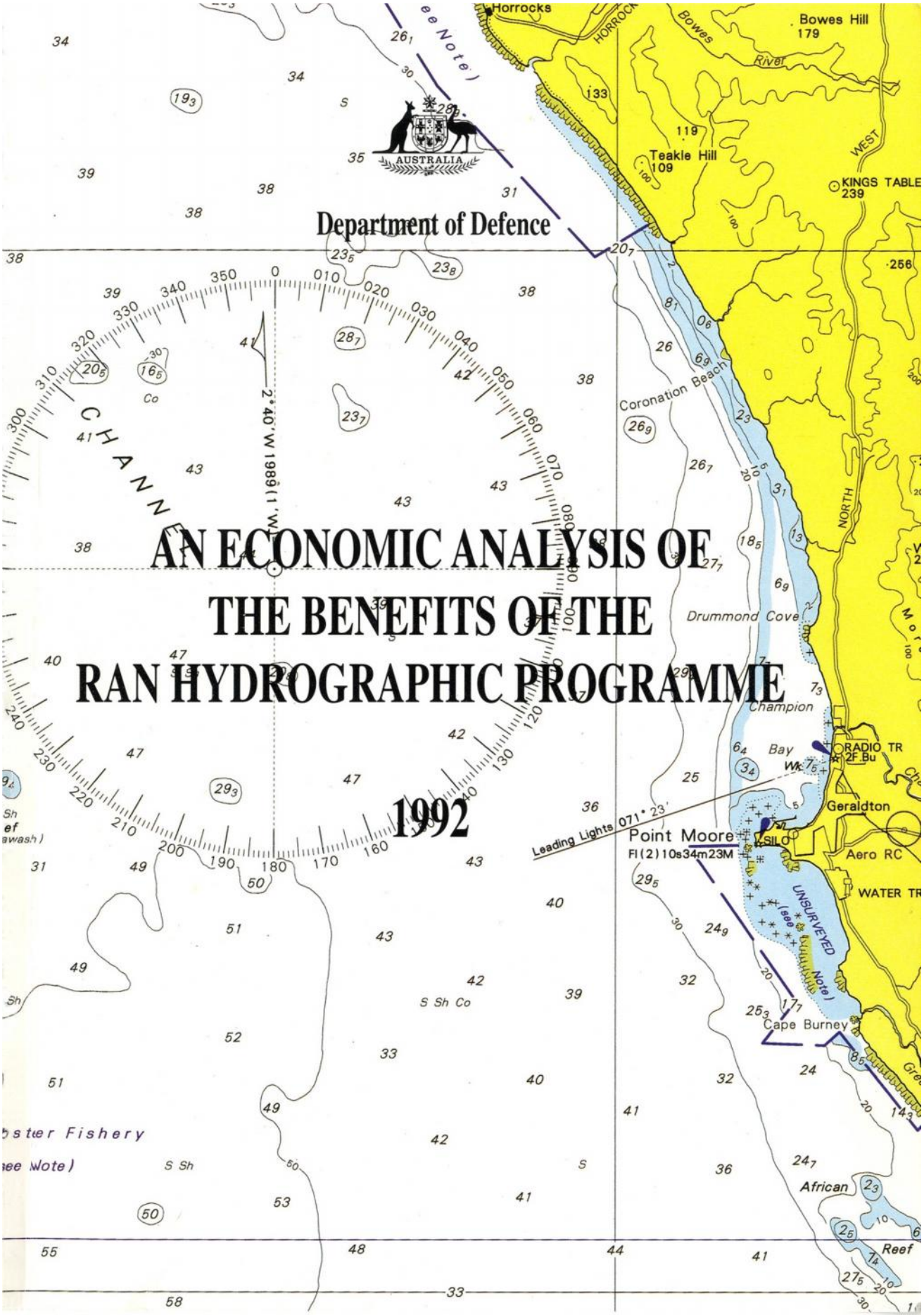

AN ECONOMIC ANALYSIS OF THE BENEFITS OF THE RAN HYDROGRAPHIC PROGRAMME

1992

Department of Defence

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ISBN 0 642 18294 9

Printed for AGPS by Pirie Printers Pty Limited,
PO Box 438, Fyshwick ACT 2609.

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30 July 1992

Four notions are commonly confused when people speak of worth: merit, as intrinsic value; usefulness, as value-in-use or utility; exchange value, as price or value-in-exchange; and best alternative, as opportunity cost. Any of these four may be reflected in an answer to the question "What's it worth'".

(Wildavsky, 1979)

New scientific knowledge, once created, can be used by any individual without preventing others from using it also. This reflects the public good nature of knowledge. Because new knowledge has similarities with environmental resources (some of which are public goods) many of the same techniques used to evaluate environmental services are relevant to evaluating basic research. Measuring such demand curves encounters many of the same difficulties as measuring environmental values. Notionally it requires many of the techniques used to measure environmental worth.

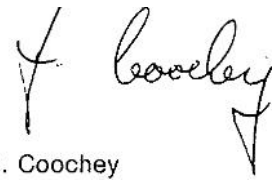
(Waters, 1992)

DISCLAIMER

I am indebted to many people and institutions for their valued assistance. To thank them all by name would double the length of this paper; however, I would especially like to thank Alan Deck for showing me how to use HAL (the computer, 'HAL, print the job' 'I'm sorry John, I can't do that') and Belinda for turning a deaf ear to my profanity when it broke down — which was frequently.

On another level I would like to thank, in alphabetical order, Phillipa Dee of the Industry Commission for her advice concerning the ORANI economic model, Joe Motha of the Bureau of Transport and Communications Economics for his comments on the value (not meaning) of life, and John Newlands from the Australian Bureau of Statistics.

The views expressed in this paper do not necessarily reflect those of the Department of Defence or the Naval Hydrographer. Any faults, shortcomings or omissions remain my own.



J. Coochey

1992

FOREWORD

I commissioned this report into the economic benefits of the RAN Hydrographic Programme for two reasons. Firstly because much has been written of a qualitative nature, but no one at that stage had attempted the difficult quantitative analysis. Secondly the economic rationale for the Hydrographic Programme had not been as well developed as the military rationale and I felt that this imbalance needed to be corrected. The resultant report builds on the very useful work done by the Inspector-General's Evaluation of the RAN Hydrographic Service. That study helped bring into the public forum a number of issues, not least of which is that only half of Australia's continental shelf is adequately charted.

To carry out the work I was fortunate in obtaining the services of John Coochey, an economist in the Department of Defence. John is an economics graduate with extensive experience in the Public Service including the Industry Commission, the Industry Policy and Operations Branch and the Inspector-General's Branch of the Department of Defence. He has also worked as Research Assistant to the Professor of Economics at the Centre for Resource and Environmental Studies, the Australian National University. He has been most successful in bringing his analytical talents and his knowledge of economics together to produce a factual report on a complex subject.

The report follows two broad themes. First by the primary areas of use of the Hydrographic Programme are identified. Then their role in the national economy and the role of the Hydrographic Programme in such activities is discussed. The results of pre-existing studies into such aspects as the economic flow-on effect from a reduction in shipping costs and the economic value of life are assessed. Opinions given in personal interviews and letters have also been recorded and evaluated. The report examines at some length the Public Good nature of the Hydrographic Programme and makes some recommendations on cost-recovery issues.

We in the Hydrographic Service are very conscious of the importance of quality assurance in our work. In the case of this report we have actively sought critical comment from many areas of Government, academia and elsewhere. I am confident that this report is a valid statement of the economic worth of the Hydrographic Programme.

I am grateful to John Coochey and to all of those who have assisted him in his research.

J. W. LEECH
Commodore RAN
Hydrographer

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PREFACE

The RAN Hydrographic Service has always had both a military and civil role. Its military role is to provide the RAN and allied Navies with charts and services which ensure safety of navigation and freedom to manoeuvre in times of conflict. Its civil role is to provide charts and services for the safe navigation of the national and international shipping in which so many of Australia's goods are carried.

The military role of the Hydrographic Service was addressed in detail in the Defence White Paper in 1987. This new report addresses in detail the economic rationale. The Navy has always sought to support national maritime activities and this report provides an excellent analysis of a Navy Program which provides substantial economic and commercial benefit to the nation.

Anyone reading this report should be convinced that the RAN Hydrographic Service is good value for money.

I.D.G. MacDougall AO RAN
Vice Admirai
Chief of Naval Staff

CHAPTER 1

EXECUTIVE SUMMARY

Of making many books there is no end; and much study is a weariness of the flesh. Let us hear the conclusion of the whole matter.

(Ecclesiastes 12: 12-13, quoted in Hoogsteden 1988)

General

101. This report is a follow-up to the 1990 Inspector-General Programme Evaluation of the Hydrographic Service. It attempts a quantitative analysis of the economic benefits of the Hydrographic Programme based on four main themes: the efficiency of shipping, the protection of the environment, safety of life at sea and the management and exploitation of resources.

102. Much of this report is not primary research. Rather it relies upon relevant pre-existing research carried out by other agencies and draws this together in the context of the Hydrographic Service. There were two reasons for this: one, the constraints on time and resources and two, that such an approach would achieve greater credibility.

Efficiency of Shipping

103. The economic benefit from the efficiency of shipping is perhaps the most obvious civil benefit from the Hydrographic Programme. Shorter and deeper routes save time and money. They also increase the efficiency of capital in cases where it is possible to use larger ships or load ships more deeply and thus realise economies of scale. The report has been able to study a number of specific instances such as the Torres Strait and the Hydrographer's Passage and has been able to relate these to other economic studies dealing with the value of marginal increases in the efficiency of shipping operations. A recent Industry Commission study in connection with waterfront reform found that the annual full economic benefits of a lowering in trade costs was seven times the initial saving.

Protection of the Marine Environment

104. Australia's marine environment is of major importance to the national economy. This includes fisheries, coastal industries, tourism and other recreational activities. Damage to this environment, for example from oil spills, would have a major economic impact. The Hydrographic Service makes a significant contribution to preventing ship wrecks and resultant pollution by supporting safety of navigation. Again the report draws from existing studies to demonstrate the value of the marine environment to Australia. For example the value of the Great Barrier Reef alone is over one billion dollars per annum.

Exploitation of Resources

105. Although intended primarily to support safety of navigation, the extensive data-bases amassed over the years by the Hydrographic Service, together with its various products and services, are of considerable economic value in assisting the management and exploitation of marine natural resources.

Safety of Life and Property

106. The national and international legislation supported by the national charting Programme is principally intended to protect lite and property at sea. Life is very valuable in an economic sense and the report relates this to the activities of the Hydrographic Service.

Total Economic Benefits from the Programme

107. The report concludes that it may never be possible to calculate the full benefits that flow from the National Hydrographic Programme to the national economy but that such benefits far outweigh the costs.

The Issue of a Public Good

108. The report also examines the question of cost recovery for the Hydrographic Service. The nature of 'public goods', in the strict economic sense, is examined and the report concludes that the programme is a classic example of a public good which by definition will not be supplied at optimal levels by market forces alone. The issue of cost recovery for the Programme is examined and concludes that some form of taxation of users is not inappropriate.

Conclusion

109. The report concludes that the work of the RAN Hydrographic Programme provides significant economic benefits to Australia and that it is good value for money. Nevertheless it suggests that the issue of cost recovery is worthy of further examination.

CHAPTER 2

THE BACKGROUND

201. The Royal Australian Navy (RAN) was appointed as the charting authority for hydrographic surveys in Australian waters and its spheres of influence in the Pacific by a Cabinet Decision in 1946. That responsibility has continued to this day.

202. The Chief of Naval Staff (CNS), as professional head of the RAN, is thus the National Hydrographic Authority. This authority includes responsibility for meeting the hydrographic needs of commerce and industry as well as Defence requirements.

203. This current study stems in part from a Programme Evaluation undertaken by The Inspector-General's Division of the Department of Defence in 1990. That evaluation stated, in paragraph 308, that only 50 per cent of Australia's continental shelf was adequately charted, the rest being of nineteenth century origin. This is shown in figure 1, Standard of Surveys of Austrâlian Waters. What is of greater importance is the degree to which major shipping lanes have been surveyed. Figure 2 shows the situation in 1992. The area of these existing lanes still to be surveyed by modern methods is 100 000 square nautical miles, about twenty years' work for a single ship.

204. That Programme evaluation was, however, only able ta make superficial comment on the economic benefits that stemmed from the work done by the hydrographic Programme. This current paper seeks to overcome that shortcoming.

205. The output of the Hydrographer can be classified under three broad headings:

206. Hydrographic charts are designed, and primarily used, for navigation. An element of this service is the weekly update of navigational information in the form of *Notices te Mariners* which notify navigators of such things as changes to navigational lights and newly found hazards. The annual consolidation of these warnings is 5 cm thick.

207. The Bathymetric Mapping Programme is primarily designed to map Australia's continental shelf for resource development purposes. This Programme is now virtually complete.

208. Oceanographic charts. These show both currents and water temperatures and • are updated frequently. They are primarily compiled for anti-submarine warfare measures but are increasingly used for activities as diverse as tuna and drop-line fishing, and monitoring Sydney's sewage outfall. This publication is usually referred to as *The East Australian Current* chart.

