An Assessment of the Saltmarsh of the Parramatta River and Sydney Harbour

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August 2007

NSW Department of Primary Industries –
Fisheries Final Report Series
No. 90
ISSN 1449-9967

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Published By: NSW Department of Primary Industries

Postal Address: PO Box 21 Cronulla NSW 2230

Internet: www.dpi.nsw.gov.au

ISSN 1449-9967

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PREFACE

This project describes the disposition of saltmarsh within the estuary of the Parramatta River on the basis of studies conducted in 2006. The sites referred to in the report may not be all-inclusive and ideally all additional sightings made by other state agencies, local government authorities or non-government organisations would be registered in comprehensive database for the whole of the estuary. The maintenance of such a database is an important issue in relation to the many multi-jurisdictional interests involved.

ACKNOWLEDGEMENTS

Funding for this project was in part provided by the National Heritage Trust via the Sydney Metropolitan Catchment Management Authority. NSW Maritime and NSW Department of Primary Industry also contributed to funds and other resources used in the study.

Ortho-rectified images of the Parramatta River and Sydney Harbour taken in 2003 were obtained by the then NSW Fisheries as part of a consortium of state and local government agencies co-ordinated by the then Office of Sydney Harbour Manager. Danielle Morrison of NSW DPI carried out the presumptive mapping of saltmarsh on these images. Greg West of NSW DPI provided technical advice. Susan Norbom and Dennis Buttigieg of NSW Maritime also provided assistance with the production of maps.

Emma Bennton and Alex Kanaar (Shell Refinery, Clyde), and Kerry Darcovich, Judy Carrington and Mark Farran (Sydney Olympic Park Authority) assisted with field access to restricted sites.

Andrew Morison and Suzanne Harris of NSW Maritime provided oversight of the project and insight into the management of the foreshore lands of the Parramatta River and Sydney Harbour, as well as reviewing data and draft reports. Paul Adam and Bob Creese provided comments on the final draft.

NON-TECHNICAL SUMMARY

An Assessment of the Saltmarsh of the Parramatta River/Sydney Harbour

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OBJECTIVES:

(a) collate existing data on the distribution of saltmarsh in the estuary of the Parramatta River-Sydney Harbour;
(b) conduct PC-based GIS analysis of ortho-rectified aerial photographic images of the Parramatta River-Sydney Harbour taken in 2003 and delimit the boundary of saltmarsh in the study area;
(c) conduct field checks to confirm vegetation boundaries;
(d) assess the condition of patches of saltmarsh;
(e) create ArcView shape files and associated data tables to indicate the area of cover for saltmarsh; and
(f) provide a report to NSW Maritime and the Sydney Metro Catchment Management Authority on the above.

NON TECHNICAL SUMMARY:

The first map showing the distribution of saltmarsh for the Parramatta River-Sydney Harbour estuary was created from aerial photos taken in the late 1970s (West *et al.* 1985). A subsequent map prepared from photos taken in 2000 (West *et al.* 2004) suggested there had been little change in distribution. However, recent anecdotal reports indicate that there may be many more small patches of saltmarsh than can be defined with aerial photography. It now appears that without fine-scale assessments there is no way of knowing if subtle changes have occurred in distribution and abundance of saltmarsh, or what natural and human influences might be implicated in bringing change about.

Aerial photography and pedestrian survey were used to locate saltmarsh on the foreshore of the Parramatta River-Sydney Harbour, including the estuarine portions of Middle Harbour, Lane Cove River and Duck River. Over 750 patches were found, having a combined area of 37.306 ha, of which 18.087 ha (48%) were under plant canopy and not able to be identified in the photos. The location, condition and species composition of each patch was determined. Large-scale maps are presented to show locations where saltmarsh occurs. Comparisons with earlier studies are made but are qualified given that the former show very few patches compared to what was found in the recent survey. A GIS-based shape file can be provided for further analysis by stakeholders.

The distribution of saltmarsh is uneven, with most patches located in the upper and middle portions of the estuary. The rare and exotic species are also restricted in distribution throughout the estuary. The majority of saltmarsh patches were in a poor condition.

Distribution was examined in terms of natural history, geomorphology, and human impact. The threats facing these saltmarshes, including incursion by mangroves, sea level rise, unauthorised access, weed invasion and pollution and dumping are considered.

Management implications are discussed. These include the recent declaration of saltmarsh as an Ecologically Endangered Community, the status of saltmarsh within designated conservation reserves, the conservation of species considered by their rarity to be "sensitive", and the removal of the exotic/invasive species *Juncus acutus*. Given that this study is the first pedestrian survey of the whole of a NSW estuary for saltmarsh, comment is also given to the importance and effectiveness of field-based 'ground truthing' in the mapping of saltmarsh wetlands. Recommendations are provided at the end of the report. It is important that future planning for the Parramatta River-Sydney Harbour estuary and foreshore minimises threats to, and protects the conservation value of, saltmarsh.

1. INTRODUCTION

1.1. Background

Coastal saltmarshes are ecosystems vegetated by herbs, grasses or low shrubs bordering saline waterbodies (Adam 1990). They occur between highest astronomical tide and mean high water neap tide (Adam 2002). Saltmarsh provides a permanent or temporary habitat for a range of animals, including species of commercial and recreational importance. In the Sydney region saltmarsh is generally bordered by mangroves to the lower estuarine side and terrestrial communities or anthropogenic structures to the higher, landward side (Plate 1). Tidal regimes generally control the distribution of saltmarsh, with lower areas within a marsh often subject to daily inundation by saline waters at high tides, while some upper marsh communities will only be reached by the highest tides.

Plate 1. Tidal waters inundating *Sarcocornia quinqueflora* dominated saltmarsh within (Badu wetland, Sydney Olympic Park). Mangroves are in the background. (Field ID number for this site is SPR209).

In 2004, coastal saltmarsh was listed in NSW as an 'Endangered Ecological Community' (EEC) in the NSW North Coast, Sydney Basin and South East Corner bioregions under the NSW *Threatened Species Conservation Act 1995* (Appendix 1). This initiative followed a long series of actions to identify the distribution, ecological contribution, and environmental sensitivity of this plant community (Adam 1981, Adam *et al*. 1988, Adam 1990).

The first project to map the distribution of saltmarsh for the whole of NSW was initiated by the then NSW State Fisheries in the late 1970s. The subsequent amalgamation of Fisheries within the Department of Agriculture New South Wales saw additional support from the latter organization and the production of a compendium of maps showing the extent of seagrass and mangrove, as well as saltmarsh along the whole NSW coast (West *et al.* 1985). Using aerial photographs taken in the late 1970s and early 1980s, maps of over 130 estuaries were prepared. These maps had, and still have, wide use as planning and management documents including oil spill planning (Carter 1994), development assessment and estuary management planning. Only three large meadows of saltmarsh are shown in the Parramatta River-Sydney Harbour estuary in the maps of West *et al.* (1985).

A large number of halophytic and salt-tolerant plant species are contained within the group collectively known as "saltmarsh". West *et al.* (1985) did not differentiate between, or map, the distribution of the various species as these tasks were beyond the resources of their project. Subsequently, other maps have been produced of the generalised cover of saltmarsh in various locations: Hawkesbury River (Williams and Watford 1997, Williams and Watford 1999, Williams and Thiebaud in preparation), Parramatta River-Sydney Harbour (West *et al*. 2004), Georges River (Pickthall *et al*. 2004), Hacking River (Williams and Meehan 2004) and elsewhere in NSW (Wilton 1998, Wilton *et al*. 2003, West *et al*. in preparation).

The study of the Georges River by Pickthall *et al*. (2004) provides more detail than the previous generalised cover maps. While not mapping the distribution of individual species, Pickthall *et al.* (2004) at least identified the species assemblage in any one meadow of saltmarsh. Characteristic saltmarsh species along the central part of the NSW coastline are shown in Table 1.

1.2. Need

In 1999 the NSW Government released its Coastal Policy, one aspect of which was to undertake the Comprehensive Coastal Assessment (CCA). Various organisations including NSW resource agencies undertook the preparation of maps of coastal and estuarine features for the CCA. One contribution of the NSW Department of Primary Industries was to remap the estuarine vegetation originally mapped by West *et al.* (1985).

Updating the mapping was necessary given the increase in population density along the coast over the past 20 years and changes in distribution of estuarine plants that may have taken place at a number of sites in a number of estuaries. Some of these changes may have been caused by natural events such as storms, whereas others are almost certainly due to human activity. Unfortunately, the ambit of the CCA did not include the Sydney metropolitan area of NSW (extending from the Hunter River south to Lake Illawarra). There is, therefore, a need to understand better the extent and nature of saltmarsh in the Parramatta River-Sydney Harbour.

The NSW Scientific Committee (2004) identified ten species of saltmarsh plant as indicative members of this type of estuarine vegetation in New South Wales. However, past mapping exercises have rarely provided information on plant species composition. The one exception is the attention given to *Gahnia filum, Selliera radicans* and *Wilsonia backhousei* by Pickthall *et al.* (2004), who described them as "sensitive" species of saltmarsh due to their limited presence relative to the other plants within the group. *G. filum* is a tall tussock sedge characteristic of the upper marsh fringe in southeast Australia (Tasmania, Victoria and south coast of NSW). Its occurrence on the Georges River is the most northerly known, and this population is markedly disjunct from the next nearest southern population in Jervis Bay. It is possible that *G. filum* may have once been present along the foreshores of the Parramatta River-Sydney Harbour, but there are no historical records to substantiate such a claim. The historical record does show that *S. radicans*, a prostrate, mat-forming species, has suffered a major decline in Parramatta River/Port Jackson

(Hamilton 1919). Along the Georges River, *S. radicans* forms dense monospecific stands at only a few sites (most notably at Voyager Point), and is generally limited to upper marsh areas. Another prostrate, mat-forming species is *W. backhousei*, which, like *G. filum*, also occurs at the northern end of its range in the Sydney region. In the 19th century it was extensive along the Sydney Harbour embayments (Hamilton 1919) but many of these areas were subsequently reclaimed. The reduction in the distribution of *W. backhousei* is such that it is now listed as "Vulnerable" under Schedule 2 of the *Threatened Species Conservation Act* 1995. Importantly, the Homebush Bay area of the Parramatta River is thought to contain the largest remaining stands of *W. backhousei* in the Sydney region (Adam 1996).

