AN INVENTORY OF IMPEDIMENTS TO TIDAL FLOW IN NSW ESTUARINE FISHERIES HABITAT

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ABSTRACT

Tidal flow is thought to be an important consideration in the maintenance of fish habitat, particularly nursery habitat. To assess the presence of structures which impede tidal flow in New South Wales, a special project was initiated in mid 1994 which collected anecdotal and field data. The former were collected via a questionnaire sent to oyster farmers and fisheries officers, while the latter were preceeded by the inspection of 148 1: 25 000 topographic maps. The presence of bridges, culverts, causeways, fords, weirs and floodgates were noted on the maps. Nearly 4230 structures located in the tidal zone were considered for their remediation potential, and we suggest 1388 are candidates for change. The majority of the candidate structures are floodgates, almost 50% of which occur in three north coast rivers. The information obtained in this inventory has important implications for habitat managers and researchers in NSW and the other Australian states.

INTRODUCTION

It is well established that coastal wetlands provide habitats for many species of fish (e.g., in regard to mangroves see Hutchings and Saenger 1987). Decline in area of these wetlands has been described as an important constraint on the harvest of wild fish (Middleton *et al.* 1985), with concern having been expressed for both the commercial (MacDonald 1992) and recreational fishing sectors (National Recreational Fisheries Working Group 1992).

While West *et al.* (1985) identified the area of seagrass, mangrove and saltmarsh present in NSW estuaries in the early 1980s, there are no figures which set out the *total* amount of coastal wetland habitat in NSW, much less on how this habitat has changed through time. Goodrick's valuable contribution (1970) estimated a 60% loss in the high value coastal waterfowl wetland habitat of NSW (from 265 km^2 to 164 km^2) during the 200 years following European settlement. These losses were due in large part to agricultural and urban activities. The degree to which Goodrick's figures are applicable to fisheries habitats, in terms of area lost, or in terms of functional loss, is unknown.

While no recent attempts have been made to update Goodrick's estimate, or generate more broadly based figures for other types of coastal habitat in NSW, the early 1990's saw an upswing in global interest in restoration of degraded aquatic habitat. In 1992 the International Wetlands and Waterfowl Research Bureau of Europe formed the Specialist Group on Wetland Restoration (de Jong, in prep.) In the same year in North America, the U. S. National Research Council received the recommendations of its Committee on Restoration of Aquatic Ecosystems (NRC 1992). Joining these initiatives, the loss of fish habitat was addressed by the Australian Society for Fish Biology at its special habitat conference in 1992 (Hancock 1993), where it was recognised (e.g., Burchmore 1993, Morton 1993) that damage caused to wetlands could be mitigated. Mitigation may involve rehabilitation (putting back into good condition or working order, i.e., functional repair), restoration (return of an ecosystem to a close approximation of its condition prior to disturbance, i.e., structural and functional repair), or may also involve the creation of new habitat (bringing into being of an ecosystem that previously did not exist on the site; NRC 1992). However, before initiating mitigation activities, it is important to have a methodology which: i) describes the extent and degree of wetland degradation, ii) determines the most cost-effective ways by which modifications can be carried out, and iii) monitors the effects of any changes.

To assist in developing a mitigation methodology that would be appropriate for southeastern Australia, in 1991 NSW Fisheries set up the Kooragang Wetland Rehabilitation Project (KWRP) to focus on

the degraded habitats of Kooragang Island in the lower Hunter River (Svoboda 1996, Streever, in press). One aspect of the study was the investigation of the fish and fisheries habitats of the western portion of the island. On the basis of the work done so far, it appears that the reduction of wetland habitat is related to structures which impede tidal flow, particularly the roadworks and culverts installed to facilitate land transport around the island by the early farmers and graziers (Williams *et al.* 1995).

As there is little knowledge about the number and distribution of structures such as culverts that effect tidal flow along the coast of NSW, we wanted to determine how common the restrictions seen on Kooragang Island were in other NSW coastal waterbodies. To achieve this objective, we collected anecdotal information from individuals working in estuaries, inspected topographic maps and examined structures in the field.

METHODS

The full set of details used to identify the impediments to tidal flow in NSW estuarine fisheries habitat is set out elsewhere (Williams and Watford, in press), but a summary is provided below.

