

RESTORATION OF ESTUARINE FISHERIES HABITAT

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PROJECT 94/041

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NON-TECHNICAL SUMMARY

This FRDC project benefits fishers in all parts of Australia by providing a methodology which can be used to assess aspects of estuarine habitat degradation.

This project provides NSW fishers with information which can be used in the decision making and policy areas relative to estuarine habitat, i.e., a comprehensive inventory of structures which reduce tidal flow, and of processes inimical to fisheries interests, is now available. These data can be used in negotiations with state and local government authorities in the rehabilitation, restoration and creation of estuarine habitat.

The project effectively began when a questionnaire soliciting information about degraded sites was sent to NSW Fisheries Officers and oyster farmers in August 1994. Subsequent analysis of the responses showed they were of limited usefulness, as they identified only a small portion of the structures and processes which impact on estuarine habitats.

To initiate field inspection of degraded sites, one hundred and forty eight topographic maps at the scale 1: 25,000 were examined. Six hundred and ninety waterbodies were found along the NSW coast. One hundred and twenty seven of these are substantial in size and/or fish production; only 12 of the 127 (9%) are not degraded in some fashion. Sixty nine percent of the nonsubstantial waterbodies (388 of 563) appear to be degraded.

Prior to going in the field, potentially degraded sites were identified on photocopies of 1: 25,000 maps, the purpose being to minimise travel and inspection time. Commercial fishers from each of the Regional Advisory Committees provided assistance in examination of these maps. A greater amount of time had to be spent in field inspection than originally anticipated due to the large number of structures present. Many structures were improperly labelled on the topographic maps.

The initial round of field inspections was completed in mid May 1995, and two types of impact on estuarine habitats were logged in the data set: process impacts such as nutrient enrichment from sewage and storm water runoff, and structural impacts from the following key structures: bridges, culverts, causeways, fords, weirs and floodgates. There were over 1000 process impacts.

Over 5300 key structures were identified in the study zone, but 1000 of these were above tidal limit. Another 1000 sites were inaccessible within the logistic framework of this project, leaving 3200 sites initially identified from the topographic maps which were directly inspected. Another 1000 sites not shown on the maps were also reviewed. Ultimately, 4229 of the key structures were assessed; 1388 of these appeared to have mitigation potential.

Another 236 sites not shown on the topographic maps were also investigated. These included agricultural and stormwater drains.

The long term mitigation focus should be with the 1624 (1388 + 236) artificial structures which alter tidal flow. The structure with the greatest potential for remedial works is the floodgate, which occurs in greatest numbers on the north coast of NSW.

Of the 1000 structures not seen because they were inaccessible, many may have potential to be modified. Additional effort should be invested in finding and evaluating these problematic structures.

In spite of our attempt to set up a scheme to rank mitigation works, there are problems in subjectively assessing the unique combinations of "ease" with which works can be implemented, and the "benefit" deriving therefrom. Further investigation of the most appropriate ranking scheme is necessary. This new scheme must incorporate a way to deal with the community's political and social expectations.

One way by which the need for, or benefit of, a mitigation project might be assessed is by estimating the change in area of wetland habitat which has taken place over time. Estimates of change at the mouth of Lake Macquarie indicated a small reduction in salt marsh and a fourfold increase in mangrove area. This increase did not occur at each of the mangrove subzones within the study site; it was concentrated at a few small areas. There is a limited amount of data to suggest that this is not an isolated phenomenon, but its occurrence and significance in eastern Australia is unknown.

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BACKGROUND

Goodrick (1970) estimated a 60% loss of coastal wetland in NSW (from 265 km² to 164 km²) in the 200 years following European settlement. These losses were due in large part to clearing, draining and other agricultural activities, increasing urbanisation and the construction of transport facilities.

Unfortunately, wetland habitats are known to provide nursery areas for many species of fish (e.g., Hutchings and Saenger 1987), and the commercial fishermen who have seen the decline in area of coastal wetlands describe these losses as an important constraint on the harvest of wild fish. A concerted attempt was made to address the loss of fish habitat by the Australian Society for Fish Biology at its special habitat conference in 1992 (Hancock 1993).

The situation in Victoria and Queensland is similar to NSW, where urban and agricultural pressures have brought about the degradation of estuarine habitat. In fact, habitat destruction has consistently rated as one of the most important issues on the agenda of the Fisheries Health and Environment Committee (a subcommittee of Standing Committee on Fisheries and Aquaculture). The project being reported on in this document will benefit fishers in Victoria and Queensland, as well as NSW, by providing a methodology by which to assess habitat degradation, and by providing information which can be used in the decision making and policy areas.

NEED

It is well recognised (e.g., Burchmore 1993, Morton 1993) that damage caused to wetlands by agricultural or transport activities may be mitigated. However, before initiating any mitigation activities which might restore, rehabilitate or create estuarine wetlands, it is essential to have a methodology which i) identifies the 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. Mitigation may involve rehabilitation (functional repair), restoration (structural and functional repair), or may also involve the "creation" of a new wetland (NRC 1992). Because of the habitat losses which have been sustained on the NSW coast, and elsewhere in Australia, there is a need to restore, rehabilitate and create wetlands over the next decade and beyond.

To assist in developing the methodology, NSW Fisheries set up the Kooragang Wetland Rehabilitation Project (KWRP) in the lower Hunter River. It is the largest mitigation activity underway in NSW at the present time. Fishers in NSW, including those of the Hunter River, were appraised of the project through the Commercial Fishermen's Advisory Council and their respective Regional Advisory Committees (RAC's). Enthusiastic endorsement was given by the local fishers, particularly as the research relates to the rehabilitation of nursery function for fish and prawns. An interim report of the results of the first summer's studies is available (Williams *et al.* 1995).

On the basis of the work done so far, it would appear that the reduction of wetland habitat at Kooragang can be related to structures which reduce tidal flow, particularly the roadworks and culverts installed many years ago to facilitate transport around the island. Other changes, such as alterations to the input of nutrients and contaminants, may also have played a role. A better understanding of the ecological interactions at Kooragang will allow benefits to other Australian coastal rivers. For example, tidal behaviour is believed to have a direct relationship to the recruitment of larvae to nursery areas, and the degree to which tidal behaviour can, or should, be modified needs to be known.

It is against this background that FRDC endorsed the NSW Fisheries' proposal "Restoration of estuarine fisheries habitat". FRDC approved the first year of the proposal in which the incidence of tidal restriction was to be defined, but did not fund the second and third years of study. The results from the first year's study are reported below; these results enhance the KWRP initiative by creating an inventory of degraded sites in NSW around which mitigation activities can be initiated in the near future.

OBJECTIVES

After negotiation with FRDC, the original objectives were reduced to the two set out below:

Objective #1: "To extend an ongoing study (Kooragang Wetland Rehabilitation Project) to make the work relevant to the general coastline of eastern Australia."

Objective 2: "To identify key degraded wetlands on the NSW coast that have the potential to be rehabilitated (or restored)"

No changes were made to these objectives during the course of the study.

METHODS

At the time the original proposal was written, there was little knowledge about the number and distribution of structures which impact on tidal flow in coastal NSW. The ambit of the first objective was therefore to quickly and efficiently determine whether the type of tidal restrictions seen on Kooragang Island were common to other NSW estuaries. To achieve this objective, we collected anecdotal information from individuals who earn their living by working in estuaries, and in addition, undertook our own field investigations. The methodology was to have the potential to be applied to other east Australian estuaries, and ultimately all of Australia.

The second objective required devising a method by which to readily identify the degree of habitat degradation, and construct a scheme that would allow sites to be ranked in terms of those most conveniently, functionally or economically modified. To accomplish the second objective we again used the anecdotal and field data, but initiated an analysis of historical change in wetland habitat. The latter task was not completely fulfilled due to time constraints imposed because the number of structures found in the field was so great as require considerably more time to locate and register than was originally budgeted. As FRDC terminated the study after the first year, it was not possible to continue with the historical analysis.

Identifying degraded sites by collection of anecdotal information

The anecdotal approach involved direct contact with fishers, oyster farmers and fisheries officers. Figure 1 is a flow diagram which sets out this process. In the longer term it is desirable to liaise with recreational fishing groups, government agencies and catchment management authorities to obtain their views on sites which require mitigation, and the appropriate mitigation activity.

To assist in structuring the collection of anecdotal information, beginning in July 1994 a questionnaire was sent to each of the 28 NSW Fisheries coastal districts, and to representatives of the NSW Oyster Farmers Association and the NSW United Oyster Growers Council. The questionnaire was comprised of an instruction sheet (Appendix 1a) and an answer sheet customised for each of the 28 districts (example provided as Appendix 1b). The answer sheet was a photocopy of that portion of the spreadsheet set up to capture incoming information. The spreadsheet was based on the 133 waterbodies listed by West *et al.* (1985). Spreadsheet columns were set out for details such as waterbody and type of structure, and each row pertained to an individual structure. The spreadsheet was constructed so that each catchment was divided into its subcatchments, and even smaller divisions if necessary.

The spreadsheet also had columns by which to conduct a preliminary assessment of mitigation opportunities. Using a score of 1, 2, or 3 (3 being the highest) we asked that two attributes be estimated: the "Rehabilitation ease" with which a structure could be removed and the "Rehabilitation potential" which its removal would have. For example, it is easier to remove a small pipe culvert (score 3) than a lengthy causeway (score 1), but the amount of wetland habitat created by the culvert removal might be negligible (score 1), relative to a large increase in wetland if the causeway were replaced with a bridge (score 3). To get a reasonable first approximation of rank by which sites could be mitigated, the two scores were multiplied.

In addition to structures which have an impact on tidal flow, there are a number of "processes" which can also have an effect on estuarine habitats. These processes are broad scale in their occurrence and are best defined by example; they include erosion, siltation, and nutrient enrichment. One other broad scale process is the production of acid and aluminium by acid sulfate soils, and anecdotal information about acid sulfate areas was included in the spreadsheet.

It was not feasible to distribute the questionnaire to the 2000 commercial fishers of NSW, so to begin the collection of anecdotal information from them a briefing was provided at the 2nd Annual Fishing Industry Habitat Workshop in early November 1994. At the workshop it was proposed that the Habitat Coordinators for each of the NSW Regional Advisory Committees (RAC's) be interviewed to assist in locating degraded sites. (There are seven RAC's and they were originally set up to provide advice to the NSW Commercial

Fishermen's Advisory Council.) Co-ordinators responded by offering the assistance of themselves and other interested commercial fishers at such time as field inspections were underway.

Identifying degraded sites 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, 1: 25,000 scale topographic maps produced by the NSW Land Information Centre (LIC) were examined. The original maps were photocopied and the copies marked to highlight suspect sites, including sites identified in the collection of anecdotal information. As the location of tidal limit was printed on some but not all maps, the +10 metre contour was used to provide an upstream boundary for the study area. All artificial structures which had the potential to obstruct tidal flow were colour coded. There were six key structures identified; bridges, culverts, causeways, fords, weirs and floodgates. The first five structures were differentiated on the basis of definitions provided in the Macquarie Concise Dictionary (Delbridge and Bernard 1988). In our view the term "floodgate" was not defined appropriately in the dictionary and we used it to describe the structures having as one of their main purposes the reduction or elimination of tidal flow to low lying areas. That the other five types of structure restrict tidal flow is more often than not a consequence of construction rather than a primary objective. It follows that all floodgates have the potential to be removed or redesigned as a way by which to mitigate damage to estuarine habitats.

One hundred and forty eight maps at the 1: 25,000 scale were needed to examine the NSW coastline for the structures or processes identified above. Table 1 sets out the number of maps relevant to each RAC, the dates inspection of the maps was completed and the dates the photocopies of the maps were sent to the RAC habitat coordinators for their inspection. In addition, nine maps produced by the NSW Forestry Commission (various dates), the inventories of NSW estuaries produced by Bell and Edwards (1980) and West *et al.* (1985), as well as aerial photographs held by FRI were used to search for and examine potentially degraded sites.

To confirm the counts of artificial structures, determine which of them (such as bridges or weirs) had a direct impact on estuarine habitat and to gain a qualitative impression of rehabilitation potential, it was necessary to conduct

field examinations of degraded sites. The original spreadsheet used to collect anecdotal information (Appendix 1a) was reconstructed to take additional field observations. The rows in the spreadsheet were extended to include each waterbody encountered on the topographic maps; the columns were extended to include details about the type of habitat problem and other relevant comments (Appendix 2). We retained the columns of the questionnaire used to estimate the attribute "Rehabilitation ease but instead of "Rehabilitation potential", a new category, "Rehabilitation benefit" was created. This was because it was easier to make a subjective assessment of benefit in terms of wetland area rehabilitated, or enhancement of fisher's catch.

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 (see Table 1). Information not available from maps or photographs, such as whether the structure had been accurately keyed on its map, the diameter of a culvert and the suitability of its invert level (ie, the height in the tidal plane of the bottom lip of the culvert), or whether a causeway or weir had been built under a bridge were obtained in this way. Qualitative assessments of water quality and vegetation were also made. A refractometer was used to measure the salinity in parts per 1000 to assist in determining the extent of tidal influence. Due to the work going on elsewhere (NSW acid soils mapping initiative, Acid Sulfate Soils Management Advisory Committee, Acid Sulfate Soils Technical Committee, as well as local action committees), we made no attempt to identify the occurrence of acid soils in our fieldwork. The decision to begin the process with the estuaries of the south coast had ramifications that will be discussed at a later stage.

Upon return from the field, observations from the problem sites were loaded into the spreadsheet. Subsets of these data were sent to the relevant habitat co-ordinators who were requested to edit and return the data to the project team. Table 1 also shows the date on which habitat co-ordinators confirmed the findings. New print outs were made and sent to the four NSW Fisheries habitat biologists stationed at various points along the coast for further editing. The dispatch and response times for each of these iterations were noted and is shown in Table 1.

Habitat creation schemes

One other way in which habitat damage can be mitigated is through habitat creation schemes. Beginning in July 1994, we examined the NSW Department of Planning's monthly summary of environmental impact statements under review. On the basis of map and aerial photographic inspection, the development proposals located within the tidal zone were further assessed in terms of capability for habitat creation.

Assessment of change in wetland habitat

In order to assess change in wetland habitat and further assist in achieving the project's second objective, initial investigations were planned at six sites: Lake Macquarie and Tuggerah Lakes (RAC 4), Berowra Creek (Hawkesbury River) and Botany Bay (RAC 5), Lake Illawarra (RAC 6) and Wallaga Lake (RAC 7). Lake Macquarie, Tuggerah Lakes and Botany Bay were chosen because of their large size, urban characteristics and because the catch of fish in each consistently rates within the top 10 estuarine fisheries in NSW (Pease and Grinberg, in prep.). Berowra Creek, in spite of being in the Sydney metropolitan area, was remote and inaccessible until recently when human impact started to make changes to habitat. Lake Illawarra was chosen as a medium size waterbody, and Wallaga Lake was chosen to represent the many small intermittently opening lagoons which occur along the NSW coast.

The entrance channel of Lake Macquarie was selected as the area for pilot study on the basis of its having been modified by the construction of breakwaters, and because it is that part of the lake where mangroves are predominant (West *et al.* 1985, Winning 1993). A number of subareas within and adjacent to the entrance channel were defined (Figure 2). Three 1: 16,000 scale aerial photos from 1993 (AAM 2037c Lake Macquarie City Council: Run LM3, photo 170; Run LM4, photo 176; Run LM5, photo 218) and two 1: 40,000 scale aerial photos from 1966 (Gosford Lake Macquarie: Run 2, photo 5124; Run 3, photo 5129) were scanned and the digital images fitted to the most recent 1: 25,000 topographic map available (LIC, 1988). Mangrove and salt marsh boundaries were identified from the aerial photos. According to West *et al.* (1985) the only species of mangrove in the lake is *Avicennia marina*. No differentiation was made between species of salt marsh. The boundaries found in the 1993 photos were confirmed by on-site inspection conducted in October

1995. Differences in the extent of the area of each of the mangrove and salt marsh communities were ascertained, and the results tabulated for each of nine subareas within the channel.

DETAILED RESULTS

The questionnaire sent out in July 1994 to law enforcement staff at the 28 NSW Fisheries coastal offices, the NSW Oyster Farmers Association and the NSW United Oyster Growers Council produced varied results. By late September 1994, responses had been received from 16 of the 28 fisheries offices: six responses were received from the nine north coast offices, four from the twelve central coast offices and six from the seven south coast offices. These responses presented information for 40 waterbodies (Appendix 3). Reminder notices were sent out in September and October, but as no additional responses were received in the latter month the survey was terminated in view of the fact that arrangements were well underway to initiate field inspections.

Representatives of the Oyster Farmers Association identified degraded sites in 37 estuaries and the United Oyster Growers Council responded with respect to ten south coast estuaries (Appendix 3). All together, the responses from the three groups identified problems in only 70 of the 133 waterbodies listed by West *et al.* (1985). There were 16 waterways seen to be problematic by at least two of the three groups. The majority of the responses were about processes rather than individual structures.

Inspection of the topographic maps for the first of the RAC's commenced in early October 1994 and field work completed shortly thereafter (Table 2). Completion of map inspection took three months, of field work took seven months and of preliminary data entry took nine months, but these tasks were conducted simultaneously where possible. By mid October 1995 the spreadsheet data had been reviewed by the seven RAC habitat coordinators and by early November the four NSW Fisheries habitat biologists had modified the master spreadsheet accordingly.

The master spreadsheet has over 20 columns and 2600 rows. (An extract is included as Appendix 2; electronic copies of the whole document are available on request.) Approximately half of the entries relate to structures which impede tidal flow; the other half refer to the "process" impacts such as erosion,

sedimentation and nutrient enrichment. The spreadsheet can be manipulated to produce various outputs for each RAC, e.g., to show for any one estuary all structures within it (Appendix 4), or to show for any one type of structure all waterways where such a structure is found (Appendix 5).

The number of structures which influence tidal flow is presented further below. To put these observations in a geographical context, we created a comprehensive list of the NSW coastal waterbodies, as to our knowledge such a list has never been published. This list identifies the "coastal aquatic estate" and is comprised of 690 entries (Appendix 6) distributed variously within each RAC and Local Government Area (LGA). These waterbodies range in size from large rivers (e.g., Clarence River) to ephemeral streams which in dry weather disappear on the ocean beach. A summary of the number of these waterbodies occurring in each RAC is shown in Table 1. Of the 690 entries, there are 127 "major" waterways, i.e., estuaries which are important because of their size, permanence and/or value to the commercial and recreational fishers of NSW. West *et al.* (1985) identified 133 (major) estuaries, but the discrepancy is accounted for as we used a different set of identification criteria. The difference in the two counts is explained at the bottom of the table. The largest number of waterbodies (295) is in RAC 7, as is the largest number of major waterbodies (43).