Table 1. Characteristic saltmarsh plant species along the central coast of New South Wales. While Coastal Saltmarsh as a whole is listed as an Endangered Ecological Community, five individual species (#) may be of particular significance because of their limited distribution in the Sydney metropolitan region.

Scientific name	Common name	Status in Sydney Metropolitan Region[1]
Baumea juncea	No common name	common
#*Gahnia filum*	No common name	rare
#*Halosarcia pergranulata* subsp. *pergranulata*	No common name	rare
Juncus kraussii	Sea rush	common
Juncus acutus (introduced)	Sharp rush	common, exotic
#*Lampranthus tegens*	No common name	rare
Samolus repens	Creeping Brookweed	common
Sarcocornia quinqueflora	Samphire, Glasswort	common
#*Selliera radicans*	No common name	rare
Sporobolus virginicus	Salt Couch, Salt-grass	common
Suaeda australis	Australian seablite	common
Triglochin striata	Sea arrow grass	common
#*Wilsonia backhousei*	Narrow-leaved *Wilsonia*	rare; 'Vulnerable' under the TSC Act 1995
Zoysia macrantha	Coast Couch	common

[1] *Derived from data provided in Adam et al. (1998) and herbarium records from the Royal Botanic Gardens, Sydney.*

In the Georges River the distribution of *G. filum* and *W. backhousei* is generally limited to the central portion of the estuary, while *S. radicans* is only found in the upper estuary (Pickthall *et al*. 2004). *S. radicans* and *W. backhousei* are likely to be particularly susceptible to damage from trampling or passage of wheeled vehicles (Kelleway 2005). Because of this sensitivity, it is important that appropriate attention is paid to the conservation of these species by the relevant state and local government authorities.

Previous flora surveys of the Homebush Bay precinct (Adam 1996) have identified the presence of two species that have been labelled as 'culturally significant.' The first, *Lampranthus tegens*, is a spreading, prostrate shrub related to coastal Pigface (*Carpobrotus* spp.). It has been suggested that *L. tegens* may have been introduced from South Africa, but at present no records exist of this species occurring in that country. It is possible that *L. tegens* is an extremely rare Australian native species, or that it has since become extinct in South Africa. Regardless of its history, attention should be given to all occurrences of this species within the Parramatta River-Sydney Harbour due to its extreme rarity.

Halosarcia pergranulata subspecies *pergranulata* is a native halophyte that grows throughout parts of inland Australia, including salt lakes, but less commonly in coastal saline areas. In New South Wales, neither *L. tegens* nor *H. pergranulata* have been recorded in coastal saltmarshes outside of the Parramatta River-Sydney Harbour. It has been hypothesised that this species may have been inadvertently transported to the Homebush Bay precinct through birds or by transport of livestock (Adam 1996). This study will help to confirm the presence and distribution of these species within the Parramatta River-Sydney Harbour.

Rise of sea level will have a significant impact on the distribution of plants living in and around estuaries (Vanderzee 1988, Williams 1990). Terrestrial vegetation, such as Swamp She-oak (*Casuarina* spp.) and Paperbark (*Melaleuca* spp.) will be forced further upstream and upslope by the rise in mean sea level. Intertidal vegetation, such as saltmarsh and mangrove will also move further upslope and upriver from their present locations. However, the expansion of saltmarsh will be limited by topography and structures such as seawalls, roads and buildings.

The expansion of mangrove is another threat that will impact on the distribution of saltmarsh. Evidence already exists of this problem across the whole of southeastern Australia (Saintilan and Williams 1999, Saintilan and Williams 2000) but the causes are as yet unknown. In the Sydney metropolitan area, invasion of saltmarsh by mangrove at Towra Point (Mitchell and Adam 1989) and elsewhere along the southern shore of Botany Bay has been occurring for many years (Fenech 1994, Hughes 1998, Evans and Williams 2001).

Downslope incursion of saltmarsh by *Phragmites australis* and similar brackish to freshwater reeds has been observed by Wilton *et al*. (2003) in Carama Inlet and Pickthall *et al*. (2004) in the Georges River. It is uncertain whether this is happening in the Parramatta River-Sydney Harbour. Spread of a European ecotype of *P. australis* has been widely recorded in recent decades in North America (Mitsch 2000, Stevenson *et al*. 2000, Weinstein *et al*. 2000), although there is no evidence of this ecotype in Australia (P. Adam, pers. comm., UNSW, 2006). The incursion of *P. australis* and other reeds into saltmarsh areas will be indicative of environmental changes (e.g., increased freshwater and nutrient inputs) and is therefore an important mappable feature.

Saltmarshes, due to their extreme conditions of salinity and waterlogging are generally less prone to invasion by terrestrial weeds than other habitats. Nevertheless, they are still susceptible, particularly to specialised exotic species. Of concern in the Sydney metropolitan area is the introduced Sharp Rush *Juncus acutus*, now widespread and very difficult to eradicate. The Endangered Ecological Community listing for coastal saltmarsh also identifies *Baccharis halimifolia* (Groundsel Bush), *Cortaderia selloana* (Pampas Grass) and *Hydrocotyle bonariensis* (Kurnell Curse) as major saltmarsh weeds.

Other threats to saltmarsh occur from unauthorised recreational access, particularly in urban areas. Human trampling can cause significant reductions in the number and cover of saltmarsh plants (Andersen 1995), while in the Sydney region recreational vehicle use (4WD, trail bikes, BMX) has been responsible for the loss of over 21,000m^2 of saltmarsh along the Georges River (Kelleway 2005). Low-growing, soft herbs such as *Sarcocornia quinqueflora* and *W. backhousei* are particularly susceptible to damage by trampling and vehicles. Vehicle use has also been shown to alter saltmarsh hydrology and cause large reductions in the numbers of saltmarsh fauna such as crabs and molluscs (Kelleway 2004, Kelleway 2005).

The extent of damage caused by recreational access along the Parramatta River-Sydney Harbour system is currently unknown. Anecdotal evidence suggests that Parramatta River saltmarshes may be at risk of damage with reports of trail biking at Mason Park (Karen Sommerville, pers. comm., UTS, 2005). It is important that saltmarshes experiencing degradation by recreational uses are identified so that measures can be taken to restrict access and remediate these sites.

The presence of bare, hypersaline flats occurring in upper marsh areas of the Homebush region was noted in the early twentieth century (Hamilton 1919). Such features are natural and were considered to be widespread in the Sydney region, although little is known of their ecology. Their absence from contemporary accounts of Sydney's saltmarsh suggests that these hypersaline flats have undergone significant reductions and may have possibly disappeared. The current mapping effort will help ascertain the status of hypersaline saltmarsh flats in Sydney Harbour / Parramatta River.

Pickthall *et al*. (2004) found that while "saltmarsh" was distributed throughout the estuary of the Georges River/Botany Bay, the "sensitive species" of saltmarsh were limited in their distributions. *G. filum* was located only in the central and upper portion of the estuary and, in a geomorphic context (*sensu* Roy 1984), this translates to what are known as the Central Mud Basin and Fluvial Delta portions of the estuary. In the Georges River, *W. backhousei* was generally limited to the Fluvial Delta and *S. radicans* was located only in the Riverine Channel. These geomorphic zones have considerable potential to be used in locating the likely distribution of saltmarsh plants, and hence in conservation management. It is relatively simple to delimit geomorphic zones with the assistance of aerial photographs, topographic maps, and bathymetric contours. For conservation and management purposes it becomes advantageous to know whether there is a greater likelihood of encountering the "sensitive" species in one portion of an estuary compared to another part. The present study will allow the above findings from the Georges River to be tested against distribution patterns in the geomorphically similar, Parramatta River-Sydney Harbour estuary.

Use of the waterway by commercial and recreational vessels, the vehicular traffic on roads draining towards the river, and the existence of a refinery and other industrial operations enhances the potential for spills of oil or other toxic substances to the Parramatta River-Sydney Harbour. Protection of the natural, commercial, and recreational resources of the river is best achieved by rapid response to spill incidents. Prior recognition of resources of ecological and social value is one key to rapid response. In Carter's (1994) categorisation of ecological sensitivity for the Parramatta River, saltmarsh was identified as a resource of extreme sensitivity. As saltmarsh and other intertidal vegetated communities contribute to estuarine productivity, and as natural and human factors can influence the location and extent of these communities, their distribution needs to be regularly assessed in order to ensure an appropriate response to a spill of oil or other materials.

There is considerable interest from land managers in the Sydney region in rehabilitating existing saltmarsh and, in some cases, in the creation of new, human-made wetlands. Such recognition of the values of saltmarsh has been motivated either by general concerns about past or probable future loss of saltmarsh at a regional scale or by specific requirements to mitigate the loss of individual sites (Adam 2002). As well as dealing with some of the issues presented above, this study will provide important insight for the need for rehabilitation/creation projects, as it will report on the current status of saltmarsh throughout the Parramatta River-Sydney Harbour.

2. METHODS

2.1. Study Site

The estuaries of southeast Australia can be readily classified into drowned river valleys and barrier estuaries (Roy 1984). All of the large estuaries within the Sydney metropolitan area, including the Parramatta River/Sydney Harbour, are drowned river valleys (Roy *et al*. 2001).