Identifying degraded sites by collection of anecdotal information

To gain a qualitative assessment of the extent of the problem, we collected anecdotal information about structures which were thought to be problematic. In July 1994 a simple questionnaire was sent to representatives of the NSW Oyster Farmers Association, the NSW United Oyster Growers Council and the officer in charge of each of the 28 NSW Fisheries coastal stations. Responses were entered in a database which captured information such as name of waterbody, type of structure present, and details pertaining to individual structures. We did not anticipate that the anecdotal information would provide a comprehensive account of all structures in estuarine habitats.

It was not feasible to distribute the questionnaire to the nearly 2000 commercial fishers of NSW, so to begin the collection of information from them, a briefing was provided at the 2nd Annual Fishing Industry Habitat Workshop held at Tilba Tilba, NSW in early November 1994. The workshop was sponsored by the Australian Fisheries Research and Development Corporation, and attended by delegates from the NSW, Queensland and Victorian fishing industries and fisheries management authorities. At that time there were seven Regional Advisory Committees (RAC's) set up to provide advice to the then NSW Commercial Fishermen's Advisory Council. (In January of 1996 the NSW Minister of Fisheries disbanded the Commercial Fishermen's Advisory Council and set in place arrangements to create a new advisory body.) Each RAC had a designated "Habitat Co-ordinator" and it was agreed at the workshop that co-ordinators and other interested commercial fishers would be interviewed to assist in locating and describing degraded sites.

Identifying impediments to tidal flow by map analysis and field inspection

The primary way by which degraded estuarine sites were identified was by field inspection. Prior to going into the field, 148 topographic maps at the 1: 25 000 scale (NSW Land Information Centre) were marked to highlight suspect structures, including sites identified in responses to the questionnaire. As the location of tidal limit was printed on some but not all maps, the +10 m contour was used to provide an upstream boundary for the study area. In addition, nine maps produced by the Forestry Commission NSW (various dates between 1983 and 1992), the inventories of NSW estuaries produced by Bell and Edwards (1980) and West *et al.* (1985), and aerial photographs held by the Fisheries Research Institute were used to search for, and examine, potentially degraded sites.

All artificial structures with the potential to obstruct tidal flow were colour coded. Six main, or key, structures, were marked in this way: bridges, culverts, causeways, fords, weirs and floodgates. The first four structures are designed for vehicular or pedestrian traffic and were readily differentiated on the basis of definitions provided in the Macquarie Concise Dictionary (Delbridge and Bernard 1988). The four structures can restrict tidal flow,

but this is more often than not a consequence of construction rather than a primary objective. Weirs were defined appropriately, and are barriers designed to retain fresh water, rather than restrict tidal flow. Some weirs can be redesigned to allow fish passage (Harris and Mallen-Cooper 1994).

In our view the term "floodgate" was not defined appropriately in the dictionary. We used this term to describe a structure having as one of its main purposes the reduction or elimination of tidal flow to low lying areas, a change which may have had an impact on the adjacent tidal habitats. It follows that many floodgates have the potential to be removed or redesigned as a way by which to mitigate damage to estuarine habitats.

To confirm the counts of artificial structures, to determine which of them had a direct impact on estuarine habitat and to gain a qualitative impression of rehabilitation potential, we conducted field examinations of degraded sites.

Field inspections were initiated on the south coast of NSW in September 1994 and by May 1995 the whole of the NSW coastline had been examined. Information not available from maps or photographs, such as whether a structure had been accurately keyed on a map, the diameter of a culvert, whether the invert level of a culvert (i.e., the elevation of the bottom lip of the culvert relevant to height datum) impeded tidal flow, or whether a causeway or weir had been built under a bridge were obtained in this way. Due to the work going on elsewhere (Atkinson *et al.* 1996), we made no attempt to identify the occurrence of acid soils in our fieldwork.

Upon return from the field, observations about the problem sites were entered into the database. Subsets of these data were sent to the relevant habitat co-ordinators who edited and returned the data to the project team. New printouts were made and sent for further editing to the four NSW Fisheries habitat biologists stationed at Wollongbar, Port Stephens, Sydney and Nowra. As a final step, the 1:25 000 topographic maps and a map of New South Wales Local Government Areas (Land Information Centre, October 1993) were then used to locate the structures with rehabilitation potential in relation to Local Government Area (LGA) boundaries.

RESULTS

The questionnaire sent to the 28 NSW Fisheries coastal offices, the NSW Oyster Farmers Association and the NSW United Oyster Growers Council produced limited results. The responses identified a range of problems in 70 of the 133 waterbodies listed by West *et al.* (1985). Sixteen of these waterways were seen to be problematic by at least two of the three groups of questionnaire recipients. The majority of the responses were about situations such as "pollution", "odours" and "nutrient enrichment" rather than individual structures.