The proximity of urban areas on the 148 topographic maps and the nine forestry maps enabled us to identify "untouched" as well as degraded estuaries. Of the 127 major waterbodies, the maps show land use characteristics which suggest 115 (91%) may be degraded in some fashion (Table 3). Of the remaining 563 waterbodies, a significantly smaller number (31%) appear from the maps to potentially degraded in one form or another, and in view of increasing urbanisation along the coast, damage to these may be only a matter of time.

There were 5325 structures shown on the 1: 25,000 topographic maps below the +10 m contour (Table 4). Of these there was no need to inspect 1024 structures (almost 20%) as field observation indicated they were above tidal limit. Of the remaining 4301 structures, 1047 (20% of total) were inaccessible (865) or otherwise not seen (182) within the time and logistic constraints of this project and not inspected. Therefore of the 4301 structures presumed to be at or below tidal limit, 3254 were seen in the field.

As soon as field work began, it became obvious there were discrepancies between the structures shown on maps and those in place, prompting us to analyse the degree of correspondence between the two. Of the 3254 tidal structures seen in the field, the greater portion of these (2753) were correctly shown on the maps (Table 4). Those structures shown incorrectly were of two types: on seven occasions the map identified a structure but no structure was in place, and 494 structures were incorrectly labelled, i.e., the map identified a structure different to the one found. Details on these aspects are presented in Appendix 7.

This discrepancy in counts was greatest for floodgates, where map work identified 203 structures designated for this purpose. Direct field observations coupled with data from technical reports indicated the presence of at least 1035 floodgates designed to exclude tidal flow. This large discrepancy is explained in part by the fact that many gates were either not shown on the 1: 25,000 maps, or were keyed as a different type of structure (e.g., bridges).

Some of the data from Appendix 7 are repeated in Table 5 to show the total number of structures considered for rehabilitation need: 2753 correctly labelled structures, 494 incorrectly labelled structures, 964 extra structures (not shown on the maps but seen in the field, or located through anecdotal or technical reports) and 18 structures not inspected but with rehabilitation possibilities. Therefore a total of 4229 structures were examined for rehabilitation possibilities. The highest number of these was in RAC 4 (1027), followed by RAC 1 (946) and RAC 3 (711). The fewest are in RAC 7 (276). Culverts were the most prevalent structure (1795), followed by bridges (1187), floodgates (1037), weirs (96), causeways (78) and fords (36).

Of the 4229 key structures examined for rehabilitation, 1388 appeared to have some form of mitigation potential (Table 6). These included 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%).

Because floodgates predominate in terms of the number of structures with the potential for mitigation, and because of their low elevation in the tidal plane which offers options for habitat modification, their numbers in each RAC have been listed separately (Table 7a). Presentation of the full set of details from the spreadsheet for all 1035 floodgates was not feasible. It is important to note that over half of the floodgates in NSW (630) are located on the far north coast: the

Tweed River has 248, the Richmond River 240, and Clarence 142. The Hunter River has the third largest number of floodgates with 176. It is highly likely that the operating regime of all of them can be modified, and many of the 1035 gates could be removed.

Table 7b identifies six of the other 352 key structures (bridges, culverts, causeways and weirs) with mitigation potential. Each of these structures scored the maximum nine points in the prototype formula devised to rank the mitigation potential: the "Rehabilitation ease" received the maximum of three points as did the "Rehabilitation benefit". Most of the problem sites occurred in RAC 2. Sixteen sites scored a total of six points (R. E. "3" x R. B. "2" = 6, and vice versa) indicating there are many other mitigation opportunities.

In addition, 236 structures other than the six key types were also found to have potential for modification (Table 8). 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 (RAC's 1, 2, 3), and most of the stormwater drains were in RAC 5, which includes the Sydney metropolitan area. Three of these sites scored nine points (Table 7b) in the prototype ranking exercise; eight scored six points.

Overall, there are 1624 structures which have mitigation potential in the tidal waters of NSW (1388 key structures and 236 "other" structures). In addition, over 1000 "processes", were also found which have an impact on estuarine habitats, such as erosion, siltation and nutrient enrichment. On the basis of the ranking formula, only seven of these 1000 sites scored highly in "Rehabilitation ease" and "Rehabilitation benefit" (Table 7c). The situation at the other sites was sufficiently complex that it was not possible to judge the ease or benefit with which the vast majority of these processes might be mitigated. We therefore deferred judgement on the basis of further information being necessary.

Habitat creation schemes

Table 9 is a list of fifteen development proposals which we feel present habitat creation options in the NSW tidal zone. This table is not a comprehensive list, rather it serves to illustrate that there is potential to advance mitigation in these terms. Five of the seven RAC's are presented. Further development of these creation options is necessary.

Assessment of change in wetland habitat

The second task falling within the project's second objective was to quantify the change in wetland habitat in selected estuaries. Of the six sites nominated for study, aerial photos were obtained, and reference points identified for Lake Macquarie, Berowra Creek (Hawkesbury River) and Wallaga Lake. Analysis of the changes at the mouth of Lake Macquarie was completed, however the termination of the project has meant that aside from the results reported below for Lake Macquarie, no further progress will be made on this task.

The area of mangrove and salt marsh habitat for the entrance of Lake Macquarie changed between 1966 and 1993 (Table 10). The combined area increased from 52.5 ha to 88.3 ha: this large change was accounted for by an increase in mangrove area from 11.0 ha to 47.5 ha; the area of salt marsh contracted slightly from 41.5 ha to 40.8 ha. The fourfold change in mangrove between 1966 and 1993 was not uniform, having occurred mostly in subareas G and I. Site G had no measurable stands of mangrove in 1966, while subarea I, historically the largest mangrove area in the entrance channel, showed a fourfold increase over 27 years. With the exception of subarea J, each of the other sample sites showed an increase in mangrove area. The change in salt marsh was more varied: two of the subareas showed no change (H and J), while small increases were seen in three areas (D, E, K) and small losses were seen in three subareas (F, G, L). The largest loss of salt marsh was 3.1 ha at subarea I, the site which showed the largest increase in mangrove. The broad scale change in mangrove over the 27 years between aerial photographs is shown in colour (Figure 2). The relatively small change in salt marsh is not readily displayed and so is not shown.

BENEFITS

While a number of studies have been conducted to describe the estuaries of NSW, to our knowledge there is no comprehensive list of the coastal waterbodies. Previous studies have dealt only with the larger systems: Bell and Edwards (1980) listed and characterised 137 of these; the inventory by West *et al.* (1985) assessed the distribution of salt marsh, mangrove and seagrass in

133 waterways. Time and budget constraints precluded investigations of the smaller waterbodies in the West *et al.* (1985) study, particularly those with no commercial fishing or recreational angling history. Presumably, similar circumstances prevailed for the Bell and Edwards (1980) investigation. The only other study done to examine coastal wetlands was by the NSW Coastal Council (1985), done to assist in establishing widespread planning and conservation powers over these habitats. None of the three studies was designed to deal with site specific problems.

Before assessing the mitigation potential of individual structures, we therefore considered it important to generate a context within which to operate, and established "the NSW coastal aquatic estate" of 690 coastal waterbodies (Appendix 6). Very few of these 690 waterbodies, whether large and "substantial" or relatively small and "nonsubstantial", are undisturbed by human activity (Table 2). Yet, for many years the fundamental management interest seems to have been in the larger features. While we do not argue that all 690 waterbodies are of equal importance, it is our impression that extra effort is needed to describe the fisheries function of many of the smaller of them. This is particularly important in regard to assessing the utility of intermittently opening waterways as nursery areas/refugia for hatchery reared marine species.

As indicated in the Introduction, any broad scale mitigation policy to restore, rehabilitate or create estuarine wetlands, must have a methodology which i) identifies the causes of wetland degradation, ii) describes the degree of wetland degradation from each specific cause, iii) determines the most cost-effective ways by which modifications can be carried out, and iv) monitors the effects of any changes. The Kooragang Wetland Rehabilitation Project conforms to these needs as culverts, roads and to a lesser degree levee banks, were identified as the main restriction on tidal flow. This project compliments the Kooragang work as it indicates the importance of floodgates as the predominant structure in tidal waters. With the exception of Middleton *et al.* (1985) and Pollard and Hannan (1994), few studies have been done on the effects of floodgates in NSW.

This FRDC project benefits the fishers of Australia by providing a methodology through which structures which impede tidal flow can be identified in the other states. To provide an indication of the amount of time spent in this project so that fisheries and other resource management agencies

can plan similar studies elsewhere in Australia, a record was kept of the steps involved in examining the maps and the review and editing of the data (Table 2). One technical officer was fully occupied for over twelve months in the map inspections where over 5300 potentially damaged sites were isolated, in field inspections for 3200 sites, in the data entry and culling of the 1624 sites where change is mandated, and in the preparation of tables for the interim and final reports. Extrapolation of labour and other costs to conduct a similar study for other parts of eastern Australia, and perhaps the country as a whole, is possible.

The project also assists the fishers of NSW (Appendix 8a) by providing information which can be used in the decision making and policy areas, i.e., this inventory can be used in negotiations with state and local government authorities on the issues of rehabilitation, restoration and creation of habitat.

In addition to the commercial fishers, there are many other potential users of the data generated in this project. For example, besides the general interest of catchment and estuarine management committees (Appendix 8b), the NSW transport authorities (Appendix 8c) have specific interest in terms of maintaining their existing structures, as well as the planning of future facilities, and needs to consider problem sites such as are listed herein. It is hoped these data can assist in sustaining the growing community and government awareness of the need for, and potential to complete remedial habitat activities.

INTELLECTUAL PROPERTY

No intellectual property was generated from the project.

FURTHER DEVELOPMENT

Identifying degraded estuarine sites

There are a number of outcomes from this project which should be given additional consideration. Pending the outcome of FRDC's ongoing fisheries habitat reviews, further studies to identify degraded habitats should be supported in other regions of Australia. The methodology used in this study should be tested elsewhere and important regional characteristics may be

identified. Ultimately, the Australian State of the Marine Environment Report would benefit from estimates of the numbers of structures which influence tidal flow, and the number of processes which influence estuarine fisheries.

If a questionnaire based approach were to be used to identify degraded sites, it should be used with caution. As indicated in the Results section, more responses were received from the north and south coasts than from the central coast, and from each of the three areas the majority of details provided were about processes rather than individual structures. The lack response from the central part of the state was understandable given the higher population density in this part of NSW and the likely presence of a large number of structures (such as bridges and culverts for transport) and processes (such as nutrient enrichment from extensive stormwater facilities).

However, the fact that questionnaires were returned with more information about processes rather than structures was unsettling. In hindsight, this may have been due to the questionnaire having been improperly constructed and not soliciting the correct information, or the prospect of filling out the questionnaire for each structure was such a daunting task that fisheries officers and/or oyster farmers could not be bothered, or in spite of the officers and farmers being the nominal experts of local geography, there are many more structures in place than they are aware of.

There was no reason to conclude that the responses from the north coast would have been any less representative of the true situation in regard to the number of structures than was the data from the south coast. It was not until field work commenced on the north coast at the end of the survey (Table 2), that we found the large discrepancy between the number of floodgates in the field and data in the questionnaires.

The conclusion with regard to use of the questionnaire is simple: at best it had limited value. If a questionnaire were to be used in other studies, it might need to be structured with prior knowledge of the type and frequency of occurrence of structures which interfere with tidal flow. As well, a considerable amount of effort might need to be budgeted to follow-up the non respondents. Were another survey to be done in NSW to assess future change in the number of structures or processes, we would not issue the questionnaire to fisheries officers and oyster farmers, but use these people in the same role as the habitat

biologists (Figure 1), as part of the review process to examine the results of our own field inspections.

While 4229 structures were found which may influence tidal flow (Tables 5 and 6), it is important to recognise that many of these could not be identified from maps and needed to be directly identified in the field. Another 1000 structures were not seen because of inaccessibility (Table 4), and many of these may also have potential to be modified. Future surveys need to apply the appropriate resources in finding and evaluating the problematic structures.

The fact that 15% of structures (494 out of 3254 structures seen in the field, Table 4) were shown incorrectly on the topographic maps is cause for some concern. Most of these errors related to floodgates. For example, map inspection showed only four floodgates in RAC 2, and field work showed 142 gates (Appendix 7b). This gross underestimate occurs as some floodgates also function as bridges or culverts and are shown as such on the maps. These errors have implications in terms of setting up similar studies in other states. Allowance must be made for mislabelled and other misclassified structures. Data management techniques need to be adjusted to accommodate structures that do not exist, are improperly labelled or are not shown on maps. Once the structures are identified and located, any mitigation planning almost certainly requires additional investigation, which in some circumstances will be very detailed.

In addition to the 1623 structures which have influence on tidal flow (Tables 6 and 8), there are over 1000 "processes" such as erosion, siltation, nutrient enrichment and other water quality problems which also have an impact on estuarine habitats. Unfortunately, few of these were readily scored in terms of "Rehabilitation ease" and "Rehabilitation benefit" (Table 8c). Many of these have posed problems for a number of years, and unlike the structures, which may be owned and/or managed by a single authority, some of the processes are so widespread in occurrence and impact (e.g., erosion) that their management has to be undertaken on a broad, and oftentimes multiagency, scale. Relative to assessing the impact of a single structure, assessment of the impact of the processes can also be difficult, as is determining the ease and benefit mitigation might bring. In general these processes are considerably more intractable to deal with than the structures.

One topical issue in regard to broad scale processes is the impact of acid sulfate soils. As indicated in the Methods, we made no attempt to identify the occurrence of these soils in our fieldwork, or consolidate the observations of others, as there is already considerable momentum on this topic (e.g., Acid Sulfate Soils Management Advisory Committee).

Ranking wetlands for future mitigation projects

The counts of structures (Tables 6 and 8) are of great value in setting out the types of problems that need to be dealt with as part of a future mitigation program. The difficulty, however, is not so much in identifying the specific rehabilitation works which should be commissioned at any given site, but in ranking the cost-effective ways by which these works can be carried out. In the Methods section it was indicated that the prototype ranking scheme was established by estimating and scoring the ease of removal of a structure, and the benefit removal would have. There were two problems which arose from this. While it was relatively easy to qualitatively estimate the ease with which a structure could be removed, or a process could be rectified (for example a "large" bridge or a "large" dredging operation would invariably score "3" points), it was much more difficult to subjectively estimate the benefit such a change would have.

Part way through the project it became obvious that there was another problem in that a political-social dimension exists in the ranking of sites. While recreational fishing groups, state and local government agencies, catchment management authorities and estuarine management committees can assist in identifying sites which require mitigation (Figure 1), they can also enhance and/or confound the political-social dimension in establishing the community based priorities by which structures can be modified. The priorities set out in Tables 7a-c have not been set up with any community input.

In reviewing the prototype ranking scheme on the basis of the experience gained in this project, we submit that it should be modified slightly *within the context of the commercial fishing industry*. The prototype was oriented around the "ease" with which structures were removed, and the "benefit" that would accrue. In assessing the benefit that is likely to occur, some sites would best be rehabilitated by maximising the AREA of wetland, irrespective of whether there is a perception of increase in commercial fish production. Another approach

would be to maximise the benefit in terms of the CATCH of the commercial fishers by maintaining or increasing catch (or catch per unit of effort) through modification of forage areas and fishing grounds, and/or in the longer term by enhancing nursery grounds. The third approach deals with the ease of mitigation in terms of detailed estimates of the EXPENSE of removal of an inappropriate structure(s) and its replacement or other remedial works, particularly in regard to works which manipulate the water flow regime or change the bathymetry of the site. The EXPENSE factor also integrates the political-social component. In some situations these three approaches may be mutually supportive, whereas in others they may be mutually exclusive, and rehabilitation projects initiated along the east coast of Australia need to be planned accordingly. Collectively we have designated this the "A-C-E" approach.

In the original proposal submitted for this project in January 1994, it had been intended that the loss of estuarine habitat from selected estuaries over the past 50 years would be quantified within six months. This AREA based approach was to have been achieved by scanning historical and present day maps and/or photographs, lodging the data within a Geographical Information System (GIS) and assessing changes in habitat boundary conditions. This exercise was initiated at Lake Macquarie. Each of the sub-areas identified and labelled (Figure 2) showed an increase in mangrove area relative to salt marsh. The extent and significance of this change is uncertain, particularly as there is little understanding of the role of salt marsh in estuarine ecology.

To complement the analysis of loss of wetland area, analysis of historical CATCH data is necessary. In NSW this is now possible as a 52 year data set of fisher's catch has recently been groomed and standardised from a number of sources (Pease and Grinberg, in prep.). In addition, a 10 year data set of effort has also been prepared and can be used to assess gross changes in estuarine fish production over time. These catch data need to be further investigated in their own right, as well as in the context of loss of habitat within specific estuaries. A correlative approach along these lines was done some years ago when Middleton *et al.* (1985, Figure 4) plotted the annual production of five major commercial fish species from the Macleay River estuary from 1955/56 to 1977/78 and found a long term decline which coincided with the construction of major flood mitigation works. (It should be noted that a major study of that part of the Macleay River degraded by the construction of the Yarrahapinni floodgates is now underway, having been financed by FRDC/NSW FIRAC.)

Ultimately, the implications of a decline of catch needs to be integrated with the loss of habitat.

A considerable amount of attention will be needed to devise cost estimates within which to conclude the ACE ranking scheme. These estimates will only be generated as a last stage in the overall consideration of mitigation plans.

Future development of mitigation policies and activities

Our studies brought us into contact with 41 mitigation projects of various types recently completed, underway or being negotiated for tidal waters (Table 11). Other projects might be underway of which we are unaware. No restoration projects were found, but there are 38 rehabilitation projects and three creation projects. Each of the RAC's is represented with at least one project: eight projects are complete, 12 are being negotiated and ten are underway. In addition, two creation projects are being negotiated and one is underway. Details for each of the 38 projects are also presented (Appendix 8); fourteen of the rehabilitation projects were or are within RAC 4 and nine pertain to RAC 5. The rehabilitation projects underway include non structural (e.g., Manning River education program) and structural activities (e.g., Tweed River transplantation of wetland vegetation and culvert redesign).

