

**The Economic Value of Australia's Estuaries:
a scoping study**

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INTRODUCTION

This paper is in the form of a scoping study. It reports on the estimated value of Australian estuaries for a number of estuarine dependent and estuarine opportunist commercial fisheries, the estimated value of a number of recreational fisheries as well as an estimate of the value of a number of large ports located on estuaries around Australia. These estimated values have relied entirely on published information about landed commercial fish catches, expenditure on recreational fishing at specific locations as well as the value of port infrastructure. The study was not intended to be complete, rather, it was undertaken to provide some indicative information for the Estuary Audit about the order of magnitude of the value of Australia's estuaries. It is intended that a more comprehensive study will be undertaken in the near future that will adopt more rigorous research techniques utilising the available scientific information about the environmental services provided by estuaries and will embark on primary data collection and community survey work.

Estuaries are described by the Derwent Estuary project website (<http://www.derwentriver.tas.gov>) as partially enclosed bodies of water formed where fresh water from rivers and streams flows into the ocean, mixing with salty seawater. These areas are transitional areas between land and sea that are typically provided with some protection from the vagaries of the ocean by geographical barriers such as reefs, islands, and sandy spits. For the purpose of the Estuary Audit, areas that would normally be classified as bays are included as estuaries. These include Shark Bay in Western Australia and Port Phillip Bay in Victoria.

There are two distinct forms of capital assets associated with estuaries. The first is the natural capital of the estuaries themselves which are comprised of a number of ecosystems providing services such as habitat, spawning and nursery areas for fish, habitat and breeding area for birds and native animals, nutrient cycling and water filtration. The quality of the natural capital provided by estuary ecosystems is dependent on the maintenance of the ecological health of estuaries where modification by human development does not degrade the natural capital. Information about the value of estuaries as natural capital assets is important because it tells us whether the ecosystems they provide are worth preserving. For example, what is the natural capital of Moreton Bay? What are the ecosystems supported by the natural capital and what is the value of the goods and services provided by these ecosystems? Is the natural capital worth preserving by undertaking capital works and implementing management strategies? For the most part, this information is, as yet, largely unavailable.

The second form of capital is human made capital assets located within an estuary to take advantage of the natural assets provided by estuaries, including sheltered deep water for shipping movement, protected shoreline for industrial and urban development, effluent disposal and dispersion and natural beauty for locating tourist activities. For the most part, human made capital assets located in estuaries require at least some and frequently substantial modification of the natural environs. For

example, port facilities require considerable dredging of estuaries to facilitate shipping movements. Some forms of human-made capital, such as port facilities, can operate without a healthy ecosystem and in fact can be responsible for damaging the ecosystem to the detriment of both natural capital as well as other human-made capital assets such as tourist resorts.

The natural capital provided by ecosystems within estuaries include wetland areas encompassing tidal forests (mangroves) and tidal marshes, Melaleuca swamps and floodplains, tidal mudflats, seagrass and algal beds, sandy beaches, rocky shores and the estuary floor. All of these ecosystems provide goods and services, some of which are directly or physically used by people, for example fisheries and recreational activities, and others that are indirectly used, for example nutrient cycling. In addition, there are a number of services provided by ecosystems that are valuable for their non-use benefits. Non-use benefits may be obtained from environmental resources without actually using them. These include existence value, option value, bequest value and vicarious value.¹

Information about the monetary value of the natural capital and the goods and services provided by estuaries is limited because they are not routinely marketed. Valuing the goods and services provided by estuarine ecosystems requires the total economic value (TEV), including use benefits as well as non-use benefits, to be valued. There is a real danger that if no quantitative measure of the value of the natural capital provided by estuaries is available, then it could be perceived that they have little or no value to society and can therefore be modified to establish human made capital such as port facilities, urban residential development and industrial development.

Attempts have been made to estimate an economic value of the world's ecosystem goods and services provided by natural capital (Costanza *et al*, 1997). Costanza *et al*. estimated the value of estuaries to be \$A39,000/ha/yr. This estimate is acknowledged to be constrained by the level of scientific information and the availability of valuation studies accessible at the time and because this estimate concentrates on the use values rather than the non-use values.

