THE PARLIAMENT OF THE COMMONWEALTH OF AUSTRALIA

PROTECTION OF THE GREAT BARRIER REEF

Report of the House of Representatives Standing Committee on Environment and Conservation

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Terms of Reference of the Committee

(1) That a standing committee be appointed to inquire into and report on:

(a) environmental aspects of legislative and administrative measures which ought to be taken in order to ensure the wise and effective management of the Australian environment and of Australia's natural resources; and

(b) such other matters relating to the environment and conservation and the management of Australia's natural resources as are referred to it by -

(i) the Minister responsible for those matters, or

(ii) resolution of the House.

Terms of Reference of the Inquiry

That the Committee inquire into and report on aspects of the protection of the Great Barrier Reef, particularly:

- problems posed by the outbreak of the Crown of Thorns starfish.

Members of the Committee

Chairman	Mr P. Milton, M.P.
Deputy Chairman	Mr D.M. Connolly, M.P.[1]
Members	Mr R.L. Chynoweth, M.P. Mr R.F. Edwards, M.P. Mr P.S. Fisher, M.P. Mr G. Gear, M.P. Ms J. McHugh, M.P. Mr C.G. Miles, M.P.
Secretary to the Committee	Mr J.R. Cummins
Secretary to the Inquiry	Mr I.A. Dundas

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1. resigned from the Committee on 15 October 1985.

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RECOMMENDATIONS

The Committee recommends that:

1. the Commonwealth Government continue to provide funds above and beyond other research funding to allow full implementation of the program of research recommended by the Crown of Thorns Starfish Advisory Committee;
(paragraph 50)

2. the Crown of Thorns Starfish Advisory Committee be reconvened to monitor and assess the effectiveness of the research program;
(paragraph 51)

3. the Great Barrier Reef Marine Park Authority carry out resurveying and monitoring of some of the Reefs included in the 1985 survey by the Australian Institute of Marine Science;
(paragraph 54)

4. the Great Barrier Reef Marine Park Authority give urgent priority to developing a research program to develop more efficient Crown of Thorns starfish population control techniques;
(paragraph 57)

5. the Great Barrier Reef Marine Park Authority review, and where necessary amend, its zoning plans to ensure identification of those reefs where special Crown of Thorns population control programs might be warranted;
(paragraph 63)

6. (i) the Great Barrier Reef Marine Park Authority urgently assess the feasibility and costs of establishing a community based response to Crown of Thorns starfish population outbreaks based on teams of volunteer divers to hand collect starfish, and

   (ii) the Great Barrier Reef Marine Park Authority establish and support such a scheme as soon as possible unless it is shown that the cost would be prohibitive or the community response inadequate;
(paragraph 64)

7. the Minister for Arts, Heritage and Environment seek discussions on the importance of the fringing reefs with the Queensland Government and jointly sponsor an independent engineering study to determine ways of reducing the impact of runoff from the Cape Tribulation to Bloomfield Road on the fringing reefs north of Cape Tribulation;

(paragraph 74)

8. the Australian Government consult with the Papua New Guinea Government on the need for an environmental assessment of the Ok Tedi mine giving particular regard to the possibility of the pollution of reefs in the Torres Strait and the northern Great Barrier Reef Marine Park;

(paragraph 80)

9. the Great Barrier Reef Marine Park Authority establish a monitoring program in the northern Great Barrier Reef Marine Park and Torres Strait to detect any pollution from the Ok Tedi mine;

(paragraph 81)

10. the area immediately north of the present northern boundary of the Great Barrier Reef Marine Park and south of the protected zone defined under the provisions of the Torres Strait Treaty be incorporated in the Great Barrier Reef Marine Park;

(paragraph 85)

11. the Great Barrier Reef Marine Park Authority develop and promulgate a policy on offshore development and issue guidelines to prospective developers.

(paragraph 88)

1. INTRODUCTION

1. The area defined in the schedule of the Great Barrier Reef Marine Park Act 1975 as the Great Barrier Reef Region extends 2000 km along Australia's east coast. The Reef comprises approximately 2500 individual reefs which range in size from less than one hectare to greater than 100 square kilometres. When the area was nominated for inclusion in the World Heritage List it was described as the largest single collection of coral reefs in the World and was said to support the most diverse ecosystem known to man. It is clearly one of the most outstanding natural features of Australia.

2. The Reef is also one of Australia's important tourist destinations. It features prominently in overseas promotions by the Australian Tourist Commission and is a major attraction for domestic and international visitors. In 1983/84 it accounted for approximately 660 000 visitor nights.[1]

3. The proper protection and management of the Reef must be a priority for any Commonwealth Government not only because of the conservation and tourism values but also because of the Government's international obligation.

4. Early in 1985 it became apparent that there was public concern that the Great Barrier Reef Marine Park Authority had underestimated the threat posed to the Reef by the Crown of Thorns starfish (Acanthaster planci). Sections of the scientific community criticised the complacency of the Great Barrier Reef

Marine Park Authority and the issue was widely reported in the media. The matter was also debated in the Commonwealth Parliament and the Senate called for a Parliamentary inquiry.[2]

5. Before its investigations the Committee had no reason to doubt the ability of the Great Barrier Reef Marine Park Authority to assess and deal with the problem. However despite statements by the Authority which implied that there was no serious problem a report by the Crown of Thorns Starfish Advisory Committee and a scientific paper from some researchers at the Australian Institute of Marine Science put a contrary view. Both of these papers referred to a possible risk which implied a more concerned approach and the need for an official re-appraisal. On the basis of this information the Committee concluded that there may be a threat to the Reef - a threat to a priceless area of World Heritage and a most significant part of the Australian environment. The Committee was also concerned that speculation about the threat and the widely reported disagreement between various academic authorities was leading to uncertainty which might eventually damage the Reef's tourist potential. Accordingly in April 1985 the Committee resolved to inquire into and report on aspects of protection of the Great Barrier Reef, particularly problems posed by the outbreak of the Crown of Thorns starfish.

6. In August 1984 the Committee in the 33rd Parliament reported on the Protection of the Greater Daintree.[3] That Committee noted that siltation of the coastal fringing reefs could follow construction of the Cape Tribulation to Bloomfield Road. Since the road was constructed in late 1984 heavy siltation of the reefs has occurred. These reefs were found to be rich in coral species and representative of an unusual association of coral reef and coastal rainforest.