While only three habitat creation plans are actively being pursued (Table 11 and details in Appendix 8), we have listed another fifteen development proposals which may present habitat creation options in the NSW tidal zone (Table 9), suggesting there is real potential to advance mitigation in these terms. It is conceivable that changes in planning policy could ensure that, as a condition of consent, developers are required to create new estuarine wetland when existing wetland is to be damaged.

The fact that a number of mitigation projects are complete, underway or being negotiated might suggest that a "mitigation mentality" is in place in NSW. Up until five years ago mitigation would have been the exclusive province of the state and local works authorities. More recently, the creation of catchment management committees and estuarine management committees in NSW (Appendix 9b) may have enhanced the mitigation process. Both types of committee are comprised of local representatives from state and local government, planning and conservation circles. The catchment management

committees report their efforts via the annual report of the NSW Total Catchment Management Committee (TCM). To our knowledge there is no analogous reporting by the estuarine management committees. To assess how well the catchment management committees were performing, we cross referenced the two annual reports (1992/93 and 1993/94) produced in the short time the TCM has been active. There was a variable level of output with some committees appearing to be quite busy, whereas others appear to be in a planning phase (Table 12). This result suggests that if a "mitigation mentality" has taken hold in NSW, it is tenuous at best. Further demonstration of progress awaits release and analysis of the 1994/95 and subsequent annual reports.

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Table 1 Number of coastal waterbodies and maps for each Regional Advisory Committee (RAC).

RAC	Number of LIC 1:25 000 Maps with 10m contour	West <i>et al.</i> (1985) Number of Major Waterways	This Study Number of Waterways : All (Major)
1	16	10	32 (10)
2	11	3	22 (3)
3	28	24	80 (24)
4	30	11	79 (8)
5	21	15	80 (14)
6	17	25	102 (25)
7	25	45	295 (43)
Total	148	133	690 (127)

The six discrepancies in the number of major waterways are as follows:

RAC	West <i>et al.</i> (1985)	This Study
4	Myall Lakes Myall River Karuah River Port Stephens	Port Stephens (system)
5	Botany Bay Georges River	Georges River / Botany Bay (system)
7	Clyde River Batemans Bay	Clyde River / Batemans Bay (system)
	Twofold Bay	(Twofold Bay not counted)

Table 2 Dates of editing and review of the inventory of degraded sites.

RAC	1:25,000 topographic map inspection complete	Checked with RAC Habitat Co-ordinator	Field work complete	Data entry complete	Dispatch full inventory to RAC Habitat Co-ordinator	Dispatch summary of structures tables to RAC Habitat Co-ordinator	Output sheets returned	Dispatch sheets to NSWF Habitat Biologist	Output sheets returned
1	20/2/95	J. Gallagher 13/5/95	19/5/95	11/8/95	ND	14/8/95	20/9/95	6/10/95	2/11/95
2	18/1/95	P. Schaeffer 9/5/95	12/5/95	30/6/95	30/6/95	14/8/95	12/10/95	6/10/95	2/11/95
3	6/1/95	P. March 22/4/95	27/4/95	8/8/95	ND	9/8/95	1/9/95	6/10/95	2/11/95
4	23/12/94	D. Cameron 10/2/95	17/2/95	13/8/95	ND	15/8/95	9/9/95	15/9/95	5/10/95
5	9/12/94	D. Campbell 21/12/94	30/1/95	7/7/95	ND	14/7/95	21/9/95	7/10/95	3/11/95
6	7/10/94	J. Wilson 2/12/94	13/10/94	4/1/95	4/1/95	13/4/95	3/5/95	5/7/95	27/7/95
7	14/11/94	A. & R. Baxter 7/11/94	2/12/94	19/12/94	23/12/94	11/4/95	15/3/95	5/7/95	27/7/95

ND = Not Done; experience with RAC's 7, 6, and 2 suggested this step would extensively lengthen the review process.

Table 3 Extent of damage to coastal waterbodies.

RAC	"Substantial" Waterbodies ¹			"Nonsubstantial" Waterbodies ²			All Waterbodies		
	Sub Total	Protected ³	Damaged	Sub Total	Protected ³	Damaged	Total	Protected ³	Damaged
1	10	0	10	22	20	2	32	20	12
2	3	2	1	19	18	1	22	20	2
3	24	2	22	56	29	27	80	31	49
4	8	1	7	71	46	25	79	47	32
5	14	0	14	66	33	33	80	33	47
6	25	3	22	77	54	23	102	57	45
7	43	4	39	252	188	64	295	192	103
Total	127	12	115 (90.6%)	563	388	175 (31.1%)	690	400	290 (42.0%)

1 "Substantial" waterbodies are defined as large permanent bodies of water including the drowned rivers, coastal lagoons and some large intermittently open lagoons as defined by Roy (1984) and documented by West et al. (1985).

2 "Nonsubstantial" waterbodies are the smallest of the intermittently open lagoons and ephemeral coastal streams. These were not investigated by West et al. (1985).

3 Wetland habitats within and adjacent to waterbodies can be protected due to ownership by NSW State Forests and / or NPWS. This classification was derived from landuse and tenure described by the (then) NSW Forestry Commission 1:125 000 map series.

Table 4 Numbers of six key structures shown on the 1:25 000 topographic maps and correspondence between them and field inspection.

RAC	N ^o . on 1:25 000 map	N ^o . not requiring field inspection ¹	Not inspected			Inspected			
			N ^o . inaccessible	N ^o . other	Sub - total	N ^o . labelled but not present in the field	N ^o . incorrectly labelled and present as some other structure	N ^o . correctly labelled	Sub - total
		Number (%)	Number (%)	Number (%)	Number (%)	Number (%) ²	Number (%) ²	Number (%) ²	Number (%)
1	1098	355 (32)	104 (9)	22 (2)	126 (11)	0 (0)	139 (23)	478 (77)	617 (56)
2	471	110 (23)	83 (18)	25 (5)	108 (23)	0 (0)	67 (26)	186 (74)	253 (54)
3	1032	142 (14)	244 (24)	60 (6)	304 (29)	2 (0)	55 (9)	529 (90)	586 (57)
4	1179	189 (16)	222 (19)	28 (2)	250 (21)	0 (0)	113 (15)	627 (85)	740 (63)
5	676	126 (19)	32 (5)	29 (4)	61 (9)	0 (0)	44 (9)	445 (91)	489 (72)
6	497	77 (15)	109 (22)	3 (1)	112 (23)	2 (1)	42 (14)	264 (86)	308 (62)
7	372	25 (7)	71 (19)	15 (4)	86 (23)	3 (1)	34 (13)	224 (86)	261 (70)
Total	5325	1024 (19)	865 (16)	182 (3)	1047 (20)	7 (0)	494 (15)	2753 (85)	3254 (61)

¹ These were structures below the 10m contour but on field inspection of the area found to be above the tidal limit.

² Percentage refers to number of inspected structures; other percentages refer to total number of structures.

Table 5 Total number of the six key structures in the tidal zone considered for their rehabilitation need.

RAC	N ^o incorrectly labelled and present as some other structure (see Table 4.)	N ^o correctly labelled (see Table 4.)	Extra Structures ¹	Structures not inspected but with rehabilitation potential ²	Total
1	139	478	323	6	946
2	67	186	95	2	350
3	55	529	121	6	711
4	113	627	284	3	1027
5	44	445	71	0	560
6	42	264	53	0	359
7	34	224	17	1	276
Total	494	2753	964	18	4229

1 "Extra structures" are those structures that were seen in the field but not shown on maps, or identified from other maps, documents and anecdotal reports.

2 These structures were floodgates or weirs and assumed to have rehabilitation potential.

Table 6 Count of six key structures occurring within each RAC and the number which have rehabilitation potential.

RAC	Bridge		Culvert		Causeway		Ford		Weir		Floodgate		Totals	
	Total	R.P.	Total	R.P.	Total	R.P.	Total	R.P.	Total	R.P.	Total	R.P.	Total	R.P.
1	164	0	279	27	5	3	1	0	5	4	492	492	946	526
2	86	1	111	5	6	5	0	0	5	5	142	142	350	158
3	282	6	264	32	12	10	13	0	15	14	125	124	711	186
4	219	3	541	24	14	11	13	3	19	19	221	220	1027	280
5	207	6	302	43	8	6	1	0	28	28	14	14	560	97
6	135	1	154	24	15	3	1	0	12	11	42	42	359	81
7	94	9	144	30	18	8	7	2	12	10	1	1	276	60
Total	1187	26	1795	185	78	46	36	5	96	91	1037	1035	4229	1388

R.P. - Rehabilitation Potential

Table 7a Floodgates in NSW coastal waterbodies

RAC	Catchment	Floodgates
1	Tweed R.	248
	Cudgera Ck.	1
	Mooball Ck.	1
	Brunswick R.	1
	Richmond R.	240
	Evans R.	1
	Subtotal	492
2	Clarence R.	142
	Subtotal	142
3	Boambee Ck.	1
	Bellinger R.	6
	Nambucca R.	9
	Macleay R.	52
	Korogoro Ck.	6
	Ryans Cut	1
	Killick Ck.	1
	Big Hill Point Cut	1
	Hastings R.	40
	Camden Haven R.	7
Subtotal	124	
4	Manning R.	26
	Port Stephens	18
	Hunter R.	176
	Subtotal	220
5	Hawkesbury R.	9
	Georges R.	5
	Subtotal	14
6	Minnamurra R.	1
	Crooked R.	1
	Shoalhaven R.	29
	Crookhaven R.	9
	Currarong Ck	1
	Jervis Bay	1
Subtotal	42	
7	Tuross R.	1
	Subtotal	1
	Total	1035

Table 7b List of structures (other than floodgates) which impact on NSW estuarine habitat and have exceptionally high potential for modification
(R.E. x R.P. = 9)

RAC	Catchment	Site	Associated road or structure	Problem	Comments	Source
1	Brunswick River	Billinudgel Creek	Kallaroo Cct.	Culvert diameter too small and invert too high	Inadequate flushing in canal estate, fish kills recorded u.s.	RAC 1
2	Clarence River	Alumy Creek (east)		Fabridam / weir (?)	Entrance possibly filled in, (fabridam in F.P.M.S. (1980)), F.A.N.	NSWF, RAC 2
2	Clarence River	Southgate Creek		Barrage weir	Concrete weir with hydraulic floodgates, built 1982 (fabridam in F.P.M.S. (1980)), on F.P.L.	NSWF, RAC 2
2	Clarence River	The Broadwater		Agricultural drains	Flood mitigation -- levees, drains, floodgates, acid sulphate soils	RAC 2, NSWF, OFA
2	Clarence River	Broadwater Creek		Fixed crest weir	F.A.N., on F.P.L., no N.I.P.	NSWF, RAC 2
2	Clarence River	Shark Creek		Agricultural drains	Flood mitigation -- levees, drains, floodgates, acid sulphate soils	RAC 2, NSWF, OFA
2	Clarence River	Wooloweyah Lagoon		Agricultural drains	Flood mitigation -- levees, drains, floodgates, acid water pumped into lagoon	RAC 2, NSWF, OFA
2	Clarence River	Shallow Channel	Yamba Rd.	Causeway with no opening	Poor flushing	RAC 2
6	Burrill Lake		Princes Highway	Causeway with inadequate opening	Old bridge insuff., causeway too long	NSWF, RAC 6

- F.A.N. - Further Assessment Necessary
- F.P.L. - Fishways Priority list (NSW Fisheries, NSW Department of Public Works and NSW Department of Water Resources, 1992)
- N.I.P. - Negotiations in Progress
- D.L.A.W.C. - Department of Land and Water Conservation
- OFA - Oyster Farmers Association
- S.T.W - Sewage Treatment Works
- G.P.T. - Gross Pollution Traps
- u.s. - Upstream

Table 7c List of processes which impact on NSW estuarine habitat and have potential for modification.

RAC	Catchment	Site	Problem	Comments	Source
2	Clarence River	Alumy Creek (east)	Water quality	Eutrophication, variable pH, algal blooms, siltation, periodic fish kills	RAC 2, NSWF
2	Clarence River	Poverty Creek	Water quality		RAC 2
4	Manning River		Siltation	At mouth	NSWF, OFA, RAC 4
4	Manning River	Lansdowne River	Bank erosion		NSWF
4	Manning River	Ghinni Ghinni Creek	Bank erosion	Livestock intrusion	NSWF
4	Smiths Lake		Shifting dune sands	Co-ord With DLAWC req'd	NSWF
6	Port Kembla	Tom Thumbs Lagoon		Extensive landform alteration of adjacent lands	NSWF

DLAWC - Department of Land and Water Conservation
 G.P.T. - Gross Pollution Trap
 OFA - Oyster Farmers Association
 S.T.W. - Sewage Treatment Works
 SMH - Sydney Morning Herald
 u.s. - upstream

Table 8 Count of "other" structures.

	Agricultural Drains ¹	Stormwater Drains	Impedance Structures	Miscellaneous Structures	Total Other Structures
RAC	Rehabilitation Potential	Rehabilitation Potential	Rehabilitation Potential	Rehabilitation Potential	Rehabilitation Potential
1	28	7	1	2	38
2	10	0	0	3	13
3	16	7	4	5	32
4	7	11	2	4	24
5	1	81	6	1	89
6	6	9	9	4	28
7	2	0	8	2	12
Total	70	115	30	21	236

1 This general category includes all other drains and drainage schemes not shown in Table 3.

Table 9 List of development proposals that may impact wetlands in NSW estuaries and have potential for wetland creation schemes.

RAC	WATERWAY	SITE	POTENTIAL SITUATION	COMMENT	SOURCE
1	Tweed River	Terranora Broadwater	Acid sulfate soils	Swamp along south side drained, proposed development in low lying acid sulphate soils area, F.A.N.	RAC 1
1	Richmond River	North Creek	Habitat destruction	Proposed gravel extraction adjacent to SEPP 14 area, F.A.N.	D.U.A.P.
4	Wallis Lakes	Breckenridge Channel	Seagrass destruction	Proposed dredging of Breckenridge Channel	RAC 4
4	Wallis Lakes	Pipers Creek	Acid sulfate soils	Proposed development	RAC 4
4	Wallis Lakes		Acid sulfate soils	New development "Lakes Estate"	RAC 4
4	Port Stephens	Myall River	Saltmarsh destruction	Proposed subdivision and development in SEPP 14 wetlands	NSWF
4	Port Stephens	Mambo Creek	Habitat destruction	Proposed development in SEPP 14 wetlands	NSWF
4	Port Stephens	Tilligerry Creek	Habitat destruction	Proposed 8km long levee banks in SEPP 14 wetlands	NSWF
4	Lake Macquarie	Pinny Beach	Seagrass destruction	Proposed marina	RAC 4
5	Georges River / Botany Bay	Towra Bay	Seagrass destruction	Proposed dredging to create Little Tern habitat	RAC 5
6	Shellharbour Swamp		Habitat destruction	Proposed marina development	NSWF
6	Minnamurra River	Rocklow Creek	Habitat destruction	Proposed route of expressway	RTA
7	Wagonga Inlet		Siltation	Development for 750 homes	RAC 7
7	Lake Brou	Whittakers Creek	Habitat destruction	Proposed bass farm	RAC 7
7	Boydton Creek		Habitat destruction	Proposed canal estate and marina	RAC 7

Abbreviations

D.U.A.P. - Department of Urban Affairs and Planning
 F.A.N. - Further Assessment Necessary

SEPP - State Environmental Planning Policy
 RTA - Roads and Traffic Authority

Table 10 Change in area (ha) of mangrove and salt marsh at the entrance to Lake Macquarie, 1966 - 1993.

	Year	CHANNEL											LAKE (interim) K	TOTAL		
		East of Road Bridge				West of Road Bridge								Channel	Lake	All
		South Side		North Side		West Side		East Side								
H	I	J	Subtotal	E	F	Subtotal	L	D	G	Subtotal						
Mangrove	1966	0.0	7.0	0.1	7.1	0.8	0.3	1.1	0.0	2.8	0.0	2.8	0	11.0	0	11.0
	1993	1.2	30.1	0.1	31.4	1.5	2.3	3.8	2.5	4.1	5.2	9.3	0.5	47.0	0.5	47.5
Salt marsh	1966	0.0	29.7	0.0	29.7	0.6	0.7	1.3	4.6	2.1	2.7	4.8	1.1	40.4	1.1	41.5
	1993	0.0	26.6	0.0	26.6	1.8	0.6	2.4	4.1	2.8	2.0	4.8	2.9	37.9	2.9	40.8
Total	1966	0.0	36.7	0.1	36.8	1.4	1.0	2.4	4.6	4.9	2.7	7.6	1.1	51.4	1.1	52.5
	1993	1.2	56.7	0.1	58.0	3.3	2.9	6.2	6.6	6.9	7.2	14.1	3.4	84.9	3.4	88.3

Table 11 Summary of number of wetland restoration, rehabilitation and creation projects recently completed, underway or being negotiated in NSW estuaries.

RAC	Restore				Rehabilitate				Create				Total
	C	U	N.I.P.	Sub total	C	U	N.I.P.	Sub total	C	U	N.I.P.	Sub total	
1	0	0	0	0	1	4	0	5	0	1	0	1	6
2	0	0	0	0	1	1	1	3	0	0	0	0	3
3	0	0	0	0	1	1	0	2	0	0	0	0	2
4	0	0	0	0	2	5	7	14	0	0	1	1	15
5	0	0	0	0	3	8	3	14	0	0	1	1	15
6	0	0	0	0	2	2	0	4	0	0	0	0	4
7	0	0	0	0	0	0	1	1	0	0	0	0	1
Total	0	0	0	0	10	21	12	43	0	1	2	3	46

Abbreviations C - Complete
 N.I.P. - Negotiations in Progress
 U - Underway

Table 12 NSW Catchment Management Committees: Strategies and actions reported for 1992/93 and 1993/94.

