaining, and therefore has no long-term future. Low numbers of tuatara may relate to the presence of kiore. More are considered a direct threat to eggs and young through predation or may inhibit reproduction through competition for food.

It is also conceivable that other changes associated with the removal of cats in the 1980s, e.g. a marked increase in the numbers of small burrow-nesting seabirds on the island, might allow a tuatara population to maintain itself there in the presence of kiore. Therefore either a near extinct population of tuatara is now on a slow and tenuous path to recovery following cat eradication; or alternatively, the population is low and will remain depressed because of

kiore predation and competition. These interactions need to be researched, understood and the results incorporated in future management.

With the present information, the condition deemed to be of the most impact on the viability of tuatara on Little Barrier Island is the presence of kiore. Therefore the most valuable management action to benefit tuatara in the long term would be the sustained control or eradication of kiore from the island.

To ensure the long-term survival of the Little Barrier tuatara population as a distinct entity in its natural habitat, three management options are identified. The appropriate option is conditional upon the results of future surveys:

Option 1: Assume only a few individuals (<30 in total) are found during surveys on the island. Bring any surviving Little Barrier Island tuatara into captivity to breed under the supervision of a zoological institution either on the island or on the mainland. Then: (a) Release any juveniles raised onto at least one rat-free island, with the long-term aim of establishing a population of at least 1000 tuatara. It is suggested that this island should be in the Mokohinau Group. (See Objective 7). (b) Concurrently evaluate and if viable instigate a sustained control or eradication programme for kiore from Little Barrier Island.

Option 2: Assume 30-100 are found in future surveys, with an age structure with less than 10% juveniles (currently 18% is the average percentage of juveniles in self-sustaining wild populations of Northern tuatara without kiore). Transfer all to a predator-free island. Then: (a) Instigate a captive breeding programme at a zoological institution if deemed necessary and viable. (b) Concurrently evaluate and if viable instigate a sustained control or eradication programme for kiore from Little Barrier Island.

Option 3: Assume 30-100 are found with an appropriate age structure (>10% juvenile). Captive breeding or island transfer would no longer be considered necessary for the short-term survival of this population. A monitoring programme should be set up and research encouraged into the ecology of tuatara on Little Barrier. However if tuatara re-introduction is planned as part of the restoration of islands in the Mokohinau Group, then Little Barrier Island is the logical source, and up to 50 animals should be transferred.

Given the information gained in the first survey, Option 1 would appear to be the most likely option.

OBJECTIVE 7: IDENTIFICATION OF NEW ISLANDS FOR LITTLE BARRIER TUATARA

Purpose: To identify and prepare an island suitable for stocking with Little Barrier tuatara.

Comments: The island should be ready to receive juvenile tuatara from as early as 1995, if further surveys on Little Barrier confirm Option 1 (Objective 6) as the appropriate option. If Option 2 is favoured then animals would be available before this date. An island in the Mokohinau Group should be considered as a possibility. These islands lie at a similar latitude to Little Barrier, at least some were once inhabited by tuatara, and kiore eradication was carried out on all but Fanal Island in 1990. An island with at least 10 ha of suitable

habitat for tuatara should be chosen (this would theoretically support a population of 1000 tuatara or more, assuming an average density of at least 100 tuatara/ha in this habitat). Following eradication, surveys to establish recovery of the invertebrate, lizard and bird fauna suitable as food for tuatara should be carried out prior to release of the juveniles. If any translocations from other sites are considered necessary to restock these islands with suitable food, these should be carried out in accordance with the translocation procedures contained in the Transfer Guidelines For Indigenous Terrestrial Fauna and Flora (DoC Policy 17 September 1990). The sedentary behaviour, late sexual maturity and low reproductive rate of tuatara mean that the release of juvenile tuatara will not necessarily prevent the same islands being used for other rare species. However, any transfers of tuatara should consider the effect that introduction of a large terrestrial predator will have on the existing fauna of the islands, and on the potential for releasing other threatened species there in the future (see Appendix 8). Additional criteria to consider when assessing the suitability of new islands for tuatara are given in Appendix 7.

At least fifty 3-4 year olds should be released on the island and the adults maintained in captivity or be also released if appropriate. Subsequent monitoring will be required to determine the success of transfer and whether or not further releases are needed.