7. The Committee's interest in the Crown of Thorns issue coincides with important public finance decisions. In November 1984 the Australian Institute of Marine Science was allocated $1.1 million under the Commonwealth Community Employment Program to carry out a survey of the occurrence of Crown of Thorns starfish over the entire Reef. At the same time a report by the Crown of Thorns Starfish Advisory Committee recommended that $3 million be provided over five years for a series of research projects. The Committee formed the opinion that the Advisory Committee's recommendations required urgent consideration by the Commonwealth Government and in July 1985 it wrote to the Minister for Arts, Heritage and Environment to ensure that the matter would receive attention in the formulation of the 1985/86 Budget. The Minister subsequently announced that $1 million had been provided in the Budget for the Great Barrier Reef Marine Park Authority to commence the research program.

8. There have been at least five investigations by Committees and Inquiries into aspects of the Crown of Thorns starfish. The early investigations included a study directed for the Queensland Government by Professor Endean at the University of Queensland in 1965, an inquiry by an ad hoc Committee of the Australian Academy of Science in 1969 and an inquiry by a Committee jointly appointed by the Commonwealth and Queensland Governments in 1970.

9. These early Inquiries were concerned with determining the significance of the starfish plagues and whether they constituted a threat to the Reef. The 1970 Joint Committee reported that damage on certain reefs had been severe but concluded that the starfish did not constitute a threat to the Reef as a whole. It was clear that there was insufficient information available to allow that Committee to make confident predictions. That Committee stated that the knowledge of reef ecology was inadequate to permit a complete assessment of present

and future problems concerning the starfish and recommended a research program and the establishment of a research trust fund and an Advisory Committee.[4]

10. The later Inquiries were concerned mostly with reviewing research programs and identifying the need for further work. However, in the mid-seventies interest in the problem diminished and the research effort declined as the outbreaks appeared to decrease and the starfish became relatively rare.[5] Concern about the starfish was rekindled in 1979 when infestations were found to be recurring on reefs attacked during the sixties. Subsequently the Crown of Thorns Starfish Advisory Committee was appointed in 1984 by the Great Barrier Reef Marine Park Authority with terms of reference to review the results of research and to advise on future research programs.

11. The Standing Committee is aware of the work of the preceeding Inquiries. It has not attempted to reproduce the efforts of the scientists who have worked on the committees which reviewed the research needs. The Committee has approached the starfish issue as a public policy problem rather than a scientific problem and has concentrated on indentifying the appropriate response from Government in the light of our current knowledge and the importance of the Reef to the people of Australia. In this regard it is interesting to note that the Crown of Thorns Starfish Advisory Committee briefly discussed the management problem posed by the starfish and reported that in its view the destruction of hard coral by aggregations of starfish posed a serious threat to the organisation and functional relationships within some reef communities within the Great Barrier Reef, at least in the short term. One of the main problems facing the Committee during its inquiry was that these findings were variously interpreted as showing that the Reef was under threat and alternatively that there was no threat.

Endnotes

1. Department of Sport, Recreation and Tourism submission.

2. S.Deb. (28.3.85) 82.

3. 'Protection of the Greater Daintree', Report from the House of Representatives Standing Committee on Environment and Conservation PP 199 (1984).

4. 'Report of the Committee on the Problems of the Crown of Thorns Starfish', PP 34 (1971).

5. Prof. P. Sale submission, p.1.

2. THE CROWN OF THORNS STARFISH CONTROVERSY

The Occurrence of Crown of Thorns Starfish Plagues

12. The Crown of Thorns starfish is a comparatively large, multi-armed starfish which is found on coral reefs throughout most tropical regions of the Indian and Pacific Oceans. It is a specialised coral feeder which has been periodically reported in plague proportions since 1957. Reef building coral polyps are its main food source and the starfish prefers to feed on hard corals. It does this by moving onto a piece of coral and then pushing its stomach out through its mouth to cover the polyp's tissues so that it can be consumed by the starfish. Only a white coral skeleton remains and in this way heavy infestations can cause the destruction of the bulk of the hard coral cover on a reef.

13. Since the early 1960's marine scientists have given considerable attention to the starfish and the results of their research have been widely reviewed. While the Committee does not intend to report on the results of the research there are several aspects of the starfish's biology and ecology that are particularly relevant to the Committee's inquiry. These include its capacity to produce millions of larvae, the dispersal of the larvae through open waters, the very high rate of larval mortality and the attraction of individuals to chemicals released by the feeding of other Crown of Thorns starfish. These characteristics are typical of species which periodically occur in large aggregations.

14. The normal population density of Crown of Thorns starfish on the Great Barrier Reef is thought to be about six adults per square kilometre.[1] At this level the starfish cause negligible damage to the reefs. Starfish numbers on infested reefs during population outbreaks range from tens of thousands to millions. A population of 140 000 would destroy the hard coral cover of an average reef of ten square kilometres in two to three years.[2] Such population outbreaks have occurred on the Great Barrier Reef.

15. The first outbreaks were recorded in Japan in 1957 and by the mid-sixties reefs in the South West Pacific were extensively damaged by the starfish. By the end of the decade infestations were reported from places such as Malaysia, Fiji, the Hawaiian Islands and Sri Lanka. During the early seventies the starfish was also reported in large aggregations off the east African coast.

16. During this period the Crown of Thorns also spread throughout many parts of the Great Barrier Reef. The first outbreaks were reported in 1962 on inner and fringing reefs in the central part of the Great Barrier Reef near Cairns. By 1970 these early infestations had declined but some outer reefs and others further to the south and possibly some to the north were affected. Subsequently the Swain Reef complex near the southern reach of the Reef was infested as were many of the reefs throughout the central section. The extent of the infestations is a matter for debate.

17. Professor Robert Endean of the University of Queensland claimed that the majority of reefs in the central third of the Great Barrier Reef have been infested twice since the early sixties and that the bulk of hard corals in this region have been destroyed at least once in the last twenty years.[3] His

conclusions were based on surveys and reports of half the reefs in the central area of the Great Barrier Reef where it was found that 58 per cent of the reefs were infested in the period 1966 to 1975 and further studies which showed that 84 per cent of reefs for which reports were available in the central area carried starfish outbreaks with marked damage to the hard coral cover. However the Great Barrier Reef Marine Park Authority provided the Committee with figures which showed that for the Reef as a whole 25 per cent of reefs have been infested at least once since the early sixties and that for the central region this figure is 45 per cent.[4]

18. Professor Endean's reports appear to agree with those of the Great Barrier Reef Marine Park Authority for the period up to about 1979. Dr Endean suggests that since 1979 the problem is at least twice as bad as that reported by the Authority for some reefs. Some of Professor Endean's figures are based on informal non-scientific sources which may overstate the extent of the problem whereas the Authority believes its data presents the worst possible case.