Catchment	Year Established	Report Presented		Restore Tidal Flow				Erosion				Acid Sulphate Soil				Water Quality				Total		Total	
		92/93	93/94	92/93		93/94		92/93		93/94		92/93		93/94		92/93		93/94		Strat.	Act.	Strat.	Act.
				Strat.	Act.	Strat.	Act.	Strat.	Act.	Strat.	Act.	Strat.	Act.	Strat.	Act.	Strat.	Act.						
Tweed CMC	#92/93	N/A	+			0	0			0	0			0	0			0	0			0	0
Brunswick CMC	93/94	N/A	-																				
Richmond CMC	92/93	+	+	0	0	0	0	0	0	0	0	0	0	*	0	>	*	1	0	0	1		
Clarence CMC	92/93	+	+	0	0	0	0	*	0	*(S)	0	0	0	*	0	*(S)	0	2	0	3	0		
Coffs Harbour Waterways CMC	#93/94	N/A	N/A																				
Bellinger CMC	93/94	N/A	+			0	0			0	0			0	0	*	0					1	0
Nambucca CMC	92/93	+	+	0	0	0	0	*	0	*	0	0	0	*	0	*(S)	0	2	0	2	0		
Macleay CMC	#93/94	N/A	N/A																				
Hastings Camden Haven CMC	#92/93	N/A	+			0	0			*	0	0	0			*	0					2	0
Manning CMC	92/93	+	+	0	0	0	0	*	0	*(N)	0	0	0	*	0	-	*	2	0			1	1
Karuah/Great Lakes CMC	#92/93	N/A	+			0	0			0	0	0	0	*	0	-	*					1	0
Hunter CMT	92/93	+	+	0	0	0	0	^	*	^	*(C)	0	0	*	0	*(S)	0	1	1	1	1	1	1
Lake Macquarie CMC	92/93	+	+	0	0	0	0	*	0	*(S)	0	0	0	-	*	*(S)	0	1	1	1	1	1	1
Tuggerah Lakes CMC	#92/93	N/A	+			0	0			0	0			0	0	*(S)	0	1	1	1	1	1	1
Brisbane Waters & Gosford Lagoons CMC	#93/94	N/A	N/A																			0	0
Hawkesbury Nepean CMT	#92/93	N/A	+			0	0			*	0	0	0			*	0					2	0
South Creek CMC	#93/94	N/A	N/A																				
Cattai CMC	#93/94	N/A	N/A																				
Berowra CMC	#93/94	N/A	N/A																				
Sydney Northern Beaches CMC	92/93	+	+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Upper Parramatta River Trust	93/94	N/A	-																			0	0
Lane Cove River CMC	92/93	+	+	0	0	0	0	0	0	0	0	0	0	*	0	0	0	1	0	0	0	0	0
Middle Harbour CMC	92/93	+	+	0	0	0	0	0	0	0	0	0	0	*	0	*	0	1	0	1	0	1	0
Cooks River CMC	92/93	+	+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Georges River CMC	92/93	+	+	0	0	0	0	*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hacking CMC	#92/93	N/A	+			0	0			0	0	0	0	*	*	*	*(C)	2	1	1	1	1	1
Illawarra CMC	92/93	+	+	0	0	0	0	^	*	^	*(C)	0	0	*	0	0	0	1	1	0	1	0	1
Upper Shoalhaven CMC	#93/94	N/A	N/A																				
Lower Shoalhaven CMC	#92/93	N/A	+			0	0			0	0	0	0			*	0					1	0
Far South Coast CMC	#93/94	N/A	N/A																				
Lower South Coast CMC	#93/94	N/A	N/A																				
Total	31	12	20	0	0	0	0	5	2	6	2	0	0	1	0	9	3	11	5	14	5	18	7

Abbreviations

Strat. = strategy

Act. = action

#92/93 = formed late 92/93 therefore unable to present summary of activities for the 1992/93 NSW Total Catchment Management Annual Report

#93/94 = formed late 93/94 therefore unable to present summary of activities for the 1993/94 NSW Total Catchment Management Annual Report

+ = report presented

- = no report presented

0 = no strategy or action

* = strategy or action in place

^ = no strategy appears to have been reported

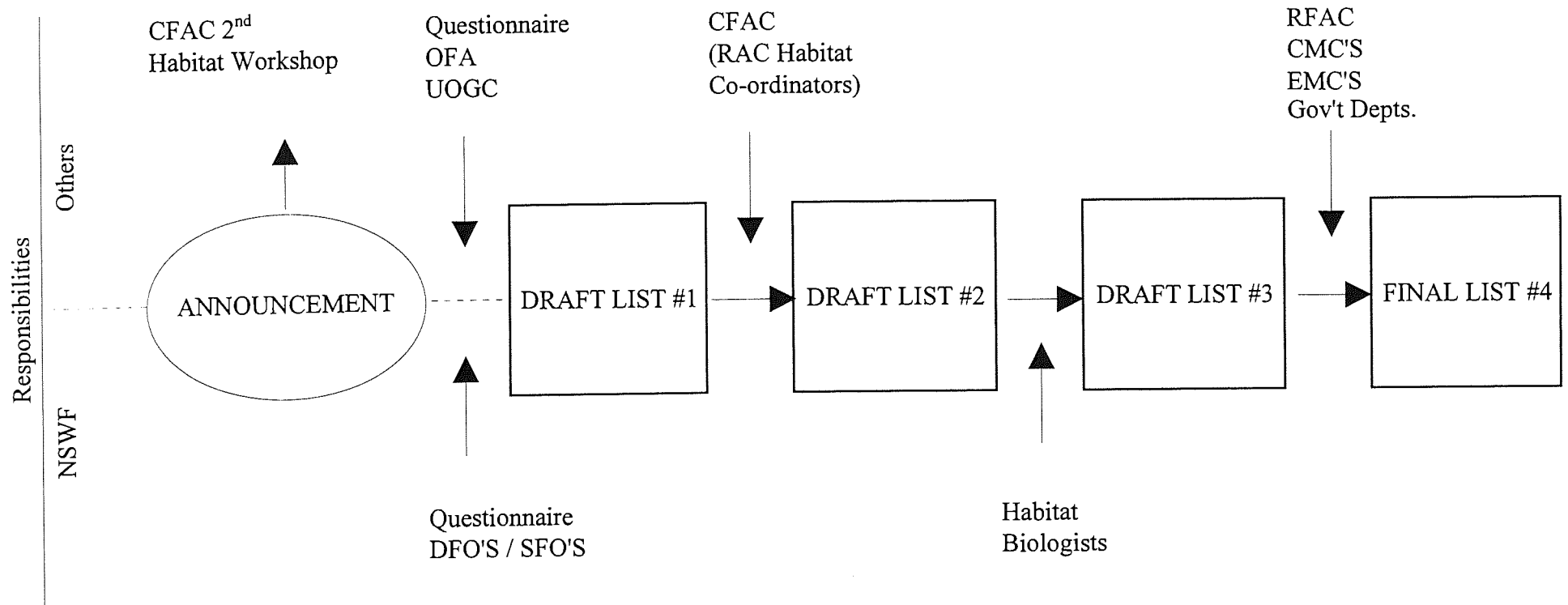
> = strategy implemented

(C) = same strategy carried over from 1992/93 Annual Report to 1993/94 Annual Report

(N) = strategy implementation being negotiated

(S) = same strategy carried over from 1992/93 Annual Report to 1993/94 Annual Report

Sources : Total Catchment Management Reports 1992/93 and 1993/94



DFO - NSW Fisheries District Fisheries Officer
 SFO - NSW Fisheries Senior Fisheries Officer
 OFA - Oyster Farmers Association
 UOGC - United Oyster Growers Council

RFAC - NSW Recreational Fishermens Advisory Council
 CMC - Catchment Management Committee
 EMC - Estuarine Management Committee

Figure 1. Flow of information to determine sites with mitigation potential.

Appendix 1a Covering letter to questionnaire.

To: All Zone and District Fisheries Officers
 From: Rob Williams, Estuarine Habitat Restoration Biologist; FRI, Cronulla
 Tel. (02) 527-8411
 Fax. (02) 527-8576

Subject: Inventory of degraded estuarine habitats and their potential for restoration

Increased use of the coastal zone over the past 200 years has changed our estuarine fish habitats in a number of ways. Unfortunately, not all of the changes have been beneficial and NSW Fisheries has commenced a program to restore degraded coastal habitats. I ask for help in putting together an inventory of sites in your zone/district so that plans can be made to restore and rehabilitate where possible.

Attached you will find a sheet which lists the catchments and subcatchment in your zone/district. From your field experience you should be able to identify sites within subcatchments that are degraded and score their Restoration Need (R. N.) and Restoration Potential (R. P.) in the following categories:

Restoration Need

3 = High need

2 = Medium need

1 = Low need

Restoration Potential

3 = High potential

2 = Medium potential

1 = Low potential

0 = Nil

Hypothetical examples follow:

Subcatchment	Problem	Comments	Restoration Need	Restoration Potential
Cobaki Broadwater	Floodgates	Hinges rusted shut, gates should be removed	3	3
Whoopwhoop Ck.	Channel con- striction,	Old reclamation for larger culverts should be used	2	2
Hawkesbury River	Channel closure	Causeway for railway at Brooklyn, bridge or culverts should be installed	3	0
Sussex Inlet	Canal estate	Canal excavation too deep to support seagrass, some filling could take place	1	1

Thank you and please contact me at the above telephone numbers if there are any problems.

Appendix 1b Example of questionnaire.

NSWF Region	NSWF Zone	NSWF District	Catchment	Subcatchment	Problem	Comments	R. N.	R. P.
N	Mac	Tweed	Tweed River	Tweed River				
				Cobaki Broadwater				
				Terranora Broadwater				
				Rous River				
		Tweed	Cudgen Lake					
		Tweed	Cudgera Creek					
		Tweed	Mooball Creek					
		Tweed	Brunswick River	Brunswick River				
				Marshalls Creek				
				Simpsons Creek				

Appendix 2 Extract from the inventory of degraded estuarine habitat (Tuggerah Lakes, RAC 4).

Catchment	Subcatchment	Subsubcatchment	Subsubsubcatchment	Associated road or structure	Problem	Comments	Deg.	R. E.	R. B.	Remediation activity	Source (2)
Tuggerah Lakes	Lake Munmorah				Nutrient enrichment and siltation	6 G.P.T.'s and numerous mini wetlands	+	1	3	Nil	W.C.
					Fixed crest weir	Ash dam, No N.I.P., F.A.N.	+	?	?	Install high fishway (?)	NSWF
		Colongra Creek			Fixed crest weir	No N.I.P.	+	3	1	Remove weir	NSWF
		Unnamed Creek		(Near Greenacre Ave.)	Nutrient enrichment and siltation	19 GPT's and numerous mini wetlands	+	1	3	Nil	W.C.
		Budgevov Lake			Rubbish up (?)	F.A.N.	?	?	?	Nil pending F.A.N.	NSWF
							0			Nil	NSWF
		Wallarah Creek									W.C.
		Tuggerah Lake			Nutrient enrichment and siltation	19 GPT's and numerous mini wetlands	+	1	3	Nil	W.C.
		Saltwater Creek		The Entrance Rd.	Stormwater drain	Concrete channel with invert too high, G.P.T.	+	3	1	Redesign invert	NSWF
		Unnamed Creek		(Near Ferndale St.)	Stormwater drain	Concrete channel with invert too high, G.P.T.	+	3	1	Redesign invert	NSWF
		Tumbi Umbi Creek		The Entrance Rd.	Stormwater drain	Rock lined channel with invert too high	+	3	1	Redesign culvert	NSWF
				The Entrance Rd.	Bridge opening too small		+	3	1	Enlarge bridge opening	NSWF
					Nutrient enrichment	Brown scum, F.A.N.	+	?	?	Nil pending F.A.N.	NSWF
		Unnamed Creek		Adelaide St.	Stormwater drain	Channel invert too high, G.P.T.	+	3	1	Redesign invert	NSWF
		Berkeley Creek		Lake Edge Ave.	Culvert invert too high		+	3	1	Redesign culvert	NSWF
		Ourimbah Creek			Siltation	Mouth has been dredged	+	3	1	C.C.R.	NSWF
					Fixed crest weir	N.I.P.	?	3	2	Remove weir / install R - ramp fishway	RAC 4, NSWF
		Wyong River			Fixed crest weir	On top twenty F.P.L., R - Ramp fishway installed two years ago, effectiveness not yet determined, F.A.N.	+	3	3	Remove weir (?)	NSWF
					Bank erosion		+	3	1	Stabilise banks	NSWF
		Unnamed Creek			Nutrient enrichment	Red algae, F.A.N.	+	3	1	Nil pending F.A.N.	RAC 4
				Reserve Rd.	Culvert invert too high	G.P.T.	+	3	1	Redesign culvert	NSWF

Abbreviations and symbols

+	Degraded
0	Not degraded
?	Uncertain
R.E.	Rehabilitation Ease
R.B.	Rehabilitation Benefit
G.P.T.	Gross Pollution Trap
N.I.P.	Negotiations in Progress
F.A.N.	Further Assessment Necessary
C.C.R.	Catchment Controls Required
W.C.	Wyong Council
F.P.L.	Fishways Priority List (NSW Fisheries, NSW Department of Public Works and NSW Department of Water Resources, 1992)

Appendix 3 Response to questionnaire.

Estuary	NSWFO	OFA	UOGC	Estuary	NSWFO	OFA	UOGC
Tweed River		x		Clyde River	x	x	x
Cudgen Lake		x		Joes Creek			x
Cudgera Creek		x		Tomago River	x		x
Mooball Creek		x		Candalagan Creek	x		x
Brunswick River		x		Moruya River	x		x
Belongil Creek		x		Coila Lake		x	
Tallow Creek		x		Tuross Lake	x	x	
Richmond River		x		Lake Brunderee		x	
Evans River		x		Lake Brou		x	x
Clarence River	x	x		Lake Dalmeny		x	
Sandon River	x			Kianga Lake		x	
Bellinger River	x			Wagonga Inlet	x	x	
Deep Creek	x			Nangudga Lake		x	
Nambucca River	x			Corunna Lake		x	
Macleay River	x			Tilba Tilba Lake		x	
South West Rocks Creek	x			Little Lake		x	
Saltwater Creek	x			Wallaga Lake		x	
Korogoro Creek	x			Bermagui River		x	
Killick Creek	x			Barragoot Lake		x	
Hastings River	x	x		Cuttagee Lake		x	
Lake Cathie	x			Murrah Lagoon		x	
Camden Haven River		x		Bunga Lagoon		x	
Manning River	x	x		Merimbula Lake	x		
Khappinghat Creek	x			Shadrack Creek	x		
Wallis Lake	x	x		Boydton Creek	x		
Smiths Lake	x			Wonboyn River	x		
Port Stephens	x			Merrica River	x		
Hunter River	x	x		Nadgee River	x		
Lake Macquarie	x	x		Nadgee Lake	x		
Hawkesbury River		x		Total Response 70	40	37	10
Towradgie Creek	x						
Port Kembla	x						
Lake Illawarra	x						
Bensons Creek	x						
Minnamurra River	x						
Wrights Creek	x						
Shoalhaven River		x	x				
Crookhaven River		x	x				
Lake Wollumboola			x				
Burrill Lake	x						
Cullendulla Creek	x		x				

NSWFO - NSW Fisheries Officer
OFA - Oyster Farmers Association
UOGC - United Oyster Growers Council
X indicates the 70 sites for which responses were received

Appendix 4 Number and location of structures that influence tidal flow in RAC 6 by waterbody.

Catchment	Site	Associated road or structure	Problem	Comments	Number of structures in each waterway
Bellambi Lake	West Bellambi Creek		Stormwater drains	Concrete channels	1
Cabbage Tree Creek	Towradgi Arm		Stormwater drains	Concrete channels	1
Port Kembla	Port Kembla Harbour Creek	Railway and Five Islands Rd. (?)	Culverts diameter too small	Box culverts	1
Lake Illawarra	Minnegang Creek	Northcliff Dr.	Culvert invert too high	Drainage channel	12
Lake Illawarra	Budjong Creek		Fixed crest weir	Near Fish Co-op, F.A.N.	
Lake Illawarra	Mullet Creek		Fixed crest weir	Impounded waters for irrigation, No N.I.P.	
Lake Illawarra	Brooks Creek		Impeded flow	Multiple steps in channel - exclusion of saltwater, F.A.N.	
Lake Illawarra	Brooks Creek		Impeded flow	Blockage between bridge at mouth and u.s. bridge, F.A.N.	
Lake Illawarra	Barrons Gully		Stormwater drain	Enclosed channel	
Lake Illawarra	Duck Creek	Under disused railway bridge	Fixed crest weir	F.A.N.	
Lake Illawarra	Albion Creek		Stormwater drain	Concrete channel, new housing estate adjacent	
Lake Illawarra	Albion Creek	U.s. of railway	Fixed crest weir	F.A.N.	
Lake Illawarra	Oaky Gully		Sewage works overflow gate	F.A.N.	
Lake Illawarra	Davies Bay Creek		Stormwater drain	Enclosed channel	
Lake Illawarra	Burroo Point	The Esplanade	Culvert invert too high	F.A.N.	
Little Lake	Bensons Creek		Stormwater drain	Enclosed channel	4
Little Lake	Bensons Creek	Landy Dr.	Culvert invert too high	Concrete channel, F.A.N.	
Little Lake	Barrack Heights Creek		Stormwater drain	Concrete channel, F.A.N.	
Little Lake	South Arm Creek		Stormwater drain	Concrete channel, F.A.N.	
Shellharbour Swamp		Bass Point Tourist Rd.	Causeway with inadequate opening	Shell Cove Marina Development proposed - removal of causeway, creation prop. south of Barrack Point, F.A.N.	1
Minnamurra River		(Near Swamp Rd.)	Agricultural drains	Water table lowered, river course altered 50 yrs ago, F.A.N.	8
Minnamurra River	Rocklow Creek	Princes Highway	Floodgate	D.s. of the Swamp Rd. bridge, not functioning correctly	
Minnamurra River	Rocklow Creek	James Rd.	Culvert diameter too small x 4		
Minnamurra River	Rocklow Creek	Railway culverts	Culvert invert too high		
Minnamurra River	Rocklow Creek		Impeded flow	Culverts ok but tidal length reduced, F.A.N.	
Bombo Beach Creek		Princes Highway	Culvert invert too high	T.O.B. (11/10/94)	3
Bombo Beach Creek		Railway	Culvert invert too high	T.O.B. (11/10/94)	
Bombo Beach Creek		Cycleway	Culvert invert too high	T.O.B. (11/10/94)	
Kendalls Beach Creek			Stormwater drain	Concrete channel	1
Werri Lagoon		Railway access Rd.	Impeded flow	Culverts ok but tidal length reduced, F.A.N.	3
Werri Lagoon			Impeded flow	Poor flushing - small head when opened artificially, houses too close to bank	
Werri Lagoon			Agricultural drains	Swamp drainage works, acid sulphate soils, F.A.N.	
Crooked River		Gerroa Rd.	Bridge opening too small	F.A.N.	2
Crooked River	Blue Angle Creek		Floodgates		
Shoalhaven River	Coomonderry Swamp	Shoalhaven Heads Rd.	Culvert invert too high	Under road bridge	19
Shoalhaven River	Coomonderry Swamp		Agricultural drains	Acid sulphate soils, F.A.N.	
Shoalhaven River	Coomonderry Swamp	Private road to property (near River Rd.)	Floodgates	Bridge on map	
Shoalhaven River	Coomonderry Swamp	(near River Rd.)	Floodgates		
Shoalhaven River	Coomonderry Swamp	(near River Rd.)	Floodgates		
Shoalhaven River	Coomonderry Swamp	Bolong Rd.	Culvert invert too high		
Shoalhaven River	Bevan Creek	(Near Bolong Rd.)	Culvert diameter too small	Restricts tidal flow to mangroves	
Shoalhaven River	Bevan Creek	(Near Bolong Rd.)	Culvert diameter too small	U.s of previous culvert	
Shoalhaven River	Unnamed Drain		Floodgates		
Shoalhaven River	Broughton Creek		Agricultural drains	F.A.N.	
Shoalhaven River	Unnamed Drain	(Near Coolangatta Rd.)	Floodgates	F.A.N.	
Shoalhaven River	Unnamed Drain	(Near Swamp Rd. (east))	Floodgates	F.A.N.	
Shoalhaven River	Unnamed Drain	(Near Black Forest Rd.)	Floodgates	F.A.N.	
Shoalhaven River	Unnamed Drain	(Near Black Forest Rd.)	Floodgates		
Shoalhaven River	Snake Island Creek	(Near Black Forest Rd.)	Floodgates		
Shoalhaven River	Unnamed Drain	(Near Black Forest Rd.)	Floodgates		
Shoalhaven River	Unnamed Drain	(Near Wharf Rd.)	Floodgates		

Appendix 4. Number and location of structures that influence tidal flow in RAC 6 by waterbody (cont).

