

## APPENDIX 1

### COMPILATION OF THE MAJOR FINDINGS AND RECOMMENDATIONS OF PROFESSOR D. T. ANDERSON'S REVIEW OF THE CROWN-OF-THORNS STARFISH RESEARCH PROGRAM

1. The current management policy of the Great Barrier Reef Marine Park Authority for crown-of-thorns starfish control is soundly based and takes account of current knowledge of crown-of-thorns starfish populations on the Great Barrier Reef. The policy could be applied more extensively only if special funds were made available for this purpose.
2. The Authority has promoted appropriate research into crown-of-thorns management under the COTSAC research program and has fully evaluated the results of this research in relation to its current management policy. The causes of outbreaks of crown-of-thorns starfish are still unknown.
3. Ecological research and management-related research under the COTSAC program both support the view that local control techniques are available and could be effective, even though expensive, but large scale control or eradication is impracticable and unaffordable.
4. The COTSAC research program indicates that population fluctuations of the crown-of-thorns starfish have occurred in the past, but the scale of such fluctuations cannot be analysed in detail. The present phenomenon appears to have a long history.
5. The COTSAC research program has been defined, reviewed and operated in an efficient and productive manner, within the limits allowed by annual funding. A high degree of dedication is evident among the research workers and research managers involved in the program.
6. The provision of Federal funds for the COTSAC program on an annual basis has disadvantaged the program in various ways, primarily through the imposition of a need for rapid decision making and the corollary that the review committee for the program (COTSARC) has been unduly constrained by time considerations. Despite this, COTSARC has carried out its task as effectively as possible.
7. The COTSAC research program had led to significant advances in the understanding of the ecology of the crown-of-thorns starfish. As a result of this program, opportunities have now been created to investigate the broadscale ecology of the species in the Great Barrier Reef more deeply, and to better analyse its reproduction, dispersal, settlement and recruitment processes. Understanding of the causes and management of the crown-of-thorns starfish depends critically on the outcome of this research. Areas of future research should include:
  - \* predation at all levels;
  - \* population dynamics;
  - \* effects of human activities, including agricultural runoff and fisheries; and
  - \* biological control.
8. The research would benefit from an injection of supplementary research workers with suitable skills, especially in experimental biology. This could be obtained through four to five suitable post-doctoral appointments guaranteed for three years, and is critical to progress in the investigation of predation and population dynamics.
9. The crown-of-thorns starfish research program on the Great Barrier Reef should be continued for another three to five years at a dedicated and committed funding level of at least AUS\$1 million a year.

10. For the GBRMPA to run the program effectively, it needs the support of a review committee that could be active in determining the initial funding and annual renewal of all projects. Composition of the committee should include Professor Swan, two experts from GBRMPA, two experts from AIMS and three external (Australian-based) experts.
11. The review committee should meet at least three times each year, to review applications of funds, to receive and deliberate upon the reports of assessors on these applications, and to review progress of the program before the next round of applications.
12. In order to maintain a flow of information about the program to the wider community, Professor Swan should also be asked to chair a coordinating committee. This committee, meeting annually, could be informed about the progress of the program with a view to allowing input from other interest groups (e.g. tourism and state government). If comprised of two members of the scientific review committee and four members chosen from the Great Barrier Reef Consultative Committee (GBRCC), the coordinating committee could report to the GBRCC annually on the research program.
13. A full time coordinator of the program should be appointed. This person would need to be ex officio a member of the scientific review committee and the coordinating committee. In anticipation of a continuation of a major part of the research program at AIMS, and the obvious need for coordination of this component within AIMS, THE GBRMPA appointed coordinator would need to work closely with the responsible staff member(s) at AIMS.
14. The facilities and expertise of the Australian Institute of Marine Science are essential to the completion of the ecological research now required, but control of the program should remain with the Great Barrier Reef Marine Park Authority.
15. All projects funded under the COTS research program should carry contractual obligations, including strict identification of the application of the funds within the project and an annual report of the progress to the GBRMPA.

## APPENDIX 2

### MEMBERS OF THE CROWN-OF-THORNS STARFISH RESEARCH COMMITTEE (COTSREC)

Professor J. M. Swan (Chair) to January 1992

Professor Graham Mitchell (Chair) from January 1992

Dr J. T. Baker OBE (Director, AIMS) to December 1992

Dr Meryl Williams (Director, AIMS) from May 1993 to December 1993

Dr Peter Moran (AIMS COTS Study Leader) to May 1993, then as Acting Director, AIMS from February 1994

Professor Peter Davies (BMR) to August 1993

Professor David Hopley (JCU) from September 1993

Professor Ray Golding (Vice Chancellor, JCU)

Professor Graeme Kelleher (Chairman, GBRMPA)

Dr Brian Lassig (GBRMPA)

Dr Tenshi Ayukai (AIMS) from May 1993 to April 1995

Mr Robert Pearson (QDPI)

Dr Keith Sainsbury (CSIRO)

Professor Chris Crossland (Director, CRC Reef Research Centre) from March 1994.