19. In August 1984 the Australian Institute of Marine Science stated that a survey of 40 reefs in the central third of the Great Barrier Reef revealed that the majority had exceptionally low living coral with extensive areas of recently killed coral.[5] An extensive survey currently being carried out by the Institute will help clarify the situation.

20. The Committee concludes that the problem may be widespread particularly in the central region but this can neither be confirmed or refuted until more extensive and reliable survey data is available. The situation in the central third of the Reef is particularly worrying because this area contains a number of reefs reasonably close to the tourist centres of Cairns and Townsville.

21. The Great Barrier Reef Marine Park Authority in supporting its public statements that there is no risk to the whole of the Reef has presented data which shows that in recent years the Crown of Thorns starfish has been present on only 14 to 16 per cent of reefs.[6] Whilst these figures are correctly derived from the Authority's records they create the impression that the situation is not as serious as suggested by the other figures which show that 48 per cent of reefs in the central region have been infested.

22. The Committee considers that the extent of these infestations is not the only significant factor. The incidence of re-infestations and the time interval between population outbreaks is also a matter for concern. Coral can regenerate after a Crown of Thorns attack but as one witness pointed out the response is highly variable. In some cases a coral cover is quickly re-established but in other cases there is very little regeneration even after periods of fifteen years.[7]

23. Where regeneration does occur some fast growing corals are favoured and the establishment of the original diversity of species and structures may take considerably longer. Scientists from the Australian Institute of Marine Science pointed out that it is difficult to assess regeneration because knowledge of the conditions of reefs before the infestations commenced is limited but advised of one case where it took ten to fifteen years to re-establish a coral cover.[8]

24. The current re-infestations which are occurring in the central region of the Great Barrier Reef are particularly worrying because there has been insufficient time since the first attacks for the development of a full and diverse coral cover. This may have serious long term implications for the ecology of the Reef as well as the tourist industry. It is particularly worrying that Professor Endean has reported that the re-infestations have resulted in the destruction of large long-lived corals which were not attacked in the first infestations.[9]

The Threat to the Reef

25. The incidence of infestations has not been uniform in distribution or impact. Some reefs have remained free of starfish population outbreaks even though nearby reefs have been heavily infested and some reefs have carried only short lived outbreaks with little damage. The reasons for this patchy occurrence are not clear and the collective data on the total distribution of starfish is also incomplete. Survey samples have been used to assess populations for the whole of the Reef area but there is still considerable disagreement and argument about the seriousness of the threat.

26. The disagreement can be partly attributed to various interpretations over the meaning of what constitutes a threat. Some witnesses stressed that there is no risk of destruction for the whole of the Reef whilst not denying that some reefs may be threatened in the short term. Other witnesses emphasised that there is some risk which cannot be precisely defined but which could involve substantial loss of coral cover. Those who argued that there is no risk correctly pointed to the lack of evidence to suggest a possible total loss of coral cover over the whole of the Reef. Alternatively those who argued that there is a risk referred to evidence of considerable damage to a number of individual reefs.

27. Another source of disagreement about the seriousness of the risk are the various interpretations of data on the actual extent of Crown of Thorns activity. Whilst Professor Endean has stressed the widespread damage that has occurred and the possibility that some reefs may be impoverished for long periods, other authorities such as the Australian Coral Reef Society have submitted that there is no substantive evidence that observed

outbreaks of the starfish will result in the permanent destruction of significant portions of the Reef.[10] Both have agreed that any conclusion is tentative given the gaps in knowledge of reef ecology including the lack of understanding of the Crown of Thorns phenomenon. Therefore although these two points of view can be taken as representative of the extremes of the debate it can be seen that neither can be taken as an unqualified statement that there is, or is not, a risk.

28. The situation is further confused by various interpretations of the Report of the Crown of Thorns Starfish Advisory Committee which stated that:

> "...the destruction of hard coral by aggregations of Crown of Thorns starfish poses a serious threat to the organisation and functional relationships within some communities within the Great Barrier Reef at least in the short term..."[11]

The Advisory Committee reported that in the absence of detailed information on the condition of the hard coral cover of each affected reef there was a difference of opinion among committee members about the actual extent of coral destruction which has occurred. Present evidence was inadequate for scientists to agree on the nature and significance of the phenomenon of aggregations of large numbers of Crown of Thorns starfish and thus on the extent of any consequent risk. The Advisory Committee's findings have been variously interpreted as concluding that there was a risk to the Reef or alternatively that there was no threat.

29. The Committee agrees with the conclusion of Dr Roger Bradbury of the Australian Institute of Marine Science who was unable to quantify the risk and stated that it was not total but neither was it negligible.[12]

30. Whether or not population outbreaks are the result of natural processes or a consequence of some human influence in the normal system is another area of controversy. The Australian Coral Reef Society submitted that there is no substantive empirical evidence that primary outbreaks are the consequence of human induced disturbance of the ecological processes on the Great Barrier Reef. On the contrary they state that there have been, and continue to be, major natural outbreaks of the starfish particulary in the central portion of the Reef.[13] The Society's President in a separate submission advised that it remains possible that in some regions of the Great Barrier Reef the frequency of outbreaks of starfish has been enhanced because of human activity.[14]

31. Some hypotheses suggest a natural process in triggering population outbreaks. One hypothesis proposes that outbreaks of adult starfish appear at irregular intervals arriving three years after heavy rains following drought.[15] Terrestrial run-off from heavy rains following the dry season or a record drought is thought to provide enough nutrients to stimulate phytoplankton blooms of sufficient size to produce enough food to allow unusually large numbers of Crown of Thorns larvae to survive. The increased survival of larvae results in an outbreak of adults three years later. Other hypotheses suggest that environmental factors or unusual weather which might bring about lowered sea salinity for brief periods, can lead to a dramatically higher survival rate of larvae.[16] These theories have not been properly tested and have been criticised. Professor Endean points to starfish population structures found on infested reefs which contained several age classes and infestations which have continued to occur since the early 1960's. Professor Endean argues that this renders it unlikely that the outbreaks could be the direct result of enhanced larval recruitment in any one particular year. These hypotheses also fail to explain how some reefs in a particular area may become infested while others do not.