Catchment	Site	Associated road or structure	Problem	Comments	Number of structures in each waterway
Shoalhaven River	Unnamed Drain	(Near Wharf Rd.)	Floodgates		
Shoalhaven River	Unnamed Drain	(Near Wharf Rd.)	Floodgates		
Shoalhaven River	Unnamed Drain	(Near Jaspers Brush Rd.)	Floodgates		
Shoalhaven River	Unnamed Drain	(Near Swamp Rd. (west))	Floodgates		
Shoalhaven River	Unnamed Drain	(Near Swamp Rd. (west))	Floodgates		
Shoalhaven River	Unnamed Drain	(Near Jennings L.)	Floodgates		
Shoalhaven River	Unnamed Drain	(Near Jennings L.)	Floodgates		
Shoalhaven River	Unnamed Drain	(Near Bolong Rd.)	Floodgates		
Shoalhaven River	Unnamed Drain	(Near Bolong Rd.)	Floodgates	Across the moputh near the starch factory	
Shoalhaven River	Abermethys Creek	(Near Bolong Rd.)	Floodgates	Blockage in channel, F.A.N.	
Shoalhaven River	Abermethys Creek	(Near Edwards Ave. bridge)	Impeded flow	Above tidal limit, N.I.P.	
Shoalhaven River	Bomaderry Creek		Fixed crest weir	Levee across entrance on the east end of the island	
Shoalhaven River	Unnamed Creek		Impeded flow		
Shoalhaven River	Terara Swamp	(Near Terara Rd.)	Floodgates		
Shoalhaven River	Terara Swamp	(Near Comerong Island Rd.)	Floodgates	F.A.N.	
Shoalhaven River	Terara Swamp	Numbaa Rd.	Floodgates		
Shoalhaven River	Unnamed Drain	(Near Numbaa Rd.)	Floodgates	F.A.N.	
Shoalhaven River	Terara Swamp	Moss St.	Culvert invert too high		
Shoalhaven River	Regatta Creek		Levee	No culvert provided, F.A.N.	
Shoalhaven River	Berrys Canal		Levee	For 1 in 100 yr flood - O'Keefes Point to Shaws Creek	
Shoalhaven River	Ryans Creek		Levee		
Shoalhaven River	Unnamed Drain		Floodgates		
Shoalhaven River	MacDonald Creek		Floodgates	At entrance to Shaws Creek	
Shoalhaven River	Apple Orchard Island		Impeded flow	Levee	43
Crookhaven River	Unnamed Creek	Culburra Rd.	Floodgates	Barrage / weir in F.P.L.	
Crookhaven River	Unnamed Creek	Bounes L.	Floodgate		
Crookhaven River	Unnamed Creek	Bounes L.	Floodgate		
Crookhaven River	Unnamed Drain (1)	Bounes L.	Floodgate		
Crookhaven River	Unnamed Drain (1)		Agricultural drains	24" pump used to drain swamp for grazing	
Crookhaven River	Crookhaven Creek	Jindy Andy L.	Floodgates		
Crookhaven River	Crookhaven Creek	Greenwell Point Rd.	Floodgates		
Crookhaven River	Unnamed Drain	Springbank Rd.	Floodgates	Connects Crookhaven River to Crookhaven Creek	
Crookhaven River	Unnamed Drain	Springbank Rd.	Culvert diameter too small	Connects Crookhaven River to Crookhaven Creek	
Crookhaven River	Eelwine Creek		Floodgates	Dead mangroves removed	
Crookhaven River	Unnamed Drain	(Near Pyree L.)	Floodgates		11
Crookhaven River	Unnamed Drain		Floodgates	Propped open with a rock 12/12/95	1
Curarong Creek	Unnamed Creek	(Near Nowra Rd.)	Floodgate		
Jervis Bay	Unnamed Creek (2)	(Near Edendale St)	Floodgate	Set in a brick wall on drainage channel, blocked up with silt	
Jervis Bay	Unnamed Creek (2)	(Near Woollamia Rd.)	Fixed crest weir	Pipes encased in concrete, may be a small opening	
Jervis Bay	Unnamed Creek	Berry St.	Culvert invert too high	STW upstream	3
St. Georges Basin	Lions Park Canal		Fixed crest weir		1
Swan Lake	Mondayong Creek	Old Berrara Rd.	Culvert invert too high		1
Berrara Creek	Unnamed Creek	?	Culvert invert too high	Usually open mouth, but closed mid Sept. 1994	1
Lake Conjola	Unnamed Creek (3)		Fixed crest weir	Rock barrier, No N.I.P.	
Lake Conjola	Unnamed Creek (3)		Culvert invert too high		
Lake Conjola	Gooloo Creek	Princes Highway	Culvert invert too high		
Lake Conjola	Pattimores Lagoon	(Near Lake Conjola Entrance Rd.)	Impeded flow	Parts of an old weir present, S.E.M.C. to determine if should be freshwater or tidal, F.A.N.	4
Narrawallee Inlet	Narrawallee Creek		Agricultural drains	F.A.N.	2
Narrawallee Inlet	Croobyar Creek		Fixed crest weir	Tidal limit since 1900's - more weirs u.s., No N.I.P.	
Mollymook Beach Creek		Mitchell Pde.	Culvert invert too high	T.O.B. (12/10/94)	1
Ulladulla Harbour	Millards Creek		Fixed crest weir	St Vincents St. Weir, near tidal limit, N.I.P. for rock ramp fishway & mini wetland at entrance	1
Racecourse Creek			Fixed crest weir	No N.I.P., F.A.N.	1
Burrill Lake		Princes Highway	Causeway with inadequate opening	Old bridge insuff., causeway too long	
Burrill Lake	Unnamed Creek	Hobbs L.	Causeway with inadequate opening	Small diameter culvert with high invert	2
Total					109

Appendix 5 Number and location of structures that influence tidal flow in RAC 7 by structure.

Structures	Catchment	Site	Associated Road or Structure	Problem	Comments	Number of structures in each waterway	Total
Bridges	Short Beach Creek		Beach Rd.	Bridge opening too small	Causeway too long	1	9
	Candlagan Creek		Coronation Dr.	Bridge opening too small	Causeway too long	1	
	Tuross River	Tuross Lake	Princes Highway	Bridge opening too small	Smarts Bridge	1	
	Wagonga Inlet		Princes Highway	Bridge opening too small	Causeway too long	1	
	Nangudga Lake		Princes Highway	Bridge opening too small	Causeway too long	1	
	Wallaga Lake		Princes Highway	Bridge opening too small	Causeway too long	1	
	Corunna Lake	Corunna Lake	Princes Highway	Bridge opening too small	Causeway too long	1	
	Merimbula Lake		Princes Highway	Bridge opening too small	Causeway too long, restriction in tidal flow, F.A.N.	1	
	Pambula Lake	Yowaka River	Princes Highway	Bridge opening too small	Possible siltation, F.A.N.	1	
	Durras Lake	Bartleys Creek	Durras Rd.	Culvert invert too high	Benandarrah State Forest	1	
Culverts	Maloneys Flat Creek		North Cove Rd.	Culvert invert too high	T.O.B. (13/10/94)	1	30
	Clyde River / Batemans Bay	Unnamed Creek	The River Rd.	Siltation of culvert	Water in culvert but no mangroves upstream, F.A.N. Road grade material Road grade material	6	
	Clyde River / Batemans Bay	Sheep Station Creek	Nelligan Rd. (52)	Culvert invert too high			
	Clyde River / Batemans Bay	Buckenbowra River	Runnyford Rd.	Culvert occlusion			
	Clyde River / Batemans Bay	Buckenbowra River	Runnyford Rd.	Culvert occlusion			
	Clyde River / Batemans Bay	Saltwater Gully	Runnyford Rd.	Culvert diameter too small and invert too high			
	Clyde River / Batemans Bay	Mundarlow Creek	Runnyford Rd.	Culvert diameter too small			
	Tomaga River			Culvert invert too high	Canal near bridge	1	
	Moruya River		North Head Rd.	Culvert diameter too small	2x3m culverts, loss of tidal flow, dead mangroves	4	
	Moruya River			Culvert invert too high	Floodgate door removed		
	Moruya River	Gilmores Creek	South Head Rd.	Culvert diameter too small		1	
	Moruya River	Unnamed Creek	South Head Rd.	Culvert invert too high		1	
	Lake Mummuga	Spring Creek	Dalmeny Dr. (?)	Culvert invert too high		1	
	Yabbara Beach Creek		Dalmeny Dr.	Culvert invert too high		1	
	Duesburys Point Creek		Dalmeny Dr.	Culvert invert too high	T.O.B. (1/12/94)	1	
	Duesburys Beach Creek		Dalmeny Dr.	Culvert invert too high	T.O.B. , green scum (1/12/94)	1	
	Wagonga Inlet	Punkalla Creek	Wild Horse Rd.	Culvert diameter too small		4	
	Wagonga Inlet	Mill Bay Creek	Riverview Rd.	Culvert diameter too small			
	Wagonga Inlet	Unnamed Creek	Riverview Rd.	Culvert invert too high			
	Wagonga Inlet	Unnamed Creek	Riverview Rd.	Culvert diameter too small and invert too high			
	Little Lake	Unnamed Creek (1)	Glasshouse Rocks Rd.	Culvert invert too high		2	
	Little Lake	Unnamed Creek (1)	Glasshouse Rocks Rd.	Culvert invert too high		1	
	Nangudga Lake	Unnamed Creek	Old South Coast Rd.	Culvert invert too high	Causeway recently constructed	1	
	Corunna Lake		Princes Highway	Culvert invert too high		1	
	Tilba Tilba Lake	Victoria Creek		Culvert diameter too small		2	
	Tilba Tilba Lake	Victoria Creek		Siltation of culvert			
	Wallagoot Lake	Scotts Bay		Culvert diameter too small	Scotts Bay - culvert partially washed out, Bournda SRA	2	
	Wallagoot Lake		Wallagoot Lake Rd.	Culvert diameter too small	Wallagoot Lake Rd., Bournda SRA	1	
	Wonboyn River	Wonboyn Lake	Wonboyn Rd.	Culvert invert too high		1	
	Causeways	Merry Beach Creek		Murramarang Rd.	Causeway with inadequate opening	Road blocks the channel, no culvert provided, T.O.B. (13/10/94)	
Clyde River / Batemans Bay		Drurys Creek	The River Rd.	Causeway with inadequate opening	Road blocks the channel, no culvert provided	4	
Clyde River / Batemans Bay		Unnamed Creek	The River Rd.	Causeway with inadequate opening	Road blocks the channel, no culvert provided		
Clyde River / Batemans Bay		Unnamed Creek	The River Rd.	Causeway with inadequate opening	Road blocks the channel, no culvert provided		
Clyde River / Batemans Bay		Nelligan Creek	The River Rd.	Causeway with inadequate opening	Culvert diameter too small and invert too high		
Tuross River		Trunketabella Creek		Causeway with inadequate opening	Prev. bridge (-1968), replaced twice :- now 2 x 3m culverts in 70m causeway	1	
Long Swamp				Causeway with no opening	Fresh water wetland, F.A.N.	1	
Nelson Lagoon				Causeway with no opening	Road forms levee	1	
Fords	Lake Brou	South Lake Brou		Ford	Partially washed out - constriction and siltation	1	2
	Nullica River	Leos Creek	Towamba Rd.	Ford		1	
Weirs	Kioloa Lagoon	Butlers Creek		Fixed crest weir	F.A.N.	1	1
	Clyde River / Batemans Bay	Water Creek		Fixed crest weir	Second weir upstream, F.A.N.	1	
	Hanging Rock Creek			Fixed crest weir		1	

Appendix 5. Number and location of structures that influence tidal flow in RAC 7 by structure (cont).

Structures	Catchment	Site	Associated Road or Structure	Problem	Comments	Number of structures in each waterway	Total
Weirs (cont.)	Saltwater Creek			Fixed crest weir	No N.I.P., F.A.N.	1	10
	Tuross River	Bowns Creek		Fixed crest weir	Was salt water wetland now freshwater, F.A.N.	1	
	Yabbara Beach Creek			Fixed crest weir	T.O.B. (1/12/94), No N.I.P., F.A.N.	1	
	Corunna Lake	Gulph Creek		Fixed crest weir	F.A.N., No N.I.P.	1	
	Murrah River	Murrah Lagoon		Fixed crest weir	Partially washed out	1	
	Bega River	Jellat Jellat Gully		Fixed crest weir	F.A.N., No N.I.P.	1	
	Merimbula Lake	Boggy Creek		V - notch weir	F.A.N., No N.I.P.	1	
Floodgates	Tuross River	Cooper Island		Floodgate		1	1
Agricultural Drains	Moruya River			Agricultural drains		1	2
	Bobundara Creek			Agricultural drains		1	
Stormwater Drains							0
Impeded flow	Clyde River / Batemans Bay	Mundarlow Creek	The River Rd.	Impeded flow	Log barrier	1	8
	Tuross River			Impeded flow	Sand barrage created to fix tidal limit in dry periods		
	Tuross River	Bumbo Creek		Impeded flow	Log barrier, F.A.N.	2	
	Lake Brunderee	Potato Creek		Impeded flow	Kikuyu grass chokes channel, "Ageing lake", F.A.N.	1	
	Corunna Lake		Princes Highway	Impeded flow	Grassing of beachfront at entrance restricts flow	1	
	Wallaga Lake	Dignams Creek		Impeded flow	Concrete dump, F.A.N.		
	Wallaga Lake	Narira Creek		Impeded flow	Structure uncertain, F.A.N.	2	
Bega River			Impeded flow	Sand barrage created to fix tidal limit in dry periods	1		
Miscellaneous	Moruya River	Mogendoura Creek		Fish ladder too high	F.A.N.	1	2
	Nangudga Lake			Illegal opening		1	
Total							72

Appendix 6 NSW waterbodies in relation to Regional Advisory Committees (RAC)
and Local Government Areas (LGA).

Waterway number	Waterway	RAC	LGA
1	Tweed River	1	Tweed
2	Cudgen Creek	1	Tweed
3	Cudgera Creek	1	Tweed
4	Mooball Creek	1	Tweed
5	Brunswick River	1	Byron
6	Belongil Creek	1	Byron
7	Unnamed Creek	1	Byron
8	Tallow Creek	1	Byron
9	Broken Head Creek	1	Byron
10-23	Unnamed Creek x 14	1	Byron
24	Unnamed Creek	1	Byron
25	Unnamed Creek	1	Byron
26	Unnamed Creek	1	Byron
27	Lake Ainsworth	1	Ballina
28	Unnamed Creek (Boulder Beach)	1	Ballina
29	Richmond River	1	Ballina, Lismore & Richmond River
30-31	Unnamed Creek x 2	1	Richmond River
32	Evans River	1	Richmond River
33-37	Unnamed Creek x 5	2	Richmond River
38	Bullock Gully	2	Richmond River
39	Unnamed Creek	2	Richmond River
40	Jerusalem Creek	2	Richmond River
41	Clarence River	2	Richmond River, Copmanhurst, Grafton, Maclean & Ulmarra
42	Mara Creek	2	Maclean
43-49	Unnamed Creek x 7	2	Maclean
50	Sasparilla Creek	2	Maclean
51	Lake Arragan	2	Maclean
52	Unnamed Creek (Red Cliff)	2	Maclean
53	Cakora Lagoon	2	Maclean
54	Sandon River	2	Maclean & Ulmarra
55	Wooli Wooli River	3	Ulmarra
56-57	Unnamed Creek x 2	3	Ulmarra
58	Station Creek	3	Ulmarra
59	Corindi River	3	Ulmarra
60	Unnamed Creek	3	Ulmarra
61	Arrawarra Creek	3	Coffs Harbour
62	Darkum Creek	3	Coffs Harbour
63	Woolgoolga Lake	3	Coffs Harbour
64	Unnamed Creek	3	Coffs Harbour
65	Hearns Lake	3	Coffs Harbour
66	Fiddamans Creek	3	Coffs Harbour
67	Moonee Creek	3	Coffs Harbour
68	Unnamed Creek	3	Coffs Harbour
69	Hayes Creek	3	Coffs Harbour
70-71	Unnamed Creek x 2	3	Coffs Harbour
72	Pine Brush Creek	3	Coffs Harbour
73	Unnamed Creek	3	Coffs Harbour
74	Unnamed Creek	3	Coffs Harbour
75	Unnamed Creek	3	Coffs Harbour
76	Jordans Creek	3	Coffs Harbour
77	Coffs Creek	3	Coffs Harbour
78	Boambee Creek	3	Coffs Harbour
79	Bonville Creek	3	Coffs Harbour
80	Scrub Creek	3	Coffs Harbour
81	Unnamed Creek	3	Coffs Harbour
82	Bundageree Creek	3	Coffs Harbour
83-84	Unnamed Creek x 2	3	Bellingen
85	Bellingen River	3	Bellingen
86	Dalhousie Creek	3	Bellingen
87	Unnamed Creek	3	Bellingen
88	Oyster Creek	3	Bellingen & Nambucca

Appendix 6 NSW waterbodies in relation to Regional Advisory Committees (RAC)
and Local Government Areas (LGA) (cont).