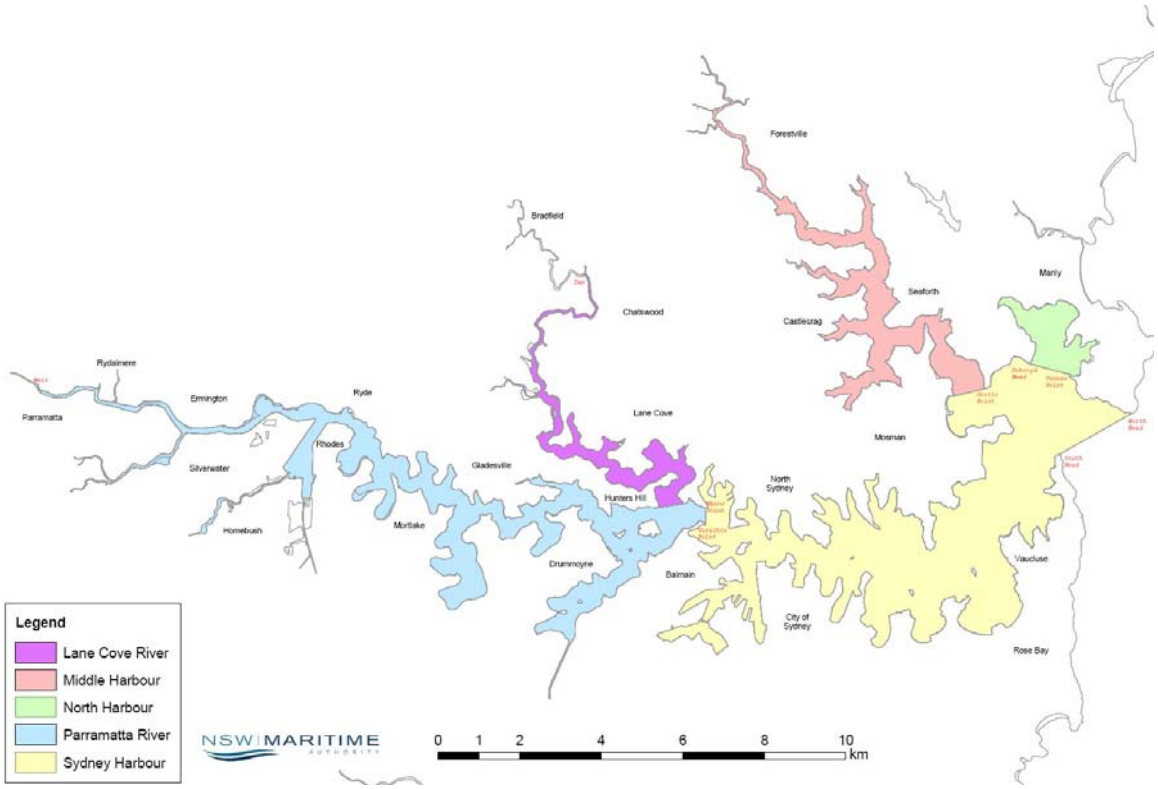

Figure 1. Map of the Parramatta River-Sydney Harbour, including estuary sub-units (NSW Maritime, 2004).

Parramatta River/Sydney Harbour has a catchment area of approximately 347 km^2 (NSW Dept of Natural Resources). The water surface area of the estuary has changed over time, most notably over the past 200 years due to dredging and reclamation of parts of the foreshore and presently stands at nearly 53 km^2 (NSW Maritime 2004; Figure 1). The estuary is defined as all the tidal waters below the eastern-most weir at Parramatta, the weir on the Lane Cove River, and the natural tidal limits in Middle Harbour at the suburbs of St. Ives and Davidson and in Duck River and Duck Creek at Granville.

NSW Maritime has divided the estuary into four sub-units (Figure 1). The most upstream of these are the Parramatta River (including Duck River) and the Lane Cove River. The lower portion of the estuary is known as Port Jackson and includes Sydney Harbour, Middle Harbour and North Harbour (see Table 2). The shoreline from the north headland to the Parramatta weir and back to the south headland, including the foreshore of islands, exceeds 300 km in length (NSW Maritime 2004).

Within the scheme devised by Roy (1984), and irrespective of type of estuary, four types of geomorphic zone can be present in any given estuary. These zones are known, from upstream to downstream, as: the Riverine Channel, Fluvial Delta, Central Mud Basin, and Marine Tidal Delta. Mesley (2003) mapped the extent of these zones in the Parramatta River-Sydney Harbour (Figure 2). It should be noted that there are multiple occurrences of each of the geomorphic zones – excepting Marine Tidal Delta – represented within the Parramatta River, Lane Cove River and Middle Harbour. In some estuaries, but not the Parramatta River-Sydney Harbour, infilling has eliminated the Central Mud Basin.

Table 2. Area and foreshore length of the estuary of the Parramatta River. Data were extracted from GIS data captured at better than 1:700 scale from this study. Mean High Water Mark (MHWM) is 1.48 m above zero level on the Fort Denison tide gauge.

Estuary Sub-unit	MHWM Water area including islands		MHWM Perimeter including islands		MHWM Perimeter excluding islands	
	(ha)	(%)	(km)	(%)	(km)	(%)
Parramatta River	1,447	27	140.0	37	132.3	37
Lane Cove River	314	6	45.2	12	44.7	12
Port Jackson:						
Sydney Harbour	2,689	51	104.6	28	99.3	27
Middle Harbour	635	12	71.6	19	70.8	20
North Harbour	216	4	14.7	4	14.3	4
Total	**5300**	**100**	**376.0**	**100**	**361.4**	**100**

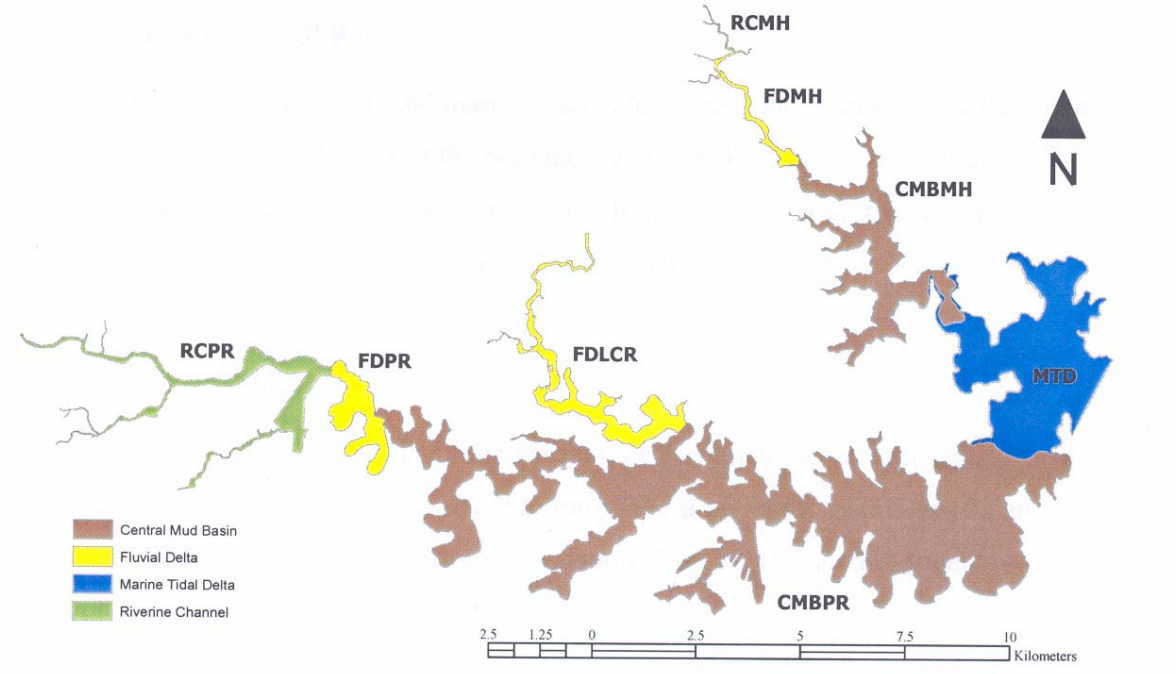

Figure 2. Geomorphic zones in the Parramatta River/Sydney Harbour (Mesley 2003).

2.2. Pilot study – South side

As no attempts have yet been made to inspect the entire shoreline of large NSW estuaries for the presence of saltmarsh, it was considered appropriate to initiate a pilot study to develop and refine methods. Of concern were two issues. The first was the number of patches likely to be encountered in relation to data collection and data management tasks. While the two whole-of-estuary studies done previously on the Parramatta River-Sydney Harbour (West *et al*. 1985, West *et al*. 2004) indicated that relatively few patches were present, studies done at Sydney Olympic Park, if extrapolated to the entire estuarine shoreline, suggested many 100s of patches might be present. Secondly, as the Royal Botanic Gardens (Sydney) has the legislative responsibility for identifying and archiving the flora of NSW, any field exercise would need to conform to its data protocols.

Of the 361.4 km shoreline length for the whole of the estuary (excluding islands), the southern shore accounts for 147.8 km (41%) of the total. Our intent for the pilot study was to visit on foot all accessible locations along the southern shoreline. Access to the Shell Clyde Refinery and Sydney Olympic Park required special arrangements and therefore these locations were not included in the pilot. At the visited sites, the location of each patch of saltmarsh was recorded on a 1:25,000 topographic map, as were the shape and approximate dimensions of these patches. Species present and relative elevation (low, medium or high marsh) were noted on a data sheet provided by the Royal Botanic Gardens (see Appendix 2).

Saltmarsh was defined as any intertidal community containing one or more species defined as "Characteristic Species" by the NSW Scientific Committee (2004). Previous experience with investigations of saltmarsh in the Sydney metropolitan area (e.g., Pickthall *et al*. 2004) indicated the likely presence of three groups of plants: the "dominant" saltmarsh plants, the rare and therefore "sensitive" saltmarsh plants, and exotic weed species. All saltmarsh plant species were recorded and their elevation in terms of three zones was estimated:

> Low marsh – growing well below the tidal debris line
> Middle marsh – growing just above and below the tidal debris line
> High marsh – growing above the tidal debris line (where this line was present), i.e., at the highest elevation at which saltmarsh plants were observed growing.

Regardless of size, every patch of saltmarsh (as defined above) was identified with an alpha-numeric code in relation to the part of the estuary in which the patch was located. A patch was defined as spatial entity (polygon) including a minimum of one species defined as saltmarsh. For example, NPR17C is a patch on the North side of the Parramatta River, and was the 17th patch visited at this part of the estuary. In cases where multiple patches were situated within the same locality, another letter was included at the end of the code. For the above example, C relates to the third patch in the locality.