32. On the other hand a number of hypotheses have been developed to show how human influence could be important at the larval stage. Professor Endean has stated that it is difficult to invisage a mechanism whereby human activities could increase the success of recruitment of larval starfish to a reef.[17] He cites the example of pollution which could selectively eliminate larval predators but which would affect recruitment to all reefs in any area rather than affecting some reefs as is the case on the Great Barrier Reef. Such hypotheses also do not explain the outbreaks of Crown of Thorns on reefs remote from sources of pollution.

33. The biology of the Crown of Thorns suggests a natural process whereby the population size could be controlled at the larval stage. The starfish produces very large numbers of larvae which are then dispersed in open waters and suffer a very high mortality rate. The starfish is thus able to show very great changes in the numbers of adult animals when conditions vary to modify the rates of survival of the larvae. This is because when a very great proportion of the larvae dies even slight fluctuations in the proportion of larvae surviving result in major changes in the number of adults.

34. There is no tested theory based on field observations which suggests a mechanism which would enhance larval survival and cause the outbreaks that have been reported. Professor Endean's hypothesis, which is also untested, is based on the assumption that the reproductive success of the Crown of Thorns is influenced by the number of larvae that are able to settle and metamorphose on a reef and also by the number of post larvae that survive to sexual maturity on the Reef.

35. Professor Endean has postulated that population explosions have been induced by humans as a result of the heavy collecting of general predators of small juvenile starfish and on the heavy collecting of specialised predators of the adults.[18]

The removal of specialised predators has reduced pressure on large juvenile starfish thereby permitting more to become adult than is normally the case. This facilitates breeding and leads to increased numbers of larvae in the plankton. The reduced numbers of predators of small juveniles then allow more post larval starfish than usual to grow into large juveniles. Professor Endean draws a distinction between primary infestations of reefs stemming from local increases in starfish numbers on certain reefs and secondary infestations resulting from the carriage by currents of larvae from infested reefs to other reefs.

36. The predator removal theory would be supported if it could be shown that initial infestations have occurred on reefs where reduction in predator species has been recorded. Professor Endean believes that there is some evidence of this and he suggests that it explains how some reefs which have been heavily visited by collectors and spear fishermen have been infested, while other nearby reefs have not experienced population outbreaks. However the research in this area is incomplete and this theory has not been validated.

37. In the Swain Reef complex to the south of the central part of the Great Barrier Reef it was noted that outer reefs on the eastern edge were infested but the inner reefs nearer the Queensland coast were free of outbreaks. It was thought that the infestations possibly resulted from the transport of larvae by southerly flowing currents. However Professor Endean has noted that the affected reefs were those most frequently visited by humans engaged in collecting elements of the fauna.[19] An alternative explanation however is that the outbreaks were noticed earlier because people were there to make the observations whereas outbreaks on less popular reefs remained un-noticed.

38. Further indirect support for the suggestion that some human influence is involved can be found in the recent series of re-infestations of previously damaged reefs in the central region. Professor Endean suggested that if the processes which caused the initial outbreaks were still operative then the reefs would be attacked again as soon as the hard coral has re-established. There is some evidence to suggest that this is in fact happening.

39. Arguments have been advanced which state that there is evidence that Crown of Thorns outbreaks have occurred periodically through the geological past before human influence was possible. Researchers from the Australian Institute of Marine Science reviewed the geological data and concluded that the occurrence of starfish remains in recent sediments does not relate to whether or not reefs had actually suffered an infestation. Therefore older sediments cannot be used as a guide to previous outbreaks of Crown of Thorns. The Institute has also developed a model derived from ecological theory to show that the process of infestation and recovery could be a stable long-lived cycle. However the Institute's work is also inconclusive in respect of whether recent outbreaks are natural phenomena or induced by human intervention. The latter view was put to the Committee by Dr Barry Goldman of the Lizard Island Research Station who suggested that human activity has in some way aggravated the severity of population increases in certain areas and that the control of the populations will be under the influence of a number of factors.[20]

40. It is not the task of the Committee to assess the scientific merits of the various theories. There is some difficulty in completely accepting Professor Endean's view that population regulation occurs at the post-larval stage as it appears reasonable that even small variations in larval survival may contribute to great variations in adult populations. However there are many aspects of the predator hypothesis which appear

feasible and the Committee believes that it is reasonable to conclude that the starfish outbreaks may not be entirely natural but may be influenced by the widespread human activity.

41. The Australian Coral Reef Society supports the view that outbreaks of Crown of Thorns are a natural and a periodic phenomenon because they consider this to be the most judicious scientific hypothesis to maintain, given no substantive evidence to the contrary.[21] While this view might be "judicious" if one wants to maintain a reputation for scientific credibility it might not be "judicious" for the people of Australia to wait until adequate scientific evidence is available. Government action may be necessary before the scientific community reaches agreement or produces all the facts.

42. The Committee finds it difficult to understand why it appears some scientists refuse to consider rationally the views of other scientists or to modify their opinions in the light of new information. The Committee considers it quite possible that the Crown of Thorns phenomenon is the result of a complex series of events and can see no reason not to consider the problem to be the result of a combination of human activity and other factors.

43. It also concerns the Committee that some scientists have been so preoccupied with either advancing their own theories or rejecting the opinions of their opponents that some important developments appear to have been given insufficient attention. Professor Endean has referred to a significant decline in both specialised and generalised predators on some reefs. This information is important to the development of his theories about the Crown of Thorns starfish but it is also an important observation in its own right. It should be a matter of concern and close investigation if such a decline is occurring regardless of its relevance to the resolution of the starfish controversy.

44. The Committee is not in a position to determine the scientific arguments but considers that the question need not necessarily be left to the scientist to resolve. Dr Bradbury suggested that limits on scientific knowledge meant that any final conclusion would be subjective.[22]

45. The Committee concludes that the apparent level of uncertainty and the probable risk are unacceptable. The value of the Reef as an area of World Heritage, as an important ecosystem and as a recreational and tourism resource is beyond measure. Any phenomenon which is so poorly understood but which has some potential to seriously damage major parts of the Reef requires the closest attention and should not be put aside as an interesting but unresolved scientific problem.

Endnotes

1. Endean R. & Stablum W. 'Population explosions of Acanthaster planci and associated destruction of the hard-coral cover of reefs of the Great Barrier Reef, Australia', Environmental Conservation 2(4) 1975, p. 248.

2. ibid, p. 249.