Environmental management requires information to be provided by scientists to verify the extent and magnitude of perceived resource degradation. However, this information is not necessarily sufficient for government agencies to take action to avoid, reduce or minimise the degradation risks. Information is required that would determine if the expected benefits from taking action are at least equal to the costs. Specifically, if a trade-off is required, then what is the value of the natural capital we are trading?

¹ Existence value is the value of simply knowing that a resource exists, bequest value is the value of knowing that a resource will be available for future generations and option value is the value given a resource when there is a risk associated with future supply and demand. It is the amount of money an individual is willing to pay to ensure that a resource is available for use in the future. Vicarious value is the value received from being a part of someone else's experience with the resource such as the value from watching a documentary on wildlife.

This section identifies and values in monetary terms examples of some of the goods and services provided by both the natural and human capital of estuaries. In an ideal world this research would have been undertaken by first outlining a theoretically sound approach to identifying all of the goods and services provided by estuaries. The valuation exercise would ideally use comprehensive primary data sources supplemented with information using extensive survey work, particularly with respect to valuing the those goods and services not traditionally marketed including the biodiversity provided by estuaries. Time and resource constraints have restricted this study to indicative information. It merely serves to provide an indication of the magnitude of a sample of the values of production and use from natural and human-made capital found in estuaries. It does not claim to be comprehensive.

With respect to the goods and services provided by natural capital, this study reports only the value of a production from number of commercial fisheries and the value of expenditure on recreational fishing with minimal discussion provided on the value of biodiversity. With respect to human-made capital, this study has confined itself to providing examples of the value of infrastructure that has arguably had the greatest visible and biological impact on estuaries, the ports. Where appropriate, information has been provided on reduced, or conversely increased, size of catch over a period of time. Although this information is interesting, it is not possible to form any conclusions as changes in catch could simply be due to variability in weather conditions or to fishers moving to another site. More meaningful interpretation of change in fish catch would be possible if information about catch per unit effort were available. For this study, this information has not been accessed.

ESTUARINE COMMERCIAL FISHERIES

For the purpose of this report, estuarine commercial fisheries (both fish and crustaceans) in Australia have been classified as being estuarine dependent or estuarine opportunist. Estuarine dependent commercial fisheries in Australia, defined as fisheries where the fish or crustaceans, as the case may be, are critically dependent on the estuarine environment for the survival of the species, include prawn fisheries such as the Northern Australian Prawn fishery, oyster fisheries such as the Sydney Rock oyster which is a native species of oyster located along the eastern seaboard as well as the barramundi fishery and mud crab fisheries along the north east coast and the Gulf of Carpentaria. Because these fisheries are dependent on the ecosystem habitat provided by estuaries, such as mud flats, tidal forests and sea grass, their continued survival is dependent on estuaries remaining largely unmodified.

Potter and Hyndes (1999) define estuarine opportunist fish, including such fish as Trevally and crustaceans such as spanner crabs, as those that spend at least a part of their life cycle, particularly as juveniles, in an estuarine environment but could equally use protected marine waters as nursery areas. These fisheries include some species of crab, the Australian Herring, the Australian Salmon and Whiting. Because

these fish or crustaceans are not critically dependent on habitat areas provided by estuaries, their continued survival is not as threatened by the modification of estuaries. Because the definition of estuaries for the audit is somewhat liberal, including a number of bays such as Shark Bay, Hervey Bay and Port Phillip Bay, the species specified here as estuarine opportunist is somewhat broad.

Estuarine dependent commercial fisheries

Table 1 provides summary information about the value of production from a number of fisheries that are estuarine dependent for each state of Australia as well as for Commonwealth fisheries. The information is not exhaustive but serves to provide an indication of the value of a number of important fisheries. The total value of the fisheries considered here is estimated to be approximately \$432m per annum.

Oyster Fisheries

Oyster fisheries are estuarine dependent. High quality water is critical to the edible oyster industry. For the most part, this fishery is located in estuaries that have not been substantially altered by human settlement and where the water quality is of a high standard. The NSW oyster industry, valued as landed catch (excluding transport, processing, marketing and retailing of the product), is estimated to have been worth approximately \$29m in 1999-2000. Production between 1997 and 2000 is estimated to have declined slightly by 350 tonnes between 1997 and 2000. Exports from the industry are negligible whilst imports of edible oysters have been steadily increasing since 1995 to 660 tonnes in 2000, mostly sourced from New Zealand (estimated to be worth over \$5m) (ABARE, 2001). The increase in imports of oysters is a matter of some concern if this is due to a failure of producers to meet domestic demand due to reduced habitat. In South Australia and Tasmania, oyster fisheries produce Pacific Oysters, an introduced species. The Pacific Oyster industry is estimated to have been worth approximately \$21m in 1999-2000. The value of this industry has increased by over \$7m since 1998 (ABARE, 2001).