Key Personnel: DoC Auckland to identify and prepare a suitable island in consultation with the Recovery Group.

OBJECTIVE 8: RESTORATION OF STANLEY, RED MERCURY AND CUVIER ISLANDS FOR NORTHERN TUATARA

Purpose: To eradicate kiore from these islands, to eradicate rabbits from Stanley, and eventually to release captive-reared juvenile tuatara back on these islands.

Progress: Eradication on Stanley Island commenced with an aerial drop of Talon 20P poison in September 1991, followed by hand-laying of Talon 50WB in October. Present indications (October 1992) following four post-poisoning visits are that this has been successful in eradicating both rabbits and kiore. Following this success, kiore eradication from Red Mercury began in October 1992. If again successful, there is a proposal for eradication from Cuvier to be carried out subsequently. Impacts on non-target species are being monitored closely on both Stanley and Red Mercury.

Following eradication, surveys to establish recovery of the insect, lizard and bird fauna suitable as food for tuatara should be carried out prior to release of juveniles. If any translocations from other sites are considered necessary to restock these islands with suitable food, these should be carried out in accordance with the procedures in the Transfer Guidelines For Indigenous Terrestrial Fauna and Flora (DoC Policy 17 September 1990), and in accordance with the Recovery Plan for Whitaker's skink and the Robust Skink (Towns, 1990). Eradication, and the re-establishment of food supplies, need to be confirmed by mid-1994 in the expectation that 4-year old tuatara from captive-reared facilities might be available by then to re-introduce. If attempts to raise juveniles from the captive adults of any of these populations are unsuccessful, Northern tuatara from a suitable nearby population should be established on these islands.

The eradication of kiore from Stanley and Red Mercury will also enable these islands to be considered as transfer sites for other rare species within the Mercury Group (e.g., the unnamed tusked weta from Middle Island; Whitaker's skink, *Cyclodina whitakeri*; and the robust skink, *C. alani*). Because of the sedentary behaviour, late sexual maturity and low reproductive rate of tuatara, the recovery of tuatara populations on these islands will not necessarily be incompatible with such uses. However, it is important that the timing, location and number of tuatara releases on these islands be organised in conjunction with recovery plans currently in preparation for these other rare species (Thompson, 1990; Towns, 1990). Similarly, the release of juvenile tuatara on Cuvier Island should be coordinated with other planned uses of this island. Impact assessment procedures (Appendix 8) should be carried out for each release.

Key Personnel: - DoC Waikato to continue kiore and rabbit eradication, monitoring and surveys, with assistance and advice from Doc S&R.

OBJECTIVE 9: MONITOR EVIDENCE FOR RECRUITMENT OF NORTHERN TUATARA ON HEN AND CHICKENS ISLANDS AND BEGIN KIORE ERADICATION AS SOON AS POSSIBLE

Purpose: To begin eradication of kiore on Lady Alice, Whatupuke, Coppermine and Hen Islands as soon as suitable methods have been determined, and to monitor recruitment of tuatara.

Comments: Current knowledge suggests that eradication of kiore on some or all of these islands will be necessary to maintain viable tuatara populations. However, the existing populations of adults are sufficiently large that tuatara do not need to be collected from the islands for captive breeding. Trials are therefore required to establish suitable methods for distributing poison without harming resident tuatara or other non-target species. The three Chickens Islands were listed by Taylor (1989) as having medium-high priority for DoC attempts at kiore eradication, and are sufficiently small that eradication should be achievable by 1994. Hen Island (500 ha) is much larger than any islands on which kiore eradication has been achieved or is currently planned, and eradication may not be feasible within the next five years.

Progress: Northland Conservancy is planning for eradication on Coppermine Island in October 1992, followed by Whatupuke and Lady Alice the following year if Coppermine is successful. Hen Island may be used as the control against which to measure the responses of tuatara and other animal and plant populations to eradication of kiore on the other three islands. Successful kiore eradications on the three Chickens Islands may allow the technique to be applied to Hen Island in the future.

In any case, Hen Island should be surveyed for tuatara during October 1993 - March 1994 (five years after the last extensive survey) to continue monitoring evidence for recruitment failure or otherwise (see Appendix 5 for survey sheets).