3. Evidence, p. 420.

4. Great Barrier Reef Marine Park Authority, Supplement to submission, 3 October 1985.

5. Great Barrier Reef Marine Park Authority, Press Release, 24 August 1984.

6. Great Barrier Reef Marine Park Authority, Press Release, 4 February 1984.

7. Evidence, p. 369.

8. Evidence, p. 169.

9. Evidence, p. 451.

10. Australian Coral Reef Society submission, p. 2.

11. 'Report of the Crown of Thorns Starfish Advisory Committee, 1985', p. 1.

12. Evidence, p. 170.

13. Australian Coral Reef Society submission, p. 2.

14. Prof. P. Sale submission, p. 2.

15. Birkeland C. 'Terrestrial runoff as a cause of outbreaks of Ancanthaster planci (Echinodermata: Asteroidea)' Marine Biology 69 1982, p. 175.

16. Sale, P.F., Potts, D.C. and Frankel E. 'Recent studies on Acanthaster planci' Search 7(8) 1976, p. 337.

17. Prof. R. Endean submission, attachment 2.

18. Prof. R. Endean submission, p. 1.

19. Prof. R. Endean submission, attachment 1.

20. Evidence, p. 159.

21. Australian Coral Reef Society submission, p. 2.

22. Evidence, p. 170.

3. MANAGEMENT IMPLICATIONS FOR THE MARINE NATIONAL PARK

Surveys and Research

46. The Committee found little disagreement over the need for more research and surveys of the Crown of Thorns starfish. This was hardly surprising given the gaps in knowledge and the controversial debates within the scientific community. There was some disagreement over the research activities which should be emphasised and some of the submissions suggested that funding should be directed towards management and control programs rather than research.

47. On the other hand one prominent researcher pointed out that the Crown of Thorns starfish is the major scientific problem on the Great Barrier Reef because of the profound effects on the coral communities of so many reefs in the central region.[1] It was also pointed out that the level of research on the starfish in Australia over the last twenty years was astonishingly low.

48. All of the previous Inquiries into the Crown of Thorns phenomenon, including the most recent by the Crown of Thorns Advisory Committee, have stressed the need for an expanded research program. The Committee agrees with this provided that the research is properly supported over a sufficient time period, is co-ordinated and properly directed to eliminate duplication and inefficiencies and is directed towards solving the management problems posed by the starfish. The Committee does not suggest that theoretical or basic research should not be supported but believes that in this case the emphasis should be on applied

research directed to discovering why and how Crown of Thorns plagues occur and how the practical problems of plague management can be overcome.

49. The Crown of Thorns Starfish Advisory Committee made detailed recommendations about a research program and recommended a funding program of $3 million over five years. The Advisory Committee noted that the previous research had not resulted in the resolution of the problem because of the limited availability of research funds and skilled personnel, the nature of the research recommended and the major logistic problems of field research on the Great Barrier Reef.[2] The program of funding and research the Advisory Committee recommended may help overcome these constraints.

50. The Government has responded to the Advisory Committee's report by providing $1 million for a research program in 1985/86. The Great Barrier Reef Marine Park Authority is to manage the program. It intends to implement the program of research as recommended by the Advisory Committee. The Committee welcomes this move and believes that funding should be provided on an ongoing basis to ensure that the program is completed. Funding should be provided even if the plagues diminish in the next few years. The research effort declined during the mid seventies when it appeared that the starfish outbreaks had run their course. It was then assumed by some scientists that it would be a long time before the Crown of Thorns returned in large numbers. This proved not to be the case and any future decline should be regarded as temporary and research should continue. The Committee recommends that:

> the Commonwealth Government continue to provide funds above and beyond other research funding to allow full implementation of the program of research recommended by the Crown of Thorns Starfish Advisory Committee.

51. The Committee considers that the research effort should be closely examined to ensure that it is appropriate, effective and efficient and recommends that:

> the Crown of Thorns Starfish Advisory Committee be reconvened to monitor and assess the effectiveness of the research program.

52. The reconstituted Advisory Committee should be smaller and include people from outside the immediate scientific community and people with an interest in management aspects of the problem.

53. The extensive research survey being carried out by the Australian Institute of Marine Science has been criticised on the grounds that the occurrence of the starfish on the Reef is already known and that all that is required is general monitoring for management purposes. The Committee agrees that there is a considerable amount of data on Crown of Thorns distribution and activity available but much of this information is based on anecdotal and unverified sources. Clearly the extensive and systematic survey by the Institute is needed.

54. The value of the Institute's survey will be greatly increased if some of the reefs are resurveyed. The Crown of Thorns problem is dynamic and a survey of starfish populations at any one point in time does not contribute very much to the understanding of the problem. Therefore the Committee considers that follow-up surveys are justified. The Commonwealth Community Employment Program under which the current survey is being carried out may not be a suitable and available funding mechanism for future surveys by the Australian Institute of Marine Science. The survey has been designed to be compatible with the Great Barrier Reef Marine Park Authority's survey procedures and data series and the Authority could use the Institute's work as the basis for a more formal ongoing survey and monitoring program. The Committee recommends that:

the Great Barrier Reef Marine Park Authority carry out resurveying and monitoring of some of the reefs included in the 1985 survey by the Australian Institute of Marine Science.

The Authority could carry out this follow-up work itself or it could contract the Institute or some other agent to do the survey work. Funding sources such as the Commonwealth Community Employment Program could be considered.

The Need to Control Crown of Thorns Starfish Plagues

55. The uncertainty about the risk posed by the Crown of Thorns starfish does not necessarily mean that an eradication program is warranted. The Great Barrier Reef Marine Park Authority has taken a cautious approach and argued that widespread eradication was not justifiable until it could be established that the Crown of Thorns was likely to cause significant damage to reefs.[3]

56. There is no doubt that the removal of all aggregations of Crown of Thorns from the entire Reef and large scale control measures would be virtually impossible, extremely expensive and possibly unwarranted on conservation or tourism grounds. The Crown of Thorns Starfish Advisory Committee reported that experience in Japan and the United States of America's Pacific Trust Territories is that large scale eradication programs have limited value and that control even on a local scale is often not achievable. On the other hand the Committee is aware that there have been successful but limited population control programs carried out on a small scale on some specific reefs. The techniques used involve hand collecting of the starfish or injection with copper sulphate. Other possibilities have been suggested, such as sprinkling slaked lime over infested reefs.