Dr William Gladstone (Secretariat; GBRMPA) to December 1991

Mr Udo Engelhardt (Secretariat; GBRMPA) from January 1992

## APPENDIX 3

### TERMS OF REFERENCE FOR THE CROWN-OF-THORNS STARFISH RESEARCH COMMITTEE (COTSREC)

#### Background

The Crown of Thorns Starfish Advisory Committee (COTSAC) established by the Great Barrier Reef Marine Park Authority (GBRMPA) in 1984 noted that establishment and coordination of a program of research relevant to particular GBRMPA needs would best be achieved with the guidance of an advisory committee appointed by GBRMPA for this specific task. It recommended that the advisory committee should report directly to GBRMPA and should liaise with research institutions in Australia and overseas.

In December 1988 the Minister for the Arts, Sport, the Environment, Tourism and Territories, Senator the Honourable Graham Richardson, called for a review of aspects of the research program recommended by the COTSAC.

The review, conducted by Professor D. T. Anderson, Challis Professor of Biology in the University of Sydney, made recommendations for improving mechanisms for defining, reviewing and operating the COTSAC research program. Professor Anderson concluded the GBRMPA needed the 'support of a review committee that could be active in determining the initial funding and annual renewal of all projects within the program'. COTSREC is intended to provide that support.

#### Terms of Reference

##### (1) Membership

The Committee shall comprise:

Chairperson

Two Representatives from the Australian Institute of Marine Science

Two Representatives from the Great Barrier Reef Marine Park Authority

A Senior Representative from James Cook University of North Queensland

Four External Experts<sup>(a)</sup>

The Committee may appoint Corresponding Members<sup>(b)</sup> to be kept informed of progress in the research program and to be routinely consulted on technical matters relevant to their areas of expertise.

The Committee may also nominate external consultants to complement the areas of expertise represented by Committee members. These consultants should be asked to review elements of the program relevant to their areas of expertise and report their assessments to COTSREC to assist the Committee's funding deliberations and reviews of program directions. As necessary, these individual consultants may be invited to join COTSREC meetings.

(a) External experts should be selected on one or more of the following criteria:

- \* Active involvement in relevant research;
- \* Wide acceptability of their scientific expertise in *Acanthaster* research, tropical marine biology, experimental design, statistics or modelling;
- \* Experience in analogous marine or terrestrial research/management programs.

(b) Corresponding members may be invited to attend COTSREC meetings from time to time.

The Committee may consult with other Australian and overseas experts on an ad hoc basis when required.

(2) Objectives

COTSREC is an advisory committee to GBRMPA, in relation to crown-of-thorns starfish issues primarily research, funding and public information.

Within guidelines established by the Authority and subject to available funds, the Committee shall meet at least three times each year to:

- i. review applications for funds for crown-of-thorns starfish research;
- ii. review and deliberate upon the reports of assessors on these applications;
- iii. review the progress of the crown-of-thorns starfish research program before the next round of applications;
- iv. advise GBRMPA on research priorities and patterns of expenditure within the crown-of-thorns starfish research program;
- v. advise on a program for keeping the public informed on the crown-of-thorns starfish phenomenon and research and management actions which are being undertaken in relation to it; and
- vi. advise GBRMPA on the implications of crown-of-thorns starfish research for management of the GBR Marine Park.

COTSREC should arrange to meet annually with the GBR Consultative Committee to report on the research program.

(3) Procedures

- i. The positions on COTSREC, other than Chairperson, are honorary.
  - ii. The Chairperson will receive a fee of up to \$5000 p.a.
  - iii. All approved expenses incurred in the conduct of COTSREC business will be met by GBRMPA.
  - iv. The Chairperson may exercise Executive Powers to recommend to GBRMPA transfer of funds (on recommendations of the research program Coordinator) up to \$5000 for any one project and up to \$50 000 overall in any one period between meetings. The Chairperson will refer all recommendations made under these Executive Powers to the next meeting of COTSREC for endorsement of actions taken.
  - v. Procedures at meetings will be determined by the Committee.
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## APPENDIX 4

### SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS OF 'A REVIEW OF THE CROWN-OF-THORNS STARFISH RESEARCH PROGRAM: 1989-1991' BY DR R. E. JOHANNES

