

REVIEW OF CONTAMINANTS STATUS

A: HEAVY METALS

Presentations

Two reports on heavy metals studies in the GBR Region were presented to this group.

The first of these was based on studies undertaken by C. Burdon-Jones and G. Denton of James Cook University since 1980. The studies involved the most comprehensive survey of heavy metals undertaken in the GBR Region to date. A copy of their report outline is enclosed in Appendix C (part a).

The second report was by M. Florence of the Division of Energy Chemistry, CSIRO. It focused on the possible effects of mainland oilshale mining in terms of heavy metal sources, levels and exports. An abstract of his report is enclosed in Appendix C (part b).

Review Discussions in Relation to Workshop Objectives

1. Sampling Design and Methods

The group considered that the broad scale survey of the GBR Region by Burdon-Jones and Denton was appropriate to the establishment of "baseline" levels. The group noted that such an approach is necessary, at least initially, because of sampling problems such as access, scale and cost.

It was generally agreed that further surveys should move from the broad scale to specific sites. This will also need to involve event sampling rather than routine monitoring, because of the variability of environmental factors affecting metal export, pathways and release in the GBR Region. This approach has been adopted in studies done by Florence and needs to be extended to other areas of the Region if a comprehensive data base, suitable for detailed analysis of long-term trends is to be developed. The group was critical that event sampling was not undertaken at present by responsible agencies. It was noted that the one metal which has been rather neglected so far is tin. Speciation work is likely to be of importance in this respect as certain forms of tin would be precipitated in seawater. Of particular interest would be organic forms of tin, found in and around living organisms.

The possibility of using organisms such as giant clams, e.g. Tridacna crocea, T. maxima is being investigated by Burdon-Jones and Denton at present. This approach has parallels with the Musselwatch program and was supported by the group as a potentially valuable monitoring technique.

2. Analytical Techniques

Members suggested that there have traditionally been problems in achieving satisfactory intercalibration with respect to metals analyses. This problem was reported to have been discussed at a recent meeting at Deakin University, where it was observed that improved equipment and analytical methods have had a dramatic effect on the comparative metal levels recorded in some longer term studies. Examples of increasing metal levels recorded during some studies, suddenly declining, due to a change in laboratory analysis methods were quoted.

In GBR studies, problems associated with the accurate measurement of very low levels of metals have been noted. However, it was generally agreed that the laboratory methods and analytical techniques employed to date have been satisfactory. Analytical methods have been verified by reference to international (NBS) standards, and more recently, by participation in an IOC/GEMS intercalibration exercise.

3. Levels and Significance

The measured levels of various metals, as recorded by Burdon-Jones and Denton throughout the GBR Region, are reproduced in Appendix C.

Group members generally agreed that the levels recorded in waters of the GBR are low compared with concentrations recorded elsewhere in Australia and overseas. Higher levels of most metals were generally confined to the coastal areas visited. Not surprisingly, higher levels of zinc, copper, cadmium and lead were found in locations such as Townsville Harbour. Those levels are, however, only indicative of low to moderate pollution compared to levels recorded elsewhere in Australia and overseas.

Difficulties were noted with respect to separating naturally occurring levels of various metals, from those which may have been influenced by low level human activity. This problem is apparently most pronounced in and around "inshore" reef areas particularly those lying within close proximity to coastal towns and major estuaries.

Participants noted that there has been no sampling to date, north of Lizard Island. It was considered that more remote areas of the GBR are important bases for comparison, and thus further sampling is required. The group indicated a need to consider the OK Tedi project in New Guinea, and its possible effects on waters of the northern GBR.

4. Threat

The group considered that the measured levels pose little threat to human health. In terms of the long-term health of the GBR system, members indicated that uncertainties associated with sub-lethal effects, bio-magnification and pathway processes make detailed assessment of the degree of threat difficult. Concern was expressed about the threat posed by a potential increase in industrial and mining projects which may involve metal discharges. A suggestion was made that any expansion of potential sources of metals in the coastal zone adjacent to the GBR should be monitored in view of this.