209. The data from which these outputs are compiled is also available on request for other applications.

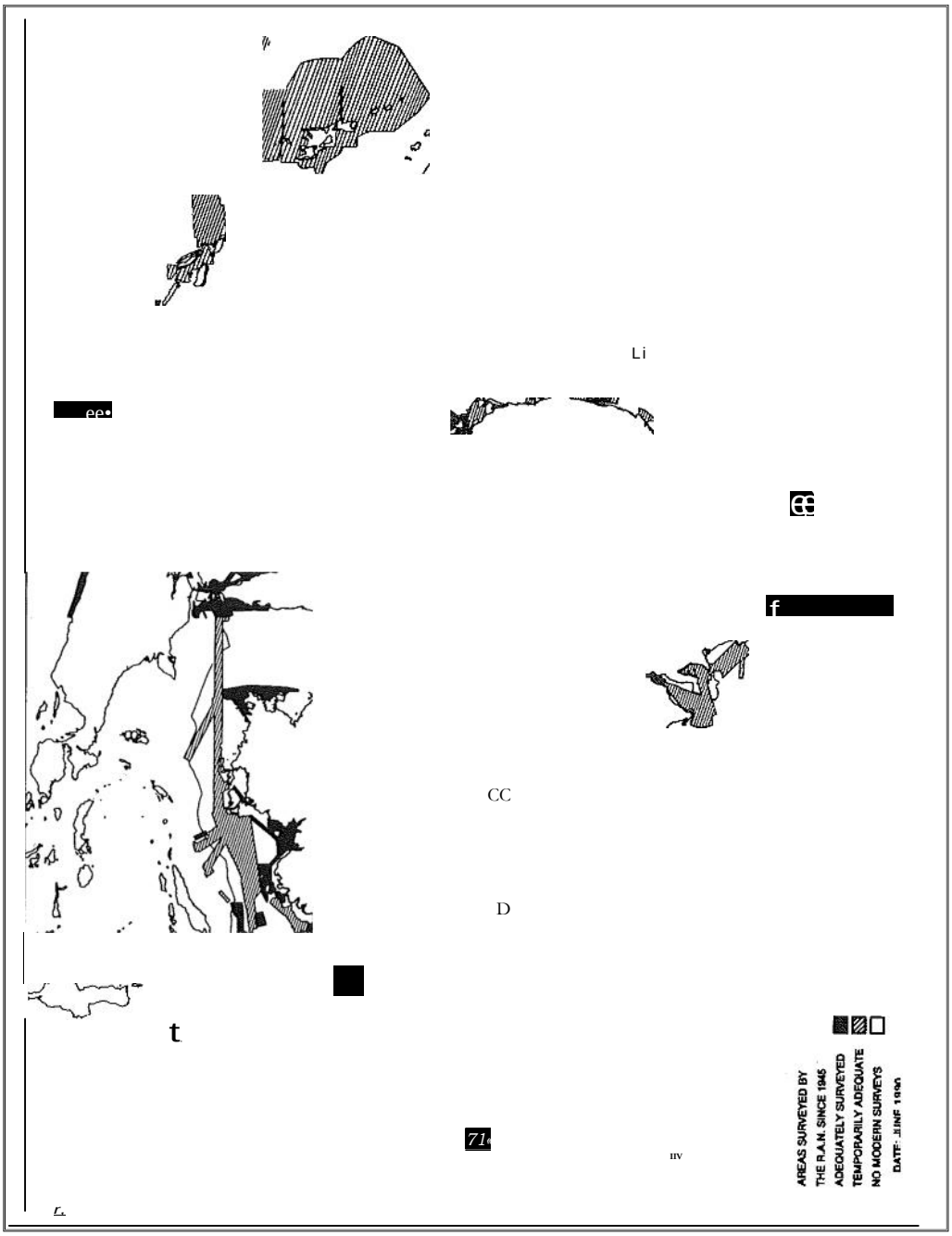

FIGURE 1

Standard of Surveys of Australian Waters

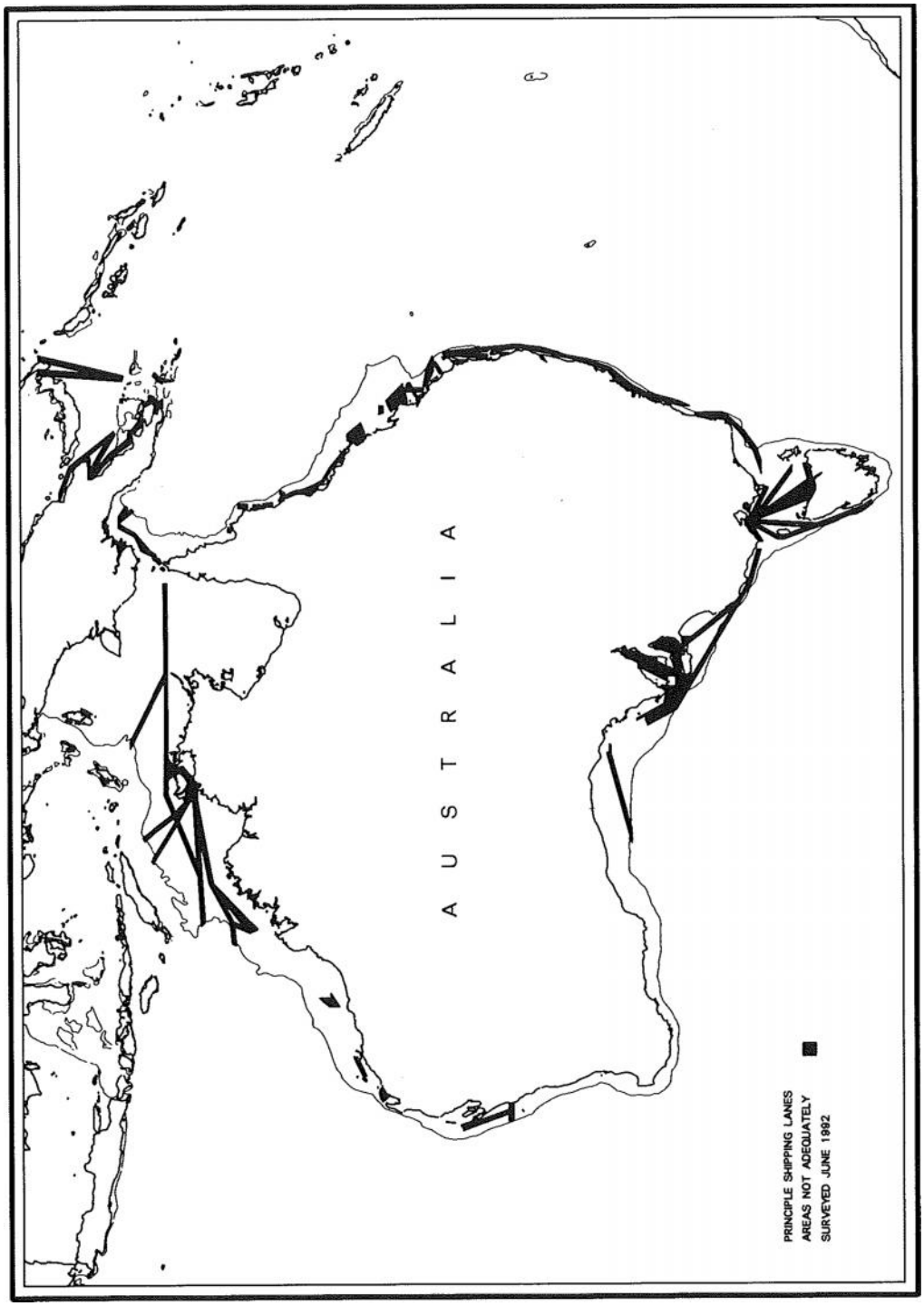

FIGURE 2
Standard of Surveys of Major Shipping Lanes

FIGURE 3

Standard of Surveys of Key Routeways Antarctica

CHAPTER 3

THE ISSUE OF PUBLIC GOODS

301. One of the central difficulties in analysing the work done by the Australian Hydrographic Programme is that it exhibits the characteristics of a public good.

302. The *Dictionary of Economics and Business,* second edition, edited by S.E. Siegler BSC. defines a public good as:

> A good or service that cannot be priced accurately and hence cannot be efficiently supplied by private industry. It has three characteristics, nonrivalness in consumption, nonexcludability, impossibility of rejection. Nonrivalness in consumption of a good means that a good being supplied to one individual can be supplied to others at no extra cost, for example a radio station will flot expend more power in transmitting to 5 000 000 than when transmitting to 1 000 000 people (if they live in the same geographical area). Nonexcludability means that an individual cannot be deprived of a public good even though he may refuse to pay for it, for example ail the citizens of a country are protected by anti-rabies measures even if many refuse to pay for them. Impossibility of rejection means that an individual cannot abstain from consumption of a public good even though he may wish to, for example a pacifist is protected by nuclear weapons in spite of his moral objections to them.
>
> Consequently, normal market forces cannot provide the optimal amount [emphasis added] since an individual will not need to reveal how much he would pay to consume the good, as he feels it will be provided anyway. If everyone adopts this attitude the good will not be produced although it is to everyone's interest that it should be produced. See externalities.

303. This gives rise to what is known as the 'free rider' situation whereby a consumer or potential consumer knows that a good will be provided without him paying; therefore there is no reason for any payment from him.

304. A further characteristic easily missed in this definition is that consumption of a public good by one consumer does not diminish the amount available for other consumers. For example the fact that a ship is guided by a lighthouse in no way diminishes the usefulness of this navigational aid to others. Thus it is important to distinguish between a public good and a good or service which happens to be in the public domain. For example if a commuter takes a seat on a public bus, that seat is not available to other commuters at that time. Thus, although the service may well be supplied by the public sector, that does not necessarily make it a 'public good' in the sense that the term is used by economists.

305. An example which illustrates the public good nature of pure research is that of the Oceanographic Charts. These are charts of changes in ocean currents and temperatures which are updated on a regular basis. They are gathered for the waters off south-east Australia primarily in connection with anti-submarine measures. They are useful to certain types of fishing, particularly for tuna. However, tuna fishermen in the Eden area do not all receive their own copies of this information, cheap though the copies be. The fishermen simply go down to the Eden Fisheries Association and see the ones that are put on public display. A similar situation occurs in the Middle Harbour Yacht Club where the same information is publicly displayed for the use of off-shore yacht races.

306. To further drive home this point, within the Torres Straits there is the possibility of a passage for bulk carriers through the Endeavour Strait. This would be a more direct and deeper passage than the Prince of Wales Channel which is currently used. At present it is considered that the standard of survey is not sufficiently reliable to take bulk carriers through the Endeavour Straits. In fact it is not certain that a navigable channel exists without dredging. A major potential user of such a passage would be Queensland Alumina (QAL) which ships ore from Weipa to Gladstone. If QAL were to survey a passage through these waters it would not be able to retain property rights over it. It would soon become apparent that bulk carriers were using the strait. Even if QAL managed to keep all copies of its charts secret other enterprises could make use of the passage, if need be by simply following a QAL ship through the straits.

307. In economic parlance it is very difficult to retain proprietary rights to information once it is in the public demain. This is particularly true in the case of charts; where there are international agreements charts will be supplied to other governments or charting agencies on a quid pro quo basis. These agreements would be extremely ditficult or impossible to modify or cancel. The US Government has an unequivocal policy that information such as maps should not be restricted, therefore a marked increase in Australian prices could see buyers buying charts offshore. This already appears to be happening in the case of the Electronic Chart. An issue which is examined later.

308. This public good aspect of hydrographic services appears to be recognised worldwide. Whilst a study of overseas practices shows about every possible permutation between Navy doing the surveying and the use of private contractors, everywhere the responsibility for general hydrographic services is seen as that of the central government.

309. Nowhere is full cost recovery achieved from the sale of charts.

310. Another point which may become more important in the future is that information gathered by Port Authorities is currently passed on to the Hydrographer free of charge. If a more 'user pays policy' were to be implemented by the Hydrographic Programme it is likely that bodies undertaking localised charting would also expect to be paid for their information by that programme.

311. It is also worthwhile to touch on the issue of externalities which have relevance to the work of the Hydrographic Programme.

312. In economic parlance an externality is a cost or benefit which does not appear in the supply or demand curves. Whilst this may be succinct it has little meaning to a layman. Basically an externality is a cost or benefit which does not accrue to the person or institution carrying out the action. For example if I am in the habit of planting trees in my garden this may well give pleasure to my neighbours to see a leafy street, but they have not had to pay any money or expend any resources to achieve this benefit. Likewise, if I am in the habit of dismantling old cars on the front lawn it may be a profitable business for me, but may result in negative externalities to my neighbours who see the area littered with rubbish and who may experience a decline in their property values.

313. This aspect has particular relevance when considering the issue of shipwrecks, especially those involving oil or chemicals.

314. It is not the purpose of this paper to enter into the debate on whether hydrographic studies should be done by uniformed personnel or civilians. The Wrigley report stated that 30 to 50 per cent of costs could be saved by civilianising both the hydrographic and oceanographic Programmes; the Programme Evaluation done by the Inspector-General's Division stated that it should remain a joint Navy civilian operation. As neither report supplied any concrete data to support its conclusion it would, in any case, be difficult to comment.

CHAPTER 4

STATUTORY OBLIGATIONS OF THE HYDROGRAPHER

All ships shall carry adequate and up-to-date charts, sailing directions, list of lights, notices to mariners, tide tables and all other nautical publications necessary for the intended voyage.

(Safety of Life at Sea Convention (SOLAS), Regulation 20, Chapter 5)

401. Hydrographic activity in Australia is performed under similar guidance andoperational constraints as exist in other maritime states around the world. There is a single national focus for the provision of navigational information. The prime bases for operation are the Cabinet decision of 1946, the requirements of international law, and arrangements put into place primarily through the International Hydrographic Organisation (IHO).

402. Hydrography is involved in a process of significant technological changebrought about by improvements in methods for survey and considerable increase in value in the method of delivery through such mediums as the electronic chart and its integration with electronic navigational aids. This does not affect the central responsibility for gathering and dissemination of accurate information of the areas of Australia's responsibility.

403. That satellite navigational equipment is now much more available is, to somedegree, a two-edged sword. Traditional navigational methods encouraged navigators to be conservative in their positioning estimates. With satellite navigation units available for only $2500 (including sales tax) which give an accuracy of plus or minus 200 metres, navigators are becoming much less cautious about their position. The need to ensure that published charts are free of anomalies is therefore greater than it used to be.

404. In some circumstances charts may be so suspect that it is not possible to usesatnav equipment. In 1985 a consultants' report, financed by the Asian Development Bank, stated in part:

Both international and major coastal vessels place a high reliance on radar for navigation during coastal voyages. Satellite navigation systems are not generally used due to the inaccuracy of existing charts (emphasis added).

(Posford et al., 1985)

405. In short there is not a great deal of use in knowing exactly where you are if you are not exactly sure where everything else is.