1. The COTS research program has operated in an efficient and productive manner during 1989-91 and has contributed significantly to the knowledge required for the use and enjoyment of the Great Barrier Reef in an ecologically sustainable manner. However, because of uncertainty over funding, some research projects started later than planned.
2. Significant additional progress is assured in the 1991-92 fiscal year, and continued support for the program into this third year is essential.
3. Some activities in the COTSREC program have the potential to contribute significantly to research in important areas outside the immediate scope of the program, including research on fisheries stocks and recruitment and on water quality.
4. The COTS monitoring program is providing exceptionally useful information. It is the key to identifying outbreaks rapidly and monitoring their spread, impact and decline. It also provides information essential to many other COTS research projects. Steps should be taken to guarantee funding of the COTS monitoring program at no less than the current (indexed) level of support at least until the cause(s) of outbreaks are known. The monitoring program should be reviewed regularly.
5. The COTS research program should also continue beyond the 1991-92 year, but at a level of support that reduces over a period of three years to fund a core program (as distinct from monitoring) of about half of the current (indexed) level. This program should be reviewed in three years.
6. The existing monitoring working group involving GBRMPA and AIMS should be responsible for reviewing the COTS monitoring program. This group should consider certain modifications to the monitoring program and report its conclusions to COTSREC before the end of 1991.
7. The GBRMPA COTS staff should be requested by COTSREC to develop, in consultation with researchers, contingency plans for research and funding to be activated in the event of a new COTS outbreak. Conclusions should be reported to COTSREC at the Committee's next meeting and the plan reviewed at each COTSREC meeting.
8. A contingency fund of \$400 000 should be sought from the Federal Government to be held in a trust fund and made available for core research in the event of an outbreak in the future. The fund should be used only when COTSREC and GBRMPA decide that an outbreak has clearly occurred.
9. Research on monoclonal antibodies and settling tubes should be given greater support.
10. No new research on COTS in the sedimentary record should be supported (other than, perhaps, modest pilot studies) unless new techniques show promise of characterising the dynamics of pre-1960 outbreaks with sufficient precision to challenge rigorously the hypothesis that human activities have caused or enhanced recent outbreaks. Proposals for research in this area could continue to be accepted and reviewed.

11. Support for hydrodynamic modelling should be phased out until existing model predictions have been field tested.
12. Screening and coordination of requests from researchers for assistance from the AIMS monitoring team should be undertaken by a group including the AIMS Project Manager, a member of the survey team and the GBRMPA Program Coordinator. Any problems with assessing priorities and resolving conflicts should be directed to the COTSREC Chairman.
13. COTSREC should provide and enforce guidelines for addressing COTSREC objectives in proposals and reports.
14. COTSREC should continue to review its funding priorities in order to reduce still further the number of projects supported.

## APPENDIX 5

### GBRMPA POLICY ON COTS CONTROLS

'Broadscale control of crown-of-thorns starfish is not to be attempted in the Great Barrier Reef Marine Park unless human activity is proven to cause or exacerbate outbreaks, or unless any future outbreaks are much more extensive and intensive than the two that have been observed.

Local control of crown-of-thorns starfish (by any method involving treatment of individual starfish) must be consistent with zoning plan provisions and should be consistent with management plan provisions.\*

Recognising the potentially high risks associated with biological and chemical control measures in complex coral reef environments, research into biological and chemical control of crown-of-thorns starfish should not be supported other than in identifying potential agents whose application in consistent with the two policies above.

In the event of a causal relationship between human activity and crown-of-thorns starfish outbreaks being established, the Authority should use all its powers and influence to regulate that activity to minimise the effects of that activity on crown-of-thorns starfish populations, and should also seek to minimise the effects of outbreaks.

- \* *Note: A permit will be required for local control measures in General Use A and B Zones where it is desired to collect more than five starfish per person in any 28-day period. A permit may be granted for local control measures in higher protection areas (MNPA and B, Conservation Park, Buffer and National Park Zones) where the provisions allow for the taking of animals that pose a threat to ecosystems or the use and amenity of an area.'*



## APPENDIX 6

### A MANAGEMENT APPROACH TO THE COTS QUESTION\*

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- \* Extracted from GBRMPA Workshop Series No. 18 (1993) 'The possible causes and consequences of outbreaks of the crown-of-thorns starfish'. U. Engelhardt and B. Lassig (eds). GBRMPA, Townsville, Qld.

#### **Abstract**

*Scientists and managers often view issues from different perspectives. Scientists as a group have traditionally wished to learn more about an issue for the sake of learning, for the sake of testing a hypothesis, for the sake of furthering their careers or for a combination of these reasons. While managers are also curiosity driven, they are usually required to focus their curiosity on those aspects of matters which are vital to the solution of management problems. From the manager's perspective, the fundamental question to be answered about the COTS phenomenon is whether or not it has been grossly affected by human activity. On the basis of the answer to that question, the manager will determine his response, particularly whether or not to interfere in the 'natural' system or to refrain from interference. The logic of this position is discussed.*

The Authority's policy on controlling COTS is not to interfere on a large scale unless it can be shown that outbreaks are caused or exacerbated by human activity. However local controls are initiated to protect sites of particular value to tourism or science. Every scientific review of this matter has supported our policy.