Prawn fisheries

Production of prawns from the Northern Australian Prawn fishery, the largest wild-harvested prawn fishery in Australia, is estimated to have been worth over \$107m in 1999-2000. Production has declined from 8,912 tonnes in 1997-98 to 5,605 tonnes in 1999-2000 (ABARE, 2001). Prawn fisheries are especially reliant on estuarine habitat areas, particularly tidal forests and mud flats, for spawning and for the development of juveniles and on substantial fresh water flows to flush adult prawns into marine areas for commercial harvesting. Native harvested prawn fisheries are located all around the Australian coastline with significant catches from Western Australia, Queensland, New South Wales and South Australia.

In Queensland, the volume and value of wild harvested prawns has declined from approximately 8,000 tonnes in 1997-98 to 6,187 tonnes in 1999-2000 worth \$75m. This reduction in wild catch contrasts significantly with production from aquaculture

which has risen from 1,697 tonnes in 1997-98 to 2,500 tonnes in 1999-2000 (ABARE, 2001).

In Western Australia, wild catch prawn fisheries were estimated to be worth over \$76.7m in 1999-2000 with over half of this sourced from the Shark Bay Prawn Fishery and from the Exmouth Gulf Prawn Fishery, producing King and Tiger prawns which are mostly exported. Both of these fisheries are managed with spatial and temporal closures to protect spawning stock levels and catch sizes (Fisheries Western Australia, www.wa.gov.au/westfish/sof/1999).

The value of prawn fisheries in NSW, producing King Prawns, School Prawns and Other Prawns is estimated to have been worth nearly \$24m in 1999-2000 and in South Australia the catch is estimated to have been worth \$43m in 1999-2000 (ABARE, 2001).

In 1998-99, Australia imported \$143m of prawns, over half of this coming from Thailand. Over the same period, Australia exported \$242m of prawns sourced from both wild and aquaculture fisheries (ABARE, 2001).

Barramundi

Barramundi caught in the wild by commercial fishers are sourced exclusively from the Northern Territory and Queensland. Barramundi are a catadromous species growing to maturity in the upper reaches of freshwater rivers and streams thriving in ecosystem habitats that are largely unmodified. Because adults move downstream to estuaries and coastal waters for spawning it is important that their movement is not hindered by in-stream water structures such as dams or barrages. It is reported that specimens captured from clean estuarine waters make excellent table fish. However, the quality of the flesh from specimens that have been captured in turbid and muddy water is less reliable (<http://www.nativefish.asn.au/barramundi.html>). The wild harvested Barramundi fishery is estimated to have been worth nearly \$11m in 1999-2000, (\$4.5m from the Northern Territory and over \$6m from Queensland). Production from this fishery is indicated to have been steadily increasing from approximately 1,300 tonnes in 1997-98 to 1,745 tonnes in 1999-2000 (ABARE, 2001). Barramundi is one of the most popular fish targeted by recreational fishers with over a third again of the commercial catch caught by recreational fishers. Recreational fishers are dealt with below.

Crabs

A number of species of crab are estuarine dependent. These include mud crabs and blue swimmer crabs (sand crabs). In NSW and South Australia, commercial crab production in 1999-2000 was valued at over \$3m, in Queensland it was worth \$19.5m and in Western Australia it was worth \$4m. Only in Queensland and the Northern Territory has the catch increased since 1997-98. The mud crab fishery is the Northern Territory's largest wild harvest commercial fishery, valued at over \$10m in 1999-2000 (ABARE, 2001; DPI and Fisheries (NT); DPI (Qld)).