CHAPTER 5

THE BATHYMETRIC MAPPING PROGRAMME

501. The Bathymetric Mapping Programme was established within the Division of National Mapping in 1970 to provide bathymetric maps for mineral exploration. A bathymetric map is essentially a contour map of the ocean floor. The programme involves the surveying of the continental shelf from the 20 m to the 300 m isobath and mapping at 1:250 000 base topographic map series. A total of 287 map sheets are required to cover the area of the continental shelf.

502. In 1989 the Bureau of Mineral Resources (BMR) commenced a series of bathymetric maps which describe the Australian Exclusive Economic Zone. These maps contain much data provided by the Hydrographer or the International Hydrographic Organisation.

503. Such maps have a different purpose to hydrographic charts. Charts aredesigned to facilitate safe and cost-effective navigation. Bathymetric maps are designed as a research tool and have been used for preliminary reconnaissance for the location of new fishing grounds, oil industry platform sites, pipelines, ports and environmental studies. For platforms, pipelines and similar constructions, once the general area has been selected detailed work is done from a hydrographic chart supplemented by additional information supplied by the Hydrographer and specific project surveys. Data gained by the Bathymetric Programme has been incorporated in a number of charts, primarily the 1:300 000 scale charts of northern Australia.

504. In 1988, following the government consideration of the Richardson Report theDivision of National Mapping was disbanded and the bathymetric function was transferred to the Hydrographic Service RAN. The assets of the Bathymetric programme have now been redirected to support hydrographic activities.

CHAPTER 6

ECONOMIC USES OF THE HYDROGRAPHIC PROGRAMME

601. The economic uses and hence benefits of the Hydrographic Programme can be categorised under the following headings:

a. Safe passage of cargo and passenger vessels

b. Commercial fishing including policing of fishing zones

c. Recreational fishing and sailing including power boats

d. Mineral exploration

e. Pollution — Prevention of environmental damage from shipwreck (primarily oil, including bunker fuel, and chemicals) and minimisation of environmental damage should it occur (knowledge of tides, etc allowing effort to be concentrated in key areas)

f. Safety of life at sea. (both by preventing or minimising accidents and facilitating search and rescue action should it be necessary)

g. Establishing and policing Australia's Exclusive Economic Zone, especially in the context of remoter areas such as Cocos Keeling Islands and Ashmore Reef

h. Asserting Australia's claims to areas of Antarctica

i. Scientific research

j. Complying with Australia's international obligations

602. It is obvious that these categories are interlinked and are not mutually exclusive.

CHAPTER 7

THE ISSUE OF THE COUNTERFACTUAL QUESTION

701. A central aspect of this study is that of the counterfactual question. That is to say, what would be the situation in the absence of the hydrographic survey. The charting of Australian waters has been an ongoing and incremental process since before European settlement. This is unlike, for example, an earth-sensing satellite which is a sudden jump in available technology so that the new service 'of today' can be compared with that of 'yesterday'. Such a study was done for the US National Environmental Satellite Service in 1978 (Hussey et al., 1978).

702. The Queensland Coast and Torres Strait Pilots Service (QCTPS) has stated that accurate hydrographic charts are essential for navigation on the Barrier Reef; shipping services as we know them would be impossible without such charts. However, QCTPS stated that if charting stopped tomorrow they would continue with existing charts which would progressively become out of date. Implicit in this situation is that there would be no marked increase in the size of ships using existing routeways.

703. This is a critical problem with this study. When assessing the benefit of, for example, upgrading a major highway the task is much easier (though not to say simple, see Mohring, 1963). It is possible to estimate the cost of fuel saved because traffic is not forever having to accelerate and decelerate, the saving of time and other immediate benefits can be calculated. It would then be possible to undertake an economic modelling exercise to analyse how these changes would flow onto the rest of the economy. However, to analyse the economic benefits of the road signs would be a far more difficult task.

704. It is important to note that in the case of maritime routeways the discovery and 'signposting' is in fact the routeway. This signposting will include accurate charts and other navigational aids.

705. The scenario of all charts disappearing, and the information that is contained in them, is obviously one of science fantasy. If it were to come about then individual entities would undertake limited charting for their own benefit. For example mineral companies operating out of major export ports would undertake charting of areas of particular interest to them. However, such charting would involve gaps, possible overlaps and have problems with consistency between charts made by different enterprises. In this context it is worth noting that internationally there are at least a dozen spheroids (representation of the world's surface) in regular use. Another problem that would undoubtedly arise would be inconsistent tidal datum used by different surveys. This would require a navigator to make constant adjustments in difficult passages to correct for different depths on different areas of what would now be a compound chart. Furthermore, to return to the issue of a public good the company doing the charting would not be able to enforce property rights on what may well be an international waterway. This is a different situation from, for example, mineral exploration where a company could obtain a lease over the area that it is surveying.

706. There is an example of naval black humour in the saying that every ship has the ability to be a mine sweeper once. The same is true that every ship has the ability to be a crude, hydrographic ship once. Having been a hydrographic ship it can then spend the rest of its career as a hazard marker. However, with the wide fitting of

increasingly sophisticated sonar equipment cargo ships do have a limited hydrographic capability and, in fact, it is desired practice for ships to report navigational hazards to the Hydrographer when they are encountered.

707. In short the zero option, that is no charts, is not a realistic one from which to start. However, there can be no doubt that the standard of marine mapping would be much lower in the absence of a centralised hydrographic service.

708. The above notwithstanding, a study is currently being completed for the Canadian Hydrographic Service which has used this scenario in order to calculate a cost-benefit ratio for the work done by that organisation (Brinkman and Calverley 1992). The consultancy team then conducted a long series of interviews with users of the Canadian charts to ask them how much they would be affected if the charts had never existed. Issues relating to such an approach are discussed in Appendix 2 to this paper. That study arrived at a figure of a benefit-cost ratio of between 9:1 and 12:1. While this gives a nice solid figure which would gladden any hydrographer's heart it does not, in itself, justify continued expenditure from general revenue. All it does show, if the figures and methodology can be taken as correct, is that past expenditure has achieved a good return. It does not in any way analyse the marginal benefit from an ongoing hydrographic programme. That may have been better assessed by using a method used by Hoodgsteden (1990) for an Australian topographical agency in which users were asked how much maps declined in usefulness as they became older, that is potentially out of date.

709. In the Australian case, where many areas of charts are still incomplete, the issue is more complicated. Efforts were made during this study to make a quantitative assessment of the value of individual years' programmes but problems immediately arose depending on which year was chosen. For example a major effort was put into charting an area to the south-east of Cape York to see if a passage existed to enable heavy shipping direct access to the outer passage around the Great Barrier Reef. No passage was found for the simple reason that none exists in that specific area. This is a characteristic of all pure research, often resources will be committed to what is later found to be a dead end. One of the more immediate tasks to which the Laser Airborne Depth Sounder will be put to is to carry out initial surveys in such waters to see if more detailed work is justified.

710. Perhaps the last word on this topic should go to Sir D. Serpell *(Report of the Ordnance Survey Review Committee,* HMSO, London, 1979):

> If the (national geodetic and topographic) archive were not provided, many of those requiring ... information would no doubt make alternative provision of a sort, but the nation would lose the benefits of continuity, of national standards, and of a common referencing system, and duplication of effort would lead to wasteful incompatibility.

711. Occasionally, however, we can find a case where it is possible to examine with some precision the benefits of a given charting operation. Such a case is the Hydrographer's Passage.

CHAPTER 8

THE HYDROGRAPHER'S PASSAGE

801. The original purpose for searching for what is now known as the Hydrographer's Passage was to find a route through the Barrier Reef to the Coral Sea for RAN patrol boats. Once it was discovered and charted it was apparent that it provided a passage for large ships, particularly coal ships out of Hay Point. Prior to the discovery, proving and charting of this passage, heavy shipping had to move north inside the reef or make the passage to the south until there was a clear route to the east. Thus, in this particular case, the more direct route could be viewed as a by-product of research intended to improve 'free movement of the fleet'.

802. In 1982 the Bureau of Transport Economics (BTE) undertook a cost-benefit study of providing navigational aids in the Hydrographer's Passage. By this time the passage had been proven by surveys conducted by the Hydrographic Service and it was now necessary to see if it was worth marking with navigational aids.

803. That study came to the conclusion that there was a cost-benefit ratio of 2:7 from marking the passage in terms of fuel savings alone, that is the cost of fuel saved by ships using this passage would be nearly three times the cost of marking it. The BTE study also calculated that the discounted present value of the passage was $91.7 million to the Australian coal industry. This was in 1982 dollars. This equates to $177 million dollars in 1990-91 terms. This is not an annual figure but the present value of future savings. The reason that the BTE took this 'lump sum' approach was because their task was to match a future flow of savings against the initial cost of putting in the navigational aids and the future cost of maintaining those aids. The presentation of the BTE paper does not lend itself to a recalculation to give annual net savings from the passage. The study took into account that traffic bound for the northern Pacific would be the major user and it assumed that not much shipping from Abbot Point would use the passage.

804. That study only 'analysed the reduction in shipping costs to the coal exports and did not attempt an analysis of the benefit to other traffic. Surprisingly it did not include the reduction of inventory cost in its calculations. (Inventory cost is the interest in having money tied up in cargo when it is in passage. With coal at $50 a tonne this could be substantial.)

805. This was not a shortcoming of the report at the time. Once it was apparent that the benefits of opening up the passage with navigational aids far outweighed the costs, it was not necessary to look any further and analyse the benefits to other types of trade.

806. Preliminary surveys indicate the possibility of other such channels further north in the region of Abbot Point. These could be proven when potential trade justifies such activity and when resources are available.

807. A considerably more complex study has been done for PNG waters which calculated an internal rate of return of 7.75 per cent for an improvement in navigational aids (Posford et al., 1985). This is in what is still a Developing Economy with low wage rates. An element in that calculation was the value of time savings to passengers calculated from an average wage rate. In a higher wage economy this would have been higher; navigational aids, however, have to be purchased at world prices and thus the savings from improved navigational aids would undoubtedly be more in higher income economies.

CHAPTER 9

THE ISSUE OF A FLOW-ON FROM A REDUCTION IN COSTS

901. It is sometimes difficult for a layman to understand the flow-on effects that can and are generated by a reduction in costs. For example in 1989 the Industry Commission (IC) calculated that a reduction in the costs of international sea freight charges equivalent to 0.25 per cent of FOB export prices and CIF import prices, that is $160 million, would be worth an overall gain to the Australian economy of $1070 million dollars per annum once resource reallocation had taken place. This was in 1986-87 dollars, that is $1.4 billion in 1990-91 values. The IC study was in the context of waterfront reform (IC, February 1989).

902. In very rough terms the flow-on effect was nearly seven times the initial saving. This is an annual saving and not a one-off event.

903. The reason for this difference between immediate savings and full economic benefit is fairly simple and can be roughly explained by the following example:

Let us assume that some, as yet undreamt of, breakthrough in technology removes all transport costs to or from Australia. The immediate saving will be the transport cost of the import bill. The benefit of the cost of the transport of exports may also accrue to the Australian economy if producers choose to raise their prices to what the overseas buyer was paying before transport became free. Alternatively they may not choose to raise their prices by the full amount and thus increase sales as the goods will be cheaper to the buyer who now faces lower prices due to the disappearance of transport costs. This would make Australian exports more competitive.

However, the effects of such a change in technology would be considerably more complex. Australia will now to a much greater extent be able to specialise in industries that it is good at and import goods that are less economic to produce here, at a cheaper price than before. This will allow the economy to function more efficiently. The effect on individual industries will also vary. The prediction of such effects, not only the fanciful one above but more realistic ones, is the realm of the economic modeller. The most successful 'model' for this type of exercise is the ORANI model developed largely by the Industry Commission in the 1970s and 1980s.

904. The critical issue is that a small saving in transport cost can have muchgreater ramifications for the economy as a whole, as can an increase in costs, possibly brought about by poor quality charting. One study (Mort 1980) indicated that a typical tanker cost $130 million dollars and had to earn $3600 an hour or almost $59 dollars a minute (inflated to 1990-91 dollars).

CHAPTER 10

FREEDOM OF MOVEMENT OF THE FLEET

1001. This is normally given as the primary purpose of the Naval Hydrography Programme, any other advantages sometimes almost being treated as a by-product. Whilst this may have been the original stated purpose it is flot perhaps supported by a study of the charting programme as it has existed in the post-World War II period.

1002. In times of peace it is very difficult to put an economic value on defence in total, let alone a subset; but when the activity of the hydrographic programme is being analysed this is flot perhaps an issue. To quote from the Inspector-General's report *(Programme Evaluation of the Hydrographic Service,* RAN, 1990):

> 454. To date there has been no apparent conflict between the national and Defence work undertaken by the Hydrographer. However, general perceptions in the commercial sector see the Hydrographer's national responsibility as secondary to his Defence role, although, historically this has not been the case. For example, during the mid-1960's major surveys were undertaken by the Hydrographer te open up channels to ports associated with the mining industry in the area of Weipa, Groote Eylandt and the Pilbara Region. Hence when there has been a national, and in this case commercial, requirement the Hydrographer has responded. The low priority of Defence requirements at this time has also enabled the Hydrographer te react accordingly. There has been no test case to date about how the Hydrographer would prioritise his activities if conflict arose between national and Defence needs.

1003. This statement is born out by a map of Australian waters which plots the areas that are considered to be adequately charted using modern techniques. With the exception of areas in the south-west — which were done partly in connection with the increased home-porting of the Fleet in the west, and three geometric patterns off the east coast which were a by-product of submarine detection tests — the areas of intense mapping are heavily biased towards key aspects of trade routes.

CHAPTER 11

SAFE PASSAGE OF CARGO AND PASSENGER VESSELS

Ships are extraordinarily expensive. Even a moderate size tanker costs about $60 million and has to earn about $40 000 a day during its life. This works out at about $1667 an hour or almost $28 a minute.