One of the project objectives was to assess the condition of saltmarsh. Methods for assessing condition in NSW were documented by Sainty and Jacobs (1997), Kessler (2004) and Kelleway (2004). Each approach has its respective strengths and weaknesses and, in due course, standardised methodologies relevant to specific tasks will emerge. The approach taken in this study was based on the data collection protocol of the Royal Botanic Gardens and Kessler (2004).

The Vegetation Recording Form used by the Royal Botanic Gardens (Appendix 2) summarises the condition of a plot of vegetation in one of four "categories": excellent, good, average, poor. Condition is related to disturbance in relation to extent of grazing, clearing, ploughing, erosion, weeds, feral animals, logging, pollution, and other. Of these disturbances, the following were determined to be of direct relevance to saltmarsh and therefore considered in the condition assessment:

- clearing,
- erosion,
- weeds,
- pollution

To incorporate condition factors specific to urban saltmarsh wetlands, the assessment procedure developed by Kessler (2004) was considered in this study. For reasons of expediency, the detailing and scoring procedures of Kessler (2004) were replaced with the overall four-category condition rating which is described above (excellent, good, average, poor). The factors proposed by Kessler (2004) are:

- Physical Site Characteristics:
  - Area of site;
  - Tidal Flushing;
  - Evidence of edge erosion.
- Anthropogenic Impacts – the key human impacts affecting the site:
  - Limits to site expansion;
  - Anthropogenic structures found within the site;
  - Presence of rubbish.
- Faunal Characteristics – an analysis of the fauna using the site:
  - Evidence of crab populations;
  - Evidence of snail populations.
- Vegetation Characteristics – an analysis of the vegetation found within the site:
  - Community distribution;
  - Species composition;
  - Vegetation cover on site, including algae;
  - Threatened species present on site;
  - Evidence of mangrove intrusion;
  - Evidence of introduced species.

In addition to the condition indicators derived from the Royal Botanic Gardens and Kessler (2004), the following factors were considered:

- Damage from recreational vehicles (following Kelleway, 2004)
- Damage from trampling/walking
- Intrusion of native brackish/freshwater species (e.g., *Phragmites australis*).

After leaving the field, latitude and longitude were extrapolated from the topographic map as Degrees^{o,} Minutes', Seconds" (equivalent to DD.MMMM). Each position was entered on a spreadsheet, transferred to a GIS file and then printed on digital map. Locations were checked and redrawn on the printed map. No island locations were visited, as in the main their foreshores have been markedly degraded (S. Harris, pers. comm., NSW Maritime, 2006).

It is likely that, particularly in the upper marsh fringe, *Zoysia macrantha* occurs intermingled with *Sporobolus virginicus* at some localities. Vegetatively the two grasses are very similar and hard to separate. When flowering, *Z. macrantha* is easily recognizable, but field observations were carried out during the non-flowering season. It is possible, therefore, that some of the records for *S. virginicus* include *Z. macrantha* (which because of the difficulty in distinguishing it from *S. virginicus* for most of the year is probably under-recorded in the Sydney region) (P. Adam, pers. comm., 2007).

2.3. Remaining south side sites and north side

Each of the analyses of West *et al.* (1985) and West *et al.* (2004) showed three large areas of saltmarsh (Homebush Bay, Newington, Silverwater) along the southern shore of the of the estuary. However, even without inspection of the refinery or Olympic Park site, close to 50 patches of saltmarsh were identified during the pilot pedestrian study, implying that many more patches of saltmarsh were present than had been previously mapped. Given the length of the shoreline, and that the distance from the Parramatta Weir to Manly is two and a half times the length of the shoreline from the weir to Vaucluse, it was therefore necessary to modify the manner by which patches were located. To assist in locating patches that might then be inspected by foot on the south side of the estuary, as well as locating saltmarsh on the north side, an aerial photographic analysis was commenced.

The most recent aerial photographic coverage of the catchment of the Parramatta River was obtained. This coverage is a digital, ortho-rectified, ECW format aerial photo-mosaic image created by the Spatial Division of Sinclair Knight Merz from aerial photographs taken in 2003. Spatial resolution was 150 mm. This product had previously been made available to a consortium of state and local government agencies, of which the NSW Department of Primary Industries and the Botanic Gardens Trust were members.

The boundaries of saltmarsh were mapped via onscreen digitising using Arcview version 3.3. To ensure consistent spatial accuracy, all digitising was carried out at an onscreen scale of 1: 700 or better. Presumptive maps of saltmarsh were printed at various scales to facilitate on-ground observations. During field inspection, sites were categorised as follows:

- locations correctly marked on the presumptive maps. Field observations were used to define species boundaries on the presumptive map as necessary and the modifications were placed on the final map.
- locations too small to be shown accurately on the presumptive maps. A detailed sketch was drawn on a separate piece of waterproof paper (with approximate dimensions, GPS locations, landmarks) to improve accuracy during the correction process.
- locations which were omitted from the presumptive maps. A sketch was made with dimensions, shape, orientation, GPS location(s) and proximity to landmarks.
- erroneous locations. These were correctly described for other mapping purposes, but removed from this data set.

Once checked in the field, site boundaries were redigitised as appropriate. GPS derived longitudes and latitudes were recorded as DDD.MMMMM. Other field observations were made as in the pilot study. No island sites were visited.

2.4. Data consolidation

Once the map locations were resolved and attributes finalised, some of the data sets were condensed to facilitate production of the final report and maps. For example, data from the Lower and Middle Marshes were combined in the GIS attribute table as “CANOPY_SP”, and the Upper Marsh was recorded in the GIS attribute table as “CANOPY_SP2”. As this project was being run in parallel with a study of terrestrial vegetation by the Royal Botanic Gardens for NSW Maritime, for the sake of consistency the condition category ‘excellent’ was not used in GIS attribute table, but was subsumed within the category ‘good’ (however, for the purposes of this document the category ‘excellent’ has been retained). The area in hectares for each patch of saltmarsh was calculated and tabulated.

The data on shoreline length in Table 1, and the location of geomorphic zones and local government boundaries were integrated to generate a table showing the type and length of foreshore occupied by saltmarsh for each Local Government Area (LGA), as well as for Sydney Olympic Park.

3. RESULTS

The results are presented in three sections dealing respectively with patch details, species composition and condition. The field portion of the study, including making arrangements to access sites, took of the order of 200 hours.

3.1. Number, area and size of patches

The pedestrian (field) survey revealed 757 patches of saltmarsh in the Parramatta River-Sydney Harbour estuary (Table 3). Appendix 3 provides details on each patch. The distribution of the patches is shown in a series of figures the scale of which (~ 1: 30,000) has been tailored to fit the page size of this report. A shape file is available on request for GIS users such that the data can be integrated in other mapping projects, or more simply to explore at a finer scale the disposition of the patches of saltmarsh.

The 757 patches found in the field survey have a combined area of 37.306 hectares (Tables 4 and 5). The size of individual patches ranged from 0.2 m^2 (NPR17C Wallumatta Bay, Appendix 3a) to 5.977 hectares (SPR93 Wanngal Wetland, Newington; Appendix 3b).

The Harbour Entrance is shown in Figure 3a and no saltmarsh is visible at the scale of presentation. However, about 20 small patches (the largest of which is 85 m^2 in area; Appendix 3a) are located in this sector. Patches are more obvious in Figure 3b, which depicts Middle Harbour, where saltmarsh was found at more than 80 sites. The largest patch in Middle Harbour (6.3 ha) is at Roseville Chase, followed by a patch at Scotts Creek (5.0 ha), and another at Bantry Bay in Garigal National Park (3.0 ha; Appendix 3a).

Saltmarsh is well represented in the Lane Cove River at over 120 sites (Figure 3c). Two patches are of the order of 8.5 ha, one of these is along the eastern shore of the river and the other is at Kittys Creek in Lane Cove National Park. Another, near Blackman Park, is 2.9 ha (Appendix 3a).

The largest concentration of saltmarsh is found in the upper portion of the estuary (Figure 3d). Many hundreds of patches are found in this region, particularly on the southern shoreline in and around Sydney Olympic Park. The largest patch in this portion of the river, which is also the largest in the estuary, was identified in the previous paragraph. It is in Olympic Park, and is nearly 6 ha in size (Appendix 3b). The second largest patch of saltmarsh is also under jurisdiction of Sydney Olympic Park, in the Badu Mangroves wetland, and is 4.5 ha.

Figure 3e expands a section of Figure 3d to illustrate the detail than can be obtained by magnifying the data contained in the shape file. Even greater magnification is possible within a GIS.

A comparison of the results of the aerial photographic interpretation (API) of the photos from 2003 and the pedestrian survey showed a poor level of correspondence between the two methodologies (Table 3). A number of spurious patches were mapped in the API, with subsequent ground truthing identifying these. The incorrectly mapped features included non-tidal reedlands dominated by *Phragmites australis* and *Typha* spp., mud, water, lawn and anthropogenic structures (these features were removed from the maps).

Plate 2. *Sporobolus virginicus* dominated saltmarsh growing partly under the canopy of mangroves (*Avicennia marina*), Homebush Bay. (SPR 225).

More importantly, a large number of saltmarsh sites (522) – mostly small in size – were overlooked in the API. Where patches of saltmarsh were hidden under canopy vegetation (Plate 2), the field survey made a substantial contribution to determination of size of patch. Ultimately, 48.48% of all saltmarsh by area was located under canopy. A further 10.3% by area of saltmarsh was within one metre of canopy and would be difficult to observe using API. Altogether, a total of 58.78% of the area of saltmarsh was either underneath canopy vegetation or adjacent to it.

As various agencies and groups are associated with the ownership, management and conservation of the Parramatta River-Sydney Harbour, the data appearing in Appendix 3 have been sorted to facilitate use by the different stakeholders. For example, Appendix 4a sets out the number of patches of saltmarsh within NSW Maritime's estuary sub-units, and by geomorphic zone. Appendices 4b and 4c set out the distribution of patches of saltmarsh along the northern and southern shores, respectively, by NSW Maritime sub-unit, geomorphic zone, and Local Government Area.