During the discussion on heavy metal pollution, some concern was expressed about the Ok Tedi project in New Guinea. The group noted that accidental discharges from this mine could represent a threat to the ecosystems of the northern section of the Great Barrier Reef.

5. Information Deficiencies

As noted above, the group was particularly concerned about the lack of information on the processes of mobilisation and movement of metals within the GBR system and their fate. A need was seen for further studies which utilise a systems approach to ecotoxicological aspects of metals contamination.

Apart from these, data on specific sites and relevant to specific events (e.g. flood discharges from the Herbert River and the extent of metal export from tin mining areas) were seen as being a critical information gap at present. Such data would enhance the capacity for interpolation and assessment of trends derived from the existing information.

6. Further Research

Apart from the research needs arising from the points raised in (5) above, the group considered it would be opportune to:

- . collate all existing data and information on metals within the GBR Region and estimate the total amount of metals entering the system presently; and
- . monitor land use activities in the coastal zone, seeking to identify existing or future possible metals sources; and
- . undertake further sampling in remote areas of the GBR (particularly north of Lizard Island).

The group also concluded that a "total system" approach be adopted in future studies of the GBR Region, thus reinforcing specific comments on sample design, methods and coverage.

B: PCBs AND OTHER ORGANOCHLORINES

Presentations

Four reports on PCBs and organochlorines studies relevant to the GBR Region, or to techniques for analysis, were presented to this group. Copies of each report outline are enclosed in Appendix D.

The first was by R. Smillie of Latrobe University who outlined recent research, undertaken in conjunction with J. Waid, into PCB levels in reef organisms. This study was part of a broader survey of PCB contamination of Australian marine biota. It also involved the incidental detection of other organochlorines.

This was followed by a report by D. Hawker of Griffith University who discussed the chemistry, characterisation and analysis of PCBs. The report was based largely on experiences with the use of GC and GC/MS facilities at Griffith University.

G. Shaw of the Queensland Government Chemical Laboratories outlined a range of important considerations in surveys of organochlorines, particularly sampling techniques and analysis procedures. The presentation concluded with a brief reiteration of results from an earlier study of PCBs in the Brisbane River which was considered an appropriate basis for comparison with GBR survey data, due to its comprehensive nature.

The final speaker in the group was D. Connell of Griffith University, who discussed aspects of the behaviour of lipophilic compounds in aquatic ecosystems. He stressed the importance of recognising environmental factors affecting uptake and the use of coefficient factors as a means of predicting uptake. His discussion was based on a range of studies, including hydrocarbon surveys in the GBR Region and the PCB survey of the Brisbane River. The outline of his report sets out the objectives of his recent research in this area.

Review Discussions in Relation to Workshop Objectives

1. Sampling Design and Methods

It was generally agreed that despite the small number of samples obtained during the study by Smillie and Waid, the results obtained were an indication of the nature and degree of seriousness of PCB contamination in the GBR Region. A contrast pointed out by the researchers in this respect was that the earlier (1976) survey by Olafson was more comprehensive, and yet no PCBs were detected.

Group members drew attention to the problems associated with sampling in the GBR Region, such as difficulties associated with access, scale (the spatial extent of the reef), and cost. It was considered that these could, however, be at least partially resolved by improved coordination of scientific collecting activities and cooperative use of samples and collection facilities.

Group members agreed that two key elements of any future sampling design should be stratification and reproducibility. The former is important with respect to defining contaminant sources and an appropriate sample scale. It is especially intended to facilitate sampling in reef areas of contrasting characteristics. A suggestion was made that proximity to urban centres be one criterion for contrast with "baseline" levels (as obtained from measurements in remote, undisturbed areas of the GBR such as the Far Northern Section of the Swain Reef complex). The recent findings of Waid and Smillie suggest, however, that few "pristine" areas may exist in the GBR Region, because the influence of non-point sources derived from atmospheric and oceanic circulation on a global scale.