Five thousand three hundred and twenty five structures below the +10 m contour were identified on the topographic maps. Almost 20% (1024) were subsequently found to be above tidal limit and so were neither further inspected nor described. Another 20% (1047) of structures were inaccessible or otherwise not seen within the time and logistic constraints of this project, meaning that 3254 structures at or below tidal limit were seen in the field.

A number of discrepancies were found between the structures shown on maps and those actually in place (Williams and Watford, in press). Five hundred and one structures were mislabelled, and of these, 494 were relabelled in terms of the six key categories, but the remaining seven were not found in the field. An additional 982 structures were identified: about half of these (541) were sighted but not shown on maps, while the remainder were identified from a series of engineering reports (423), or otherwise identified as having the potential to be modified (18). The discrepancy in counts was greatest for floodgates, as map work identified only 203 structures designated for this purpose, whereas fieldwork and other sources identified 1037 of these structures.

All together, 4229 structures in the six key categories were reviewed for their potential to be modified. Culverts were the most prevalent structure (1795), followed by bridges (1187), floodgates (1037), weirs

(96), causeways (78) and fords (36), (Williams and Watford, in press). One thousand three hundred and eighty eight of the key structures appeared to have some form of mitigation potential (Table 1). These were comprised of 1035 floodgates (99% of the total number of floodgates), 91 weirs (95% of total weirs), 46 causeways (59%), five fords (14%),185 culverts (10%) and 26 bridges (2%).

As floodgates are the predominate structure with the potential for mitigation,we have listed the number which occur along the coast (Table 2). Over 94% of the gates (978) are located in northern half of NSW, ie, in the Richmond-Tweed, Mid-North Coast and Hunter Statistical Districts (see Bray 1995 for district boundaries). Four large rivers in these three districts account for 806 of the 1035 gates: the Tweed River with 248 floodgates, the Richmond River with 240, the Clarence with 142 and the Hunter River with 176.

In addition, 236 structures other than those of the six key types were found to have potential for modification (Table 1). One hundred and eighty five of these were drains (70 agricultural drains, 115 stormwater drains). Most of the agricultural drains were on the north coast, and most of the stormwater drains were in the Sydney metropolitan area.

In overall terms, 1624 structures were identified in the tidal zone which appear to have mitigation potential: 1388 of the key structures and 236 other structures. These are distributed variously among the 31 LGA's which directly abut the Tasman Sea and 34 LGA's which are subject to tidal influence in NSW (Table 1). The largest number of structures is located in Tweed Council (277), followed by Ballina Shire Council (154), Kempsey Council (113), Maclean Council (111), Port Stephens Council (110), Maitland Council (91), Shoalhaven City Council (74) and Lismore City Council (72). These eight councils account for over 60% of the total structures counted. Another 200 structures occur in the Sydney Statistical District (incorporating 38 of the 65 coastal LGA's, and stretching from Wyong Shire Council to Sutherland Shire Council).

DISCUSSION

There are a number of issues arising from this project that need to be highlighted. Firstly, the questionnaire was of limited utility even within its qualitative ambit, as the responses identified few of the structures which impede tidal flow. In the initial stages of fieldwork this was not obvious because site inspections began south of Sydney and progressed to the Victorian border. However, as fieldwork moved from Sydney to the north, it became obvious that the number of structures was going to be so large as to preclude effective data capture by a simple questionnaire. If a questionnaire were to be used to identify problems with tidal habitats elsewhere in Australia, we suggest it would need to be structured with knowledge of the type and frequency of occurrence of structures that interfere with tidal flow at the regional, and if possible, at the local level. If we were to do another survey in NSW to assess change in the number of structures over time, we would not issue the questionnaire to fisheries officers and oyster farmers, but use these people in the same role as the habitat biologists, that is as part of the review process to examine the results of our own field inspections.

Over 1000 structures were not seen in the field because of inaccessibility, and many of these may have potential to be modified (Williams and Watford, in press). Therefore, the 1388 structures which appear to have mitigation potential can only be viewed as a first estimate subject to modification. Future surveys need to apply the appropriate resources in finding, evaluating, and where necessary, spatially referencing the problematic structures within a geographic information system.