Waterway number	Waterway	RAC	LGA
89	Deep Creek	3	Nambucca
90	Swimming Creek	3	Nambucca
91	Secluded Creek	3	Nambucca
92	Unnamed Creek (Beilbys Beach)	3	Nambucca
93	Nambucca River	3	Nambucca
94	Middle Head Creek	3	Kempsey
95	Unnamed Creek (Grassy Beach)	3	Kempsey
96	Macleay River	3	Kempsey
97	South West Rocks Creek	3	Kempsey
98	Saltwater Creek	3	Kempsey
99	Unnamed Creek	3	Kempsey
100	Unnamed Creek (Gap Beach)	3	Kempsey
101-108	Unnamed Creek x 8	3	Kempsey
109	Korogoro Creek	3	Kempsey
110	Ryans Cut	3	Kempsey
111- 16	Unnamed Creek x 6	3	Kempsey
117	Killick Creek	3	Kempsey
118	Goolawah Lagoon	3	Kempsey
119	Big Hill Point Cut	3	Kempsey
120	Hastings River	3	Kempsey & Hastings
121	Unnamed Creek (Shelly Beach)	3	Hastings
122-123	Unnamed Creek x 2 (Miners Beach)	3	Hastings
124	Lighthouse Gully	3	Hastings
125	Unnamed Creek (Lighthouse Beach)	3	Hastings
126	Cathie Creek	3	Hastings
127	Duchess Gully	3	Hastings
128	Unnamed Creek	3	Hastings
129	Greenhills Gully	3	Hastings
130	Unnamed Creek	3	Hastings
131	Unnamed Creek	3	Hastings
132	Unnamed Creek	3	Hastings
133	Camden Haven River	3	Hastings
134	Unnamed Creek (Diamond Head)	3	Hastings
135	Mineral Creek	4	Greater Taree
136	Unnamed Creek (Kylies Beach)	4	Greater Taree
137	Abby Creek	4	Greater Taree
138	Manning River	4	Greater Taree
139	Racecourse Creek	4	Greater Taree
140	First Rock Gully	4	Greater Taree
141	Khappinghat Creek	4	Greater Taree
142	Unnamed Creek (Diamond Beach)	4	Greater Taree
143	Unnamed Creek (Shelly Beach)	4	Greater Taree
144	Unnamed Creek (Black Head Beach)	4	Greater Taree
145	Unnamed Creek	4	Greater Taree
146	Wallis Lake	4	Great Lakes
147	Unnamed Creek (Mile Beach)	4	Great Lakes
148-151	Unnamed Creek x 4	4	Great Lakes
152	Unnamed Creek (Lobster Pot Beach)	4	Great Lakes
153-154	Unnamed Creek x 2	4	Great Lakes
155	Unnamed Creek (McBrides Beach)	4	Great Lakes
156-165	Unnamed Creek x 10	4	Great Lakes
166	Smiths Lake	4	Great Lakes
167-169	Unnamed Creek x 3	4	Great Lakes
170	Port Stephens	4	Great Lakes & Port Stephens
171	Wreck Beach Creek	4	Port Stephens
172-174	Unnamed Creek x 3	4	Port Stephens
175	Hunter River	4	Port Stephens, Dungog, Maitland & Newcastle
176	Unnamed Creek	4	Newcastle
177	Murdering Gully	4	Newcastle
178	Flaggy Creek (Glenrock Lagoon)	4	Lake Macquarie
179-181	Unnamed Creek x 3	4	Lake Macquarie
182-184	Unnamed Creek x 3	4	Lake Macquarie

Appendix 6 NSW waterbodies in relation to Regional Advisory Committees (RAC)
and Local Government Areas (LGA) (cont).

Waterway number	Waterway	RAC	LGA
185	Freshwater Creek	4	Lake Macquarie
186	Jewells Swamp	4	Lake Macquarie
187	Lake Macquarie	4	Lake Macquarie & Wyong
188-189	Unnamed Creek x 2	4	Lake Macquarie
190	Unnamed Creek	4	Lake Macquarie
191	Unnamed Creek (Pinny Beach)	4	Lake Macquarie
192	Unnamed Creek (The Caves)	4	Lake Macquarie
193-197	Unnamed Creek x 5	4	Lake Macquarie
198	Middle Camp Gully	4	Lake Macquarie
199	Unnamed Creek (Middle Camp Beach)	4	Lake Macquarie
200	Moonee Beach Creek	4	Wyong
201-203	Unnamed Creek x 3	4	Wyong
204	Bongon Lagoon	4	Wyong
205-206	Unnamed Creek x 2	4	Wyong
207	Birdie Creek	4	Wyong
208	Soldiers Beach Creek	4	Wyong
209-210	Unnamed Creek x 2	4	Wyong
211	Tuggerah Lakes	4	Wyong
212-213	Unnamed Creek x 2	4	Wyong
214	Wamberal Lagoon	5	Gosford
215	Terrigal Lagoon	5	Gosford
216	Unnamed Creek	5	Gosford
217	Avoca Lake	5	Gosford
218	Unnamed Creek	5	Gosford
219	Winney Bay	5	Gosford
220	Copacabana Creek	5	Gosford
221	Cockrone Lagoon	5	Gosford
222-223	Unnamed Creek x 2	5	Gosford
224	Little Beach Creek	5	Gosford
225	Unnamed Creek	5	Gosford
226	Caves Creek	5	Gosford
227	Maitland Bay	5	Gosford
228-229	Unnamed Creek x 2	5	Gosford
230	Putty Beach Creek	5	Gosford
231	Little Tallow Beach Creek	5	Gosford & Brisbane Water
232	Brisbane Water	5	Gosford
233	Hawkesbury River	5	Gosford, Baulkham Hills, Blacktown, Blue Mountains, Campbelltown, Camden, Hawkesbury, Hornsby, Ku-Ring-Gai, Liverpool, Penrith, Pittwater, Warringah & Wollondilly
234	Pittwater	5	Pittwater
235	Bilgola Creek	5	Pittwater
236	McMahons Creek	5	Pittwater
237-239	Unnamed Creek x 3	5	Pittwater
240	Narrabeen Lagoon	5	Pittwater & Warringah
241	Dee Why Lagoon	5	Warringah
242	Curl Curl Lagoon	5	Warringah
243	Manly Lagoon	5	Warringah & Manly
244	Parramatta River	5	Ashfield, Auburn, Concord, Drummoyne, Hornsby, Hunters Hill, Ku-Ring-Gai, Lane Cove, Leichhardt, Manly, Mosman, Parramatta, North Sydney, Ryde, Sydney, South Sydney, Warringah, Willoughby & Woollahra
245	Georges River / Botany Bay	5	Bankstown, Botany, Burwood, Campbelltown, Canterbury, Fairfield, Hurstville, Kogarah, Liverpool, Marrickville, Randwick, Rockdale, South Sydney, Strathfield & Sutherland
246	Hacking River	5	Sutherland
247	Marley Creek	5	Sutherland
248	Little Marley Creek	5	Sutherland
249	Wattamolla Creek	5	Sutherland
250	Curraurrang Gully	5	Sutherland
251	Curraurrang Creek	5	Sutherland
252	Curra Brook	5	Sutherland

Appendix 6 NSW waterbodies in relation to Regional Advisory Committees (RAC)
and Local Government Areas (LGA) (cont).

Waterway number	Waterway	RAC	LGA
253	Unnamed Creek	5	Sutherland
254	North Rill	5	Sutherland
255	Middle Rill	5	Sutherland
256	South Rill	5	Sutherland
257	Black Gin Gully	5	Wollongong
258	Collaery Gully	5	Wollongong
259	Stockyard Gully	5	Wollongong
260	Cutty Gully	5	Wollongong
261	Era Gully	5	Wollongong
262	Unnamed Creek	5	Wollongong
263	Wren Rill	5	Wollongong
264	Whip Rill	5	Wollongong
265	Robin Rill	5	Wollongong
266	Bee Rill	5	Wollongong
267	Figure Eight Gully	5	Wollongong
268	Hell Hole	5	Wollongong
269	Hargraves Creek	5	Wollongong
270	Stanwell Creek	5	Wollongong
271	Stony Creek	5	Wollongong
272	Morong Park Creek	5	Wollongong
273	Unnamed Creek	5	Wollongong
274	Horse Creek	5	Wollongong
275	Reeces Creek	5	Wollongong
276	Meparko Creek	5	Wollongong
277	Unnamed Creek	5	Wollongong
278	Bartons Gully	5	Wollongong
279	Unnamed Creek	5	Wollongong
280	Stockyard Creek	5	Wollongong
281	Coledale North	5	Wollongong
282	Coledale South	5	Wollongong
283	Unnamed Creek	5	Wollongong
284	Wards Creek	5	Wollongong
285	Unnamed Creek	5	Wollongong
286	Jacky Jones Creek	5	Wollongong
287	Brickyard Creek	5	Wollongong
288	Bells Point Creek	5	Wollongong
289	Flanagans Creek	5	Wollongong
290	Thirroul Creek	5	Wollongong
291	Hewitts Creek	5	Wollongong
292	Woodlands Creek	5	Wollongong
293	Tramway Creek	5	Wollongong
294	Slacky Creek	6	Wollongong
295	Whartons Creek	6	Wollongong
296	Collins Creek	6	Wollongong
297	Bellamy Gully	6	Wollongong
298	Bellambi Lake	6	Wollongong
299	Towradgi Lake	6	Wollongong
300	Cabbage Tree Creek	6	Wollongong
301	Port Kembla	6	Wollongong
302	Perkins Beach Creek	6	Wollongong
303	Lake Illawarra	6	Wollongong & Shellharbour
304	Little Lake	6	Shellharbour
305	Shellharbour Swamp	6	Shellharbour
306	Unnamed Creek	6	Shellharbour
307	Killalea Lagoon	6	Shellharbour
308	Minnamurra River	6	Shellharbour & Kiama
309	Unnamed Creek	6	Kiama
310	Bombo Beach Creek	6	Kiama
311	Spring Creek	6	Kiama
312	Surf Beach Creek	6	Kiama
313	Kendalls Beach Creek	6	Kiama
314	Munna Munnora Creek	6	Kiama

Appendix 6 NSW waterbodies in relation to Regional Advisory Committees (RAC)
and Local Government Areas (LGA) (cont).

Waterway number	Waterway	RAC	LGA
315-319	Unnamed Creek x 5	6	Kiama
320	Werri Lagoon	6	Kiama
321	Gerringong Harbour	6	Kiama
322	Walkers Beach Creek	6	Kiama
323	Crooked River	6	Kiama
324	Shoalhaven River	6	Shoalhaven
325	Crookhaven River	6	Shoalhaven
326	Lake Wollumboola	6	Shoalhaven
327	Plutus Creek	6	Shoalhaven
328	Unnamed Creek	6	Shoalhaven
329	Currarong Creek	6	Shoalhaven
330	Abrahams Bosom Creek	6	Shoalhaven
331-334	Unnamed Creek x 4	6	Shoalhaven
335-340	Unnamed Creek x 6	6	Shoalhaven
341	Jervis Bay	6	Shoalhaven & Commonwealth Territory
342-343	Unnamed Creek x 2	6	Commonwealth Territory
344	Stony Creek	6	Commonwealth Territory
345-367	Unnamed Creek x 23	6	Commonwealth Territory
368	Whiting Beach Creek	6	Commonwealth Territory
369	Unnamed Creek	6	Commonwealth Territory
370	Summer Cloud Cove	6	Commonwealth Territory
371	Mary Cove	6	Commonwealth Territory
372	Ryans Swamp	6	Commonwealth Territory
373	St. Georges Basin	6	Shoalhaven
374	Swan Lake	6	Shoalhaven
375	Berrara Creek	6	Shoalhaven
376	Nerrindillah Creek	6	Shoalhaven
377	Washerwomans Creek	6	Shoalhaven
378-379	Unnamed Creek x 2	6	Shoalhaven
380	Lake Conjola	6	Shoalhaven
381	Narrawallee Inlet	6	Shoalhaven
382	Unnamed Creek (Mollymook Beach)	6	Shoalhaven
383	Mollymook Creek	6	Shoalhaven
384	Unnamed Creek	6	Shoalhaven
385	Ulladulla Harbour	6	Shoalhaven
386	Racecourse Creek	6	Shoalhaven
387	Unnamed Creek	6	Shoalhaven
388	Burrill Lake	6	Shoalhaven
389-391	Unnamed Creek x 3	6	Shoalhaven
392	Tabourie Lake	6	Shoalhaven
393	Termeil Lake	6	Shoalhaven
394	Meroo Lake	6	Shoalhaven
395	Willinga Lake	6	Shoalhaven
396	Unnamed Creek (Cormorant Beach)	7	Shoalhaven
397	Unnamed Creek (Murramarang Beach (1))	7	Shoalhaven
398	Unnamed Creek (Murramarang Beach (2))	7	Shoalhaven
399-400	Unnamed Creek x 2	7	Shoalhaven
401	Kioloa Lagoon	7	Shoalhaven
402	Merry Beach Creek	7	Shoalhaven
403	Pretty Beach Creek	7	Shoalhaven
404-413	Unnamed Creek x 10	7	Shoalhaven
414	Pebbly Beach Creek	7	Shoalhaven
415-417	Unnamed Creek x 3	7	Shoalhaven
418	Depot Beach Creek	7	Shoalhaven
419	Durras Lake	7	Eurobodalla
420	Durras Creek	7	Eurobodalla
421-422	Unnamed Creek x 2	7	Eurobodalla
423	Myrtle Beach Creek	7	Eurobodalla
424	Unnamed Creek	7	Eurobodalla
425	Richmond Beach Creek	7	Eurobodalla
426-428	Unnamed Creek x 3	7	Eurobodalla
429	Little Oaky Beach Creek	7	Eurobodalla

Appendix 6 NSW waterbodies in relation to Regional Advisory Committees (RAC)
and Local Government Areas (LGA) (cont).

Waterway number	Waterway	RAC	LGA
430	Oaky Beach Creek	7	Eurobodalla
431-434	Unnamed Creek x 4	7	Eurobodalla
435	North Head Beach Creek	7	Eurobodalla
436	Unnamed Creek	7	Eurobodalla
437	Reef Point	7	Eurobodalla
438	Maloneys Flat	7	Eurobodalla
439	Cullendulla Creek	7	Eurobodalla
440	Unnamed Creek	7	Eurobodalla
441	Clyde River/Batemans Bay	7	Eurobodalla
442	Hanging Rock Creek	7	Eurobodalla
443	Joes Creek	7	Eurobodalla
444	Short Beach Creek	7	Eurobodalla
445	Denhams Beach Creek	7	Eurobodalla
446	Surf Beach Creek	7	Eurobodalla
447	Wimbie Beach Creek	7	Eurobodalla
448	Grandfathers Gully	7	Eurobodalla
449	Circuit Beach Creek	7	Eurobodalla
450	Lillie Pilli Beach Creek	7	Eurobodalla
451	Mosquito Beach Creek	7	Eurobodalla
452	Garden Beach Creek	7	Eurobodalla
453	Reedy Creek	7	Eurobodalla
454	Pretty Point	7	Eurobodalla
455	McKenzies Beach Creek	7	Eurobodalla
456	Rosedale Beach Creek	7	Eurobodalla
457	Saltwater Creek	7	Eurobodalla
458	Rosedale Beach South Creek	7	Eurobodalla
459	Tomakin Beach Creek	7	Eurobodalla
460	Guerilla Bay	7	Eurobodalla
461	Unnamed Creek	7	Eurobodalla
462	Barlings Beach Creek	7	Eurobodalla
463	Tomaga River	7	Eurobodalla
464	Candlagan Creek	7	Eurobodalla
465	Waldrons Swamp	7	Eurobodalla
466	Moruya River	7	Eurobodalla
467	Congo Creek	7	Eurobodalla
468-469	Unnamed Creek x 2	7	Eurobodalla
470	Meringo Creek	7	Eurobodalla
471-472	Unnamed Creek x 2	7	Eurobodalla
473	Kellys Lake	7	Eurobodalla
474	Unnamed Creek	7	Eurobodalla
475	Coila Lake	7	Eurobodalla
476	Tuross River	7	Eurobodalla
477	Lake Brunderee	7	Eurobodalla
478	Jemisons Beach Creek	7	Eurobodalla
479	Lake Tarourga	7	Eurobodalla
480	Lake Brou	7	Eurobodalla
481	Lake Mummuga	7	Eurobodalla
482	Unnamed Creek	7	Eurobodalla
483	Yabbara Beach Creek	7	Eurobodalla
484	Duesburys Point Creek	7	Eurobodalla
485	Duesburys Beach Creek	7	Eurobodalla
486	Kianga Lake	7	Eurobodalla
487	Unnamed Creek	7	Eurobodalla
488	Carters Beach Creek	7	Eurobodalla
489	Unnamed Creek	7	Eurobodalla
490	Wagonga Inlet	7	Eurobodalla
491	Little Lake	7	Eurobodalla
492	Bullengella Lake	7	Eurobodalla
493	Nangudga Lake	7	Eurobodalla
494-495	Unnamed Creek x 2	7	Eurobodalla
496	Nargal Lake	7	Eurobodalla
497	Corunna Lake	7	Eurobodalla
498	Unnamed Creek	7	Eurobodalla

Appendix 6 NSW waterbodies in relation to Regional Advisory Committees (RAC)
and Local Government Areas (LGA) (cont).