Should this earning rate not be achieved, freight rates must rise causing most other costs to rise, so even from this point of view it is in everybody's interest that these ships are flot hampered.

(Mort, 1980)

1101. As has been stated, some form of charting is essential for ail navigation. This can range from a mental picture built up from local knowledge to electronic mapping interconnected to sophisticated navigational equipment.

1102. The importance of accurate hydrographic data varies with the particular situation. Some of the charting of waters off South Australia goes back to Flinders' surveys of 1803. Whilst this is far from satisfactory, sometimes it is not too critical. For commercial navigation of freight it is seldom important if there is sixty metres of water under the keel rather than sixty-three. This is especially true when the area is not heavily trafficked. That is not invariably the case, however, as was shown when the MV SANKO HARVEST hit a reef off Esperance, in waters marked as poorly charted — an example of every vessel having the capability to be a hydrographic vessel once. (It has to be said, however, that the particular reef that was actually hit had in fact been accurately charted but the vessel's charts were not up-to-date.)

1103. Likewise the west coast of Tasmania is not well charted, not because the waters are benign — far from it — but because there is, at present, little commercial traffic.

1104. In some cases the depth of a channel can be of critical economic importance, not only to know whether the channel is navigable but to know **exactly** how deep the vessel can be laden. In critical channels, such as the Torres Strait one metre of water can be worth millions of dollars.

1105. To give a couple of illustrations:

At present the only navigable passage for large vessels through the Torres Straits is the Prince of Wales Channel — a channel which has a restrictive depth, is narrow and subject to tidal streams. Vessels transiting this channel are presently allowed a maximum draft of 12.2 metres. This draft restriction prevents optimal use of the inner route of the Great Barrier Reef and. as a consequence, places a direct cost on Australian exports. More specifically, it imposes an additional cost on the supply of Weipa bauxite to Queensland Alumina's refinery in Gladstone. The four purpose-built vessels used in this trade have the capacity to load much deeper but are restrained by this restriction. These vessels could lift an additional 10 per cent (about 900 000 tons per annum) for the same number of voyages were it not for this restriction. A possible solution to this problem lies in the much wider Endeavour Strait which is largely clear water deeper than the Prince of Wales channel but at this

stage appears barred by sandbanks along its western entrance. It is obvious that shipping costs through the Torres Strait would be significantly reduced if such a route could be found by more detailed survey and/or dredged.

When the channel into Dampier was being charted the depth was ascertained as 40 feet. When one of the large bulk carriers was using the port it recorded a bump of one foot on the bottom of the channel. A dredger was brought in to clear the channel and the obstruction turned out to be a large tyre from construction equipment. In the meantime the ore ships had to load lighter to maintain a minimum clearance of the bottom. It is estimated that this temporary loss of load-carrying capacity cost the company $2 million (in 1960's dollars).

1106. These are a number of specific examples which would undoubtedly be mirrored in other cases around Australia. The sum of all these cases may be difficult to calculate with any accuracy but it is worth remembering the study done by the Industry Commission which is examined in more detail in Chapter 9. This showed the marked flow-on effects which can stem from a change in shipping costs.

CHAPTER 12

COMMERCIAL FISHING

Our once thriving tuna industry has been consciously destroyed. It is so frightening, frustrating and demoralising to watch your fishery and business collapse, and be helpless to take corrective measures. Whilst we all require management and are prepared to pay for it, we want productive, positive management that benefits all.

Mrs Anna Stehr of the Stehr Group testifying before the Industry Commission Inquiry 'Cost Recovery for Managing Fisheries'

1201. The Industry Commission has just finished a report on the Australian Fishing Industry. This put the value of the Australian catch at $800 million down from a peak of just under $1065 million in 1987-1988 (in 1990-91 dollars).

1202. This illustrates a number of points: the size of the Australian catch, the need for management of fisheries and the need for official charts for proper management, policing and prosecutions should they be necessary.

1203. This last point is also valid in connection with international infringements of Australian fisheries. International poachers are not sunk on sight and it is necessary to prosecute in a court of law in which the onus of proof is on the prosecution and in which the accused is entitled to mount a legal defence. In the absence of accurate official charts such prosecutions could be exceedingly difficult.

1204. To give just a couple of examples of the money that can be involved: in 1990 two Japanese long-line tuna boats were found to have been under-reporting their blue fin tuna catch (which is subject to quota). The first by half and the second by 30 per cent. The master of the first was banned from fishing in Australian waters for two years, and ordered to pay costs of $4635. The second boat and its catch and equipment were forfeited to the Commonwealth and its owner and skipper fined $10 000 each. In the first case the catch was valued at $3.5 million and in the second $6.3 million.

1205. Again in April 1991 a Japanese tuna long-line boat was caught fishing without a licence. The boat, catch and' fishing gear were forfeited and the fishing master and captain fined $2000 and $1000 respectively.

1206. The issue of policing and managing fisheries is of course in addition to the provision of up-to-date charts for the purpose of safe navigation of fishing craft. The usefulness of such charts will vary considerably between different circumstances. Inshore short-range craft may use them only during periods of unexpected bad weather; for others such as the Tasmanian Orange Roughy fishery accurate navigation is essential. Here a few metres are the difference between an empty net and losing it completely at a loss of some fifty thousand dollars. Currently the annual catch for this species is $50 million but the Industry Commission has pointed out that this is not sustainable in the long term.

1207. In addition to navigational charts and the bathymetric survey the Hydrographer is also responsible for the compilation and promulgation of oceanographic charts. These plot ocean temperatures and currents. Their primary purpose is in connection

with anti-submarine warfare measures but they are now used extensively by the fishing industry, primarily the tuna and dropline fishermen — the latter being concentrated on blue eye, harpooka and ling.

1208. In one case cited in a US study (Hussey et al., 1978) a third of the salmon catch was put down to up-to-date information on water temperature.

CHAPTER **13**

PREVENTION OF ENVIRONMENTAL DAMAGE

Small wonder that Australian marine authorities are nervous. Since March 1987, they have been watching, waiting to mobilise their comparatively minor resources in the event of the unthinkable — a major oil spill on the Great Barrier Reef.

(Wright, 1989)

The limited quantity and capability of response equipment combined with the geography of the Great Barrier Reef pose some almost insurmountable difficulties for oil spill response in this part of the world. Should a large oil spill occur in the Swains Reef or off remote areas of Cape York there would be almost nothing that response authorities could do.

(Raaymaker, 1991)

1301. It is obvious that accurate navigation is essential in preventing environmental damage from shipwreck but beyond that it gets more complex.

1302. There are a number of difficult issues in analysing the damage of pollution from a shipwreck or an oil spill from a terminal. This is obviously the cost of the clean-up plus the difference between the value of the resource before the incident and the value atter. In the event of the environment eventually repairing itself then the cost is the loss of value over the period of regeneration.

1303. The other aspect is the risk of such an event taking place. Oil spills have been characterised as 'very low probability estimates for high consequence events'.

1304. Nevertheless a Government study (BTCE, August 1991) concluded that the probability of one or more major oil spills (over 1370 tonnes) occurring in Australian waters, from tankers, could be as much as 48 per cent in the next five years and 93 per cent in the next twenty years.

1305. The report went on to say that for platforms and pipelines, based on US data and assuming the same determinants apply to the present Australian situation, the probability of one or more major oil spills (greater than 1000 tonnes) occurring could be as much as 39 per cent in the next five years and 83 per cent in the next twenty years. It also pointed out that shipping accident rates per unit of shipping traffic are highest on the inner route of the Great Barrier Reef where there is strong evidence for the effectiveness of pilots to prevent groundings.

1306. Another aspect of the minimisation of environmental pollution which is easily overlooked is the that of the monitoring of sewage out-fall. The Environmental Management Unit of the Sydney Water Board is a regular recipient of the East Australian Current data and is one of the few organisations that can put a value on it (or more precisely, the cost of reproducing it from other sources were it to become unavailable.) Mr Peter Tate considered that much of the information could be created from data from the NOAA (National Oceanographic and Atmospheric Administration) satellite but that would cost about $15 000 a year in labour costs.

1307. This information is also being used by a separate programme to monitor methane levels, and hence possible pollution levels from sewage discharge.

1308. The *Oceanographic Charts* are the only publications that are supplied directly to the users. A 'telephone dipstick' of the address list indicates an almost bewildering list of uses ranging from pure research to the more direct benefits mentioned above.

The Issue of Pollution

1309. A critical issue when assessing navigation is the economic effects of pollution. This is one of the more nebulous areas of economics due largely to the public good nature of a clean or pleasing environment. There have been a number of ways developed to try and put monetary values on such things as national parks but none of them are above criticism.

1310. One method is sometimes referred to as the travel cost method. This involves calculating the cost that people pay to visit an area of scenic beauty such as a national park or coastal area. If they are acting rationally they would not pay more for that than the value that they get from visiting the area in question. Thus travel and accommodation costs for the entire population of visitors would be the minimum value that should be put on the asset. As many visitors would be prepared to pay more if it were necessary to do so, the total value will normally be more. In economic parlance the visitors experience a consumer surplus.

1311. Another method is to assess what is known as the 'contingent value' of an asset. This can be described as the pleasure that people get from knowing that an asset exists whether or not they intend to make use of it. Thus people get satisfaction from knowing that there are live gorillas in Ruanda even if they have no intention of ever visiting Ruanda to see them. Likewise, sectors of the population support the international ban on whaling even though they have never seen a whale and do not expect ever to do so.

1312. The central problem is to assess what the total value of individual contingent values is. The normal method of trying to assess the contingency value of an asset is by surveying a sample of the community. This is normally along the lines of 'what would you be prepared to pay to ...'. The criticism of this technique is that respondents usually know full well that they will not in fact be required to pay the stated amount so if they have an interest in the asset in question they may exaggerate their value for it. Nevertheless recent work by J. Walter Milan 1989 among others, indicates that, when properly used, the technique is far more accurate than its critics suggest.

1313. In his experiment Milan surveyed a random selection of boat owners taken from a list of boat licensees. Three surveys were conducted among different samples. Two groups were asked what extra tax on boat fuel they would be prepared to pay to finance the construction of an artificial reef off the coast (presumably to be used for fishing). The third group was told that a tax on outboard fuel was going to be imposed to finance the reef but only if the majority of boat owners voted for it. In the end analysis there was very little difference between the responses of the group which was asked the hypothetical question 'what would you be prepared to pay' and those who believed they were faced with the genuine possibility of actually having to pay the stated amount.

1314. 'Contingency valuation' is considered to be sufficiently credible to be incorporated into US legislation, the Comprehensive Environmental Response Compensation and Liability Act (CERCLA). In 1989 Chief Judge Wald upheld the validity of the contingency valuation aspects of the CERCLA legislation in a case heard on the District of Columbia Circuit.

1315. There was a great deal of investigation on the determination of the economic value of environmental damage in connection with the Exon Valdez. Unfortunately the case was settled out of court and extensive work done by both the defence and prosecution cases will not, under the terms of the settlement, be published. The case was settled out of court for US $1 billion. The latest situation appears to be that the Alaskan Government has refused to accept the settlement and the matter may have to go back to the public arena. In addition it has been reported that E>c<on Corporation will spend almost $2 billion in the attempt to clean up the mess (Morkve and Mathisen, 1991).

1316. So the cost of an oil spill may well be US $3 billion.

The Value of National Assets, The Great Barrier Reef as an example.

1317. If we take the cold-blooded approach policy that the insurance premium should equate the value of the insured asset multiplied by the likelihood of its loss, it is necessary to know three factors: the risk and the value of the asset and what proportion of that value would be lost if the event in question occurs.

1318. So what is the value of, for example, the Barrier Reef?

1319. In 1987 a study by Marc Carter was presented at ANZAAS, James Cook University, Townsville. In this paper Carter calculated that the financial values accruing to the Reef-associated economy was $653.7 million p.a. and the consumer surplus was $144.2 million p.a. In 1990-91 dollars this sums to $1050 million. What Carter chose to term the consumer surplus was the travel costs that consumers paid to reach the Barrier Reef. That is not the usual use of that term but the inclusion of travel costs is a legitimate inclusion in such an estimate. In addition to these figures Carter gives a contingent valuation of $45.4 million p.a. for people who did not visit the reef; this equates to a further $60 million in 1990-91 dollars.

1320. Carter emphasises that these figures are conservative; for example they do not include the contingency value to people living overseas. This could be considerable as 27 per cent of visitors to the Reef are from overseas.

1321. *Thus as an example of a naturel asset the minimum value of the Great Barrier Reef alone is $1110 million p.a.*

1322. The BTCE Report (August 1991) states:

> Extrapolating from international tanker oil spill data and anticipated Australian exposure, the probability of one or more major oil spills (over 1370 tons) occurring in Australian waters, from tankers, could be as much as 48 per cent in the next five years and 93 per cent in the next 20 years.

1323. It should not be necessary to emphasise that the Barrier Reef is only one of Australian national assets that could be damaged by pollution. Less spectacular but more accessible areas, such as Sydney's beaches, would also have a high contingency value.

1324. What is very much an unknown variable in this analysis is the size and circumstance of an oil spill. To quote from correspondence from Mr Steve Raaymaker, Research and Monitoring Officer of the Great Barrier Marine Park Authority:

Given that coral reefs, mangroves and seagrasses have a range of values any oil spill that impacted on those resources would have economic impacts. The nature and extent of those impacts would depend on a number of variables such as the location of the spill, the amount and type of oil, the weather conditions, the geography of the area and the resource and ecosystems present in the area. It is possible for a spill of 500 tons of diesel to have greater economic impact than a spill of 5000 tons of heavy crude. For example the diesel may be spilt close to say a pearl farm or important mangrove fish nursery when the wind and currents are such that it drifts onto these sensitive sites, and the larger quantity of heavy crude may be spilt off-shore in open waters between coral reefs during neap tides when winds and currents are off-shore (a real-life example of this is the comparison of the SANKO HARVEST and KIRKI spills in WA, where the SANKO HARVEST spilt much less oil but caused far more impact).