Key Personnel: DoC Northland to develop and implement suitable eradication and monitoring procedures with advice and assistance from DoC S&R. DoC Northland to survey during October 1993-March 1994 any tuatara populations on which kiore eradication has not been achieved.

OBJECTIVE 10: ERADICATION OF KIORE FROM MIDDLE CHAIN ISLAND IN THE ALDERMEN GROUP

Purpose: To eradicate kiore from Middle Chain Island to increase the security of tuatara populations in the Aldermen Group.

Progress: Financial approval has been obtained. Pre-eradication surveys of the island are to be undertaken in the 1991/92 financial year. Eradication is planned to commence in September 1992.

Comments: Middle Chain Island was given high priority for kiore eradication by Taylor (1989) and is small enough that eradication attempts stand a high chance of success. Eradication should be carried out according to approved DoC eradication procedures and is likely to benefit the existing fauna on Middle Chain (Taylor, 1989), as well as increase the security of tuatara on other islands in the group.

Key Personnel: DoC Waikato to organise kiore eradication with assistance and advice from DoC S&R.

OBJECTIVE 11: SURVEY OTHER POPULATIONS OF NORTHERN TUATARA OF UNCERTAIN STATUS

Purpose: To confirm the population status and genetic identity of tuatara on Half, Middle Chain Stack and North Stack in the Aldermen Group; to confirm whether or not tuatara are extinct or absent from Whenuakura Island and nearby Hauturu Island; and to establish whether tuatara populations exist on Archway Island in the Poor Knights Group.

Progress: Surveys of Hauturu and Whenuakura are under way (October 1992).

Comments: The tuatara populations on Half, Middle Chain Stack and North Stack have not been surveyed since the early 1970s and have never been blood-sampled. Night-time searches for tuatara on these islands should be attempted, survey details recorded (Appendix 5), and blood samples and morphological measurements collected for analysis by Dr C.H. Daugherty (VUW).

No tuatara were seen on Whenuakura in 1985 following the appearance of Norway rats and the disappearance of tuatara between 1981 and 1984. It is conceivable that eggs or a few small juveniles could have survived rat introduction and been missed in the subsequent survey.

Archway Island appears to have habitat suitable for tuatara (A.H. Whitaker, pers. comm.), but has never been thoroughly surveyed. Night-time searches, blood-sampling and morphological measurements should be carried out. In addition, if visits are made by DoC or other parties to other islands that could conceivably harbour tuatara (particularly large, kiore-inhabited islands such as Fanal, which once had tuatara), visitors should be requested to look for the possible presence of tuatara there.

Key Personnel: Doc Waikato to organise surveys of Half, Middle, Chain Stack, North Stack, Whenuakura and Hauturu. Doc Northland to organise surveys of Archway Island.

OBJECTIVE 12: RESTORATION OF NORTHERN TUATARA ON AN ISLAND ON WHICH CONTROLLED PUBLIC ACCESS IS PERMITTED

Purpose: To establish a self-maintaining stock of Northern tuatara on an island capable of supporting at least 1000 tuatara, preferably on an island from which they have become extinct in historic times, in order to allow the public to view wild tuatara and an island restoration programme without endangering existing tuatara populations, and to increase the population size and number of habitats of Northern tuatara towards their former levels.

Comments: Little Barrier Island has controlled public access but there is doubt that a substantial wild tuatara population can be maintained there at present. Whale Island once had tuatara, lies within the present geographic range of Northern tuatara, and at present appears to be an ideal site. Norway rats, goats and rabbits have recently been eradicated, allowing a revision of the island's future management to occur (Smale and Owen, 1990). If Whale is used as a restoration island (*sensu* Atkinson, 1990; Towns et al., 1990), then re-establishment of a tuatara population there would be appropriate. However, this might not be appropriate if Whale is to be used as a reserve for endangered species other than tuatara. It is large enough (170 ha) that if tuatara became distributed over half the island at an average density of 100 tuatara/ha, the total population supported could be about 8500 animals.