Table 3. Correspondence between the API analysis of 2003 and field survey.

General category	Specific category	Number
Spurious locations		182
Unmapped (omitted) saltmarsh patches		522
Mapped saltmarsh patches	Correctly located and sized	7
	Correctly located but incorrectly sized	228
Total		**757**

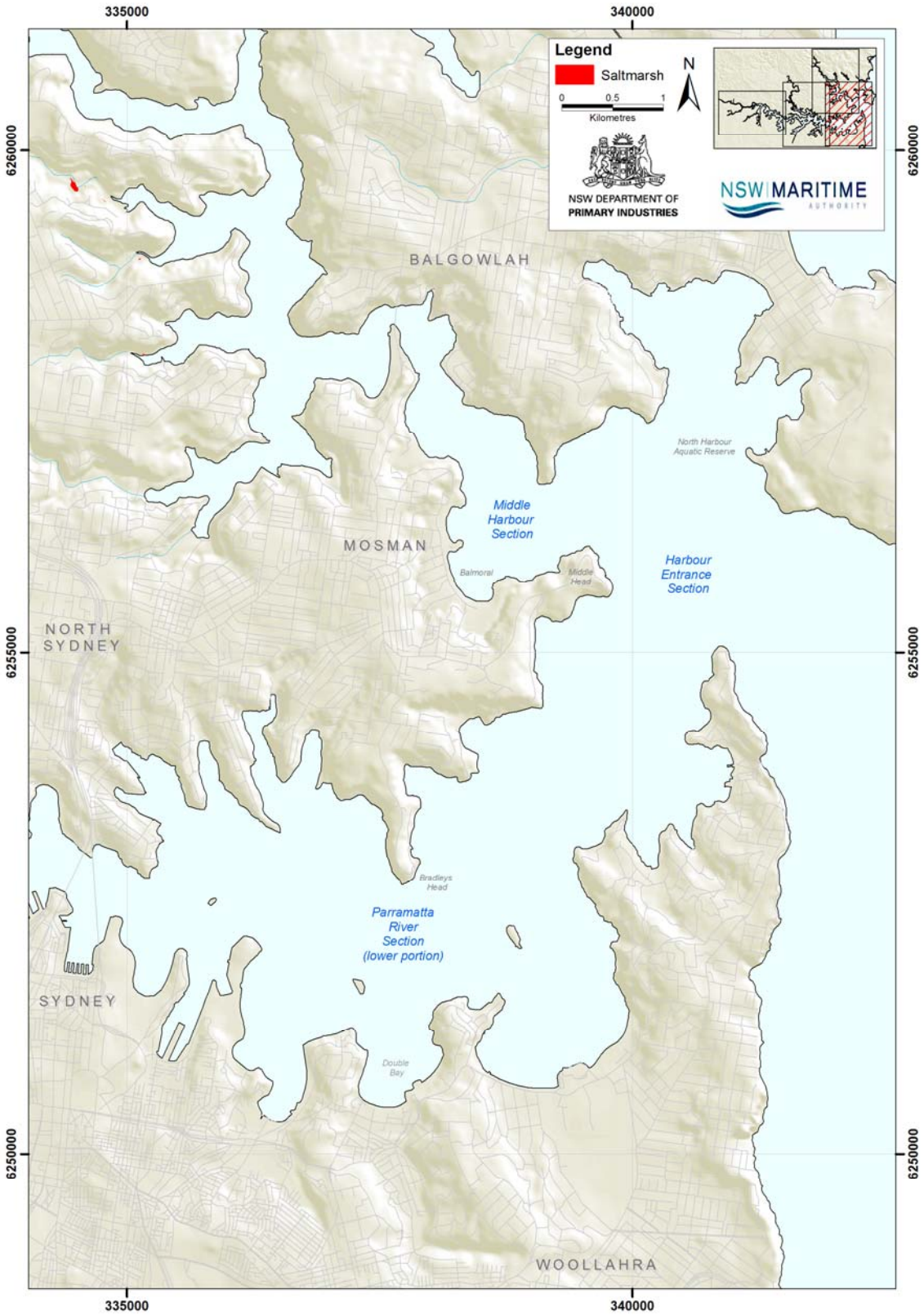

Figure 3a. Saltmarsh of the Parramatta River-Sydney Harbour, Harbour Entrance, 2005.

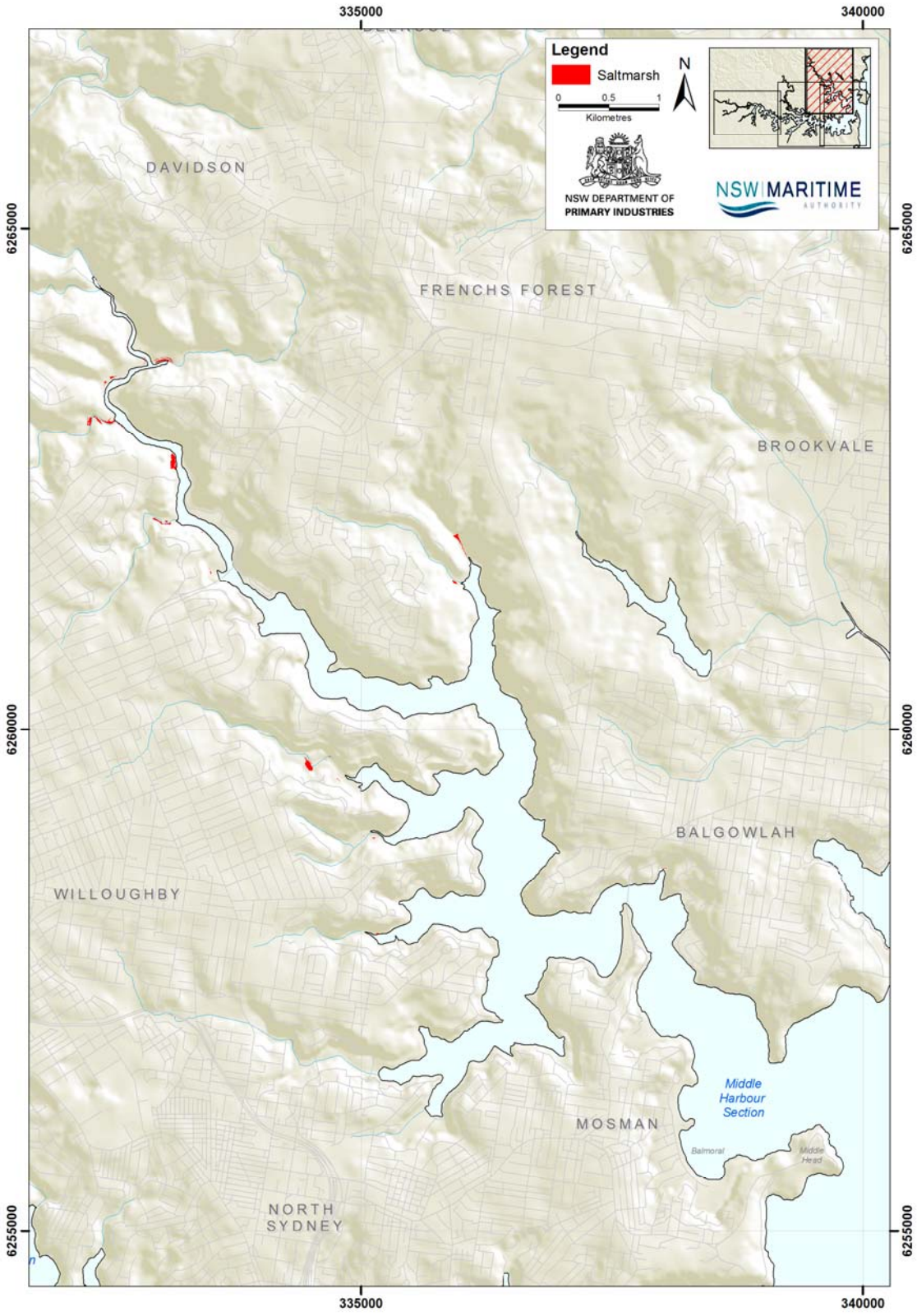

Figure 3b. Saltmarsh of the Parramatta River-Sydney Harbour, Middle Harbour, 2005.