1325. That paper also stated that:

Due to the nature of oil on water the practical limitations on the physical capabilities of oil spill response equipment such as booms and skimmers and the extreme logistical difficulties posed by vast distances and the remoteness of many parts of the Great Barrier Reef, any response to a significant oil spill on the GBR would have a negligible effect on preventing significant impact on GBR resources and ecosystems. This reality strongly emphasises the need for effort to be focussed on total prevention of oil spills rather than response, and of course accurate, up-to-date and comprehensive hydrographic charts play a vital role in prevention.

1326. It may be seen as self-serving to quote from such correspondence but it should be remembered that the National Plan to Combat Pollution of the Sea by Oil was set up as a response to the oil-slick that was caused in 1971 when the OCEANIC GRANDEUR struck an uncharted rock in the Torres Straits.

CHAPTER 14

ESTABLISHING AUSTRALIA'S EXCLUSIVE ECONOMIC ZONE

A very good example of the requirements for a field check of a feature occurred in Fiji waters. The Island of Ceva-I-Ra was first discovered and its position fixed by Captain H. M. Denham in HMS Herald in 1855. Captain Denham termed the feature of a reef Conway Reef, because it had all the characteristics of a reef, that is it became submerged at high water. Some 130 years later the survey vessel, HMS Hydra, redefined its geographical position using transit satellite navigational Geoceiver and a closer investigation by surveying vessels from the Fijian Hydrographic Unit revealed that the reef was supporting both animal and plant life above high water. Ceva-I-Ra Island is now a key base point for the boundary with a neighbouring state and it contributes an area of 20 per cent of the Fiji EEZ.

(Lamont 1991)

1401. The usuel baseline for maritime boundaries is the low water mark as shown on large-scale nautical charts. This can be difficult to ascertain for certain reefs and atolls when there is a lack of survey or chart information. The primary purpose of early charter was to mark hazards to navigation. Reefs may not be marked as drying or non-drying and thus it is not clear whether they form the basis for international boundaries. Precise location can also be important, and not just to avoid groundings.

1402. The United Nation's Convention on Law of the Sea 1982 recognises a nation's right to claim a 12-mile territorial sea, a 24-mile contiguous zone, a 200-mile exclusive economic zone and its continental shelf. Where the continental shelf extends more than 200 nautical miles from the territorial sea baseline it is to be delineated by straight lines not exceeding 60 nautical miles in length at points determined in relation to either the foot of the continental slope, sediment thickness or the 2500 - metre isobath.

1403. Australia's boundaries with her neighbours have not been completely settled under current conventions and there is still work to be done on the boundaries with New Zeeland and Indonesia. There is no EEZ agreement with Indonesia and there are areas where there is still no agreement on the seabed boundary. These include the area between Christmas Island and Java and an area south-west from the Ashmore Reef and Cartier Islet. There is an interim agreement concerning the Timor Gap. Australie and Indonesia do not agree on the emphasis that should be played by the Ashmore Reef and Cartier Islet and hydrography has a role to play in resolving this dispute.

CHAPTER 15

MINERAL EXPLORATION

1501. There are currently two types of offshore mineral extraction in Australia:

a. Hydrocarbons — oil and gas and

b. other minerals, primarily dredging for road aggregate.

1502. Of these two, oil and gas exploration is obviously of far greater economic importance.

1503. In order of detail the maps available for offshore exploration are the bathymetric survey maps, hydrographic charts, information prepared by the Continental Margins Project done by the BMR and specific survey work done by the exploration companies themselves.

1504. There are a few problems in assessing the value of exploration in this field. Since 1985 there has been a policy which allows the department responsible to allocate mineral lease to areas on an auction system. Basically they would be allocated to the highest bidder. If this were done widely then this figure could be used to calculate the value of the exploration or, more precisely, the value placed on the potential field by the highest bidder. However, contacts with the Department of Primary Industries and Energy indicate that some 90 per cent of leases are allocated on a competitive work value program. Under this system, which was heavily criticised by both Treasury and the Industry Commission in the late 1970s, leases are allocated to whichever company offers what is viewed as the 'best exploration and development program.

1505. Telephone contact with the Department of Primary Industries and Energy suggests that in 1986 there were three offshore titles sold by cash bidding and since then about two more, one in the Bonaparte Gulf at about $1 million and one later for about $4.6 million.

1506. However, under the 'competitive work program bids system' the companies are asked to put a dollar value on the proposed work program.

PETROLEUM EXPLORATION EXPENDITURE IN AUSTRALIA 1984-90 ($ MILLION)

YEAR	ONSHORE	OFFSHORE	TOTAL
1984	359	424	783
1985	432	783	820
1986	221	279	500
1987	244	161	405
1988	264	324	588
1989	165	404	569
1990	170	414	584
TOTAL	1855	2394	4249

Source: ABS. November 1991

1507. Figures supplied by the Department of Primary Industries and Energy indicate that this level of activity is likely to continue for the immediate future. It is normal for companies to submit their future development plan for three years. Such plans for both onshore and offshore exploration together amount to some $1.4 million for the next three years. This is consistent with figure for the last decade.

1508. The Hydrographic Programme is frequently asked to provide copies of survey sheets for evaluation by engineers for such tasks as the routing of pipelines.

1509. A recent study by Hugh Young and Associates indicates that world hydrographic activity is divided roughly evenly between government and commercial enterprises. This is because of the predominance of commercial operations in the oil and gas positioning market. As has been stated elsewhere in this paper this is because individual companies can appropriate the benefits of this knowledge and thus have the incentive to pay for the work to be done. This is not the case for general hydrographic work, once again for reasons explained elsewhere. To quote from a summary of the Young paper:

> Ocean survey grew out of the need for hydrographic charts for safe navigation and was primarily a government activity. As scientific need for oceanographic and biological data grew it was largely met by academic work, often with government support. Thus most Research and Fishery Research ships to-day are operated by non-commercial organisations. The comparatively recent advent of the offshore oil and gas industry gave rise to commercial survey companies in considerable numbers.

CHAPTER 16

RECREATIONAL FISHING AND BOATING

1601. Information supplied by the Australian Recreational and Sport Fishing Confederation indicates that 4.5 million people in Australia go fishing once or more a year; of these 80 000 would go more than twenty times a year. Of the 4.5 million 17 per cent, or 765 000, would be classed as blue water anglers who would use an offshore boat and thus could, or should, have need for up-to-date charts. The total value of the Australian recreational fishing industry is put at $13.1 billion a year.

1602. Figures supplied by Mr A. Mitchell of the Australian Yachting Federation indicate that there are some 900 000 pleasure craft privately owned in Australia. He considered that this would be a conservative estimate. Of these 23 per cent are classed as cabin cruisers, that is they have toilets and bunks, 13 per cent are yachts and keel boats, 32 per cent aluminium runabouts and the remaining 32 per cent, are sailboards, boats and dinghies. Of this 32 per cent, slightly less than half (120 000) would be sailboards.

1603. Thus, about 35 per cent of these craft would be considered suitable for some degree of offshore travel. This is very much a subjective judgment as a number of cabin cruisers and keelboats would be permanently used in inland waterways, and major offshore journeys have, on occasions, been made by very small craft. For example sailboards have made the passage from Australia to New Guinea.

1604. Contact with the leisure industry suggests that recreational yachtsmen are notoriously slack in updating their charts either by purchasing new ones or by regular receipt of notices to mariners. This is further compounded by a reputation for not reading the 'fine print' on charts and taking anything on possibly outdated charts as gospel.

1605. It would appear that this area of users of hydrographic information would receive particular benefit from ECDIS should it be made available for the Australian area of responsibility, subject of course to the information on the 'electronic chart' being accurate.

CHAPTER 17

THE ISSUE OF SAFETY OF LIFE AT SEA

1701. The responsibility for major search and rescues in Australia's area is vested in the Australian Maritime Safety Authority (AMSA). The word 'major' has to be used with caution here because there are a large number of rescue organisations in Australia which may become involved in coastal rescues. The AMSA is only called in when a situation is beyond the capabilities of such local organisations. These include such bodies as the Royal Volunteer Coastal Patrol, relevant police services and the Royal Surf Lifesaving Societies. This poses severe problems in assessing how many lives are saved each year as it is necessary to aggregate widely dispersed and possibly overlapping statistics. A further issue is to define exactly what is a rescue. There is anecdotal evidence of almost competition between different rescue services who are eager to inflate their 'save rate' with a view to prestige and possible further funding. Likewise there has been some criticism of 'rescues' which involve towing pleasure craft back which have run out of fuel in calm weather. However, such action may well prevent more dramatic situations from arising.

1702. The above notwithstanding, it is interesting to look at the statistics of just one of the organisations involved in rescue around Australia's coast, The Royal Volunteer Coastal Patrol,

1703. Their statistics for 1990 show that they rescued or assisted 2362 vessels and 5460 persons in that year. The value of the vessels rescued or assisted was put at $67 072 000. If the value of the lives saved is put at $700 000 per person (as will be shown later) then it is interesting to calculate that if only 1 per cent of the persons saved owe their lives to the existence of up-to-date charts then this equates ta the annual budget allocation to the entire RAN Hydrographic Programme, **This of course does not make allowance for those vessels and lives which do not come into harm's way in the first place because of charts and other navigational aids.**

1704. In addition to the value of the lives saved there is of course the value of the ships saved by good navigational aids. This is a very difficult figure to establish because of the wide variation of ship types which could otherwise be at risk. While the RVCP is prepared to put a value on this for vessels actually assisted, in other circumstances it is more difficult — especially when we are trying to value the vessels which are not put at risk in the first place. One estimate of individual values is that of O.T. Morkve and L. Mathisen (1991). They put the individual value of a vessel at 'from 1 million for a small passenger ferry ta more than $US 200 million for a liquefied natural gas carrier. Drydock and repair bills for less serious accidents usually range from $US 500 thousand to well above $US 1 million.'.

1705. A 1985 study on navigational aids for PNG (Posford et al.) stated in part:

> From the above it can be seen that such a casualty as described could cost almost any sum, but perhaps it is safe to say that an absolute minimum would be $US 5.0 million, and perhaps a more likely amount would be $US 15-20 million (1985 US dollars).

1706. The role of charts and related information will obviously vary between different situations. Inshore work in good weather may not involve charts at all, whereas they would be essential for major searches offshore as well as for actual recovery operations once survivors have been located.

1707. The AMSA has stated that it considers hydrographic charts as being essential for the types of rescues that it is involved in.

1708. The area of the AMSA specifically responsible for rescue is the Maritime Rescue Coordination Centre. In its first *Report for the six months ending June 1991* it stated that the number of lives directly saved through the coordination of the MRCC was 43 at an operating cost of $1.9 million compared to 24 lives at a cost of $1.6 million for the preceding six months.

1709. An estimate made by the Commander of the Ulladulla Division of the Royal Australian Coastal Patrol is that the Coastal Patrol conducts some 200 rescues a year in NSW of which nine to ten would be 'hectic'. Hydrographic charts are consulted in a very large proportion of incidents such as flare sightings in order to get some idea of location before more vigorous action is taken should it be deemed necessary.

1710. The Ulladulla Division is also a recipient of the 'East Australian Current' information which is considered important in many of the 'hectic' incidents.

1711. Another of the regular recipients of that information is the National Meteorology Centre in Melbourne. This sometimes gives information of likely weather patterns to yachtsmen. It appears that a regular occurrence is the sudden appearance of cyclonic conditions when a low pressure zone passes over an area of warm water. This was considered responsible for at least one death in 1990.

The Value of Human Life

1712. Putting an economic value on human life is always going to raise a few eyebrows. There will always be some people who consider that such an exercise should never be attempted as human life is sacred. However, society continually puts a price on life. As Mr Dick Smith, the past Chairman of the Civil Aviation Authority has pointed out, if human lite was indeed beyond price the speed limit on our roads would be 5 kilometres an hour and commerce as we know it would cease.

1713. In fact valuing life is not as cold-blooded as it may at first appear. If the value to society of an average life can be calculated, then the value to society can be measured against the cost of preventing its loss. If the cost-benefit is positive it is not necessary to look any further. For example if road improvements are calculated to save x lives a year and the cost of the improvements is less than the economic value of the lives saved, then the project should go ahead., This is without looking at such moral and ethical issues as the grief that is spared to the family and friends of the, otherwise potentially, deceased.

1714. Such a calculation to some degree parallels the work done by the BTE on the Hydrographer's Passage. Once it was shown that the savings in fuel for coal ships alone far outweighed the cost of installing navigational aids it was not necessary to look at the total economic benefit. There was already sufficient benefit for the project to go ahead.

1715. The methods for assessing the economic loss from death have been recently examined in a publication by the Bureau of Transport and Communication Economics (Steadman and Bryan, 1988). This was done in the context of motor vehicle accidents but many, if not most, of the issues examined are directly relevant to loss of lite at sea. To quote the beginning of chapter 2 of that report:

Assuming that the objective of a study of the costs of road accidents is to assist in determining how much expenditure is warranted to reduce their number and/or severity, two basic approaches exist:

- examination of the costs of accidents which have already occurred, assuming that society would pay at least this average amount per accident for them not to have occurred; and

- seeking to determine the amount the community would pay to reduce road accidents in the future.

These basic approaches, upon which there are many variations, are referred to as 'ex-post' and 'ex-ante' approach respectively.

EX-POST APPROACH

The ex-post approach involves summing component costs resulting from the occurrence of a road accident to derive a total cost to society. The three broad types of cost are the costs involved in accident-generated activities, the loss or partial loss of the victim and the intangible cost of pain and suffering.

Costs relating to accident-generated activities are derived by estimating costs for each resource used. Items include vehicle damage, hospital and medical services, accident investigation, insurance administration legal and court proceedings and traffic delay.

The loss or partial loss of the victim to society can be estimated in a variety of ways. Some measures are:

- the amounts awarded by the courts to victims or their families by way of compensation;

- the value of life implicit in past public sector decisions on safety programs or legislation; and

- the amount of the victims' production capacity lost (or foregone income) as a result of the accident.