Many people adopt one of two fundamentally different explanations for why crown-of-thorns populations suddenly increase dramatically. One is that the phenomenon is entirely 'natural'. That is, it is not affected by human activity. The other is that it is entirely human-induced.

Of course, bearing in mind the pervasive effect that human activity is having on the world's biosphere, it is quite likely that the truth is a mixture of these two views, that is, that crown-of-thorns infestations are affected to some degree by human activity. We don't however, know whether this is so, and if it is, whether human activity is contributing to the intensity, frequency or extent of the phenomenon positively or negatively.

The Authority recognises that long-term protection of the Reef ecosystem is the primary reason for the existence of the Authority and for everything that we do. Therefore we approach the crown-of-thorns issue from the perspective of risk.

We know that the animal is a natural inhabitant of the Reef and that it has been around for millennia. We know, therefore, that the Reef as we know and cherish it has developed in the presence of the starfish. That is not to say that there have always been recurrent population explosions, but there may have been. The primary question is: should we undertake widespread and massive destruction of crown-of-thorns starfish whenever there is a primary outbreak?

What are the risks and benefits of non-interference? Clearly, an immediate benefit is the saving of an enormous amount of money. Experience has shown that it costs up to \$35 per starfish to kill large

numbers of them using the best methods identified so far - copper sulphate injections (Johnson et al. 1990). Since there can be millions of starfish on a single reef, the people of Australia stand to save much more than the annual budget of the Authority by not embarking on massive starfish killing programs.

What are the risks? At the start of both recent starfish infestations we were told that, if the starfish numbers were not controlled, the entire GBR ecosystem would be at risk, with the possibility of a major phase-shift from a coral-dominated community to something else, with massive erosion of the existing reef structure and the adjacent mainland. In fact, thorough surveys have shown that in the last major wave of infestations starting in 1979 and evidently petering out now, only  $17 \pm 4\%$  of all the 2900 or so reefs of the GBR were affected visibly by infestations and only about one third of these (i.e. 6% of all of the GBR reefs) were seriously affected. It is hard to believe that permanent damage to the Reef ecosystem could be caused by an event of only this magnitude.

The conclusions from this last experience therefore are that very significant economic benefits accrued from the 'non-interference' policy and that the risks from applying that policy were small.

What about the risks and benefits of applying a policy of massive starfish destruction programs? The benefits have to be conjectural because we cannot be sure that very large populations could be controlled. However I suppose we could assume that the number of reefs seriously affected by the starfish could have been reduced from the 6% that were so affected. But it's not so easy to argue that this is a benefit. Many people have conjectured that crown-of-thorns infestations might be beneficial to reefs in ways similar to the effect of bushfires on some Australian native forests. So perhaps there would have been no benefits.

There would have been great costs, however. Even if only Green Island Reef had been subject to starfish destruction action, the costs would have been many millions of dollars. Further, there is the possibility that our massive interference in what might be a natural element of the Great Barrier Reef system could have major unforeseen ecological effects. I would count such effects as costs because we value the Reef for what it is naturally, not for what human interference might make it. Further still, it is at least conceivable that such an action focussing on Green Island might have shortened the time for the next outbreak or created a chronic elevated crown-of-thorns population state as has occurred in the Ryukyu Islands (Birkeland and Lucas 1990).

The conclusion is that the risks from adopting a policy of massive destruction of crown-of-thorns starfish are very significant and that the only potential benefits may turn out to be costs in the long run.

In contrast, no long-term risks to the whole GBR are identified in not interfering massively with infestations, unless they are much more extensive and intensive than the two that have been observed. In such a case, the Authority would definitely reconsider its policy. If, for instance, it appeared that 30% of all the reefs of the system were to be seriously affected, then I would be asking the Government for the resources to attempt population control.

This explains why the Authority has maintained the policy of not undertaking massive starfish killing programs. However, I should explain why we do encourage or cooperate in protecting small reef areas that are important for tourism or research. Again, the reasoning is based on benefits and costs. We can in such cases identify very clearly the economic benefits of protecting such reef areas. The costs are limited to the costs of killing comparatively few starfish. There is no risk that this small amount of human interference could have a significant unforeseen effect on the whole Reef ecosystem. So the benefits clearly outweigh the costs, both those that are identifiable and those that can be classified only in risk terms.

## References

Birkeland, C. and Lucas, J. S. 1990, *Acanthaster planci*: Major management problem of coral reefs, CRC Press, Boca Raton, 257pp.

Johnson, D. B., Moran, P. J. and Driml, S. 1990, Evaluation of a crown-of-thorns starfish (*Acanthaster planci*) control program at Grub Reef (central Great Barrier Reef), *Coral Reefs*, 9: 167-171.