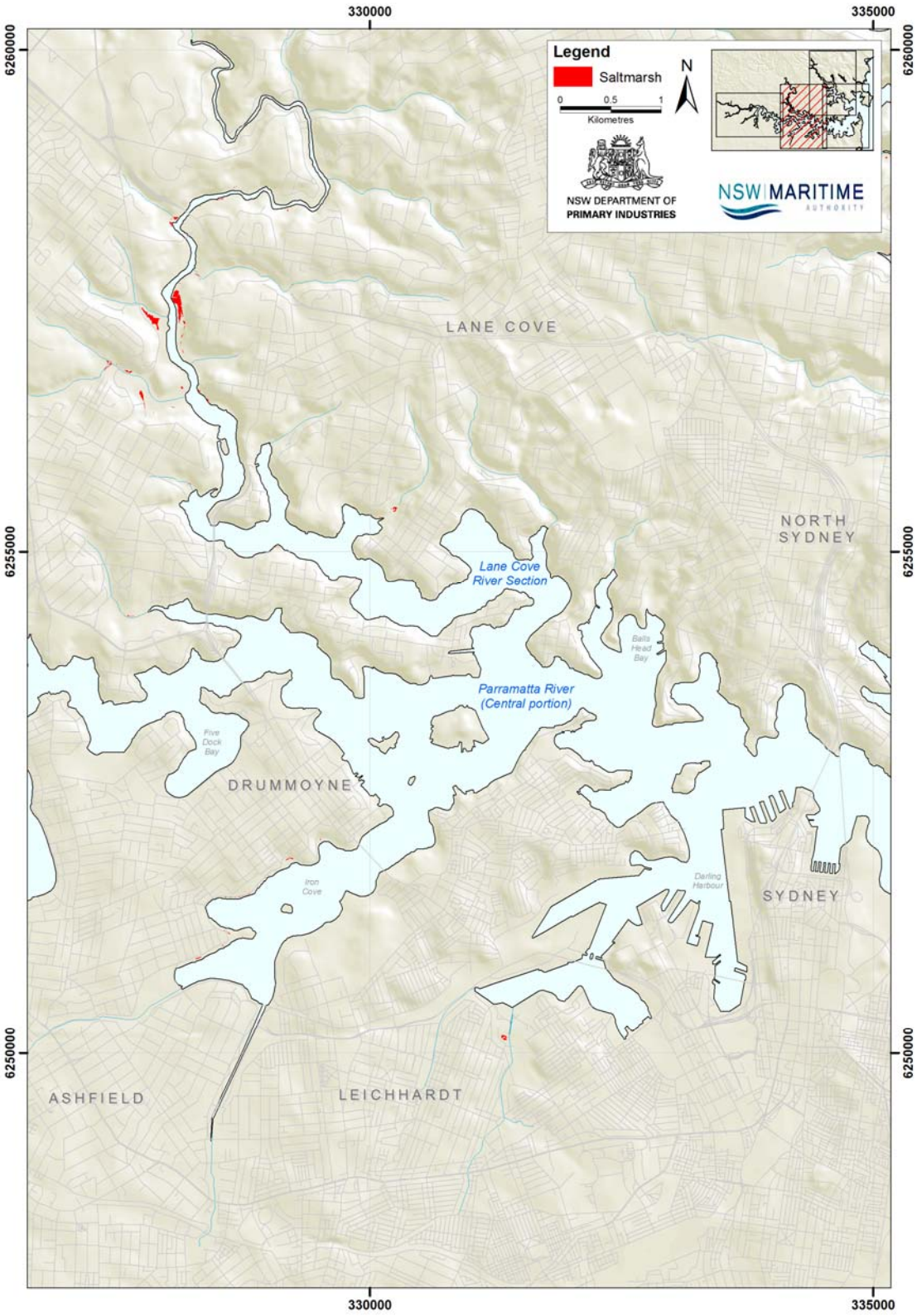

Figure 3c. Saltmarsh of the Parramatta River-Sydney Harbour, Lane Cove River and Parramatta River (Central portion), 2005.

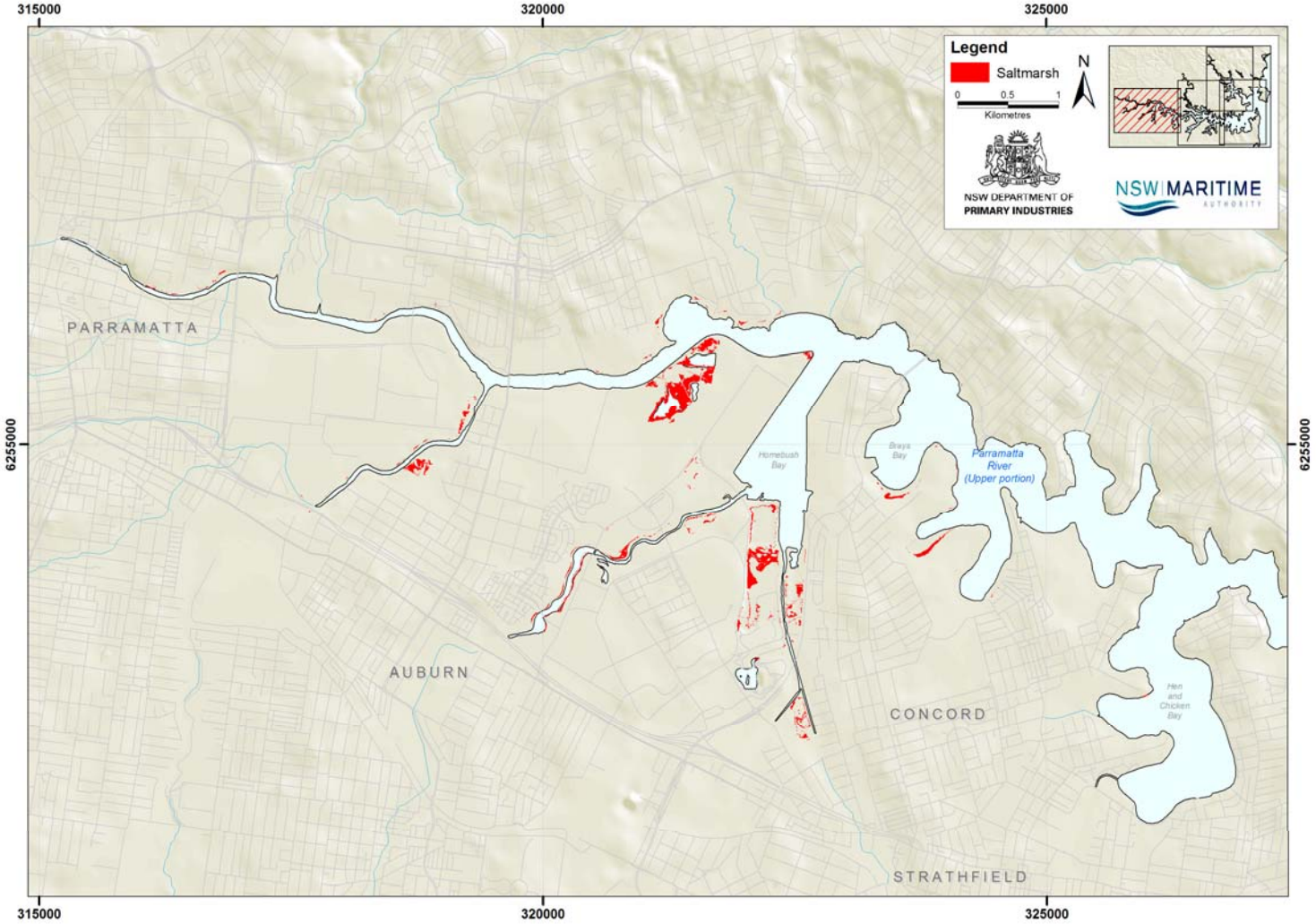

Figure 3d. Saltmarsh of the Parramatta River-Sydney Harbour, Parramatta River (Upper portion), 2005.

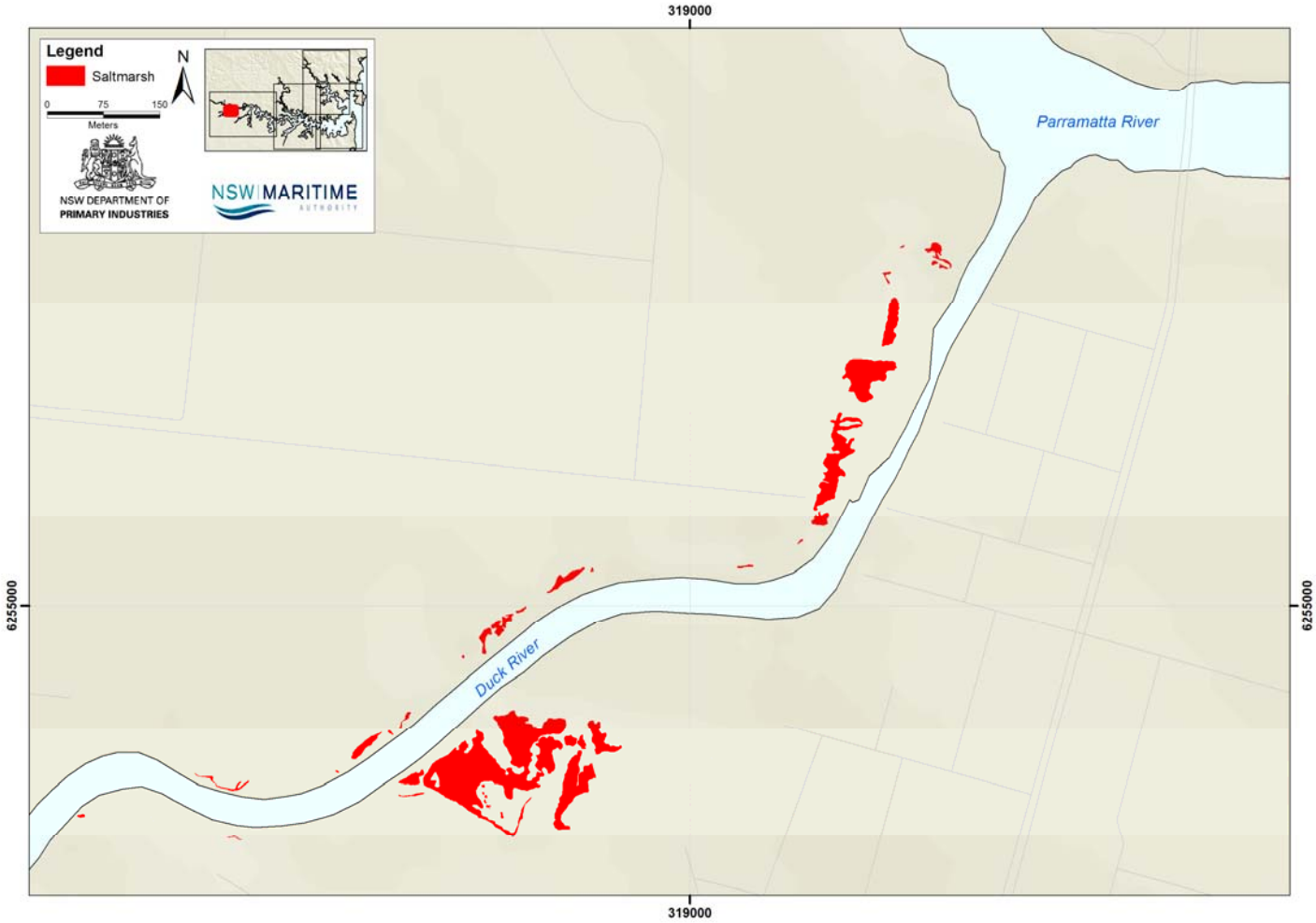

Figure 3e. Saltmarsh of the Parramatta River-Sydney Harbour, magnification of a portion of the Duck River, 2005 (Figure provided as an example of the detail available in the GIS shapefile provided in the accompanying Compact Disc).