Survey reproducibility was considered to be of importance, in terms of measuring variations over time. Suggestions were made that GBR sampling should also form part of a national network, such as that being investigated at present by the Victoria Marine Science Laboratories, under contract to the Department of Home Affairs and Environment.

2. Analytical Techniques

Laboratory procedures and analytical techniques for the detection and measurement of PCBs and organochlorine substances generally were considered to be important questions, particularly in relation to sample intercalibration and reproducibility. Group members also questioned the interpretation of Gas Chromatograph (GC) peaks and the validity of GC use alone, as an analytical tool for PCB detection.

Members agreed with the suggestion of J. Baker that in accordance with UNEP (1982), GC not be considered an appropriate sole analytical tool in future studies. It was suggested that a Mass Spectrometer (MS) be used as the standardising analytical technique, although it was recognised that access to MS in Australia is limited in some areas at present.

3. Levels and Significance

The levels of PCBs detected in GBR organisms by Waid and Smillie are very low compared to surveys undertaken both in Australia (e.g. Shaw and Connell, 1980) and overseas. As shown in Appendix D, the highest concentrations were found to occur in sharks (range 6.5 to 85.8 ng PCB g⁻¹ WW, average 35.8 ng g⁻¹).

Four main points of concern remain in relation to the findings, namely:

- . that there may have been a change in PCB levels since Olafson's survey in 1976;
- . PCBs may act synergistically with other chemicals;
- . although the measured levels are low, PCBs bioaccumulate through the food chain and as a consequence higher order organisms may be at risk; and (related to this)
- . global production of PCBs has been substantially reduced, but large quantities remain, and PCBs are very persistent

A further possible point of concern noted by Smillie was the suspected presence of photo-dieldrin in some of the samples he obtained from the GBR. This substance may have an adverse effect on photosynthesis. Dieldrin was also detected by Olafson (1978). Confirmation of its presence and current levels requires further study.

4. Threat

The group agreed that the measured levels of PCBs do not threaten the functioning or integrity of the GBR system at large. The group, was, however, concerned on the possible long-term risk to the GBR system of organochlorine pesticide used in mainland farming operations (see 5 below).

5. Information Deficiencies

Concern was expressed about the lack of knowledge of sources of PCBs, levels of use of organochlorine pesticides on the mainland, contaminant pathways in ecosystems of the GBR and possible sub-lethal effects of organochlorines on photosynthesis and reproduction.

6. Further Research

The need for further monitoring of PCBs and other organochlorines in the GBR Region was discussed at length. The group concluded that in view of the perceived low degree of threat from PCBs and the existence of baseline information from the Waid and Smillie study, only measurements which are incidental to other analyses be undertaken in the near future. The group did, however, agree that the Authority should seek information on the levels and areas of organochlorine usage. A suggestion was made that the Queensland Water Quality Council and the Bureau of Sugar and Experimental Stations could be valuable contacts in this regard.

It was suggested that the design and implementation of a monitoring system can remain a low priority while the objectives and program for a broader scale GBR Marine Park monitoring system are developed.

Group members did, however, consider that organochlorine pesticides should be given more attention. A desk-top study on the level of organochlorine/pesticide use in mainland agriculture was recommended as a priority for further study. The study should attempt to evaluate, on a region by region basis, trends in the useage of organochlorine pesticides in coastal areas adjacent to the Great Barrier Reef Marine Park. This may then necessitate a baseline survey of organochlorine levels in reef organisms coupled with a study of their ecotoxicological effects.

The group also expressed its concern about the lack of trained scientists in the area of ecotoxicology in Australia. A comparison with the other OECD countries by D. Connell indicated that Australia lags well behind in this respect.