Of the 4229 structures reviewed for their modification potential, 501 (12%) were mislabelled on the topographic maps, and 982 (23%) were not shown at all (Williams and Watford, in press). These discrepancies might appear to be cause for concern, but it must be understood the maps were plotted from 1: 50 000 aerial photographs and were never designed to explicitly identify all structures, or be regularly reprinted to show changes (E. Clifford, pers. comm.). Most of the errors discovered in this study related

Table 1: Number and type of structures influencing tidal flow in NSW Local Government Areas (LGA) which have potential to be modified. Small letters in columns indicate structures common to more than one LGA. Location within an LGA does not imply "ownership".

Councils	Bridges	Culverts	Causeways	Fords	Weirs	Floodgates	Subtotal	Agricultural Drains	Stormwater Drains	Impeded Flow	Misc.	Subtotal	Grand Total
Richmond-Tweed Statistical District													
Tweed Council	0	9	2	0	2	250	263	11	1	1	1	14	277
Byron Council	0	4	0	0	1	1	6	3	0	0	1	4	10
Ballina Shire Council	0	13	0	0	0	129	142	7	5	0	0	12	154
Lismore City Council	0	0	0	0	1	68	69	3	0	0	0	3	72
Richmond River Council	0	1	1	0	0	44	46	4	1	0	0	5	51
Subtotal	0	27	3	0	4	492	526	28	7	1	2	38	564
Mid-North Coast Statistical District													
Copmanhurst Council	0	0	0	0	3	23	26	1	0	0	0	1	27
Maclean Council	1	5	3	0	2	93	104	7 g	0	0	0	7	111
Grafton City Council	0	0	1	0	0	6	7	1	0	0	3	4	11
Ulmarra Shire Council	0	1	1	0	0	20	22	2 g	0	0	0	2	24
Coffs Harbour City Council	0	1	0	0	1	1	3	0	1	3	0	4	7
Bellingen Shire Council	1	1	0	0	2	6	10	1	0	0	0	1	11
Shire of Nambucca	0	6	1	0	1	9	17	3	3	1	2	9	26
Kempsey Council	2	8	6	0	7	78	101	9	0	0	3	12	113
Hastings Council	3	15	3	0	3	30	54	3	3	0	0	6	60
Greater Taree City Council	0	5	3	0	1	26	35	3	1	0	0	4	39
Provisional subtotal	7	42	18	0	20	292	379	30 (-1)	8	4	8	50 (-1)	429 (-1)
Subtotal	7	42	18	0	20	292	379	29	8	4	8	49	428
Hunter Statistical District													
Great Lakes Council	0	2	5	2	2	0	11	0	1	0	0	1	12
Port Stephens Council	1	1	0	0	1	99	102	3 h	1	2	2	8	110
Dungog Council	0	0	0	0	0	3	3	1 h	0	0	0	1	4
Maitland City Council	0	0	0	0	0	89	89	2 h	0	0	0	2	91
Newcastle City Council	0	10	2	0	0	3	15	1 h	4	0	0	5	20
Lake Macquarie City Council	1	2	1	1	8	0	13	0	0	0	1	1	14
Provisional subtotal	2	15	8	3	11	194	233	7 (-3)	6	2	3	18 (-3)	251 (-3)
Subtotal	2	15	8	3	11	194	233	4	6	2	3	15	248

Table 1: Number and type of structures which influence tidal flow in each Local Government Area (cont.)