This last measure, added to the costs of accident-generated activities, is frequently referred to as the 'human capital' approach and has to date been the approach most commonly adopted. It usually relates to a limited, mostly tangible range of cost items.

1716. There are a number of esoteric nuances which exist in the approaches developed from these broad concepts. Space does not allow me to go into all of these in this paper. To give just one example most measures of national economic output are expressed in terms of Gross National Product (GNP) or Gross Domestic Product (GDP), with GDP equalling GNP plus net remissions overseas. However, neither of these concepts include output in the non-traded sector of the economy such as work done in the household for which no payment is made. Many of the studies done to calculate the cost of death include allowances for this element which is ignored in GDP.

1717. To arrive at a minimum economic value for human life it is necessary not only to estimate the future earnings of the casualty in question but to discount them to current value. This is done because income in some future time period has a lower

value than income at the present time. In very simple terms $50 earned now can be invested at interest. $50 which will be received in ten years cannot be invested until it is received so it has a lower present value.

1718. In some of the studies examined by the BTCE an allowance was made for pain and suffering, in others not. The dominant factor has been a judgment of whether or not the available data were reliable enough.

1719. Using these concepts the BTCE arrived at a figure of the cost of a fatal accident as between $381 000 (using a method known as the adjusted income method), and $433 300 (using a method known as the opportunity cost method). This translates to $562 000 and $645 600 respectively once the rate of inflation is factored in. If a growth rate of 2 per cent is also allowed for, the figures rise to $646 000 dollars and $742 000. This is a very similar figure to the results of a completely separate study done in the UK (O'Raithaille and Weideman). That study put a value on the life of a British seaman in 1980 at between 100 000 and 120 000 pounds Sterling. That equates to some $A 692 000, in 1990-91 dollars, once inflation and a growth factor of 2 per cent have been factored in.

1720. The BTCE study took two economists eleven months from inception to publication. It is not known how long the O'Raithaille paper took.

1721. A study done for Papua New Guinea (Posford et al.) put a value of $US 100 000 per New Guinean life in 1985 but also stated that:

> Loss of life costs depends entirely on nationality, earning and ail other matters usually considered by the courts in assessing damages. Applying research in this area, to the PNG situation we suggest an economic value of SUS 100 000 per life.

1722. It has to be emphasised that the BTCE figures do not relate to a male in the prime of life. They were calculated on the basis of a weighted average of the road accident victims by sex and age. EEO not withstanding, males still have a higher earning capacity than females, so the death of a female carries a lower economic value for the purpose of the BTCE study.

1723. The calculations also include figures for children and although they may well have ail their productive years ahead of them, the value of such income is less due to the discount rate mentioned earlier. Their earnings will not accrue for some time so the value is less.

1724. The figures above that were extracted from the BTCE study do not include costs for such things as vehicle damage, delays to traffic and hospitalisation. This is because it would be expected that these would be so markedly different for maritime as opposed to road traffic accidents. Death, and thus the ability to earn future income, tends to be absolute, whether it is by drowning or by being hit by a truck.

1725. Thus, subject to the above provisos, the minimum cost of a death to the Australian community is in the region of $700 000.

1726. 11 is fair to assume that these figures would be conservative when applied to maritime casualties. Mariners tend to be almost by definition male and from the normal wage-earning age groups. Recreational users tend to be drawn from the upper income groups and thus, from the view of the BTCE analysis, they represent a higher economic loss.

CHAPTER 18

THE MAINTENANCE OF AUSTRALIAN TERRITORIAL SOVEREIGNTY - AUSTRALIA'S CLAIM TO ANTARCTICA

1801. Australia is one of seven 'claimant states' and currently lays claim to 42 per cent of the Antarctic continent. It is government policy to maximise the achievement of Australia's interest in the Antarctic and to provide effective administration of Australia's Antarctic Territory and the Territory of Heard and McDonald Islands.

1802. Beyond that the situation is far from clear. Australia refused to sign the Antarctic Minerals Convention in 1989 but in June 1991 negotiations were compieted on a draft protocol to the Antarctic Treaty on Environmental Protection. This designates Antarctica as a natural reserve 'devoted to peace and science'. This draft protocol establishes legally binding measures for protection of the Antarctic environment and includes a prohibition on Antarctic minerais activity.

1803. It is not known what the net value of Australia's Antarctic mineral wealth is, based on extraction by either existing or future technology, and it may well be that the contingent value to Australia of leaving this area as a world park is greater than that of the mineral wealth. Mineral extraction would, in any case, be extremely difficult. Antarctica is covered by an ice cap approximately 12 000 000 square kilometres with a mean thickness of between 2000 and 2500 metres (Lowering and Prescott, 1979). An exception to this problem would obviously be offshore oil extraction.

1804. Nevertheless to quote from a paper by Patrick Quilty, Chief Scientist to the Antarctic Division (1984):

> Market forces may not be the only considerations in development as there are many, particularly northern hemisphere nations, that are highly industrialised and lack sufficient indigenous supplies, especially of oil. Lack of home supply of strategic metals could also lead to Antarctic development. Having said this, I believe technology already exists for drilling on the deeper continental shelf of Prydz Bay. If supplies were found, they could be produced from safe subseas completion systems. The occurrence of coal, iron ore, significant sediment thickness and high concentrations of krill in the vicinity of Prydz Bay make this a particularly attractive part of Antarctica for sovereignty purposes in strictly resource terms.

1805. This relates directly to the issue of sovereignty: Just because Australia may like to leave the area as it is does not mean that the rest of the world would continue to agree. For example as early as 1982 the Malaysian Prime Minister, Dr Mahatir, whilst addressing the United Nations General Assembly, argued that Antarctic resources should be regarded as the common heritage of mankind. This theme was repeated at the meeting of non-aligned nations in 1983 which called in part for Antarctic resources to be 'exploited for the benefit of ail mankind'. In the absence to a recognised territorial claim Australia's power to prevent commercial exploitation would be limited to complaints in international forums.

1806. However, given that Australia has a policy of asserting or maintaining its national sovereignty over this area, it would be difficult to make a case that hydrographic charting should not be an element of any such program. The issue here is that Australian claims to Antarctica are not universally accepted unlike, for example, claims to the Cocos Keeling Islands which are accepted as being part of Australia under international law. In the event of a continuation of the current policy of using the area solely for scientific research then hydrographic work is an element in this activity.

If future policies include mineral extraction or greater recreational access then the groundwork for safer and wider ranging navigation has already been laid. This is in addition to ensuring safe navigation for scientific parties.

1807. The mapping of this area, other than for nautical charts, is the responsibility of the Antarctic Division of the Department of Arts, Sport, the Environment and Territories (DASET). The actual mapping is done by The Australian Surveying and Land Information Group. The budget for this is some $800 000 p.a. This is credited to DASET in the annual budget. In addition AUSLIG does some geodesy work. It chooses to term this a community service obligation. That work is financed out of General Revenue.

1808. The hydrographic surveys are currently paid for out of Navy's budget. They are not notionally costed to DASET.

1809. Australia continues to occupy four stations in the Australian Antarctic Territory; Casey, Davis and Mawson and in addition, sub-Antarctic Macquarie Island. Navigational hazards have been reported on the approach into Mawson and, if not properly charted, could result in damage to shipping and possible oil slicks. Whilst no oil tankers currently use these waters there has, in the past, been consternation at the possibility of oil spills from bunker and heating fuel. One incident occurred in 1990 in which an Argentinian supply ship hit a rock and caused a major spill. This gave impetus to new initiatives by the Scientific Committee on Antarctic Research (SCAR) to improve charting activity.

1810. In this context it is worth drawing from the 'Preliminary Investigation into the Grounding of *M. V. Nella Dan* at Macquarie Island, 3 December 1987':

1811. 'Charts

> The hydrographic chart for Macquarie Island is issued by the Hydrographer Royal Navy as chart 1022, from a survey of the Australian Antarctic Expedition under the command of Douglas Mawson (later Sir Douglas Mawson) in 1914. The chart includes a plan of Hasselborough Bay which also shows Buckles Bay but on a scale of 1:40000, which is too small to be of practical use for vessels anchored within Buckles Bay. The only other officially published map of the Island is that produced by the Division of National Mapping, Canberra, entitled 'Australia, Macquarie Island'.
>
> This too has an insert of the isthmus between the main Island and Wireless Hill on a scale of 1:7500, but shows no depths and is generally unsuitable for navigation.'

1812. The grounding in question led to a complete loss of the *Ne//a Dan.*

CHAPTER 19

THE ISSUE OF OVERSEAS AID

> *It is hard to quantify the economic benefit of hydrographic projects, but they should be given at least equal priority as those with more obvious benefits, since lack of modern hydrographic data and updated nautical charts will inevitably seriously impair a nation's economy should it rely, as most countries do, on the efficient export and import of goods and if it is to benefit fully from the potential available within its Exclusive Economic Zone.*
>
> *(IHO Paper, no.* 6, revised September 1990)

1901. It is fair to say that little of what is reported as overseas aid is not without an element of self-interest. Frequently aid is little more than the disposal of agricultural surpluses, and often monetary aid ties the recipient to spending it on the industrial production of the donor country. It is outside the ambit of this paper to analyse whether such tied aid is of any more benefit to the economy of the donor country than untied aid.

1902. Assistance from the RAN Hydrographic Programme has been given to Papua New Guinea, Vanuatu, Western Samoa and the Solomon Islands. In addition hydrographic advisers are or have been supplied to Vanuatu and the Solomon Islands. These advisers are paid for out of the Defence Cooperation Programme which is the responsibility of another area of Defence. The cost for the PNG programme is paid for from the Hydrography budget, not from a foreign aid allocation or from the DCP.

1903. In December 1985 a study funded by the Asian Development Bank was completed by the consultants Posford, Parry & Partners. This stated in part:

> The existing navigation aids in PNG are inadequate in terms of the numbers of lighted beacons on important passenger and freight routes and have a poor record of reliability.
>
> Both international and major coastal vessels place a high reliance on radar for navigation during coastal voyages. Satellite navigation systems are not generally used due to the inaccuracy of existing charts. Smaller coastal vessels also rely heavily on radar for coastal navigation and many stretches of coastline passed by coastal craft are totally unlit. Major problems exist with the level of radar training and experience of national seamen, and with the reliability and servicing of radar equipment in PNG
>
> ... In several instances the groundings were the result of incompetent seamanship but it is significant that in many instances radar malfunction was cited as contributory cause. This tends to reinforce the real need for reliable navaids as a back-up to radar reliance, particularly for small coastal vessels with only one radar set.

1904. The Posford, Parry and Partners study. concluded that the improvement of navigational aids in New Guinea, specifically recommended in their report, would give a rate of return of 7.75 per cent p.a.

1905. Once again it is not the purpose of this paper to examine all issues relating to foreign aid. However, it is always useful when such aid is given in such a way that it cannot be misused or appropriated by whichever party happens to be in power at the time. Moreover it would seem to be sensible to allocate aid to areas which have a

significant benefit to the recipient country and also aid the donor country. As PNG is Australia's nearest neighbour it is likely that some economic benefit from improved charting of these waters would flow back to Australia.

CHAPTER 20

THE ELECTRONIC CHART - THE WAY AHEAD

A unique property of the electronic chart is the fact that it represents a legal document. The paper nautical chart is the document accepted in courts around the world as the basis for describing accidents at sea and in some cases, may actually be the cause of an accident if there is a charting error. Consequently the acceptance and use of electronic charts has become complicated by their potential as a replacement for paper charts. Technical factors alone are not pacing their development, but also questions of legal acceptance.

(M. Rogoff, 1990)

2001. The electronic chart or, as it is more formally known, The Electronic Chart Display and Information System (ECDIS) is no longer in the realms of science fiction. A medium-sized ECDIS for a merchant vessel can be purchased for $US 50 000. There is evidence that these are already appearing among the Australian fishing fleet. During an informai survey of trawler owners operating from NSW ports, a number of captains stated that they did not use charts much only the electronic map' (sic). These are believed to be US-sourced and based on pirated hydrographic data. These have already reached the stage where it is possible to put a tracer on the radar image of another fishing vessel to record its course with a view to duplicating that course at a later date. This is particularly useful when fishing near or among shoals. A rather specific example of the public-good nature of pure research.

2002. One North American study has found that 90 per cent of vessel strandings are caused by errors of navigation and that 70 per cent of these might be avoided in future by ECDIS technology.

2003. There can also be savings in fuel costs tram the precise positioning available from such equipment. One industry estimate puts this at over 1 per cent of fuel costs (Gibbons, 1990).

2004. Since 1986 the IMO and IHO have been working on provisional performance standards for the ECDIS. These were approved in 1989. The standards are expected to remain provisional until 1993, by which time some experience will have been gained in their use. Alter that, it is expected that the SOLAS regulations will be amended to allow use of an approved electronic chart system as an alternative to the paper chart. This could eventually flow through to domestic legislation.

2005. Included in these programs is the development of an IHO digital data exchange standard. Known as DX-90 this will permit digital nautical chart data exchange between hydrographic charting agencies and ECDIS manufacturers.

2006. The increased use of electronic charts is not without its problems. As is discussed elsewhere in this paper, until recently navigators have been very cautious about their positioning allowing a margin of error. Now that they can get very accurate real time fixes, they are becoming much less cautious and are relying on electronic equipment — what is sometimes referred to by the Air Force as 'The Great Green Goddess'. Thus any anomalies which exist in old charts that used less sophisticated methods of positioning can become critical hazards to navigation.

2007. It appears, therefore, that ECDIS has the potential to reduce accidents which result from human error. In addition it can lead to fuel savings from more precise navigation. This would, subject to the reservations expressed above concerning the accuracy of charts, increase the national benefit from the Hydrography Programme.

CHAPTER 21

THE ISSUE OF COST RECOVERY

The consequences of raising the needed funds by taxation may be just as harmful or 'inefficient' as the charging of a price to the beneficiaries of the service. No cogent general case can be made for the free distribution of a good or service even though marginal cost is zero — if total costs are positive and have to be covered somehow. Where it is possible to exclude non-paying users, charging the beneficiaries need not be any less economical or less equitable than charging the general tax-payers, many of whom neither directly nor indirectly benefit from the service.