If DoC Bay of Plenty decides to pursue restoration as a management goal, either Karewa or Plate should be used as a source island for tuatara (Moutoki is closer, but this population is smaller and collection of eggs or adults could harm the population). One procedure would be to collect adults (at least 10 gravid females and 10 males) from the source island and transfer them to Whale.

Surveys of Whale Island will be necessary to establish whether suitable habitat and food supplies for tuatara are present (see Appendices 1 and 7) and impact assessment procedures carried out (Appendix 8). A detailed plan for the entire restoration project will be required, and this should include discussion of how the public can best be involved in restoration activities and in visiting the island to view tuatara.

Monitoring of any introduced tuatara population should be carried out to determine the impacts and success of re-introduction, information that would be very useful for any future attempts on other islands.

Progress: The Moutohora (Whale) Island Draft Management Plan has been produced (Hunt, 1991). Re-introduction of indigenous fauna is one option presented and if this is to occur, tuatara is one of the preferred species.

Key personnel: DoC Bay of Plenty to complete management planning for Whale Island. If tuatara re-introduction is chosen, the actions listed below should occur. DoC Bay of Plenty to survey Whale Island to identify a release site of suitable habitat. This site should be surveyed to establish whether sufficient food supplies for tuatara are present. DoC Bay

of Plenty to identify source island for tuatara, in consultation with the Recovery Group, and collect adults for transfer. DoC S&R to provide advice on procedures for surveying Whale Island for tuatara food supplies and assessing possible impacts of re-introductions. Drs C.H. Daugherty (VUW) and A. Cree (U. Otago) to provide advice on selecting adults for transfer.

COOK STRAIT TUATARA

OBJECTIVE 13: RESTORATION OF COOK STRAIT TUATARA ON AN ISLAND ON WHICH CONTROLLED PUBLIC ACCESS IS PERMITTED

Purpose: To establish a self-maintaining stock of Cook Strait tuatara on an island capable of supporting at least 1000 tuatara, preferably on an island from which tuatara have become extinct in historic times, in order to allow the public to view wild tuatara and an island restoration programme without endangering existing tuatara populations; and to increase the population size and number of habitats of Cook Strait tuatara towards their former levels.

Comments: Appendix 7 identifies islands that have been suggested as possible sites for the establishment of Cook Strait tuatara. Ideally this should be carried out as part of a restoration programme on an island within or close to the existing geographic range of Cook Strait tuatara. Further, the island should ideally be close to Wellington City because of the enormous potential for generating public interest and support from a major population centre. At least two islands, Somes and Maria, appear to have greatest potential and should be investigated further. Somes Island in Wellington Harbour once had tuatara, and is large enough (25 ha) to potentially support about 1250 tuatara (assuming distribution over half the island at an average density of 100 tuatara/ha). The island is currently a MAF Quarantine Station, and tuatara establishment could not proceed without whole-hearted endorsement by MAR. Ship rats have recently been eradicated and a tree-planting programme started by the RF&BPS, suggesting that a long-term commitment to restoration may be possible. The support of resident MAF officers would be required to keep the island free of rats, cats and other potential predators, and to help discourage illegal landings.

A detailed restoration plan, including surveys to ensure sufficient habitat and food supplies for tuatara, would be required. The timing and release site for introduction of tuatara should be considered with other recovery goals for the island (e.g. proposed releases of rare invertebrates (RF&BPS)). Monitoring of tuatara movements, growth rates and survivorship post-release should be carried out. The status of Mokopuna Island (which lies about 50 m from Somes) would need to be upgraded from Wildlife Refuge so that landing becomes illegal without permit (at present, public landings are permitted on Mokopuna, and these could easily result in the re-introduction of rats to Somes). Opportunities for increasing public visits to Somes Island (presently approximately 4-6 open days a year) should be investigated. Capital Discovery Place, the children's interactive museum on the Wellington waterfront within sight of Somes Island, has developed an exhibit on the biodiversity of a tuatara island. This could be tied in with a Somes introduction and the museum should be involved in development of future plans.