Table 1 Estimated value of estuarine dependent commercial fisheries, 1999-2000

<i>Fishery</i>	<i>Queensland</i>	<i>NSW</i>	<i>Western Australia</i>	<i>Northern Territory</i>	<i>Tasmania</i>	<i>South Australia</i>	<i>Victoria</i>	<i>C'wealth Fishery</i>
Oysters	\$0.65m	\$28.8m	-	-	\$13m	\$9.3m	-	
Prawns	\$75m	\$24m	\$76m	-	-	\$43.7m	\$1.3m	\$107m
Barramundi	\$6m	-	-	\$4.5m	-	-	-	
Crabs	\$19.5m	\$3.4m	\$4m	\$12m	-	\$3.4m	-	

Source: ABARE, 2001

Estuarine opportunist commercial fisheries

The value of production from fisheries that use the protection of estuaries, but are not totally dependent on the conditions offered by estuaries is substantial. This valuation of commercial fisheries depends heavily on statistics provided by ABARE Fisheries. There are two notable shortcomings with reliance on this source. The first is that ABARE only publish specific species information about the more valuable commercial fisheries so that there are many species of fish that are not individually identified, such as Flathead. The second shortcoming is that ABARE Fisheries statistics adopt the common name for fish rather than the biological name. In so doing, the estimates of fish catches could be adopting a common name that is not necessarily compatible with the biological name and which has a different local name in another state, for example the jewfish. A summary table of the aggregate value of commercial estuarine opportunist fisheries in each state is provided below. The total value of the fisheries considered here is estimated to be approximately \$40m per annum.

Lenanton and Potter (1987) estimated that in temperate Western Australia, estuarine opportunist commercial fisheries were worth \$3.7m per annum. In Western Australia, these fisheries include Cobbler, Sea Mullet, Yelloweye Mullet, Australian Herring, Australian Salmon and Whiting. In 1999-2000 these fisheries are estimated to have been worth \$4.5m (ABARE, 2001).

In Queensland, these fisheries include Bream, Mullet, Snapper, Tailor and Whiting valued at \$5m to commercial fishers in 1999-2000. Production from these fisheries in 1999-2000 has declined by almost 50% since 1997-98.

Estuarine opportunist commercial fisheries in NSW include Black and Yellowfin Bream, Australian Salmon, Rubberlip Morwong, Snapper and Sand Whiting. In 1999-2000 these fisheries were valued at \$6m. As was the situation in Queensland, the tonnage of harvested fish has declined substantially since 1997-98, from 1,039 tonnes to 742 tonnes in 1999-2000.

Victorian commercial fisheries that are estuarine opportunist, including Bream, Australian Salmon, King George Whiting, Pilchards, Snapper and Sea Garfish, have remained relatively stable over the period 1997-2000, valued at \$5.2m in 1999-2000.



Estuarine opportunist commercial fisheries in South Australia include the Australian Salmon, Mullet, Australian Herring, King George Whiting, Yellowfin Whiting, Pilchards, Snapper and Garfish. These fisheries were estimated to be worth over \$14m in 1999-2000.

Production in Tasmania from estuarine opportunist commercial fisheries, including Australian Salmon, Garfish, varieties of Morwong and Trumpeter fish as well as School Whiting were valued at \$1.5m in 1999-2000. Catches have remained relatively stable between 1997-98 and 2000.

In the Northern Territory, estuarine opportunist commercial fisheries are include Jewfish, Snapper and Threadfin Salmon valued at \$2m in 1999-2000.

Table 2 Estimated value of estuarine opportunist commercial fisheries, 1999-2000

State	Western Australia	Queensland	New South Wales	Victoria	South Australia	Tasmania	Northern Territory
Value of Fishery	\$4.5m	\$6.2m	\$6m	\$5.2m	\$14m	\$1.8m	\$2m

Source: ABARE, 2001

RECREATIONAL FISHERIES

Fishing authorities around Australia have only recently begun to collate reliable statistics on recreational fishers to include the number of days spent fishing per annum, the nature of the catch, the location of the catch as well as information about expenditure on this popular leisure activity. It is important to note at the outset of this section that recreational fisheries are valued here as expenditure on the activity of fishing for recreation and should not be compared with the value of commercial fisheries, valued on the basis of production.