C: HYDROCARBONS

Presentations

Four reports on hydrocarbon studies in the GBR Region were presented to this group. The first of these was by M. Coates from Griffith University. His studies in the GBR Region have involved analysis of alkane and mono-olefin hydrocarbons in GBR organisms and environment. A summary of his report is presented in Appendix E (part a).

The second report was by J. D. Smith of Melbourne University. His research in the GBR Region has been centred on the distribution of polycyclic aromatic hydrocarbons in reef ecosystems. A summary of his report is presented in Appendix E (part b).

B. Johns of Melbourne University outlined his work on surveys of hydrocarbons, which in the GBR Region have been mainly focussed on mangrove environments. N. Millis, also of Melbourne University, outlined her research in the field of quantification of oil-utilising bacteria. This research is of considerable relevance to understanding oil degradation processes.

Review Discussions in Relation to Workshop Objectives

1. Despite the general problems of scale, access, cost and the like which are typically associated with GBR studies, the group agreed that the research undertaken to date has involved sufficient sampling to provide a reasonable assessment of the level of hydrocarbon contamination in key areas of the GBR.

Most studies undertaken to date have sought to identify whether hydrocarbon compounds measured were of biogenic or anthropogenic origin. The studies have therefore yielded data on "baseline" hydrocarbon levels, and levels which have been raised or altered by human activity in the GBR Region.

2. Analytical Techniques

These were generally considered to be adequate by the group, although intercalibration remains a problem. The group also noted that there was a need for closer integration of chemical and microbiological techniques and levels of analysis.

3. Levels and Significance

The studies by Coates and Smith indicated that only trace amounts of various hydrocarbon compounds occur in areas of the GBR which have not been directly influenced by human activities. Highest concentrations were found around harbours, areas visited by boats and in waters adjacent to tourist resorts.

Levels measured in Gladstone and Townsville harbour sediments were by far the highest, and they were comparable to levels reported in other harbours around the world. Hydrocarbon levels detected in reef areas were extremely low, as would be expected where the dominant source is biogenic.

4. Threat

The group identified two time frames of threat associated with hydrocarbons. The present level of threat is very low due to the low intensity of hydrocarbon use in the immediate environs of the GBR. The most common point source was identified as spillages from boats. Mainland sources are not considered to be a major threat because of the influence of prevailing wind and current patterns. These combine to keep possible mainland inputs away from the reef proper, although further knowledge of pathways may be necessary before the potential threat from this source can be completely discounted in all areas of the GBR.

Two possible future threats to the GBR in terms of hydrocarbon pollution are oil shale mining and oil spills. The group agreed that the former is of low concern because of the long lead time involved in oil shale production and the many uncertainties associated with, for example, possible levels and pathways of hydrocarbons from this source.

Members considered the possibility of an oil spill to be of high concern, and expressed concern that an oil spill contingency plan is not yet operational for the Great Barrier Reef Region. (At the time of preparation of this document, a contingency plan [REEFPLAN] was at an advanced stage of preparation, and was under review by staff of the Great Barrier Reef Marine Park Authority.)

5. Information Deficiencies

The group identified several information deficiencies in relation to hydrocarbon pollution. These include a need for:

- . further long-term data on hydrocarbon levels near point sources;
- . improved intercalibration capacity;

- . better understanding of the ecotoxicological effects of pure compounds on sensitive species;
- . greater understanding of the fate of hydrocarbons after an oil spill, such as the spatial extent of the effects of oil dispersion, degradation (including bacterial action) and transfer to the food chain; and
- . more knowledge of the fate of detergents (used in any oil spill clean-up action).

6. Further Research

The group considered that the priorities for further research in this area are (not in order):

- . improved intercalibration between test laboratories
- . hazard assessment, focussed on the risk of an oil spill and assessment of factors influencing response (e.g. how, when, where, oil type etc.);
- . development of an oil cleanup plan, including determination of the scale of monitoring needed for waters, biota and sediment after an oil spill; and
- . improved coordination of chemical and microbiological approaches to hydrocarbon analysis