Mana Island could also be investigated as a potential site in the long term for Cook Strait tuatara, or for the Brothers tuatara (see below), but not both. It is possible, though not certain, that tuatara were once naturally present on Mana (Appendix 2). The island is now rodent-free following the success of an exhaustive mouse-eradication programme carried out

in 1988-1990, and it has enormous potential for restoration. It is also sufficiently large (217 ha) that if suitable habitat was available it could potentially support several thousand tuatara. However, the introduction of tuatara to Mana will have to be assessed within the context of a total restoration/recovery plan for the island being developed by Wellington Conservancy.

Establishment of Cook Strait tuatara on whatever island is chosen could proceed by transferring some tens of adult tuatara from Stephens Island (the large population on Stephens Island would not be harmed by such collection). In addition, about 20 3-4 year old tuatara from Stephens Island currently held in captivity could be used to help establish a population. Trials to compare the success of restocking with adults vs juveniles could thus be carried out and would provide extremely useful information for future re-introduction programmes.

Progress: A proposal is being developed by Don Newman (DoC Science & Research) and Dr Charles Daugherty (VUW) to evaluate a transfer of Stephens Island tuatara (from wild and captivity) to Somes Island.

Key Personnel: Drs Newman and Daugherty and DoC Wellington to pursue this proposal in consultation with DoC Nelson-Marlborough, MAF, the Lower Hutt branch of RF&BPS, Dr G. Hicks of the Museum of New Zealand, and the recovery group. DoC Nelson-Marlborough to collect adults from Stephens Island.

ALL TUATARA TAXA

OBJECTIVE 14: UNDERTAKE RESEARCH REQUIRED FOR TUATARA CONSERVATION

To increase the chances of success within this recovery plan, and to improve the knowledge base for future tuatara recovery plans, the following areas of research need to be addressed. An approximate order of priority is given.

Priority 1: Projects which have major implications for other species as well as tuatara:

- a) Biotic effects of the eradication of kiore from islands.

Comment: It is widely agreed that kiore have an impact on tuatara populations but there is debate about whether their presence alone is enough to cause extinctions. Kiore also affect vegetation and invertebrate, lizard and small seabird populations. Research aimed at increasing understanding of these interactions is needed to determine when kiore eradication is appropriate. Such research should be tied into planned eradications within the Hen and Chickens Group (Objective 9).

- b) Development of techniques for eradicating rodents from large islands (>100 ha) in the presence of tuatara and other threatened species.

Priority 2: Projects associated with the restoration of tuatara populations to islands.

c) Techniques for establishing and monitoring survivorship, movements and impacts of (re)introduced tuatara on new islands, including the use of electronic transponders to mark newly-released tuatara.

Comment: A research proposal has been developed by Don Newman (DoC) and Charles Daugherty (VUW) for an experimental release of adult and juvenile Cook Strait tuatara on to Somes Island (see Objective 13). Transponders are being assessed as an alternative marking technique by implanting them in captive-held (Wellington Zoo) juvenile tuatara for this purpose.

d) Techniques for establishing (or re-establishing) populations of invertebrates and small seabirds on islands following predator removal.

e) Nesting behaviour of tuatara and nest locations on forested islands.

f) Nutritional importance of petrels (a marine-feeding component of the diet) for reproduction in tuatara.

Priority 3: Projects associated with captive breeding

g) Finish research in progress examining whether incubation temperature influences sex in tuatara (Dr M.B. Thompson, University of Sydney).

Comment: Preliminary results suggest an influence is unlikely but further work is needed to be certain (Thompson, pers. comm.).

h) Reasons for high juvenile mortality in captivity.

i) Effect of nutrition on growth, reproduction and egg quality in captive tuatara.

j) Methods of sexing juvenile tuatara (applicable before ages 4-5 years when it is planned to release animals to establish new island populations).

Lower priority projects:

Reproduction and Survival in Wild Populations

k) New techniques (e.g., ultrasound) for monitoring reproductive condition in adult females.

l) Importance of nesting sites in sheep pasture and other areas on Stephens Island, and the likely effects on the population if revegetation of these occurred.

m) Survival and growth rates on Stephens Island (these may be obtainable from existing toe-clip records for Stephens Island dating from the 1940s).

Captive Breeding

n) Relationship between number of tuatara in a captive group, social interactions and reproduction.

o) Techniques to monitor and improve reproduction in relictual populations of ageing northern tuatara.