A survey of Queensland residents was undertaken in 1997 and was repeated annually thereafter (<http://www.dpi.qld.gov.au/fishweb/>). The survey revealed that approximately 33% of Queensland's households had at least one member who had engaged in recreational fishing at least once over a 12 month period. It was further found that 60% of the catch was sourced from estuaries. Fishers are estimated to spend approximately \$1,000 per annum on their fishing activities, including tackle, boats, travel and accommodation. Using these estimates, the contribution to the Queensland economy from individual fishers is approximately \$880m with \$528m of this attributable to fishers in estuaries.

One of the most important target fish for recreational fishers in North Queensland is the Barramundi fishery. Of the estimated 867 tonnes of Barramundi caught by commercial fishes in 2000, an additional 289 tonnes is likely to have been caught by recreational fishers (Rutledge *et al.*, 1990). According to Rutledge *et al.*, fillets of Barramundi are worth considerably more to a recreational fisher than to a commercial fisher. Estimates of the direct cost or expenditure for recreational fishers fishing for Barramundi, including travel costs, suggest a value of approximately \$51 per recreational fish and approximately \$19 per commercial fish (assuming the fish to weigh approximately 3kg). The study goes further, and estimates the flow-on or multiplier effects to the state and regional economies in Queensland from recreational Barramundi fishers to be approximately three. According to Rutledge *et al.*, a single Barramundi caught by a recreational fisher could be worth \$153 to the economy of Queensland. This suggests that the recreational fishing of Barramundi in Queensland is estimated to be worth in the vicinity of \$22m per annum.

However, these estimates are somewhat inflated. Rutledge *et al.*, did not provide sufficient detail about the source of expenditure by recreational fishers, specifically, what part of expenditure was directly transferable to government as taxes or charges or what part of expenditure by fishers was on imported goods and services. In addition, a multiplier of three is quite significant and as Rutledge *et al.*, indicated that a previous study by Hundloe (1985) had suggested a multiplier of two for a regional economy in North Queensland, this figure might have been more appropriate than a multiplier “borrowed” from an economy that may not bear any resemblance to the Queensland economy. Typically, expenditure by fishers on locally produced goods and services, net of taxes and charges, is only 50% of actual expenditure (West, 1993). This being the case for recreational Barramundi fishers, and adopting the more conservative multiplier, recreational Barramundi fishing in Queensland would be worth in the vicinity of \$15m per annum.

Two recent surveys of recreational fishers have been undertaken, one in Hervey Bay and the Great Sandy Straits area and the other in the Pumicestone Passage region (Murphy, 2000; 2001). Murphy estimates that fishers spend \$38m to go fishing in the Hervey Bay and Great Sandy Straits area whilst fishers visiting the area are estimated to spend an additional \$102m on accommodation. These estimates are for direct expenditure and do not include expenditure on capital such as boats, trailers or boat storage facilities. When the direct expenditure is considered together with the flow-on effects to the regional economy, assuming that 50% of the expenditure is sourced locally and an output multiplier of two, then the total impact on output in the region is considerable.

In the Pumicestone Passage region of south east Queensland, recreational fishers are estimated to spend \$8m per annum on fishing associated items (Murphy, 2000).

In the Northern Territory, a total of 430,000 days are fished annually by recreational fishers responsible for an estimated \$30m per annum of direct expenditure (DPI and Fisheries, NT). Information is not available to identify what part of the catch was sourced from estuaries. As for the estimates of flow-on benefits to the economy from Barramundi fishing, this level of expenditure needs to be considered in terms of what proportion of this stays in the regional economy.

Western Australia’s recreational fisheries are claimed as a major community asset and are estimated to contribute over \$500m a year to the State’s economy (Fisheries Western Australia, 2001. <http://www.wa.gov.au/westfish>). About 600,000 people or 34% of the population are estimated to fish. The coastal area between Kalbarri and Augusta attracts the highest level of recreational activity in the State with around 380,000 anglers responsible for a catch of approximately 400 to 500 tonnes per annum, mostly sourced from the Peel-Harvey Estuary.

Direct expenditure by recreational fishers in the Gascoyne Coast bioregion on the central Western Australian Coast is estimated to be in the order of \$50m per annum. This industry, together with tourism is the biggest industry in the region. According

to the Australian National Sportfishing Association (2001), the recreational fishing industry in Australia is worth over \$2.9bn per annum (<http://www.ansa.com.au>). It is likely that over 60% of this will have been sourced from estuarine fisheries. The value of expenditure on recreational fishing in Australian estuaries, excluding flow-on impacts, is in the vicinity of \$1.7bn per annum. It should be noted however, that estimates of expenditure on recreational fishing encompass the total experience of taking a holiday where recreational fishing is available as well as the expenditure on actual fishing trips.