Councils	Bridges	Culverts	Causeways	Fords	Weirs	Floodgates	Subtotal	Agricultural Drains	Stormwater Drains	Impeded Flow	Misc.	Subtotal	Grand Total
Sydney Statistical District													
Wyong Shire Council	1	4	0	0	7	0	12	0	4	0	1	5	17
Gosford City Council	1	21	3	0	11	3	39	1	9	3	0	13	52
Pittwater Council	0	1	0	0	0	1	2	0	7	0	0	7	9
Warringah Council	1	2	0	0	1 c	0	4	0	1	0	0	1	5
Manly Council	0	1	0	0	1 c	0	2	0	0	0	0	0	2
Hornsby Shire Council	0	2	1	0	0	1	4	0	0	0	0	0	4
Ku-Ring-Gai Municipal Council	0	0	0	0	1 d	0	1	0	0	0	0	0	1
Willoughby City Council	0	0	0	0	0	0	0	0	1 i	0	0	1	1
Mosman Council	0	0	0	0	0	0	0	0	2	0	0	2	2
North Sydney Council	0	0	0	0	0	0	0	0	2 i	0	0	2	2
Lane Cove Municipal Council	0	0	0	0	0	0	0	0	1	0	0	1	1
Hunters Hill Council	0	1	0	0	0	0	1	0	1	0	0	1	2
Ryde City Council	0	0	0	0	2 d	0	2	0	7	0	0	7	9
Hawkesbury City Council	0	0	0	0	1	2	3	0	0	0	1	1	4
Shire of Baulkham Hills	0	1	0	0	0	2	3	0	0	1	0	1	4
Parramatta City Council	0	0	0	0	1	0	1	0	3	0	0	3	4
Auburn Council	0	0	0	0	0	0	0	0	4 j	1	0	5	5
Strathfield Municipal Council	0	0	0	0	0	0	0	0	1 k	0	0	1	1
Concord Council	0	0	0	0	0	0	0	0	4 j	0	0	4	4
Burwood Municipal Council	0	0	0	0	0	0	0	0	1 k	0	0	1	1
Ashfield Council	0	0	0	0	0	0	0	0	2 l, m	0	0	2	2
Drummoyne Council	0	0	0	0	0	0	0	0	1 l	0	0	1	1
Leichhardt Municipal Council	0	0	0	0	0	0	0	0	3 m	0	0	3	3
Marrickville Council	0	0	0	0	0	0	0	0	2 n	0	0	2	2
Sydney City Council	0	0	0	0	0	0	0	0	0	0	0	0	0
South Sydney City Council	0	0	0	0	0	0	0	0	1	0	0	1	1
Botany Council	0	0	0	0	1	0	1	0	1	0	0	1	2
Woollahra Municipal Council	0	0	0	0	0	0	0	0	0	0	0	0	0
Waverley Council	0	0	0	0	0	0	0	0	0	0	0	0	0
Randwick City Council	0	0	0	0	0	0	0	0	1	0	0	1	1
Canterbury City Council	0	0	0	0	1	0	1	0	5 k, n, o	0	0	5	6

Table 1: Number and type of structures which influence tidal flow in each Local Government Area (cont.)

Councils	Bridges	Culverts	Causeways	Fords	Weirs	Floodgates	Subtotal	Agricultural Drains	Stormwater Drains	Impeded Flow	Misc.	Subtotal	Grand Total
Sydney Statistical District (cont.)													
Bankstown City Council	2 a	5	1 b	0	2	1	11	0	4	0	0	4	15
Fairfield City Council	0	1	0	0	3 e, f	0	4	0	0	0	0	0	4
Liverpool City Council	0	0	0	0	4 e, f	0	4	0	3	0	0	3	7
Rockdale Council	1	2	0	0	2	2	7	0	5 o	1	0	6	13
Hurstville City Council	1 a	0	1 b	0	0	0	2	0	1 o	0	0	1	3
Kogarah Municipal Council	0	1	0	0	0	0	1	0	5	0	0	5	6
Sutherland Shire Council	1	3	1	0	1	2	8	0	11	0	0	11	19
Provisional subtotal	8 (-1)	45	7 (-1)	0	39 (-4)	14	113 (-6)	1	93 (-9)	6	2	102 (-9)	215 (-15)
Subtotal	7	45	6	0	35	14	107	1	84	6	2	93	200
Illawarra Statistical District													
Wollongong City Council	0	4	0	0	3	0	7	0	4	2	0	6	13
Shellharbour Council	0	7	1	0	1	0	9	0	5	1	1	7	16
Kiama Council	1	3	0	0	0	2	6	2	1	2	0	5	11
Shoalhaven City Council	0	12	3	0	8	40	63	4	0	4	3	11	74
Subtotal	1	26	4	0	12	42	85	6	10	9	4	29	114
South Eastern Statistical District													
Eurobodalla Shire Council	6	27	5	1	6	1	46	2	0	5	2	9	55
Bega Valley Council	3	3	2	1	3	0	12	0	0	3	0	3	15
Subtotal	9	30	7	2	9	1	58	2	0	8	2	12	70
Provisional total	27 (-1)	185	47 (-1)	5	95 (-4)	1035	1394 (-6)	74 (-4)	124 (-9)	30	21	249 (-13)	1643 (-19)
Total number of structures*	26	185	46	5	91	1035	1388	70	115	30	21	236	1624

*This is the actual number of structures in place. It is determined by reducing the provision totals by the numbers in the brackets in order to account for structures that occur in more than one LGA.

Table 2. Floodgates in NSW coastal waterbodies. Statistical districts from Bray (1995); some rounding errors are present.