Genetics, Taxonomy and General Biology

p) Biology (particularly diet) of different genetic types of tuatara, especially the Brothers tuatara.

q) Genetic relationships of populations on Half, Middle Chain Stack and North Stack in the Aldermen Group, and any new ones found.

r) Taxonomic status of tuatara fossils and museum specimens, particularly those from East Island.

Comment: Buller (1878) suggested that East Island once held a population of Brothers Island tuatara. Morphometric and DNA analyses of museum specimens are required to confirm this.

Restoration

s) Influence of large petrels and shearwaters on tuatara.

OBJECTIVE 15: CO-ORDINATION OF CAPTIVE BREEDING OF TUATARA

Purpose: To develop co-ordinated programmes of captive breeding to ensure accurate record-keeping, appropriate stock composition and to foster improvement in husbandry techniques.

Comments: Captive breeding is important for the survival of several tuatara populations, particularly Brothers tuatara. Given the importance of tuatara to New Zealand, and the difficulty of providing many people with an opportunity to see them in the wild, owing to the vulnerable nature of the islands on which they live, a captive population of tuatara is encouraged for advocacy and education purposes. The display of tuatara in suitable surroundings with appropriate supporting written material is encouraged, both here, and if stocks allow, overseas, subject to the current policies in place. Successful captive breeding depends on continuing research to improve the husbandry of captive animals, as addressed in the previous objective. Co-ordination of captive breeding programmes will be based on the appointment of a co-ordinator and the development of a Captive Management Plan. The recovery plan has identified the goals of the different captive breeding programmes and the captive management plan will identify how these goals will be achieved. It will be endorsed by the recovery group.

Progress: A workshop on the captive maintenance and breeding of tuatara took place in October 1990 involving all those in New Zealand holding tuatara in captivity. This reviewed past efforts and made recommendations for future initiatives. Barbara Blanchard,

Senior Keeper, Wellington Zoo, was nominated as captive co-ordinator at this workshop and subsequently approved by the Director, PSPD.

It was agreed that Drs A. Cree (U. Otago) and C.H. Daugherty (VUW) would produce a final version of 'Guidelines for maintenance and breeding of tuatara in captivity' which was printed in draft form in May 1988.

Key Personnel: Barbara Blanchard (Wellington Zoo), DoC TSU, Drs. Cree (U.Otago) and Daugherty (VUW), all holders of tuatara.

OBJECTIVE 16: MAINTAIN NATIONAL DATABASE WITH RECORDS OF ALL WILD TUATARA PERMANENTLY MARKED

Purpose: Establishment of a national co-ordinating centre within DoC to record and co-ordinate all toe-clipping or other permanent marking procedures performed on wild tuatara. Toe-clipped animals are now present on almost all tuatara islands (Appendix 3), but recent records are distributed between at least two institutions (DoC S&R and VUW), and some old records are uncatalogued or have been lost. A national recording centre is needed to ensure that: (i) the opportunity for obtaining extremely valuable information on growth rates and survivorship on different islands in the future is not lost; and (ii) duplication of toe-clips, which may have occurred in the past, does not occur in the future.

The proposed Somes Island transfer (Objective 13) involves the marking of tuatara with implanted transponders. This technique may replace toe-clipping in future.

Key Personnel: Scientists in DoC S&R, VUW, U. Otago and other universities; DoC S&R to organise national centre for recording and coordinating toe-clipping activities; conservation advisory scientists and DoC regional conservancy staff to assist as appropriate.

OBJECTIVE 17: FORMULATION OF RECOVERY GROUP

Purpose: A recovery group responsible for overseeing implementation of this plan and for producing subsequent plans is required.

Progress: A recovery group has been established with Don Newman, DoC S & R as leader. The group includes representation from DoC TSU and DoC Conservancies with major involvement in the recovery programme, university scientists with experience in tuatara research and the captive breeding co-ordinator.

Comments: The group should meet at least twice-yearly (e.g., January and July) to evaluate progress over the previous six months and oversee plans for the coming six months. In early 1996, the group should begin preparing the recovery plan for 1997-2001 inclusive. Many of the activities proposed in this plan commit DoC to long-term investment of time and resources over at least a decade, and continuity of effort is therefore essential. However, the level of effort required beyond 1998 is likely to be less than during 1992-1997 (Fig. 4).