57. The Great Barrier Reef Marine Park Authority has conducted limited research into control techniques and has funded a study into the cause of disease in starfish which might lead to biological control of population outbreaks. Such research is essential if wide spread control measures are contemplated because it is clear that a control method is required which does not involve the individual treatment of starfish. The Crown of Thorns Starfish Advisory Committee recommended that funds be made available for an assessment of the feasibility of developing more efficient techniques such as biological control. In general the Committee supports the Advisory Committee's findings and recommends that:

> **the Great Barrier Reef Marine Park Authority give urgent priority to developing a research program to develop more efficient Crown of Thorns starfish population control techniques.**

58. Hand collecting is time consuming and is unlikely to result in the complete removal of the starfish from a particular area, particularly when the density of starfish declines and individuals remain hidden under overhanging coral and in crevices. More starfish can be killed in a given time period using chemical injection although this technique may turn out to be more expensive because of the cost of the chemical and equipment. Furthermore there are obvious risks involved in introducing any chemical into the waters of the Great Barrier Reef and the Committee considers that such activities should not be encouraged.

59. The Committee visited Beaver Cay south east of Cairns and saw how an intensive program of hand collecting had allowed a tourist operator to protect a small area of coral for tourist appreciation on a reef which had been heavily infested and damaged. It appears to the Committee that this technique may be effective in achieving some degree of population control at least on a small scale to protect tourist activities.

60. Although the Great Barrier Reef Marine Park Authority considers general eradication to be both unjustified and futile it has recognised the need for some localised control and has assisted some tour operators by providing advice and assistance. This approach is well supported, even by those who consider that the population outbreaks are probably a natural phenomenon which does not appear to pose a threat to the Reef. The Australian Coral Reef Society supported limited direct management intervention in the form of control measures designed to protect specific sites of importance for tourism or scientific research.[4] This view was shared by the Crown of Thorns Starfish Advisory Committee.[5]

61. The Committee strongly believes that even if it is eventually proved that the plagues are natural events and that the impact is minor there will still be a need to take action to protect the main recreation and tourism sites. Given that the risk to the Reef and the factors controlling population outbreaks are unknown it is essential for the Great Barrier Reef Marine Park Authority to develop and maintain a capacity to effectively respond to starfish outbreaks in key locations.

Procedures and Costs of Population Control

62. The experience at Beaver Cay shows that a tourist operator using volunteer divers and some assistance from the Government can achieve a measure of local population control. The role of the Great Barrier Reef Marine Park Authority in responding to the starfish plagues has been limited to research, education and the provision of some direct support to tourist operators. The Committee believes that an expansion of this role could be achieved without the allocation of greatly increased funding by expanding the role of volunteer divers from the general community of coastal north Queensland in properly directed local control programs.

63. The development of a volunteer based response program could be facilitated if the Authority identified the sites where control programs should be applied in response to population outbreaks. The Authority's zoning procedures provide a mechanism whereby this could be achieved. A special "reef appreciation" zoning category exists. If necessary the Authority could amend existing plans to ensure that all the reefs which are important for tourism are identified and appropriately zoned. The Committee recommends that:

> the Great Barrier Reef Marine Park Authority review, and where necessary amend, its zoning plans to ensure identification of those reefs where special Crown of Thorns population control programs might be warranted.

64. Once the Great Barrier Reef Marine Park Authority has identified those places where control programs might be appropriate it should develop and facilitate a broadly based contingency response. This would involve working with tourist operators and diving schools to mobilize, co-ordinate and support volunteers as part of a formalised response structure. It would be an extension of the type of assistance already provided to the operators who have achieved some success using volunteer teams of divers. This scheme would be a low cost community based operation that in some ways is analagous to the volunteer bush fire brigades. It would however involve the Great Barrier Reef Marine Park Authority in a considerable amount of planning and preparatory work to ensure that the procedures are in place in advance of future outbreaks. It would also require the Authority to carry out a stronger community education campaign on the north Queensland coast to ensure that the voluntary response is both appropriate and effective. The Committee recommends that:

- the Great Barrier Reef Marine Park Authority urgently assess the feasibility and costs of establishing a community based response to Crown of Thorns starfish population outbreaks based on teams of volunteer divers to hand collect starfish; and

- the Great Barrier Reef Marine Park Authority establish and support such a scheme as soon as possible unless it is shown that the cost would be prohibitive or the community response inadequate.

65. In the event that the Authority finds that such a scheme is not feasible then it should investigate ways of entering into cost sharing arrangements with the tourist industry to employ professional divers on limited control programs. This could involve some sort of levy, licence fee or head tax on tourist operations to raise revenue for a starfish control fund.

66. Any scheme to protect major tourist sites or other areas which the Great Barrier Reef Marine Park Authority believes should be preserved will depend on an effective early response. This will only be achieved if monitoring and surveying is adequate to identify the initial signs of population increases. For this reason emphasis needs to be placed on surveys, research and modelling.

Endnotes

1. Evidence, p. 161.

2. 'Report of the Crown of Thorns Starfish Advisory Committee, 1985' p. 10.

3. Great Barrier Reef Marine Park Authority submission, p. 2.

4. Australian Coral Reef Society submission, p. 2.

5. 'Report of the Crown of Thorns Starfish Advisory Committee, 1985' p. 1.

4. OTHER ASPECTS OF THE PROTECTION OF THE GREAT BARRIER REEF

Introduction

67. Most submissions dealt with the Crown of Thorns starfish problem but some referred to a number of other issues including the protection of the fringing reefs north of Cape Tribulation. Some submissions dealt exclusively with this issue.

68. Although the Committee did not inquire deeply into all these other problems it did come to some preliminary conclusions on four issues. These were the protection of the fringing reefs, pollution, zoning and the management of offshore developments. These are discussed below and together with the other issues that the Committee considered, but has not included in this report, could provide the basis for further inquiries.

The Fringing Reefs North of Cape Tribulation

69. In August 1984 the Committee in the previous Parliament reported on the Protection of the Greater Daintree. This report dealt with the construction of a coastal road north of Cape Tribulation. At that time little was known of the condition of the reefs adjacent to the shoreline north of Cape Tribulation. However the Committee did note the possibility that sedimentation of the streams following construction of the road could cause siltation of these reefs.

70. Subsequent to the Committee's report considerable construction work was undertaken by the Douglas Shire Council to develop a permanent road in the area. The impact of that work on the rain forest is a matter of concern to the conservation movement and to the Committee. This problem has been well documented elsewhere and will not be restated in this report. However it now appears that the impact on the fringing reefs may be severe and requires further comment.