THE VALUE OF BIODIVERSITY

The diversity of flora and fauna found in estuarine environments around Australia is enormous. However, no studies have been undertaken to estimate what this is worth to society. Biodiversity is an example of existence value or bequest value, where biodiversity it is not used, either directly or indirectly, but it still has a value to society. Biodiversity has a value to society in terms of the option to visit areas where a variety of flora and fauna, or more specifically, endangered species exist as well as a value in simply knowing that different species of plant and animal life exist. The loss of biodiversity is identified by the State of the Environment Advisory Council (SEAC) (1996) as one of the most serious environmental problems in Australia. The Council claims that the stockpile of genetic diversity can be crucial defence against predators or disease. It is outside the scope of this valuation exercise to identify the economic value of the biodiversity offered by estuarine environments. However, there are a number of species of mammals, fish and birds that have been identified as being “at risk” either as a result of estuarine environments being modified or because these species have been fished close to extinction. Estimates are provided of the value of visitor expenditure to Hervey Bay where there are rare or endangered species, including Humpback Whales and Dugongs, to enable some observations to be made about the potential value to the economy of other areas with rare species requiring protection.

It is estimated that in 1999 approximately 75,000 people visited Hervey Bay on Queensland’s central coast to watch the Humpback Whales. Using statistics on visitor expenditure and length of stay in the area from the Bureau of Tourism Research (BTR), it is estimated that expenditure by visitors on whale watching in 1999 could have been in the vicinity of \$12m. In addition to this direct expenditure there would be significant flow-on impacts on the regional economy to help service the accommodation, travel and services required by these visitors.

The Derwent River in southern Tasmania hosts two species of animal, the Spotted handfish and the southern right whale that are likely to be of interest to visitors. The Spotted handfish (*Brachionichthys hirsutus*) is found only in the lower Derwent Estuary (southern Tasmania) and adjoining bays and channels. Although considered “common” until the early 1980s, recent CSIRO surveys have located only three small and restricted colonies (<http://www.dewentriver.tas.gov.au>). The cause of the decline

may include the loss of critical habitat due to increased sediments and degradation of water quality. All species of handfish are protected under the *Commonwealth Endangered Species Protection Act 1992*.

Also in the Derwent Estuary, is the southern right whale (*Eubalaena australis*). This species once used the sheltered bays and estuaries around south east Tasmania for calving grounds. This species of whale was present in large numbers in the estuary until the 1980s when it had been hunted to the edge of extinction. This species is also protected under the *Commonwealth Endangered Species Protection Act 1992*.

Another marine mammal that could be of interest for ecotourism is the Dugong. Dugongs (*Dugong dugon*) are found along the Red Sea, around the Solomon Islands and along the Pacific Coast of Australia. Worldwide, the species is listed as being vulnerable to extinction (1996 ICUCN) (http://www.gbrpa.gov.au/corp_site/info/services/publications/dugong.html). Dugongs feed only on seagrass meadows and are therefore vulnerable to loss of this critical habitat that is threatened from increased sediment loads from land-use activities. In addition, fishing nets, particularly those belonging to commercial fishers have been cited as being responsible for Dugong deaths. It is interesting to note that although Dugongs are not listed as endangered by Environment Australia, the Great Barrier Reef Marine Park Authority (GBRMPA) have recognised a threat to the species and have taken action to protect it within the marine park. Again, as for the southern right whale and the spotted hand fish, these species are worth preserving for the potential or option value they represent to society.

INDIGENOUS FISHING

Information about the volume of fish caught in estuarine areas by the indigenous populations Australia is not available. The National Recreational and Indigenous Fishing Survey has been commissioned with the results expected to be released in early 2002 (<http://www.dpie.gov>).

HUMAN-MADE CAPITAL LOCATED IN ESTUARIES

Human-made capital located on estuaries has taken advantage of the function of these areas to provide for deep and sheltered anchorage as well as for natural beauty.