Waterway number	Waterway	RAC	LGA
499	Mystery Bay	7	Eurobodalla
500	Unnamed Creek	7	Eurobodalla
501	Tilba Tilba Lake	7	Eurobodalla
502-503	Unnamed Creek x 2	7	Eurobodalla
504	Little Lake	7	Eurobodalla
505	Bobundara Creek	7	Eurobodalla
506	Wallaga Lake	7	Bega Valley
507	Long Swamp	7	Bega Valley
508	Unnamed Creek	7	Bega Valley
509	Bermagui River	7	Bega Valley
510	Barragoot Lake	7	Bega Valley
511	Unnamed Creek	7	Bega Valley
512	Cuttagee Lake	7	Bega Valley
513-515	Unnamed Creek x 3	7	Bega Valley
516	Murrah River	7	Bega Valley
517	Unnamed Creek	7	Bega Valley
518	Bunga Lagoon	7	Bega Valley
519-523	Unnamed Creek x 5	7	Bega Valley
524	Aragunnu Creek	7	Bega Valley
525-531	Unnamed Creek x 7	7	Bega Valley
532	Wapengo Lagoon	7	Bega Valley
533	Stink Bay	7	Bega Valley
534	Middle Lagoon	7	Bega Valley
535	Nelson Lagoon	7	Bega Valley
536	Unnamed Creek	7	Bega Valley
537	Bega River	7	Bega Valley
538-541	Unnamed Creek x 4	7	Bega Valley
542	Kianinny Bay	7	Bega Valley
543-550	Unnamed Creek x 8	7	Bega Valley
551	Games Bay	7	Bega Valley
552-553	Unnamed Creek x 2	7	Bega Valley
554	Wallagoot Lake	7	Bega Valley
555	Bondi Lake	7	Bega Valley
556	Bournda Lagoon	7	Bega Valley
557-568	Unnamed Creek x 12	7	Bega Valley
569	Unnamed Creek (Tura Beach)	7	Bega Valley
570	Back Lagoon	7	Bega Valley
571	Merimbula Lake	7	Bega Valley
572	Unnamed Creek	7	Bega Valley
573	Pambula Lake	7	Bega Valley
574-595	Unnamed Creek x 22	7	Bega Valley
596	Curalo Lagoon	7	Bega Valley
597	Unnamed Creek	7	Bega Valley
598	Cocura Lagoon	7	Bega Valley
599	Mangaema Creek	7	Bega Valley
600	Shadrack Creek	7	Bega Valley
601	Brandy Creek	7	Bega Valley
602	Nullica River	7	Bega Valley
603	Boydton Creek	7	Bega Valley
604	Towamba River	7	Bega Valley
605	Unnamed Creek	7	Bega Valley
606	Fisheries Creek	7	Bega Valley
607-621	Unnamed Creek x 15	7	Bega Valley
622	Salt Water Creek	7	Bega Valley
623	Woodburn Creek	7	Bega Valley
624-630	Unnamed Creek x 7	7	Bega Valley
631	Bittangabee Creek	7	Bega Valley
632-649	Unnamed Creek x 18	7	Bega Valley
650	Wonboyn River	7	Bega Valley
651-655	Unnamed Creek x 5	7	Bega Valley
656	Merrica River	7	Bega Valley
657-670	Unnamed Creek x 14	7	Bega Valley
671	Wirra Birra Creek	7	Bega Valley

Appendix 6 NSW waterbodies in relation to Regional Advisory Committees (RAC)
and Local Government Areas (LGA) (cont).

Waterway number	Waterway	RAC	LGA
672-677	Unnamed Creek x 6	7	Bega Valley
678	Table Creek (Little Creek)	7	Bega Valley
679-684	Unnamed Creek x 6	7	Bega Valley
685	Nadgee River	7	Bega Valley
686-687	Unnamed Creek x 2	7	Bega Valley
688	Nadgee Lake	7	Bega Valley
689-690	Unnamed Creek x 2	7	Bega Valley

Appendix 7a Correspondence between structures shown on maps and inspected in the field for RAC 1.

Structure	N° on 1:25 000 map	N° not requiring inspection ¹	Not inspected				Inspected				Extra structures (classified as other structures)		Extra structures (unclassified)					Total	N° with rehabilitation potential
			N° inaccessible	N° other	Subtotal	N° with rehabilitation potential	No. incorrectly labelled	No. correctly labelled	Subtotal	N° with rehabilitation potential	N°	N° with rehabilitation potential	N° inspected	N° anecdotal	N° other sources	Subtotal	N° with rehabilitation potential		
Bridges	326	109	44	5	49	0	25	143	168	0	18	0	3	0	0	3	0	164	0
Culverts	662	239	56	10	66	0	108	249	357	19	9	1	21	0	0	21	7	279	27
Causeways	13	3	2	2	4	0	4	2	6	1	2	1	1	0	0	1	1	5	3
Fords	8	4	1	0	1	0	2	1	3	0	0	0	0	0	0	0	0	1	0
Weirs	2	0	0	0	0	0	0	2	2	1	1	1	2	0	0	2	2	5	4
Floodgates	87	0	1	5	6	6	0	81	81	81	109	109	101	1	194	296	296	492	492
Total	1098	355	104	22	126	6	139	478	617	102	139	112	128	1	194	323	306	946	526

1. These were structures below the 10m contour but on field inspection of the area found to be above the tidal limit

Appendix 7b Correspondence between structures shown on maps and inspected in the field for RAC 2.

Structure	N° on 1:25 000 map	N° not requiring inspection ¹	Not inspected				Inspected				Extra structures (classified as other structures)		Extra structures (unclassified)					Total	N° with rehabilitation potential
			N° inaccessible	N° other	Subtotal	N° with rehabilitation potential	No. incorrectly labelled	No. correctly labelled	Subtotal	N° with rehabilitation potential	N°	N° with rehabilitation potential	N° inspected	N° anecdotal	N° other sources	Subtotal	N° with rehabilitation potential		
Bridges	158	23	31	7	38	0	14	83	97	1	2	0	1	0	0	1	0	86	1
Culverts	280	68	48	17	65	0	50	97	147	5	6	0	8	0	0	8	0	111	5
Causeways	18	13	0	1	1	0	3	1	4	1	4	3	1	0	0	1	1	6	5
Fords	8	6	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fords	8	6	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Weirs	3	0	1	0	1	1	0	2	2	2	1	1	1	0	0	1	1	5	5
Weirs	3	0	1	0	1	1	0	2	2	2	1	1	1	0	0	1	1	5	5
Floodgates	4	0	1	0	1	1	0	3	3	3	54	54	36	1	47	84	84	142	142
Floodgates	4	0	1	0	1	1	0	3	3	3	54	54	36	1	47	84	84	142	142
Total	471	110	83	25	108	2	67	186	253	12	67	58	47	1	47	95	86	350	158

1. These were structures below the 10m contour but on field inspection of the area found to be above the tidal limit

Appendix 7c Correspondence between structures shown on maps and inspected in the field for RAC 3.

Structure	N° on 1:25 000 map	N° not requiring inspection ¹	Not inspected				Inspected				Extra structures (classified as other structures)		Extra structures (unclassified)				Total	N° with rehabilitation potential	
			N° inaccessible	N° other	Subtotal	N° with rehabilitation potential	No. incorrectly labelled	No. correctly labelled	Subtotal	N° with rehabilitation potential	N°	N° with rehabilitation potential	N° inspected	N° anecdotal	N° other sources	Subtotal			N° with rehabilitation potential
Bridges	532	46	162	26	188	0	25	273	298	5	5	0	3	1	0	4	1	282	6
Culverts	420	93	59	30	89	0	22	216	238	14	10	1	36	2	0	38	17	264	32
Causeways	11	1	2	0	2	0	6	2	8	1	4	3	5	1	0	6	6	12	10
Fords	24	2	11	3	14	0	3	5	8	0	3	0	5	0	0	5	0	13	0
Weirs	12	0	9	1	10	5	1	1	2	0	2	2	5	2	0	7	7	15	14
Floodgates	33	0	1	0	1	1	0	32	32	31	31	31	34	20	7	61	61	125	124
Total	1032	142	244	60	304	6	57 ²	529	586	51	55 ²	37	88	26	7	121	92	711	186

¹ These were structures below the 10m contour but on field inspection of the area found to be above the tidal limit

² Some structures labelled on maps were not present in the field. As a result the total number of incorrectly labelled structures differs from the total number of extra structures that were classified as other structures.

Appendix 7d Correspondence between structures shown on maps and inspected in the field for RAC 4.

Structure	N° on 1:25 000 map	N° not requiring inspection ¹	Not inspected				Inspected				Extra structures (classified as other structures)		Extra structures (unclassified)					Total	N° with rehabilitation potential
			N° inaccessible	N° other	Subtotal	N° with rehabilitation potential	No. incorrectly labelled	No. correctly labelled	Subtotal	N° with rehabilitation potential	N°	N° with rehabilitation potential	N° inspected	N° anecdotal	N° other sources	Subtotal	N° with rehabilitation potential		
Bridges	304	31	59	1	60	0	28	185	213	2	20	1	14	0	0	14	0	219	3
Culverts	814	149	150	25	175	0	71	419	490	15	28	6	94	0	0	94	3	541	24
Causeways	26	2	5	0	5	0	14	5	19	2	5	5	4	0	0	4	4	14	11
Fords	22	6	7	0	7	0	0	9	9	1	2	0	2	0	0	2	2	13	3
Weirs	7	0	1	2	3	3	0	4	4	4	0	0	9	2	1	12	12	19	19
Floodgates	6	1	0	0	0	0	0	5	5	4	58	58	42	0	116	158	158	221	220
Total	1179	189	222	28	250	3	113	627	740	28	113	70	165	2	117	284	179	1027	280

1. These were structures below the 10m contour but on field inspection of the area found to be above the tidal limit

Appendix 7e Correspondence between structures shown on maps and inspected in the field for RAC 5.

Structure	N° on 1:25 000 map	N° not requiring inspection ¹	Not inspected				Inspected				Extra structures (classified as other structures)		Extra structures (unclassified)				Total	N° with rehabilitation potential	
			N° inaccessible	N° other	Subtotal	N° with rehabilitation potential	No. incorrectly labelled	No. correctly labelled	Subtotal	N° with rehabilitation potential	N°	N° with rehabilitation potential	N° inspected	N° anecdotal	N° other sources	Subtotal			N° with rehabilitation potential
Bridges	255	31	13	12	25	0	20	179	199	5	21	0	7	0	0	7	1	207	6
Culverts	386	88	7	15	22	0	22	254	276	30	19	6	29	0	0	29	7	302	43
Causeways	10	0	1	1	2	0	0	8	8	6	0	0	0	0	0	0	0	8	6
Fords	12	7	3	1	4	0	1	0	1	0	0	0	1	0	0	1	0	1	0
Weirs	13	0	8	0	8	0	1	4	5	4	0	0	21	3	0	24	24	28	28
Floodgates	0	0	0	0	0	0	0	0	0	0	4	4	10	0	0	10	10	14	14
Total	676	126	32	29	61	0	44	445	489	45	44	10	68	3	0	71	42	560	97

1. These were structures below the 10m contour but on field inspection of the area found to be above the tidal limit

Appendix 7f Correspondence between structures shown on maps and inspected in the field for RAC 6.

Structure	N° on 1:25 000 map	N° not requiring inspection ¹	Not inspected				Inspected				Extra structures (classified as other structures)		Extra structures (unclassified)				Total	N° with rehabilitation potential	
			N° inaccessible	N° other	Subtotal	N° with rehabilitation potential	No. incorrectly labelled	No. correctly labelled	Subtotal	N° with rehabilitation potential	N°	N° with rehabilitation potential	N° inspected	N° anecdotal	N° other sources	Subtotal			N° with rehabilitation potential
Bridges	219	23	62	0	62	0	20	114	134	1	12	0	9	0	0	9	0	135	1
Culverts	255	54	41	3	44	0	24	133	157	18	9	2	10	2	0	12	4	154	24
Causeways	9	0	2	0	2	0	0	7	7	3	8	0	0	0	0	0	0	15	3
																		1	0
Fords	3	0	3	0	3	0	0	0	0	0	1	0	0	0	0	0	0	1	0
Fords	3	0	1	0	1	0	0	2	2	2	0	0	10	0	0	10	9	12	11
Weirs	3	0	1	0	1	0	0	2	2	2	0	0	10	0	0	10	9	12	11
Weirs	3	0	1	0	1	0	0	2	2	2	0	0	10	0	0	10	9	12	11
Floodgates	8	0	0	0	0	0	0	8	8	8	12	12	5	6	11	22	22	42	42
Floodgates	8	0	0	0	0	0	0	8	8	8	12	12	5	6	11	22	22	42	42
Total	497	77	109	3	112	0	44 ²	264	308	32	42 ²	14	34	8	11	53	35	359	81

1 These were structures below the 10m contour but on field inspection of the area found to be above the tidal limit

2 Some structures labelled on maps were not present in the field. As a result the total number of incorrectly labelled structures differs from the total number of extra structures that were classified as other structures.

Appendix 7g Correspondence between structures shown on maps and inspected in the field for RAC 7.

Structure	N° on 1:25 000 map	N° not requiring inspection ¹	Not inspected				Inspected				Extra structures (classified as other structures)		Extra structures (unclassified)				Total	N° with rehabilitation potential	
			N° inaccessible	N° other	Subtotal	N° with rehabilitation potential	No. incorrectly labelled	No. correctly labelled	Subtotal	N° with rehabilitation potential	N°	N° with rehabilitation potential	N° inspected	N° anecdotal	N° other sources	Subtotal			N° with rehabilitation potential
Bridges	116	5	15	3	18	0	12	81	93	8	12	0	0	1	0	1	0	94	9
Culverts	198	16	34	8	42	0	16	124	140	23	15	5	5	0	0	5	2	144	30
Causeways	21	1	0	0	0	0	7	13	20	6	3	0	2	0	0	2	2	18	8
Fords	28	2	19	2	21	0	1	4	5	2	3	0	0	0	0	0	0	7	2
Fords	28	2	19	2	21	0	1	4	5	2	3	0	0	0	0	0	0	7	2
Weirs	8	1	3	2	5	1	1	1	2	0	1	1	4	4	1	9	8	12	10
Weirs	8	1	3	2	5	1	1	1	2	0	1	1	4	4	1	9	8	12	10
Floodgates	1	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	1	1
Floodgates	1	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	1	1
Total	372	25	71	15	86	1	37 ²	224	261	40	34 ²	6	11	5	1	17	12	276	60

1 These were structures below the 10m contour but on field inspection of the area found to be above the tidal limit

2 Some structures labelled on maps were not present in the field. As a result the total number of incorrectly labelled structures differs from the total number of extra structures that were classified as other structures.

Appendix 8a Catchment Management Committee and Estuarine Management Committee contacts.

RAC	Catchment Management Committees and Coordinators	Estuarine Management Committees and LAWC Representatives
All	Mr B. Johnston 02-228 6383	
1	<p>Tweed CMC:- Mr W. Garrard- 066 721 213</p> <p>Brunswick CMC:- Mr W. Garrard- 066 286 079</p> <p>Richmond CMC:- Mr W. Garrard- 066 286 079</p> <p>Clarence CMC:- Mr M. Foley- 066 427 799</p>	<p>Tweed Entrance CLC:- I. Taylor- 066 210 600</p> <p>Tweed River MPAC-Lower Tweed Management Plan:- I. Taylor- 066 210 600</p> <p>Tweed River MPAC-Upper Tweed Management Plan:- I. Taylor- 066 210 600</p> <p>Tweed Coast EMC:- I. Taylor- 066 210 600</p> <p>Belongil Creek EMC:- R. Hagley- 066 210 600</p> <p>Lake Ainsworth EMC:- R. Hagley- 066 210 600</p> <p>Lower Richmond River EMC:- R. Hagley- 066 210 600</p> <p>Tuckean Broadwater EMC:- R. Hagley- 066 210 600</p> <p>Evans River EMC:- R. Hagley- 066 210 600</p>
2	Clarence CMC:- Mr M. Foley- 066 427 799	Lower Clarence River EMC:- R. Hagley- 066 210 600
3	<p>Clarence CMC:- Mr M. Foley- 066 427 799</p> <p>Coffs Harbour Waterways CMC:- Mr G. McDonald- 066 551 010</p> <p>Bellingen CMC:- Mr M. Foley- 066 427 799</p> <p>Nambucca CMC:- Mr R. Stanley- 065 631 212</p> <p>Macleay CMC:- Mr D. Warton- 065 631 212</p> <p>Hastings Camden Haven CMC:- Mr R. Stanley- 065 631 212</p>	<p>Ulmarra Council EMC-Wooli Sub Committee:- G. Empson- 066 520 405</p> <p>Ulmarra Council EM-Corindi Sub Committee:- G. Empson- 066 520 405</p> <p>Coffs Harbour Coastal/Estuary MC:- P. Ramstadius- 066 520 405</p> <p>Bellingen Coastline & EMC:- R. Kasmarik- 066 520 405</p> <p>Nambucca River EMC:- R. Kasmarik- 066 520 405</p> <p>Killick Creek EMC:- R. Bailey- 065 820 563</p> <p>Hasting River EMC:- G. Casement- 065 820 563</p> <p>Koolungbong Creek Environ. Comm.:- G. Watkins- 065 820 563</p> <p>Lake Cathie/Innes EMC:- G. Casement- 065 820 563</p> <p>Camden-Haven EMC:- G. Casement- 065 820 563</p>

Appendix 8a Catchment Management Committee and Estuarine Management Committee contacts (cont).