71. The reefs offshore from the new Cape Tribulation to Bloomfield Road are the most extensive mainland fringing reefs of eastern Australia and are the only extensive fringing reefs which are adjacent to rain forests. These reefs have developed despite the high rainfall along this part of the coast because the water-shed is drained by numerous small creeks and not by a major river system. The wave motion here is also too strong for extensive mangrove development. In January 1985 scientists from the Australian Institute of Marine Science informally commenced the first scientific survey of the corals on these reefs. They found that the coral communities were not as scenic as those on the outer reef where the water is clearer and where coral development occurred to greater depth.[1] However, they did find that the reefs were more diverse with an unusually high number of coral types. This tends to suggest that the reefs are significant from both a conservation and a scientific view.

72. The scientists later observed that muddy water from the road was flowing into creeks and discharging over the reefs where some of the sediment was deposited. There are no relevant studies in Australia which would enable the effects of this increased sediment load on the reefs to be assessed but reports from Thailand and Japan suggest that the loss of coral and death of the reefs is possible.[2] It is difficult to predict what the long term outcome will be but it appears that at best there will be an alteration of the species composition and possibily a

reduction in the diversity of the reefs. At worst the reefs will be destroyed. The Committee views these possibilities with concern and considers that urgent action is required, not only to protect the reefs in the long term but also to prevent further erosion and damage to the rain forest. Extensive work will be required to stabilize the road and the surrounding earth works, regardless of whether the road remains open or is closed.

73. A submission from a civil engineer who investigated the problem early in 1985 proposed that stabilization works be carried out on the three worst sections of the road to remove the source of suspended sediments which were being carried to the fringing coral reefs.[3] The proposed works included stabilization of cuts and fills, stabilization of steep road sections and the provision of retaining walls using wire cages. These works were designed to be as compatible as possible with the conservation of the rain forest but did not require closure of the road. These works were costed at approximately $1.5 million which does not appear excessive given that the scientific and conservation value of both the rain forest and the fringing reefs is immeasurable.

74. The Committee has not had the report independently assessed and cannot comment on the feasibility or the accuracy of the costing of the works. However it does regard the report as indicating that conservation works are both necessary and possible. The main problem seems not to be one of engineering but rather one of political will caused by the lack of co-operation between the Commonwealth and State Governments. The Committee believes that the two Governments should reach a reasonable compromise in relation to the protection of the fringing reefs particularly now that the significance of the reefs and the potential for damage has been recognised. Therefore the Committee recommends that:

the Minister for Arts, Heritage and Environment seek discussions on the importance of the fringing reefs with the Queensland Government and jointly sponsor an independent engineering study to determine ways of reducing the impact of runoff from the Cape Tribulation to Bloomfield Road on the fringing reefs north of Cape Tribulation.

75. Whether or not such discussions should address the broader questions of closing the road and the future of the rain forest should be resolved by the two Ministers. If no progress can be made on these matters then efforts should be concentrated on protecting the fringing reefs.

Pollution

76. Some witnesses raised the possibility that general pollution levels on the Great Barrier Reef were increasing. However the Chairman of the Great Barrier Reef Marine Park Authority advised the Committee that a recent conference of scientists working in this area had concluded that pollution was not a problem and that levels of contaminants were so low as to be barely measurable.[4] The conference recommended that continual monitoring was not necessary but that periodic monitoring and re-assessment should occur.

77. There was one possible pollution problem which is a matter of concern. This was the possibility that considerable volumes of sediment containing toxic heavy metals could enter the northern part of the Great Barrier Reef from the Ok Tedi mine on the Fly River in Papua New Guinea. Development of this mine which is owned by a consortium including BHP (30 per cent) and the Papua New Guinea Government (20 per cent) began in 1981. The mine has been plagued by technical difficulties and pollution problems. In June 1984 a barge containing drums of sodium cyanide capsized. Shortly after this first incident there was a leak of

one thousand cubic metres of untreated tailings into a tributary of the Fly River from a temporary tailings dam. Since the pollution spills last year the mine has been shut down on two occasions because of continuing environmental problems and disputes with the Papua New Guinea Government about development of the mine.

78. The Fly River rises in one of the highest rainfall areas of the World and there is a very high runoff and discharge of waters into the Gulf of Papua. The Committee was told by the Australian Littoral Society that it was expected that sediment runoff resulting from the Ok Tedi mining would increase by 40 per cent and it was possible that heavy metals including copper, zinc, lead and cadmium would pollute the sediment.[5] There is no evidence yet to suggest that such pollution is occurring and it is unlikely to occur until such time as copper mining is underway. However the possibility that polluted sediments may enter the Gulf of Papua and flow into the Great Barrier Reef cannot be excluded.

79. The Great Barrier Reef Marine Park Authority advised the Committee that although it was probable that Ok Tedi pollutants would enter Torres Strait it was not known whether any silt from the Fly River would enter the northern Great Barrier Reef region. There is no monitoring program in progress which would indicate if this is happening.[6] The Authority was also uncertain if the results of monitoring programs at Ok Tedi would be made available.

80. The area administered under the provisions of the Great Barrier Reef Marine Park Act 1975 does not extend north of Cape York Peninsula. The Reef itself extends beyond Cape York Peninsula into the Gulf of Papua. In 1981 the previous Committee recommended that the Australian Government should negotiate with the Papua New Guinea Government on measures which would enable

the Torres Strait Region to be administered as part of the Great Barrier Reef Marine Park.[7] The Committee was advised that any possible effects of the Ok Tedi mine on reefs in the Strait are covered under the provisions of the Torres Strait Treaty and are therefore the joint responsibility of both the Australian and Papua New Guinea Governments. The Committee recommends that:

> the Australian Government consult with the Papua New Guinea Government on the need for an environmental assessment of the Ok Tedi mine giving particular regard to the possibility of the pollution of reefs in the Torres Strait and the northern Great Barrier Reef Marine Park.

81. The Authority stated that a proposed pilot monitoring program for Torres Strait and the northern Great Barrier Reef would cost $200 000. The Committee is aware of a number of calls for the introduction of a monitoring program and considers that early identification of any pollution which might occur is essential. The Committee accordingly recommends that:

> the Great Barrier Reef Marine Park Authority establish a monitoring program in the northern Great Barrier Reef Marine Park and Torres Strait to detect any pollution from the Ok Tedi mine.

82. The Committee considers that it is in Australia's interest to take further action to ensure that measures are implemented to prevent erosion and pollution from the Ok Tedi mine site into the Fly River system. The role and responsibility of Australian companies with interest in the mine should be examined. The Government may have to consider measures through diplomatic and foreign aid channels to ensure that Australian waters are not polluted by actions in another country.