The port infrastructure and annual revenue

An important use of estuaries is as ports for shipping, handling transport of exports and import, both from or to overseas and interstate sources or destinations, of much of the output from agriculture, manufacturing and mining sectors. The location of large ports on estuaries has required often substantial dredging of the estuary to facilitate access for large shipping. In addition, industrial waste from shipping has, in the past severely damaged the estuarine environment.

Ports are located around the Australian coastline with the largest sited close to the state capitals. Table 3 provides summary information about the estimated value of infrastructure, including property, plant and equipment held by a number of port authorities in Australia as well as the operating revenue of these authorities during the year 1999-2000.

Table 3 Value of infrastructure and operating revenue for a selection of Australian Ports, 1999-2000

Port Authority	Operating Revenue (\$m)	Property, Plant and Equipment (\$m)
Sydney Port Authority	107	485
Melbourne Port Corporation	77	535
South Australian Port Authority	38	85
Fremantle Port Authority	55	88
Port Hedland	12	162
Port of Brisbane Corporation	79	480
Gladstone Port Authority	86	294
Hobart Ports Corporation	16	52
Darwin Port	6	56
TOTAL	476	2,237

Source: Annual Reports 1999/2000 Port Authorities, various

Not all of the ports in Australia are included in the table above. However, the information provides an indication of the value of investment in port infrastructure located on a number of estuaries around Australia.

Port Melbourne is the biggest port in Australia, with an investment of over \$535m in property, plant and equipment. The port handles \$50bn of trade annually for which it received payments totalling \$77m in 2000 and is estimated to contribute \$5bn per annum to the Victorian State economy in direct and flow-on benefits (Melbourne Ports Corporation, 2001 (<http://melbport.com.au>)).

The value of foreign trade handled at Queensland ports exceeds \$14bn per annum with marine-based tourist activities estimated to be in excess of \$5bn per annum. The Port of Brisbane Corporation has strived to establish the image of a “green port” and was the first port management in Australasia to receive ISO 14001 environmental accreditation. This accreditation is also held by the Fremantle Port Authority.

Darwin Port is poised to become a major gateway to northern trade routes with the construction of the Adelaide to Darwin railway as well as the development of the Timor Sea gas fields. Currently, the port is not only responsible for marine industry and naval support, but also for tourism and recreational facilities.

For the most part, a review of policy statements from the authorities managing these ports indicates that all of these ports are conscious of the need to improve their environmental image and use expressions such as “meeting the triple bottom line” for investment criteria as well as “community consultation” to develop future management plans.

The value of the ports around Australia is substantial. Substitution of many of the services offered by shipping transport is not available so that these facilities can be



regarded as being asset specific and as such provide a service to the Australian economy that is far beyond the value of infrastructure and annual revenue.

CONCLUDING COMMENT

This economic valuation of estuaries has concentrated on two areas, the value of fisheries resulting from the natural capital provided by estuaries and on the value of ports as taking advantage of the facilities provided by estuaries. Whilst fisheries flourish in an unmodified environment, for the most part, ports require the natural environment to be modified to some degree.

Production from estuarine dependent and estuarine opportunist commercial fisheries is estimated to have been worth \$432m and nearly \$40m respectively in 1999-2000 to the Australian economy, excluding the value-added for cleaning, marketing and distribution of the product as well as the expenditure on boats and equipment.

Information about recreational fisheries, in this report expenditure on fishing activity, cannot be quoted with the same degree of confidence as is the case for commercial fisheries. Information from authorities in some states of Australia is incomplete or simply not provided. However, for those states where information about recreational fishers is available, Queensland, Western Australia and the Northern Territory, the value of direct expenditure on recreation fisheries in estuarine areas is significant, \$1.06bn (\$528m in Queensland, \$30m in the Northern Territory and \$500m in Western Australia). This would appear to be within the expenditure estimate of \$2.9bn from the Australian National Sportfishing Association.

The infrastructure, property, plant and equipment, for a number of major ports located in estuaries around Australia, is valued at over \$2bn in 1999-2000 and the annual revenue from these ports is estimated to be nearly \$500m per annum. Again, if ports were valued on the basis of the value of cargo passing through the port, then this estimate would be substantially larger.

Both of these activities, fishing and shipping transport make significant contributions to the Australian economy.

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