(F. Machlup, 1962)

2101. Aids to navigation are as old as navigation itself. History records that lighthouses were established on the shores of the Mediterranean before the third century BC. Many of the earliest lights were wood-burning fires lighted by religious men as an act of charity to warn mariners of hazards ahead and, presumably, to gain merit for the afterlife.

2102. In more recent years the responsibility for the provision of navigational aids has been assumed by administrations, usually — if not invariably — under Government control, for the increased safety of mariners' ships and their cargoes and for the encouragement of commerce and communications.

2103. Some countries such as Great Britain, Australia and New Zealand have established a custom of levying light dues on shipping calling at their ports to cover the cost of providing and maintaining navigational aids; whereas others, notably France, Germany, Holland, Japan, USA and Canada, consider the provision of navigational aids so essential to the economy of the country that they make no charge to shipping for the lights and meet the cost out of the national budget.

2104. When Cabinet passed responsibility for hydrography to the Navy in 1946 it was envisaged that 40 per cent of the costs would be born by the private sector. This has never occurred and the sale of charts to the general public raises only about $1 million a year out of a direct budget allocation to the programme of between $35 and $40 million. This contrasts with the situation in, for example, Sweden, where 70 per cent of the hydrographic budget is met from navigational charges.

2105. It is doubtful whether this revenue can be greatly increased. A rise in prices could give rise to increased pirating (photocopying and more sophisticated reproduction) as is already happening with the electronic charts which are appearing on the Australian coast. These are digitised from hydrographic charts usually obtained from US sources. A rise in prices coud also give rise to 'Mud Maps', that is the use of much less detailed maps and reluctance to obtain or replace charts on the part of yachtsmen and other recreational users. This could give rise to increased need for both rescue operations and dangers of pollution from shipwreck. In economic parlance there could be strong negative externalities from raising prices for little increase in revenue.

2106. A method for maximising revenue and minimising the consumer surplus of users would be to charge different prices to different classes of users. It is doubtful whether this could be policed to prevent charts purchased by, for example, 'yachtsmen' finding their way onto merchant ships.

2107. One option is to continue with the present arrangements whereby hydrographic charting is totally paid for out of general government revenue allocated to the Defence Department. Another alternative would be to charge what is known as the 'constituency'. Given that a strict user-pays policy, based on chart sales, is not practicable for a public good for reasons explained earlier, it may be seen as sensible to take the next best approach and charge the area that receives most immediate benefit from the work of the hydrographer — that is to say the maritime community. To some degree this occurs already. Surveys done by port authorities are passed on to the RAN Hydrographer free of charge, these are paid for from the budget of the port concerned; this budget is itself raised largely or totally from port charges.

2108. The current practice is to pay for navigational aids, such as lighthouses, by a levy placed on all commercial ships, other than fishing vessels, both overseas and domestically registered, that use Australian ports and which are longer than 24 metres. This does not at present directly pay for any element of the Hydrographer's operation. The question of a civil contribution to the running of the Programme is under discussion. However, even if it were to be agreed to establish a charting levy, this would still leave a large proportion of the 'constituency' free riding — that is to say, receiving a direct benefit for which they are not paying. This includes recreational sailors and anglers and commercial fishermen. To put this in context, if it were possible to raise only $45 from each offshore recreational angler each year this would be sufficient to pay the whole direct budget cost of the entire Hydrography Programme.

2109. Whilst it would be electorally unpopular to impose charges on some if not all of these groups it is certainly not beyond the bounds of reason. The Industry Commission has recently recommended that all recreational anglers pay a fishing licence of $25 a year for what is really only access to an existing good. There would appear to be a much stronger case for imposing charges down to this level when it is payment for a service rendered. This would appear to be in line with current economic reforms.

2110. There are two phrases which are sometimes used as if they are interchangeable when in fact they are not. These two phrases are 'full cost recovery' and 'user pays'. Full cost recovery is simply that; that the provider of a service should recover all the costs of providing that service to the customer. Thus cost recovery is really an issue of revenue raising or, quite simply, paying the bills. It is not necessarily involved with the optimal allocation of resources via a price mechanism.

2111. 'User pays' however, incorporates the concept that resources are allocated by market forces by consumers deciding how they will spend their money. If a good or service cannot be provided at a price that the markets is prepared to pay then it will not be, and should not be, provided. The proviso here is that market forces will operate. In the real world there are many cases of 'market failure' where the nature of the good or service is such that it will not be supplied in socially optimal quantities if such supply is left to the market alone. Thus user pays is really an issue of resource allocation.

2112. This distinction is important when looking at the work of the hydrographic Programmes because in the absence of Government intervention much of the activity of such Programmes would not take place.

2113. In this paper we have sometimes used impossible scenarios, for example the disappearance of all existing charts, in order to examine an issue. Now let us examine a further one. *That charting has no other purpose whatsoever other than free movement of the fleet.* If this had been the findings of this study, and it most certainly

is not, would this justify a reduction in the Hydrographic Programme? Most probably not. All expenditure, at current levels, is from the Defence vote and there is no allowance, be it explicit or implicit, for the benefits that flow on to the civilian sector.

2114. As such, current activity could be viewed as military research and any subsequent use by the civil sector as a by-product. It would be interesting to speculate what would be the reaction if, for example, research for a protection to chemical warfare agents found a cure for asthma, AIDS or Parkinson's disease. Would it be politically or ethically acceptable to insist that this knowledge, which would now be already in existence, only be distributed on the basis of full cost recovery? Likewise would any sector of Government advocate that such knowledge be provided free to companies which intended to maximise their profit?

2115. Where an organisation is prevented for political reasons from making legitimate charges for its services it is normal for it to look to general revenue to make up any resultant shortfalls.

2116. The fact that exact benefit-cost ratios could not be calculated is perhaps not that important as such ratios, even if arrived at objectively, would not tell us the optimum level of activity in any given year. That would require the marginal cost-benefit ratios a far more complex analysis. What is beyond reasonable doubt is that the existence of official up-to-date charts has a benefit to the national economy that greatly exceeds the cost of the Hydrography Programme.

CHAPTER 22

CONCLUSIONS

On the basis of average utility values of maps ... the distribution of map sales amongst economic, educational and general users, and the volume of map distribution in fiscal year 1969, total annual dollar benefits to the national economy are estimated at more than $900 000 000. It is significant to note that the total expenditure by USGS on topographic mapping since 1896 is only $430 000 000, or less than half of the estimated annual benefits for 1969..... the annual benefits that could be expected from complete 1:24,000 scale map coverage would be $900 million plus $860 million.. ..These estimates of benefits are based on user responses and are considered to be conservative. We think that the benefits from map use are considerably greater than most users expressed in terms of willingness or ability to pay.

(Lyddan, 1971, p. 511)

The benefit cost ratios show the return earned for every dollar invested in the CHS. Therefore, with benefit-cost ratios from 9/1 to 17/1, clearly, the CHS is a great investment for the Canadian economy.

(Brinkman, 1992)

First, users across the board value the topographical map at considerably more than the purchase price. Second, users were well aware that the prices were comparatively cheap but, nevertheless, appeared to adopt 'free-rider tactics' in stating values. Finally, the value which users place on the information contained in a timeously presented topographical map is substantially more than: the selling price; the value which they place on the physical map itself; and, the production cost of the map. Dare it be said - the benefit-cost ratio is certainly positive and possibly large!

(Hoogsteden, 1988 (after ten years of doctoral study))

2201. While it has not been possible to put exact figures on the economic benefits that flow on from the work of the Hydrography Programme there can be not doubt that they are very large. Such benefits include the efficient passage of shipping, protection of the environment and safety of life at sea, and the management and exploitation of marine resources.

2202. There is a tendency in some quarters to assume that charts once made are pretty well fixed and, in the absence of silting or volcanic eruption, do not require updating. This is not true. Charts of Australia's area of responsibility are subject to constant updating, most obviously through the weekly *Notices to Mariners.* The development of the electronic chart is also a major issue, if not a problem which has to be faced. As has been stated in the body of this report, navigators have in the past been cautious in assessing their exact position but with the increased use of modern navigational aids, most notably GPS, they are becoming much less conservative and more inclined to 'cut things much finer'. This means that charts have to be, if anything, more accurate than in the past.

2203. The fact that exact cost-benefit ratios could not be calculated in this study is perhaps not that important as such ratios, even if arrived at objectively, would not tell us the optimum level of activity in any given year. That would require the marginal

cost-benefit ratios a far more difficult and nebulous analysis. What is beyond reasonable doubt is that the existence of official up-to-date charts has a benefit to the national economy that greatly exceeds the cost of the Hydrographic Programme.

2204. The Hydrographic Programme is a public good, in the strict economic sense of the word. Such a good or service would, by definition, not be supplied in nationally optimal levels if left to market forces alone. However, there are no theoretical or empirical reasons why more active cost recovery should not be considered, aimed towards carefully targeted groups of beneficiaries.

2205. Hydrographic activity has traditionally been viewed as a naval activity but this analysis has described, and where possible, analysed its effect on the national economy. The role played by the Hydrographic Programme is such that it is perhaps time to question whether it should continue to be viewed as a purely military Programme which has benefits to the civil community or whether it should be seen more as a national programme which has both civil and military benefits.

LIST OF RECENT GROUNDINGS ON UNCHARTED HAZARDS IN AUSTRALIAN WATERS

1971 Oil Tanker OCEANIC GRANDEUR hit an uncharted rock in the Torres Strait (resulting pollution destroyed 20 pearl farms).

1978 General Cargo Vessel TRANSGOLD, 11 000 tons, grounded on poorly surveyed area near Rosade Spit PNG.

1980 Cruise liner LINBAD EXPLORER, 28 000 tons, hit an uncharted rock in the Antarctic.

1981 WA State Ship KIMBERLEY, 12 000 tons, grounded off Derby outside charted area (ship broke her back on the falling tide).

General Cargo Vessel HAIGONI EXPRESS grounded in poorly surveyed waters near Hood Point PNG.

1982 Oil Tanker AMPOL SAREL, 78 000 tons, touched ground in Prince of Wales Channel probably due to shifting sandbanks (this highlights the need for re-surveys in areas known to be unstable).

Patrol Boat HMAS BARBETTE grounded in the approaches to Derby, probably due to shifting sandbanks.

Landing Ship HMAS TOBRUK grounded in Port Clinton in an area which had been surveyed by 'sketch' methods.

Timber ship PEONY grounded in poorly surveyed waters in Open Bay, PNG.

1983 Landing Ship USS VANCOUVER grounded on an uncharted shoal off the Lancelin range, in an area marked 'incompletely surveyed'. Screws were damaged and ship's capability was impaired.

Bulk Carrier MV BRAVENESS, 18 000 tons, hit a reported but unsurveyed shoal off Cape Otway. Several double bottoms were punctured.

Timber Ship MARINE STAR grounded in poorly charted waters off West New Britain.

Tanker MANHATTAN DUKE, 82 000 tons, grounded on ill-defined Basilisk Reef PNG.

1984 Bulk Carrier IRON CURTIS, 70 000 tons, drawing 12.2 metres on passage in the Great Barrier Reef recommended route near Lizard Island, crossed a 12.2 metre uncharted rock. Fortunately it was high tide,

Antarctic Support Ship ICEBIRD, 6000 tons, entering Mawson in general depths of 400 metres, struck an uncharted rock. Ship's draught 5 metres.

Car Carrier BRIGHT ACE on passage from Japan to Australia grounded on an uncharted shoal in the vicinity of the Star Reefs, PNG.

Grounding of the MV CAPE PILLAR on an uncharted rock near Salisbury Island.

1986 HMAS BETANO was holed by an uncharted rock whilst surveying in Napier Broome Bay.

HMAS BRUNEI grounded in poorly surveyed water in Endeavour Strait whilst on surveying duty.

1987 Cargo Ship HYUNDAI No. 21 drawing 10 metres, grounded on an uncharted reef in about 6 metres in the vicinity of the Engineer Group on the New Guinea Coast whilst on passage between Rabaul and Port Moresby.

Timber Ship SMILAX grounded on poorly surveyed water off Goodenopugh Island, PNG.

Note: The Hydrographic Office does not keep comprehensive records of groundings. An incomplete set of statistics supplied by the Department of Transport and Communications shows that 38 strandings occurred in Australian waters in 1981-82, and 16 vessels touched ground. As a result, eight ships were a total loss and 11 were severely damaged. In 1980-81 the figures were 66 strandings and 31 touched ground. Uncharted rocks are blamed for a total of eight of these casualties, and abnormal tides/currents for a further seven.

ECONOMIC TERMS AND CONCEPTS SPELT OUT IN GREATER DETAIL

There are none as deaf as those who don't want to hear.

(North of England Saying)

1. The purpose of this section is to describe and discuss at further length some of the key economic issues that relate to an analysis of a topic such as the Hydrographic Programme. This appendix has been included to try and explain in an unequivocal fashion which economic issues are pertinent to such analysis and which are not. At times it quotes directly from the body of the report. Some of the issues and concepts are dealt with in the body of the report simply because there are a large number of readers who will give only cursory attention to appendixes. It has also been included because of the habit of a seemingly large section of the population of using terms without understanding the concepts that they represent.

2. There is a rising philosophy that market forces, if allowed to operate, will always allocate resources to the optimum benefit of society without any government intervention whatsoever. While this is really moving into areas that may be politically contentious, even the 'driest' of (real) economists will acknowledge that even in a totally free market economy there are certain areas which will always exhibit a significant characteristic of market failure.

Market Failure

3. Market failure is the situation that occurs when pure market mechanisms are incapable of allocating resource to their optimum benefit. it does not mean that a good or service is not being produced at the price or in the quantity that the speaker in question would like. For example the fact that Australia has a lower private-sector research effort than many industrialised countries does not necessarily mean that there has been a market failure, lt means simply that industry, using the best information available has decided to allocate a lower proportion of resources than our industrial competitors.