Zoning and Park Boundaries

83. Both the Australian Littoral Society and the North Queensland Conservation Council were critical of the fact that some areas of the Reef region as defined by the Great Barrier Reef Marine Park Act 1975 are not included within the Marine Park boundaries. These areas correspond to existing or possible sites for ports or tourist facilities. They occur at 26 separate localities along the Queensland coast line and cover 1.4 per cent of the defined Reef region. One of the reasons that these areas are excluded appears to be that the Authority would have to spend time and resources on matters which are peripheral to the management and protection of the Reef and for which generally there are adequate environmental assessment procedures in place to protect the Reef.

84. The Committee found nothing to suggest that the exclusion of these areas from the Marine Park had in any way compromised the management of the Park and therefore considers that the western boundary does not need to be changed to incorporate these areas.

85. In the Torres Strait area north of Cape York there are some 550 reefs which are part of the Great Barrier Reef but not in the defined Reef region managed by the Great Barrier Reef Marine Park Authority. Most of this area falls within the ambit of the Torres Strait Treaty. However there is an area north of the present northern boundary of the Marine Park and south of the protected zone defined by the Torres Strait Treaty. There are 60 reefs in this area and the Committee can see no good reason why they should not be protected and managed in the same way as the other areas of the Reef. The Committee recommends that:

the area immediately north of the present northern boundary of the Great Barrier Reef Marine Park and south of the protected zone defined under the provisions of the Torres Strait Treaty be incorporated in the Great Barrier Reef Marine Park.

86. The Committee also supports the findings and recommendations of the previous Committee which reported in 1981 on the administration of the Great Barrier Reef Marine Park Act and which recommended that the Torres Strait Region should be administered as part of the Great Barrier Reef Marine Park. The Committee calls upon the Government to respond to this report as soon as possible.

Offshore Developments

87. Recent years have seen significant and novel changes in tourist operations on the Great Barrier Reef. These have involved the permanent anchoring of pontoons and platforms and the stationing of semi-submersable coral viewing vessels over some reefs. Proposals have now been put forward which will bring this type of development to new levels. These involve the establishment of floating hotels and other semi-permanent offshore developments. The Committee recognises the very high value of the Reef as a tourist and recreation facility and is satisfied that adequate environmental assessment procedures are in place to ensure that these proposed developments are properly planned and carried out.

88. There must be limits on the extent and type of these developments and it would be useful for potential developers to have some guidance as to the types of requirements and limitations which might apply. At present the Great Barrier Reef Marine Park Authority appears to lack a specific comprehensive policy on offshore developments and appears to respond to such developments on an ad hoc basis. Whilst this has not diminished

environmental controls or led to any inappropriate development a more consistent and long term approach would be useful. The Committee recommends that:

> the Great Barrier Reef Marine Park Authority develop and promulgate a policy on offshore development and issue guidelines to prospective developers.

PETER MILTON
Chairman

November 1985

Endnotes

1. Evidence, p. 129.
2. Evidence, p. 130.
3. Evidence, p. 486.
4. Evidence, p. 471.
5. Evidence, p. 335.
6. Great Barrier Reef Marine Park Authority, supplementary submission, p. 4.
7. 'Environmental Protection Adequacy of Legislative and Administrative Arrangements', Report from the House of Representatives Standing Committee on Environment and Conservation, PP 278 (1981).

APPENDIX 1

Conduct of the Inquiry

1. On 31 May 1985 the Committee resolved to inquire into and report on aspects of the Protection of the Great Barrier Reef, particularly problems posed by the outbreak of the Crown of Thorns starfish.

2. The inquiry was publicised by press releases to the media throughout Australia particularly on the north Queensland coast. The Committee also wrote to over sixty individuals, organisations and Authorities thought to have an interest in the protection of the Reef. Those written to included tour operators, academics, conservation groups and local governments.

3. The Committee received thirty one submissions and held public hearings in Townsville, Brisbane and Canberra. The Committee also travelled to Cairns and Townsville for informal meetings and inspections, including an examination of two popular reefs where the Crown of Thorns starfish had been a problem.

4. The Committee acknowledges the co-operation and assistance from those who made submissions or who gave oral evidence to the Committee and would particularly like to thank Mr Graeme Kelleher, Chairman of the Great Barrier Reef Marine Park Authority, Mr Perry Harvey, Mr Doug Tarca and the conservationists who assisted with the Committee's inspections.

APPENDIX 2

List of Witnesses

BONHAM, Mr A.J.	Senior Lecturer (Civil Engineering) Faculty of Military Studies, University of New South Wales
BRADBURY, Dr R.H.	Co-ordinator, Coral Reef Ecology Group, Australian Institute of Marine Science
BUNT, Dr J.S.	Director, Australian Institute of Marine Science
CAMERON, Dr A.M.	Lecturer, University of Queensland
CHALOUPKA, Mr M.	Honorary Treasurer, Australian Coral Reef Society
DIGHT, Mr I.J.	Treasurer, North Queensland Conservation Council
ENDEAN, Professor R.	Associate Professor of Zoology, University of Queensland
HAYLES, Mrs M.F.	Marketing Manager, Hayles Holdings Pty. Ltd.
HEGERL, Mr E.J.	Director, Australian Littoral Society
KELLEHER, Mr G.	Chairman, Great Barrier Reef Marine Park Authority
KENCHINGTON, Mr R.A.	Assistant Executive Officer, Planning, Great Barrier Reef Marine Park Authority
STANNARD, Ms M.	Tropical Rain Forest Campaign Officer, Australian Conservation Foundation

APPENDIX 3

List of Submissions

Persons and Organisations who made submissions but did not appear at public hearings.

Australian Marine Science and Technology Advisory Committee
Australian Museum
Brown, Mr T., World Life Research Institute
Cairns City Council
Goldman, Dr B., Director, Lizard Island Research Station
Harvey, Mr P., Mission Beach, Qld
Johnstone Shire Council
Jones, Dr G.B., Townsville, Qld
Lucas, Dr S., James Cook University
McKauge, Mr G., Cairns, Qld
Minister for Arts, Heritage and Environment
Minister for Sport, Recreation and Tourism
Mulgrave Shire Council
Queensland State Government
Sale, Prof. S., University of Sydney
Tarca, Mr D., Townsville, Qld
Tibbs, Mr P., Cairns, Qld
Townsville City Council
Wallace, Mr J., Port Douglas, Qld
Wilderness Action Group
Wildlife Preservation Society of Australia
Wildlife Preservation Society of Queensland