RAC	Catchment Management Committees and Coordinators	Estuarine Management Committees and LAWC Representatives
4	<p>Manning CMC:- Mr C. Atchinson- 065 522 788</p> <p>Karuah Great Lakes CMC:- Mr C. Atchinson- 065 522 788</p> <p>Hunter CMT:- Mr G. Evans- 049 335 455</p> <p>Lake Macquarie CMC:- Ms A. Ferguson- 049 269 971</p> <p>Tuggerah Lakes CMC:- Mr S. Northard- 049 269 971</p>	<p>Manning Estuary & Coastline MC:- M. Donohue- 065 820 563</p> <p>Wallis Lake EMC:- B. Beljaars- 049 269 920</p> <p>Smiths Lake EMC:- B. Beljaars- 049 269 920</p> <p>Port Stephens/Myall Lakes EMC:- R. Slater- 049 269 920</p> <p>Lake Macquarie Estuary/Coastal MC:- R. Slater- 049 269 920</p> <p>Tuggerah Lakes Advisory Committee:- B. Baker- 02 482 0444</p> <p>Wyong/Ourimbah Creek MC:- G.Pelosi- 02 372 8877</p>
5	<p>Brisbane Water & Gosford Lagoons CMC:- Mr M. Dean- 02 325 564</p> <p>Hawkesbury Nepean CMT:- Mr S. Burrows- 045 774 243</p> <p>Cattai CMC:- Ms L. Banks- 02 651 2170</p> <p>South Creek CMC:- Ms D. Tkachenko- 045 774 243</p> <p>Berowra Creek CMC:- Mr D. Cameron- 02 482 7187</p> <p>Sydney Northern Beaches CMC:- Ms J. McNeill- 02 325 5651</p> <p>Middle Harbour CMC:- Ms R. D'Arcy- 02 325 5654</p> <p>Lane Cove River CMC:- Ms R. Turner- 02 325 5649</p> <p>Upper Parramatta River Trust:- Dr S. Lees- 02 891 4633</p> <p>Cooks River CMC:- Ms B. Bengston- 02 795 5138</p>	<p>Gosford Lagoons CLP:- B. Coates- 02 372 8877</p> <p>Brisbane Waters Plan of MC:- E. Zvirbulis- 02 372 8877</p> <p>Berowra Creek EMC:- B. Coates- 02 372 8877</p> <p>Pittwater EMC:- G. Pelosi- 02 372 8877</p> <p>Narrabeen Lagoon EMC:- B. Coates- 02 372 8877</p> <p>Curl Curl/Dee Why EMC-Curl Curl Subcommittee:- M. Fitzhenry- 02 372 8877</p> <p>Curl Curl/Dee Why EMC-Dee Why Subcommittee:- M. Fitzhenry- 02 372 8877</p> <p>Manly Lagoon EMC:- G. Freeman- 02 372 8877</p> <p>Lane Cove River EMC:- B. Coates- 02 372 8877</p> <p>Vineyard Creek EMC:- L. Sharma- 02 482 0444</p>

Appendix 8a Catchment Management Committee and Estuarine Management Committee contacts (cont).

RAC	Catchment Management Committees and Coordinators	Estuarine Management Committees and LAWC Representatives
5 cont.	Georges River CMC:- Ms S. Gould- 02 795 5238 Hacking CMC:- Mr J. Thompson- 02 795 5243	Long Bay EMC:- D. Miller- 02 372 8877 Port Hacking Planning & Advisory Committee:- M. Porter- 02 372 8877 Yowie Bay EMC:- D. Miller- 02 372 8877
6	Illawarra CMC:- Ms J. Caldwell- 042 277 225 Upper Shoalhaven CMC:- Mr D. Thompson- 048 230 655 Lower Shoalhaven CMC:- Ms S. Fritz- 044 293 539	Lake Illawarra Authority:- M. Monaghan- 042 268 500 Minnamurra River EMC:- G. Clarke- 042 268 500 Shoalhaven Floodplain Coastal & River MC:- G. Clarke- 042 268 500 Shoalhaven Lakes EMC-Lake Wollumboola Subcommittee:- G. Clarke- 042 268 500 Shoalhaven Lakes EMC-St. Georges Basin Subcommittee:- G. Clarke- 042 268 500 Shoalhaven Lakes EMC-Lake Conjola Subcommittee:- G. Clarke- 042 268 500 Shoalhaven Lakes EMC-Narrawallee Inlet Subcommittee:- T. Roper- 042 268 500 Shoalhaven Lakes EMC-Tabourie Lake Subcommittee:- T. Roper- 042 268 500
7	Lower South Coast CMC:- Mr D. McPhee- 064 921 622 Far South Coast CMC:- Mr D. McPhee- 064 921 622	Tuross/Coila Lakes EMC:- T. Roper- 042 268 500 Wallaga Lake EMC:- T. Roper- 042 268 500 Merimbula/Back Lakes EMC:- T. Roper- 042 268 500

Abbreviations

- CLC-Community Liason Committee
- CLP-Coastline Lagoon and Coastal Planning Committee
- CMC-Catchment Management Committee
- CMT-Catchment Management Trust
- EMC-Estuarine Management Committee
- MC-Management Committee
- MPAC-Management Plan Advisory Committee

Sources : Department of Land and Water Conservation, Sept. 1995

Mr W. Johnston, State Co-ordinator for Catchment Management, Sept. 1995

Appendix 8b State Rail Authority and Roads and Traffic Authority contacts.

RAC	State Rail Authority	Roads And Traffic Authority
All	Freight Rail John Cree Locked bag 9, Parramatta 2124 Ph. 02 843 9091	Ms J. Stricker General Manager Environment and Community Impact 260 Elizabeth Street, Surrey Hills, NSW 2010 Ph. 02-218 6843 Fax 02-218 6970
1		Mr P. Hatton Environment Manager Northern Region 1 Mort Street, Port Macquarie, NSW 2444 Ph. 065-830444 Fax 065-849170
2		Mr P. Hatton Environment Manager Northern Region 1 Mort Street, Port Macquarie, NSW 2444 Ph. 065-830444 Fax 065-849170
3		Mr P. Hatton Environment Manager Northern Region 1 Mort Street, Port Macquarie, NSW 2444 Ph. 065-830444 Fax 065-849170
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Sources

City Rail Environment Protection Unit, Oct. 1995

RTA Regional Development Branch Environmental Section, Oct. 1995

Appendix 8c Fishing industry rehabilitation contacts.

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1	Co-ordinator-John Gallagher, 11 Burns Point Ferry Road, Ballina 2478 Ph. 066 864121 Secretary-Barbara Radley, 9 Arika Avenue, Brunswick Heads Ph. 066 802815	
2	Co-ordinator-Peter Schaeffer, Yamba Road, Palmers Island 2464 Ph. 066 460220 Secretary-Pearl Ryan, 51-55 River street, Maclean 2463 Ph. 066 452055 Fax 066 454155	
3	Co-ordinator-Phil March, Lot 442 Boyter's Lane, Jerseyville 2431 Ph. 065 666879 Fax 065 666430	Port Macquarie Oyster Farmers Assoc. Inc. Stuart Bale, 10 Newport Cres., Port Macquarie, 2444 Ph. (065) 836744. Fax. (065) 810311 Northern Rivers Sydney Rock Oyster Growers Assoc. L. Mohr, 20 Bismark St., Nambucca Heads, 2448. Ph. (065) 687515. Fax. (065) 690509.
4	Co-ordinator-Don Cameron, 18 Caves Beach Road, Caves Beach 2281 Ph. 049 712856 Fax 049 712496	Independent Oyster Growers of Wallis Lake, Trevor Dent, P.O. Box 163, Tuncurry. 2428. Ph. (H) 065 557113 (W)065 556540 New South Wales Shellfish Assoc. Ltd. Barry Clulow, P.O. Box 61, Karuah. 2324. Ph. 049 975463 Fax. 049 975800

Appendix 8c Fishing industry rehabilitation contacts (cont).

RAC	RAC Habitat Co-ordinators	Oyster Farmers
5	Co-ordinator-Graham Hillyard, 330 Blackwall Road, Woy Woy 2256 Ph. 043 416147	Clyde River Oyster Farmers Assoc. Inc. Paul Westman, 52 Calga Crescent, Batemans Bay. 2536. Ph. 044 727007 Fax. 044 727007
6	Joint Co-ordinator-Bob Burton, Ph. 044 216629 Secretary/Joint Co-ordinator-Shirley Massey, 8 Short Street, Berkeley 2506 Ph. 042 713295 Fax 042 714415	Southern United Oyster Growers Assoc. J. Dujardin, 71 Oysterly Ave., Orient Point. 2540 Ph. (H) 044 473173 (W)044 471394 United Oyster Growers Assoc. Mark Fleming, PO Box 29, Batemans Bay 2536 Ph. 044 786377 United Oyster Growers Assoc. Gary Smith, Eurobodalla E.O. Ph. 044 741258 Wagonga Inlet Oyster Farmers Assoc. W. Saunders, 30 Nioka St., Dalmeny. 2546. Ph. 044 767819 Fax. 044 763322 Pambula Oyster Growers Assoc. Gordon Dalziel, P.O. Box 132, Pambula. 2549. Ph. (H) 064 956701 (W) 064 956704
7	Co-ordinator-Annette Baxter, 2 Princes Highway, Bodalla 2545 Ph. 044 735429 Fax 0044 735594	Wagonga Inlet Oyster Farmers Assoc. W. Saunders, 30 Nioka St., Dalmeny. 2546. Ph. 044 767819 Fax. 044 763322

Appendix 9 List of wetland restoration, rehabilitation, and creation projects recently completed, underway or being negotiated in NSW estuaries.

Project	RAC	Waterway	Site	Situation	Remedial Activity	Status	Comment	Responsible Authority	Source
Restoration		Nil							
Rehabilitation	1	Richmond River	Rocky Mouth Creek	Acid water and loss of wetlands from floodgates and drains	Installation of a manageable floodgate system	C	"Rocky Mouth Creek Habitat Improvement Program"	DLAWC, Richmond River Council	NSWF
	1	Tweed River	Fingal Peninsula	Wetlands degraded by inappropriate culverts and human activity	Replanting wetland vegetation, redesigning culverts, fencing and road improvements to restrict human access	U	"Tweed Estuary Management Plan: Fingal Peninsula Enhancement"	Tweed Council	NSWF
	1	Richmond River	Entire river	Water quality	Monitoring program	U		DLAWC, Ballina Shire Council, Lismore City Council, Richmond River Council	TCM 1992/93
	1	Richmond River	Entire river	Bank erosion, siltation, noxious vegetation, acid sulphate soils	Initiate rehabilitation projects	U	Proposals from Landcare and community groups considered	DLAWC, Ballina Shire Council, Lismore City Council	TCM 1992/93
	1	Richmond River	Tuckean Swamp	Acid water and loss of wetlands from floodgates and drains	Development of management plan, modification of drainage structures, implementation of selected management options	U	"Tuckean Land and Water Management Plan"	DLAWC, Ballina Shire Council, Lismore City Council, Richmond River Council	NSWF
	2	Clarence River	Entire river	Bank erosion, siltation, noxious vegetation, water quality	Establishment of 12 Landcare and Dunecare groups	C	To address issues such as revegetating banks and coastal dunes, removing weeds, changing farming practices and estuary management	DLAWC, Copmanhurst Council, Grafton City Council, Maclean Council, Ulmarra Council,	TCM 1992/93
	2	Clarence River	Roberts Creek	Loss of wetlands from floodgates and drains	Installation of a manageable floodgate system	U	"Roberts Creek Habitat Improvement Program"	DLAWC, Maclean Council	NSWF
	2	Clarence River	Everlasting Swamp	Acid water and loss of wetlands from floodgates and drains	To be determined, landholder consultation underway	NIP	"Everlasting Swamp Wetland Rehabilitation Project", Landholder consultation	?	NSWF
	3	Nambucca River	Warrell Creek	Barrage	Barrage removed	C		DLAWC, Nambucca Shire Council	NSWF
	3	Macleay River	Borrigalla Creek	Acid water and loss of wetlands from floodgates and drains	Floodgates opened and moved upstream	U	"Yarrahapinni Wetland Rehabilitation Project"	DLAWC	NSWF
	4	Tuggerah Lakes	Wyong River	Fixed crest weir	Remove weir / install R-Ramp fishway	C	Site No. 3 on FPL Fishway installed two years ago	Wyong Shire Council	NSWF
	4	Hunter River	Throsby Creek	Siltation	Remedial dredging	C	"Throsby Creek Dredging and Rehabilitation Contract"	Newcastle City Council	TCM 1992/93
	4	Manning River	Entire river	Bank erosion and siltation	Education program	U	Video "Riverine corridor vegetation management"	DLAWC, Greater Taree City Council	TCM 1992/93
4	Manning River	South Channel	Bank erosion	Stabilisation of banks	U		DLAWC, Greater Taree City Council	NSWF	

Appendix 9 List of wetland restoration, rehabilitation, and creation projects recently completed, underway or being negotiated in NSW estuaries (cont).

Project	RAC	Waterway	Site	Situation	Remedial Activity	Status	Comment	Responsible Authority	Source
Rehabilitation (cont.)	4	Hunter River	Kooragang Island Creeks	Inappropriate culverts	Remove culverts	U	"Kooragang Wetland Rehabilitation Project"	Newcastle City Council	NSWF
	4	Lake Macquarie	Winding Creek	Nitrification and sedimentation	GPT installed	U	"Winding Creek Improvement Works"	DLAWC, Lake Macquarie City Council	TCM 1992/93
	4	Tuggerah Lakes		Nitrification and sedimentation	Installation of stormwater treatment zones, GPT's, remedial dredging and removal of macro algae	U	"Tuggerah Lakes Restoration Project"	Wyong Shire Council	
	4	Manning River	Landsdown River	Fixed crest weir	Remove the weir	NIP		DLAWC, Greater Taree City Council	
	4	Coolongolook River	Locketts Crossing	Causeway (fixes tidal limit)	Open causeway / install R-Ramp fishway	NIP		Great Lakes Council	NSWF
	4	Port Stephens	Crawford River	Fixed crest weir with inappropriate fishway	Remove weir / install V-slot fishway	NIP		Great Lakes Council	NSWF
	4	Hunter River	Hexham Swamp	Acid water and loss of wetlands from floodgates and drains	Remove floodgates	NIP	"Ironbark Creek Wetland Rehabilitation Project"	Hunter Catchment Management Trust	NSWF
	4	Lake Macquarie	Dora Creek	Fixed crest weir	Remove weir / install R-Ramp fishway	NIP		Lake Macquarie City Council	NSWF
	4	Lake Macquarie	Mud Creek	Nitrification and sedimentation	Reconnect to Stony Creek, remedial dredging	NIP		DLAWC, Lake Macquarie City Council	RAC 4
	4	Tuggerah Lakes	Ourimbah Creek	Fixed crest weir	Remove weir / install R-Ramp fishway	NIP	Site No. 4 on FPL	Wyong Shire Council	NSWF
	5	Dee Why Lagoon		Nitrification and sedimentation	Installation of stormwater treatment zones	C		Warringah Council, DLAWC	Griffiths (1995)
	5	Cooks River	Wolli Creek	Siltation	GPT installed	C		Canterbury Council, Rockdale Council	TCM 1992/93
	5	Cooks River	Eve St. Marsh	Siltation, reduction of tidal flow	Remedial dredging, replanting native vegetation	C		SW	Stricker (1995)
	5	Narrabeen Lakes		Nitrification and sedimentation	Remedial dredging	U	"Narrabeen Lakes Entrance Maintenance Works"	Warringah Council, DLAWC	NSWF
	5	Narrabeen Lakes	Middle Creek	Nitrification and sedimentation	Stormwater treatment zones built, future construction of a sediment basin and wetland, weed removal and replanting native vegetation	U	"Middle Creek Rehabilitation Project"	Warringah Council, DLAWC	Griffiths (1995)
	5	Curl Curl Lagoon	Greendale Creek	Nitrification and sedimentation	Construction of stormwater treatment zones, GPT , remedial dredging, construction of a water pollution control pond.	U	"Curl Curl Lagoon Rehabilitation Study"	Warringah Council, DLAWC	Griffiths (1995)
5	Manly Lagoon	Burnt Bridge Creek	Nitrification and sedimentation	Construction of stormwater treatment zones, artificial wetlands	U	"Manly Lagoon Estuary Management Study"	Manly Council, Warringah Council, DLAWC	Griffiths (1995)	
5	Parramatta River	Homebush Bay	Water quality		U	"Homebush Bay Rehabilitation Project"	DLAWC (?)	NSWF	

Appendix 9 List of wetland restoration, rehabilitation, and creation projects recently completed, underway or being negotiated in NSW estuaries (cont).

Project	RAC	Waterway	Site	Situation	Remedial Activity	Status	Comment	Responsible Authority	Source
Rehabilitation (cont.)	5	Parramatta River	Middle Harbour	Siltation, urban runoff	Development of land management codes, education	U	Distribution of pamphlets	Various Councils, DLAWC	TCM 1992/93
	5	Georges River / Botany Bay	Salt Pan Creek			U		DLAWC	TCM 1992/93
	5	Georges River / Botany Bay	Forbes Creek	Removal of mangroves	Mangrove replanting	U		DLAWC	RAC 5
	5	Parramatta River	Lane Cove River	Water quality		NIP	Pollutant source - disused tip	Ryde City Council	TCM 1992/93
	5	Georges River / Botany Bay	Liverpool	Fixed crest weir	Install V-slot fishway	NIP	Site No. 6 on FPL	Liverpool City Council	NSWF
	5	Hacking River	Audley	Fixed crest weir	Install V-slot fishway	NIP	Site No. 7 on FPL	NPWS	NSWF
	6	Lake Illawarra		Siltation, erosion	Establishment of 17 Landcare and Dunecare groups	C	To address issues such as farm planning, revegetation, weed and litter removal	DLAWC, Wollongong City Council	TCM 1992/93
	6	Lake Illawarra	Macquarie Rivulet	Fixed crest weir	Converted to R-Ramp fishway	C		Wollongong City Council	NSWF
	6	Bellambi Gully		?	?	U	"Pioneer Beach Estuarine Environmental Regeneration Area"	?	NSWF
	6	Bellambi Lake		Nutrication and sedimentation	Remedial dredging	U	"Bellambi Lagoon Improvement Works"	DLAWC, SW	NSWF
	7	Tuross Lake	Trunketabella Creek	Nutrication and sedimentation	Enlarge bridge opening	NIP		DLAWC, Eurobodalla Shire Council	RAC 7
Creation	1	Richmond River	North Creek	Mangrove destruction	Creation of equivalent area of wetland	U	Bridge and access road, approx. 8 ha lost, F.A.N.	Ballina Shire Council	Burchmore (1992) p186
	4	Smiths Lake			Creation of artificial reefs	NIP		?	NSWF
	5	Georges River / Botany Bay	Third Runway	Seagrass destruction	Seagrass replacement and creation of artificial reefs	NIP		FAC	NSWF

Abbreviations C - Complete
 NIP - Negotiations in progress
 U - Underway
 FAN - Further Assessment Necessary

FPL - Fishway priority list of the 20 most urgent sites
 FAC - Federal Airports Corporation
 DLAWC - Department of Land and Water Conservation
 NPWS - National Parks and Wildlife Service
 SW - Sydney Water
 TCM - Total Catchment Management Committee
 GPT - Gross Pollution Trap

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