The Issue of Public Goods

4. A public good is an example of genuine market failure, but not all market failures are public goods.

5. The *Dictionary of Economics and Business,* second edition, edited by S.E. Siegler BSC, defines a public good as:

> A good or service that cannot be priced accurately and hence cannot be efficiently supplied by private industry. If has three characteristics, nonrivalness in consumption, nonexcludability, impossibility of rejection. Nonrivalness in consumption of a good means that a good being supplied to one individual can be supplied to others at no extra cost, for example a radio station will not expend more power in transmitting to 5 000 000 than when transmitting to 1 000 000 people (if they live in the same geographical area). Nonexcludability means that an individual cannot be deprived of a public good even though he may refuse to pay for it, for example all the citizens of a country are protected by anti-rabies measures even if many refuse to pay for them. Impossibility of rejection means that an individual cannot abstain from consumption of a public good even though he may wish to, for example a pacifist is protected by nuclear weapons in spite of his moral objections to them.

> **Consequently, normal market forces cannot provide the optimal amount** [emphasis added] since an individual will not need to reveal how much he would pay to consume the good, as he feels it will be provided anyway. If everyone adopts this attitude the good will not be produced although it is to everyone's interest that it should be produced (see externalities).

6. This gives rise to what is known as the 'free rider' situation whereby a consumer or potential consumer knows that a good will be provided without him paying, therefore there is no reason for any payment from him.

7. A characteristic easily missed in this definition is that consumption of a public good by one consumer does not diminish the amount available for other consumers. For example the fact that a ship is guided by a lighthouse in no way diminishes the usefulness of this navigational aid to others. This is in fact an example used by a very eminent economist, Samuelson (1970) writing in a general economic textbook, not particularly one concerned with maritime affairs. To labour the example, certain passages may become congested with shipping so that the fact that one ship is using a lighthouse may in fact cause problems for another that wishes to use the same seaway. That does not mean that the lighthouse has ceased to be a public good or that the concept is invalid. It simply means that a real-world example may not always exhibit perfectly all the characteristics of the analytical model. No internal combustion engine is more than 40 percent efficient but people still drive cars.

8. Thus it is important to distinguish between a public good and a good or service which happens to be in the public domain. For example if a commuter takes a seat on a public bus, that seat is not available to other commuters at that time. Thus although the service may well be supplied by the public sector, that does not necessarily make it a public good. Likewise there are examples of public goods which are supplied by the private sector. A local example in the Canberra region is that of radio repeater stations on Citizen Band radios in the FM band. There are three repeater stations which pick up transmissions on the FM band and then retransmit them, at no cost to the user. This allows operators to achieve much greater range and clarity. None of these were put in by Government. One was put in by the Outward Bound adventure organisation so that they could communicate with parties in the Snowy Mountains area and the two others were put in by Phillips Communications Services so that they would sell more radios. Now it is obvious that Phillips is not the only seller of radios in the Canberra region but they obviously thought that their increase in sales would more than pay for the cost of the repeaters.

9. Manufacturers of other brands of radios are 'free riding' on the repeaters as they would also have experienced an increase in sales.

10. An example which illustrates the public-good nature of pure research is that of the Oceanographic Charts. These are charts of changes in ocean currents and temperatures which are updated on a regular basis. They are gathered for the waters off south-eastern Australia primarily in connection with anti-submarine measures. They are useful to certain types of fishing, particularly for tuna. However, tuna fishermen in the Eden area do not all receive their own copies of this information, cheap though the copies be. They simply go down to the Eden Fisheries Association and see the ones that are put on public display for that purpose. A similar situation occurs in the Middle Harbour Yacht Club where the same information is publicly displayed for the use of offshore yacht races.

11. In economic parlance it is very difficult to retain proprietary rights to information once it is in the public domain. This is particularly true in the case of charts where there are international agreements that they will be supplied to other governments or charting agencies on a quid pro quo basis. These agreements would be extremely difficult or impossible to modify or cancel. The US Government has an unequivocal policy that information such as maps should not be restricted, therefore a marked increase in Australian prices could see buyers buying charts offshore. This already appears to be happening in the case of the Electronic Chart. An issue which is examined elsewhere.

12. This public-good aspect of hydrographic services appears to be recognised worldwide. Whilst a study of overseas practices shows about every possible permutation between Navy doing the surveying and the use of private contractors, everywhere the responsibility for general hydrographic services is seen as that of the central government.

The Issue of Externalities

13. In economic parlance an externality is a cost or benefit which does not appear in the supply or demand curves. Whilst this may be succinct it has little meaning to a layman. Basically an externality is a cost or benefit which does not accrue to the person or institution carrying out the action. For example if I am in the habit of planting trees in my garden this may well give pleasure to my neighbours to see a leafy street but they have not had to pay any money or expend any resources to achieve this benefit. Likewise if I am in the habit of dismantling old cars on the front lawn it may be a profitable business for me but may result in negative externalities to my neighbours who see the area littered with rubbish and who may experience a drop in the value of their houses.

The Concept of a Ment Good

14. Whilst it would be impossible to find a trained economist to seriously argue against the validity of the concept of a public good (although many would argue over individual applications of the concept) the concept of a 'merit good' is a little less accepted, and with good reason. Examples of merit goods are usually given as compulsory education or restrictions on cigarette advertising. In other words governments feel that consumer sovereignty (the right to spend one's money as one chooses) should be negated. It can also be described in terms of 'the Government knows best'.

15. The problem is that the concept of a merit good quickly either becomes purely subjective or really becomes part of more rigorous concepts such as an 'externality'. For example one pensons merit good is another's unjustified subsidy. Likewise if a child does not receive basic education, his future employment prospects will be minimal and thus he will be a drain on society. If people continue to smoke then they will require increased medical resources in later life and their contribution to society will be less. These are really examples of negative externalities.

16. Nevertheless some writers such as Hoogsteden have chosen to state that mapping is a merit good (1988, Vol. 1).

17. In short, while there is general agreement about what characterises a 'public good', a 'merit good' is anything that an individual chooses it to be.

18. That is why the concept of a merit good has not been used in this paper.

The Issue of Consumer Surplus

19. Consumer surplus is simply the difference between what an individual or group of consumers pay for a good or service and what they would have been prepared to pay. Naturally a wise seller will try to minimise this and the wise buyer to maximise it. This aspect is of particular importance when assessing public goods.This is because, for reasons explained earlier, it is difficult to obtain the true value of such goods or services from market data. One method which has been used to try and ascertain this value is the use of surveys.

Surveys

20. One technique that has been used to ascertain the consumer surplus for public goods has been the use of surveys of users. This was done by Lidding (1971) and Hoogsteden (1988). However, such a course of action is fraught with difficulties. There are basically two types of surveys in this context. Interviews and postal surveys. The return rate for postal surveys is, characteristically, never more than 30 per cent when it is on a voluntary basis. A recent survey of Australian industry on contracting matters yielded a return rate of some 17 per cent and it was difficult to get statistically valid results in many categories. The 'Hite Reports' which claim to give results on human relationships have a return rate of 4.5 per cent. The problem here is not only that there may be a shortage of information but that the voluntary returns may not reflect the position of the whole population.

21. This is why the Australian Bureau of Statistics has the right, which it enforces, to compel people to answer the questionnaires that it distributes. The object is to ensure that the replies of the returns reflect the situation of the population as a whole.

22. In a voluntary survey the replies tend to be biased towards those people with strong views on a subject.

23. Interviews as a survey method also have their drawbacks. Hoogsteden reports (1988, p. 198) that although a considerable amount of time was spent arranging and preparing for this type of interview the approach was abandoned. This was because the sample of high-ranking officials from government departments who were interviewed could only give general unquantified opinions. This was despite the fact that they were interviewed for more than an hour each.

24. Another and equally serious problem about doing surveys of consumer surplus, basically how much people would be prepared to pay, is that respondents may deliberately minimise or exaggerate the consumer surplus that they report, even when they know in their own minds what it is. This is known as strategic answering. If a respondent thinks that there is a definite chance that the price of the good in question will undergo a rise in price towards what he states he would be prepared to pay if necessary, then he has an incentive to mark down that price. On the other hand he may consider that there is no real likelihood of an increase in price but that the Government is seriously considering a reduction in the good or service. He then has an incentive to inflate the value in the hope that the subsidised service is continued at existing or higher levels.

25. A further distortion can occur when there is a close link between the surveyed and the organisation carrying out the survey. For example a recent Defence survey of organisations which needed export permits under COCOM guidelines resulted in nothing less than a large number of eulogies directed towards Defence — the reason being that the firms wanted to ensure that they continued to receive reasonably prompt

export approvals and did not want to get offside with the bureaucrats running the survey. Likewise a consumer who was pleased with services received may exaggerate his consumer surplus in the survey as a gesture of thanks.

26. This is not to say that any consideration of a survey should be abandoned with a suitable gesture of despair but that there are major difficulties involved, especially when there are people who are determined not to believe the results, no matter how objectively the study was conducted (see opening quote).

ABBREVIATIONS AND ACRONYMS

BTE	Bureau of Transport Economics, later to become the Bureau of Transport and Communication Economics
COCOM	Common Committee on Exports
BTCE	Bureau of Industry and Communication Economics
DCP	Defence Cooperation Program
GBRMPA	Great Barrier Reef Marine Park Authority
IC	Industry Commission, formerly known as the Industries Assistance Commission
GPS	Global Positioning System
IAC	Industries Assistance Commission
IHO	International Hydrographic Organisation
QCTPS	Queensland Coast and Torres Straits Pilot Service
SCAR	Scientific Committee on Antarctic Research

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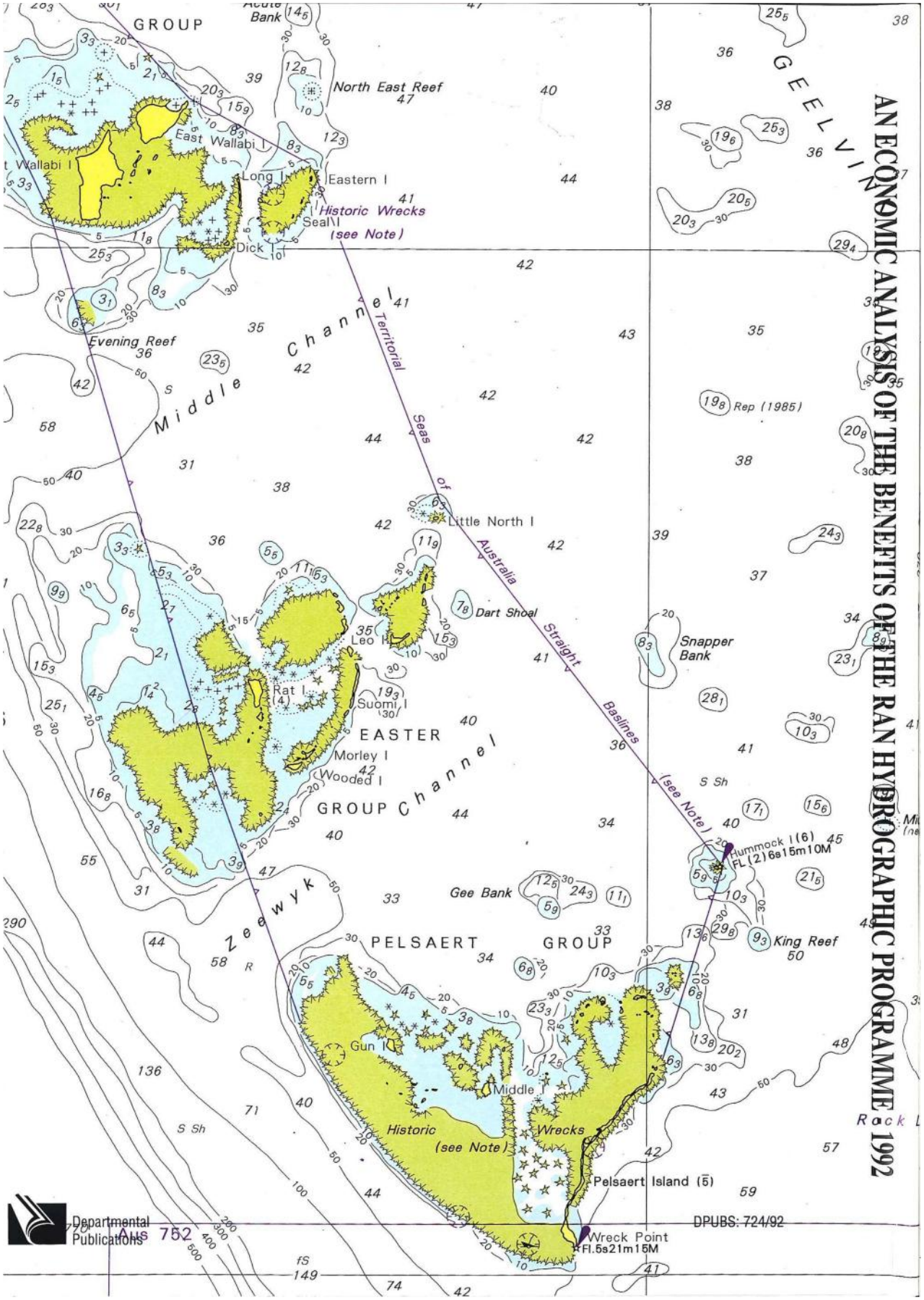
GROUP
Acute Bank
North East Reef
East Wallabi I
Long I
Eastern I
Historic Wrecks
(see Note)
Seal I
Dick I
Evening Reef
Middle Channel
Territorial Seas of Australia Straight Baselines (see Note)
Little North I
Dart Shoal
Leo I
Rat I (4)
Suomi I
Morley I
Wooded I
EASTER GROUP Channel
Zeewyk
Gee Bank
PELSAERT GROUP
Gun
Middle
Historic Wrecks (see Note)
Pelsaert Island (5)
Wreck Point Fl.5s21m15M
Hummock I (6) FL (2)6s15m10M
Snapper Bank
King Reef
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AN ECONOMIC ANALYSIS OF THE BENEFITS OF THE RAN HYDROGRAPHIC PROGRAMME 1992
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