Table 4 consolidates the data in terms of the sub-units defined by NSW Maritime. Most of the patches (69.6%) occur in the Parramatta River, followed to a much lesser degree by the Lane Cover River (16.2%) and Middle Harbour (10.3%). Sydney Harbour and North Harbour had few occurrences of saltmarsh. By area, most saltmarsh is found in the Parramatta River (81.9%), followed by the Lane Cove River (9.1%) and Middle Harbour (8.3%).

Table 4. Number and area (ha) of saltmarsh meadows by NSW Maritime estuary sub-unit.

Sub-unit of estuary	**Saltmarsh patches**			
(after NSW Maritime 2004)	**Number**	**Percent of total number**	**Total area (ha)**	**Percent of total area**
Parramatta River	527	69.6	30.560	81.9
Lane Cove River	123	16.2	3.393	9.1
Sydney Harbour	15	2.0	0.209	0.6
Middle Harbour	78	10.3	3.109	8.3
North Harbour	14	1.9	0.036	0.1
Total	**757**	**100.0**	**37.306**	**100.0**

Table 5 presents data on number, total area and size of saltmarsh patches by geomorphic zone. The number of patches decreases in a downstream direction. Most patches are located in the Riverine Channel, and to a lesser extent in the Fluvial Delta and Central Mud Basin zones. The distribution by total area follows a similar trend. To avoid bias in determining average size of patches, the median value was used. The median size of patches in the Riverine Channel (29.7 m^2) is considerably larger than the Fluvial Delta (19.5 m^2) and Central Mud Basin (12.2 m^2) environments.

Table 5. Number and area (ha) of saltmarsh patches in the Parramatta River-Sydney Harbour by geomorphic zone, 2006.

Geomorphic zone	**Saltmarsh patches**				
(after Roy 1984, Mesley 2003)	**No. of patches**	**Percent of total number**	**Total area (ha)**	**Percent of total area**	**Median patch size (m^2)**
Riverine Channel	461	60.9	29.029	77.8	29.7
Fluvial Delta	182	24.0	6.634	17.8	19.5
Central Mud Basin	100	13.2	1.607	4.3	12.2
Marine Tidal Delta	14	1.8	0.036	0.1	4.7
Total	**757**	**100.00**	**37.306**	**100.00**	**22.3**

Irrespective of whether the NSW Maritime sub-units or a geomorphic scheme is adopted, there are distinct differences in concentration of saltmarsh patches. Most are located in the upper portion of the estuary. There is a clear decrease in the number and size of saltmarsh patches towards the more seaward zones of the estuary.

Table 6a highlights the size distribution of saltmarsh patches. Seventy percent of patches are less than 100 m^2 in area; nearly 40% are less than 10 m^2. Plate 3 shows patches in the smaller size categories. Only six saltmarsh patches greater than one hectare were identified, all of which occur

in the upper parts of the Parramatta River, including the Duck River – the most downstream location for one of these large patches was Yaralla Bay. Two other large patches (5,000 to 10,000 m^2) patches were identified in each of the Lane Cove River and Middle Harbour, but still in upper estuarine conditions.

The 245 patches that account for 70% of the total number make up only 3% of the total area. The three largest size categores account for 30% of the total area.

Table 6a. Size distribution of saltmarsh patches in the Parramatta River-Sydney Harbour estuary, 2006, by number and area.

Patch area (m^2)	No. of patches	% of total number of patches	Cumulative % of total number	Area of patches (ha)	% of total area (ha)	Cumulative % of total area
<1	34	4.49	4.49	0.002	0.005	0.005
1–5	152	20.08	24.57	0.046	0.123	0.128
5–10	102	13.47	38.04	0.080	0.214	0.342
10–100	245	32.36	70.40	0.957	2.565	2.907
100–500	131	17.31	87.71	3.066	8.219	11.126
500–1,000	34	4.49	92.20	2.366	6.342	17.468
1,000–5,000	43	5.68	97.88	8.431	22.600	40.068
5,000–10,000	10	1.32	99.20	6.954	18.640	58.708
10,000+	6	0.79	100.00	15.404	41.291	100.00
Total	**757**	**100.00**	**100.00**	**37.306**	100.00	**100.00**

An analysis of the size distribution by geomorphic zone shows the most downstream sector, the Marine Tidal Delta, to be dominated by small patches, i.e., areas less than 100 m^2. Patches within the Central Mud Basin are mostly concentrated in the <1–100 m^2 patch sizes. The largest patches were in the Fluvial Delta and Riverine Channel.

Table 6b. Size distribution of number of saltmarsh patches in the Parramatta River-Sydney Harbour estuary, 2006, by geomorphic zone: RC=Riverine Channel, FD=Fluvial Delta, CMB=Central Mud Basin, MTD=Marine Tidal Delta.

Patch area (m^2)	% of patches per geomorphic unit			
	RC	**FD**	**CMB**	**MTD**
<1	1.95	6.59	11.00	14.29
1–5	19.52	19.78	20.00	42.86
5–10	13.02	12.64	18.00	7.14
10–100	32.75	31.32	33.00	28.57
100–500	18.22	19.78	10.00	7.14
500–1,000	4.77	3.85	5.00	0
1,000–5,000	7.59	3.30	2.00	0
5,000–10,000	1.08	2.20	1.00	0
10,000+	1.08	0.55	0	0
Total %	**100.00**	**100.00**	**100.00**	**100.00**
Total number of patches	**461**	**182**	**100**	**14**

Plate 3. Patchy saltmarsh growth between mangroves and infilled slope (bare and lawn), Homebush Bay.

3.2. Species composition

Fifty-two species plants were found within or adjacent to the 757 patches of saltmarsh. Seventeen true saltmarsh species were identified, some of which were commonly found, while others were rare (Table 7). Due to their rarity the latter are considered 'sensitive' species. Four exotic species were located. Table 7 shows the occurrences of the 17 saltmarsh species in relation to the four geomorphic zones of the Parramatta River-Sydney Harbour. Presentation in terms of geomorphic zones is considered more ecologically relevant than NSW Maritime sub-units. Some of the latter contain more than one geomorphic zone (Appendix 4a shows the relationship between sub-units and zones).

There is an apparent differential distribution of saltmarsh between zones, with more species found upstream compared to downstream. All of the 17 true saltmarsh species shown in Table 7 were found in the Riverine Channel, with 13 saltmarsh species in each of the Fluvial Delta and Central Mud Basin zones, and only seven species in the Marine Tidal Delta. All of the seven species found in the Marine Tidal Delta were found in upstream locations. This finding may imply that some species of saltmarsh can not cope with the environmental conditions found in the lower parts of estuaries.

Six species were found throughout the estuary, i.e., in all four geomorphic zones. All of these species were natives and none were so rare as to be classified as "sensitive". Of the 17 species found in the Riverine Channel, four were found in only this zone. Of these, three were sensitive (*L. tegens, H. pergranulata* subspecies *pergranulata, S. radicans*) natives and the remaining one (*Cortaderia selloana*) was an exotic.

The Chenopods *Suaeda australis* and *S. quinqueflora* were among the most common saltmarsh plants, being recorded throughout the estuary except for the Marine Tidal Delta. *S. quinqueflora* was often the most dominant species, particularly in larger marshes. The Marine Tidal Delta had generally lower species richness and was dominated by *Isolepis nodosa* and *S. virginicus.*

Samolus repens and *Juncus kraussii* were the most common species (in terms of presence/absence) in the middle portions of the estuary (Fluvial Delta and Central Mud Basin), with *S. repens* generally being dominant at lower marsh elevations and *Juncus kraussii* dominant in the upper marsh.

Tetragonia tetragonioides (New Zealand Spinach) was recorded in over 300 saltmarsh patches throughout the estuary. This species grows almost exclusively at the upper boundary of saltmarsh but was rarely extensive in any saltmarsh patch.

The rush *Baumea juncea* was common, but only in the Fluvial Delta of the Lane Cove River and the nearby Central Mud Basin section of Parramatta River.

Table 7. Occurrences of species of saltmarsh of the Parramatta River-Sydney Harbour, 2006, by geomorphic zone

Family	Species	"Sensitive"	Exotic	Riverine Channel	Fluvial Delta	Central Mud Basin	Marine Tidal Delta	Total
	Total number of saltmarsh patches			461	182	100	14	757
AIZOACEAE	*Lampranthus tegens*	*		50	-	-	-	50
	Tetragonia tetragonioides			201	84	34	4	323
APIACEAE	*Hydrocotyle bonariensis*		*	7	-	6	5	18
ASTERACEAE	*Baccharis halimifolia*		*	2	3	-	-	5
CHENOPODIACEAE	*Halosarcia pergranulata* subsp. *pergranulata*	*		16	-	-	-	16
	Sarcocornia quinqueflora			266	53	47	-	366
	Suaeda australis			324	54	31	-	409
CONVOLVULACEAE	*Wilsonia backhousei*	*		29	1	3	-	33
CYPERACEAE	*Baumea juncea*			1	36	8	1	46
	Isolepis nodosa			9	5	14	11	39
GOODENIACEAE	*Selliera radicans*	*		2	-	-	-	2
JUNCAEAE	*Juncus kraussii*			108	104	49	3	264
	Juncus acutus		*	85	3	1	-	89
JUNCAGINACEAE	*Triglochin striata*			46	29	13	-	88
POACEAE	*Cortaderia selloana*		*	2	-	-	-	2
	Phragmites australis[1]			4	14	3	-	21
	Sporobolus virginicus			113	87	37	8	245
PRIMULACEAE	*Samolus repens*			52	113	29	2	196
Number of saltmarsh species	**17**	**4**	**4**	**17**	**12**	**12**	**7**	

[1] *Not considered a true saltmarsh species and hence not counted in totals. Shown here for comparative purposes.*

Species categorised as 'sensitive' were generally confined to the upper portion of the estuary. *L. tegens* was located exclusively in the Riverine Channel, with all but one patch occurring in the Homebush Bay locality (including Mason Park and Wanngal Wetland) (see also Appendix 5). *H. pergranulata* subspecies *pergranulata* was also limited to the Riverine Channel, but was also found further upstream than *L. tegens*, with several stands along the Duck River (see Appendix 5). *S. radicans* is extremely rare in the saltmarshes of the Parramatta River-Sydney Harbour, with just two small stands located on the western shore of the Duck River (see also Appendix 5). *G. filum* was not encountered in this study.