Statistical District	Catchment	Floodgates	%
Richmond Tweed	Tweed R.	248	23.96
	Cudgera Ck.	1	0.10
	Mooball Ck.	1	0.10
	Brunswick R.	1	0.10
	Richmond R.	240	23.19
	Evans R.	1	0.10
	Subtotal	492	47.54
Mid-North Coast	Clarence R.	142	13.72
	Boambee Ck.	1	0.10
	Bellinger R.	6	0.58
	Nambucca R.	9	0.87
	Macleay R.	52	5.02
	Korogoro Ck.	6	0.58
	Ryans Cut	1	0.10
	Killick Ck.	1	0.10
	Big Hill Point Cut	1	0.10
	Hastings R.	40	3.86
	Camden Haven R.	7	0.68
	Manning R.	26	2.51
	Subtotal	292	28.21
Hunter	Port Stephens	18	1.74
	Hunter R.	176	17.00
	Subtotal	194	18.74
Sydney	Hawkesbury R.	9	0.87
	Georges R.	5	0.48
	Subtotal	14	1.35
Illawarra	Minnamurra R.	1	0.10
	Crooked R.	1	0.10
	Shoalhaven R.	29	2.80
	Crookhaven R.	9	0.87
	Currarong Ck.	1	0.10
	Jervis Bay	1	0.10
	Subtotal	42	4.06
South Eastern	Tuross R.	1	0.10
	Subtotal	1	0.10
	Total	1035	100.00

to floodgates. For example, map inspection showed only four floodgates in the Clarence River, whereas field work showed 142 gates. The underestimate occurs as many floodgates also function as bridges or culverts and are shown as such on the maps. Underestimation is particularly relevant in the context of fisheries habitat in NSW, as with the exception of Middleton *et al.* (1985) and Pollard and Hannan (1994), few studies have been done in floodgate environments. There is a need to review this issue in the context of coastal rehabilitation initiatives.

One topical issue in regard to wetland habitat management is the impact of acid sulfate soils. However, and as indicated, we made no attempt to identify the occurrence of these soils in our fieldwork or consolidate the observations of others due to the considerable momentum that already exists on this issue (Smith and Smith 1996). It is ultimately desirable to combine the relevant data from the acid soils initiative and this study in a readily accessible database so that appropriate consideration can be given to ranking structures most deserving of modification. For example, it is highly likely that the operating regime of many of the 1035 floodgates can be modified, or that some of them could be removed. The hydrologic, ecologic, economic, social and political implications, particularly in terms of acid soils management would need to be well understood before such modifications could take place (Smith and Smith 1996).

Ultimately, the community will need to make choices between the need to maintain or modify structures erected many years ago and competing land uses. As a first step, the NSW catchment and estuarine management committees need to review the results of this study. State and local government transport authorities will also have interest in this inventory in relation to maintainance/replacement of existing structures, as well as the planning of future facilities, e.g., the Sydney to Brisbane super-highway.

Outside of NSW, there should be considerable interest in the methodology used in this project. The methodology should be tested elsewhere to determine its suitability for application at other Australian coastal sites. In the longer term it is desirable for recreational fishing groups, government agencies and catchment management authorities to identify sites which require mitigation, suggest the appropriate mitigation activity and rank the priority with which remedial activity should be undertaken. Ultimately, the Australian State of the Marine Environment Report would benefit from estimates of the numbers of structures which restrict tidal flow, and the number of processes which influence estuarine fisheries. It is also hoped these data can assist in sustaining the growing community and government awareness of the need for remedial habitat activities.

ACKNOWLEDGMENTS

This work was undertaken with a grant from the Australian Fisheries Research and Development Corporation. Paul Adam Philip Gibbs, Jack Hannan, Bill Streever and Duncan Worthington made many helpful suggestions on the manuscript. C. Copeland, J. Holliday, A. Lugg and A. Smith reviewed field data; Melanie Taylor assisted with data entry, manipulation and presentation.

The following members of the fishing industry assisted with data acquisition.

RAC Habitat Co-ordinators and other members of the NSW commercial fishing industry: A. Baxter, R. Baxter, R. Black, G. Bobeldjik, D. Cameron, D. Campbell, C. Davis, R. Dobson, T. Elliot, J. Gallagher, G. Hillyard, C. Hyde, S. Johnson, R. McDermott, S. Manson, P. March, S. Massey, N. Peterson, B. Radley, F. Roberts, J. Rose, P. Ryan, P. Schaeffer, R. Snape, R. Stace, C. Whatson, J. Wilson

NSW Oyster Farmers Association: J. Griffiths, D. Maidment, R. Roberts

NSW United Oyster Growers Council: B. Clulow, M. Fleming

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