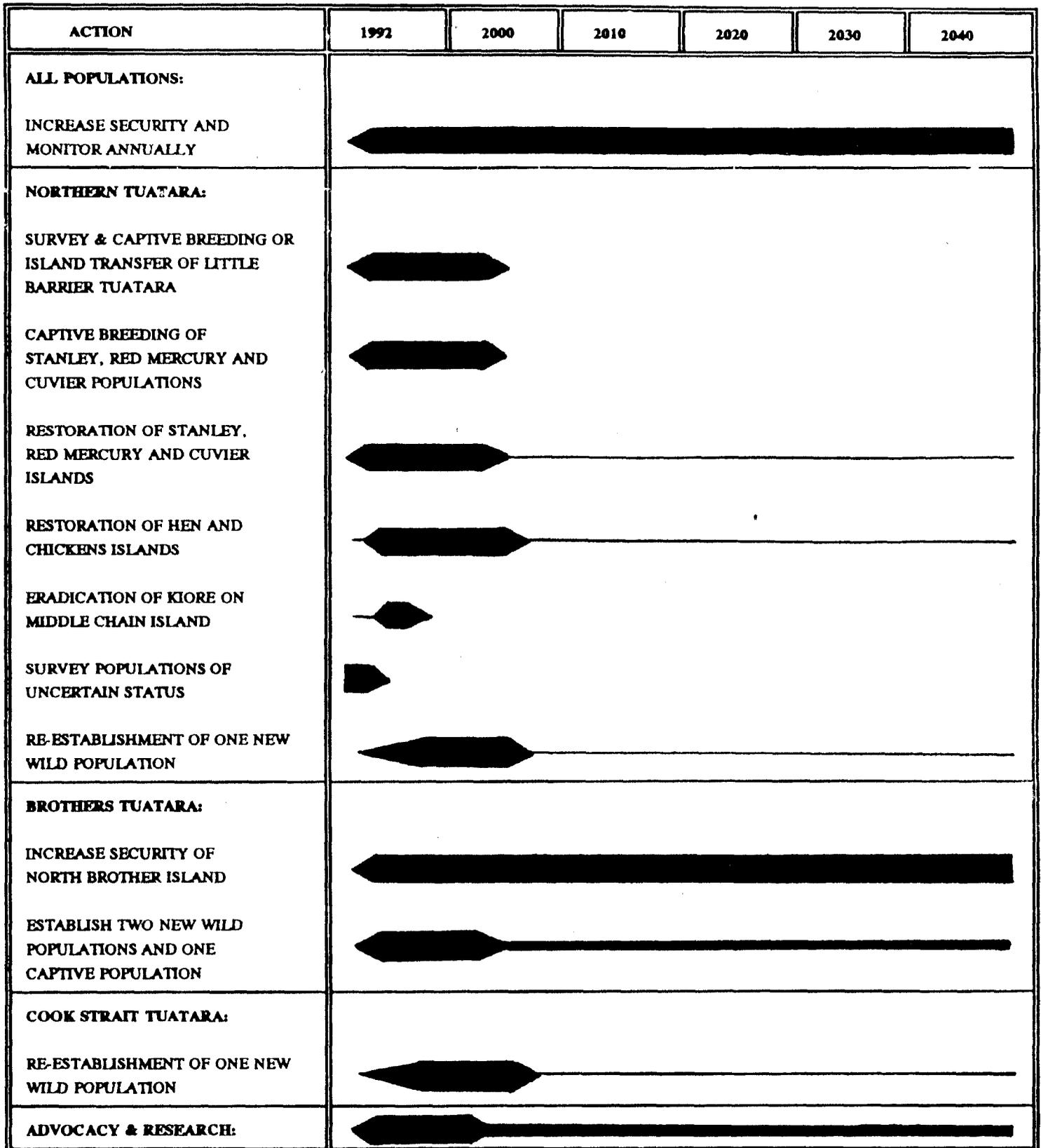


Fig. 4 Extension of critical path from 1992 until 2040. Note the reduced amount of effort (height of horizontal bars) required following 1996.

OBJECTIVE 17: ADVOCACY

Purpose: To increase public awareness of and support for tuatara conservation measures.

Comments: The enthusiastic support of the public is essential for the success of the plans outlined here. Ways of increasing this support include:

- establishment and maintenance of partnerships between DoC and other institutions and organisations involved in tuatara research and conservation;
- production of accurate, up-to-date pamphlets on tuatara, to be available from all DoC conservancy offices (all dated and inaccurate material should be removed), and regular press releases;
- visits to schools and conservation organisations by those involved with tuatara research and conservation;
- opportunities for the public to participate in and view the results of tuatara restoration programmes as proposed in this plan (at present, controlled public access is not permitted on any tuatara island);
- opportunities for selected members of the public to participate in field surveys;
- towns or cities close to boat departure points for tuatara islands, including restoration islands, should be especially targeted for involvement in restoration, surveillance and other activities;
- encouraging zoos, especially those holding tuatara, to develop modern displays illustrating tuatara and the conservation programmes underway for them.

Key Personnel: DoC conservancy or Head Office staff with skills in public relations; DoC conservancy staff who have contacts with local conservation organisations, zoos, etc.; DoC S&R, DoC TSU and Drs C.H. Daugherty (VUW) and A. Cree (U Otago) to assist with providing up-to-date information and visiting schools, zoos and other interested groups (see Appendix 1 also).

COSTS

The approximate costs of projects outlined in this recovery plan for the next five years are given below. These costs exclude salaries of DoC staff, but include provision for contracts where these are likely to be involved (e.g., for many research projects).

DoC Northland

- \$15,000 total over five years for annual surveys and upgrading signs on all tuatara islands, and for surveying Archway Is.
- \$50,000-100,000 to eradicate kiore from the three Chickens islands, depending on method chosen and success rate.

DoC Auckland

- \$12,000 for two further surveys of Little Barrier Island.
- \$30,000 for surveying food supplies and habitat on an island for release of Little Barrier tuatara (should this option prove necessary), and for monitoring survival and impacts of tuatara subsequent to release.

DoC Waikato

- \$30,000 total over five years for annual surveys and upgrading signs on all tuatara islands, and for surveying Whenuakura and Hauturu (Whangamata Group) and Penguin and Rabbit islands (Slipper Group).
- \$50,000-100,000 for kiore eradication on Stanley, Red Mercury, Cuvier and Middle Chain, depending on method chosen and success rate.
- \$2000-3000 for recovery and release of juvenile tuatara on Red Mercury, Stanley and Cuvier islands.
- \$30,000 for surveying food supplies and habitat, and modifying these if necessary, on Stanley, Red Mercury and Cuvier; and for monitoring survival and impacts of tuatara subsequent to release.

DoC Bay of Plenty

- \$10,000 total over five years for annual surveys and upgrading signs on all tuatara islands
- \$2,000 for adult collection and transfer to Whale Island.
- \$30,000 for surveying food supplies and habitat, and modifying these if necessary, on Whale; and for monitoring survival and impacts of tuatara subsequent to release.

DoC Wellington

- \$30,000 for surveying food supplies and habitat, and modifying these if necessary, on at least one new island for Cook Strait tuatara; and for monitoring survival and impacts of tuatara subsequent to release.

DoC Nelson-Marlborough

- \$30,000 total over five years for annual surveys and upgrading signs on all tuatara islands, for increased surveillance and monitoring of North Brother population, and for surveying South Brother Island.
- \$30,000 for surveying food supplies and habitat, and modifying these if necessary, on at least two new islands for the Brothers tuatara; and for monitoring survival of tuatara subsequent to release.

Research and Advocacy

- \$40,000 for research on reproduction and survivorship in wild populations.
- \$50,000 for research on captive breeding.
- \$30,000 for research on genetics, taxonomy and general biology.
- \$50,000-\$100,000 for research on restoration.
- \$5,000 for establishment of data bases.
- \$20,000 for pamphlets and other publicity material.

Possible Sources of Funding in Addition to DoC:

Commercial sponsors, manufacturers of poison baits, universities, zoos, local communities near restoration islands, RF&BPS, World Wide Fund for Nature, Zoological Society of San Diego, and other overseas conservation organisations.

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