The large majority of stands (29 of 33) of *W. backhousei* were located in the Riverine Channel (see also Appendix 5), but this species was also found further downstream. The three occurrences within the Central Mud Basin were small stands, growing on intertidal rock platforms (Plate 4), as opposed to the meadow-like stands (of various sizes) in the Riverine Channel and the single stand in the Fluvial Delta.

Plate 4. The threatened *Wilsonia backhousei*, growing in the depressions of a rock platform in Looking Glass Bay, Gladesville. (NPR21C).

With respect to the four most notable 'exotic' species, of greatest concern is *Juncus acutus*. At the time of fieldwork this invasive rush was found at 89 locations (see also Appendix 6), mostly within the upper Parramatta River portion of the estuary. Here it was observed to occur in high proportions, often covering significant areas of saltmarsh. At its most downstream location, *J. acutus* was also found growing within Garigal National Park at Bantry Bay (Location EMH1).

Almost 40% of the area of saltmarsh recorded in this study occurs in patches either entirely or partly within defined conservation reserve boundaries (Table 8). A large number of the saltmarshes

of Middle Harbour are located along the shoreline boundary of Garigal National Park, but most are relatively small in size. Many of the largest saltmarsh patches identified in this study occur within the Wanngal Wetland of Newington Nature Reserve. Combined, the patches in Wanngal Wetland cover 12.121ha, which is by far the greatest area included in conservation reserves, and almost one-third of the estuary's entire saltmarsh. None of the large saltmarshes of Duck River are contained within conservation reserves, although one of the largest patches here is under the ownership of NSW Maritime and managed for conservation purposes. By geomorphic zone, the saltmarshes of the Riverine Channel are most highly represented within reserves. The area of Fluvial Delta and Central Mud Basin saltmarshes in reserves is low in proportion to the total area of saltmarshes within these geomorphic zones.

Table 8. Area (ha) and number of patches of saltmarsh in conservation reserves.

Conservation Reserve	**Area and (number of patches) of saltmarsh per geomorphic zone**				**Total area and (number of patches)**
	RC	FD	CMB	MTD	
Newington Nature Reserve	12.121 (18)				12.121 (18)
Lane Cove National Park		0.992 (18)			0.992 (18)
Garigal National Park	0.710 (19)	0.471 (22)	0.391 (4)		1.572 (45)
Sydney Harbour National Park			0.004 (2)	0.019 (6)	0.023 (8)
Total	**12.831 (37)**	**1.463 (40)**	**0.395 (6)**	**0.019 (6)**	**14.709 (89)**

Table 9 consolidates the data in terms of northern or southern shoreline and Local Government Area (LGA). It should be noted that presence within an LGA does not imply jurisdiction, as another agency such as NSW Department of Environment and Conservation (DEC) or NSW Maritime may be responsible. As Parramatta LGA covers both northern and southern parts of the shoreline it is shown separately. Exclusive of Parramatta LGA, most of the patches, and by far the greatest area of saltmarsh, occur on the southern shore. Ku-ring-gai, Lane Cove and Ryde LGA's account for over half of the nearly seven hectares of saltmarsh on the north shore.

Sydney Olympic Park Authority is responsible for the largest number (246) and area of saltmarsh patches within the estuary (23.456 ha). On the southern shore, Canada Bay has the next greatest amount of saltmarsh (2.1 ha). Outside of Sydney Olympic Park, Parramatta LGA has the greatest number of distinct saltmarsh patches.

Table 9. Number, extent and condition of saltmarsh patches in the Parramatta River-Sydney Harbour, by Local Government Area and Sydney Olympic Park. N.B. jurisdiction may be the responsibility of another authority (e.g., NSW Department of Environment and Conservation or NSW Maritime).

Shoreline	Local Government Area	No. Patches per Condition Category				Number of saltmarsh patches	Total saltmarsh area (ha)
		Poor	Average	Good	Excellent		
	Parramatta	59	36	5	0	100	1.656
North shore	Ryde	41	39	2	1	83	1.443
	Hunters Hill	21	18	2	0	41	0.347
	Ku-ring-gai	5	20	9	2	36	1.785
	Lane Cove*	21	34	5	5	65	1.958
	North Sydney*	1	2	0	0	3	0.008
	Mosman	0	0	0	0	0	0
	Warringah	16	6	6		28	0.725
	Willoughby	14	12	1	0	27	0.639
	Manly	5	6	3	0	14	0.036
	*-overlap**	*-1*	*-1*			*-2*	*-0.008*
	Subtotal					289	6.934
South shore	Auburn	17	4	4	0	25	1.855
	Sydney Olympic Park	148	81	16	1	246	23.456
	Strathfield	29	11	1	0	41	1.067
	Canada Bay	18	17	3	0	38	2.137
	Leichhardt	0	0	0	0	0	0
	City of Sydney	4	2	0	0	6	0.193
	Woollahra	6	0	0	0	6	0.008
	Subtotal					354	28.716
Total		**404**	**287**	**57**	**9**	**757**	**37.306**

** Two saltmarsh patches occur on the border of North Sydney and Lane Cove LGAs*

3.3. Condition of saltmarshes

Overall, more than 50% of the saltmarsh patches (404 in total) were considered to be of poor condition (Table 9). Of the remainder, a vast majority were of average or medium condition, with relatively few marshes declared good or excellent. Throughout the estuary, the growth of exotic species, presence of infill and litter, evidence of mangrove incursion and physical disturbance were the main factors behind the low condition ratings.

Table 10 is an examination of the condition of patches of saltmarsh in which the rare species are found (see also Appendix 5). Only a quarter of these patches are in good or excellent condition. Importantly, three quarters of the patches containing *L. tegens* are currently in poor condition.

Table 11 describes where the exotic rush *Juncus acutus* occurs within the saltmarsh areas of the estuary. With the exception of one patch in Middle Harbour (Warringah), all *J. acutus* was located in the upper Parramatta River and Duck River portion of the estuary (see Appendix 6), with over half (48 out of 89 patches) in Sydney Olympic Park. This species was also observed growing in

non-saltmarsh locations – most notably within the Shell Refinery freshwater wetland near the junction of Duck and Parramatta Rivers.

Table 10. Summary of condition of saltmarsh patches in which "sensitive" species are found

Species	LGA	Poor	Average	Good	Excellent	Total
Lampranthus	Ryde	1	0	0	0	1
	Sydney Olympic Park	8	13	5	0	26
	Strathfield	22	1	0	0	23
	Subtotal	31	14	5	0	50
Halosarcia	Parramatta	0	2	3	0	5
	Auburn	0	1	1	0	2
	Sydney Olympic Park	0	5	3	1	9
	Subtotal	0	8	7	1	16
Wilsonia	Parramatta	2	2	2	0	6
	Ryde	2	1	0	0	3
	Auburn	1	0	2	0	3
	Sydney Olympic Park	1	9	6	0	16
	Strathfield	3	0	0	0	3
	Canada Bay	0	1	1	0	2
	Subtotal	9	13	11	0	33
Selliera	Parramatta	0	1	1	0	2
	Subtotal	0	1	1	0	2
Total		**40**	**36**	**24**	**1**	**101**

Table 11. Summary of condition of saltmarsh patches in which invasive/exotic *Juncus acutus* was found, 2006.

LGA	Poor	Average	Good	Excellent	Total
Parramatta	19	4	2	0	25
Ryde	3	0	0	0	3
Warringah	0	1	0	0	1
Auburn	8	1	0	0	9
Sydney Olympic Park	22	20	6	0	48
Strathfield	2	1	0	0	3
Total	**54**	**27**	**8**	**0**	**89**

4. DISCUSSION

4.1. Background: History of saltmarsh in the Parramatta River-Sydney Harbour

The present distribution of saltmarsh throughout the Parramatta River-Sydney Harbour estuary is a consequence of the estuary's geomorphology, natural history, and human-induced modifications.

4.1.1. Geomorphology and natural history

Over the past two and a half million years (Pleistocene era) sea level has risen and fallen 17 times over an interval of roughly 105,000 years. At its maxima and minima, sea level has changed by the order of 130 m. Hence, the valley of the Parramatta River-Sydney Harbour has been flooded and emptied of seawater at regular, although lengthy intervals. In geomorphic terms the estuary is considered a drowned river valley (Roy *et al*. 2001).

Sea level, in rising and falling over past eons, has extended and compressed the seaward extent of the catchment of the Parramatta River-Sydney Harbour, as well as the shape and character of the river. When the most recent melting of the polar ice-caps and rise of ocean level began twenty thousand years ago, the present estuary was a small freshwater creek, and the estuarine section of the river was located some kilometres further east. As sea level rose, the catchment was foreshortened and the freshwater vegetation along the foreshores of the river was destroyed. The estuarine vegetation we see today derives from sea level stabilising at its present level about 6,000 years ago. (Although, evidence is accumulating of a slightly higher maximum about 3000 years ago and then a drop to present level; Baker and Haworth 1999, Baker and Haworth 2000). The distribution of all estuarine plants, especially saltmarsh, has been influenced by this change in sea level as well as by natural features including topography, soil type, extent of tidal inundation, rainfall, salinity and water clarity.

Once sea level stablised, it probably took some centuries for the vegetation to also reach an equilibrium: sediments were mobilised and redeposited, and small species were succeeded by larger ones. Seagrass came to grow on submerged sandflats that overlay steep gullies where terrestrial plants once grew. Mangrove and saltmarsh appeared on the tidal fringes of the new foreshores.

4.1.2. Human modifications

With the stabilisation of sea level, and after an equilibration of plant communities was reached, it is assumed that the vegetation along the Parramatta River-Sydney Harbour changed little up until the early and mid 1800s. From that time onwards land-use patterns were highly modified by vegetation clearing in the catchment, extraction of freshwater, exclusion of tide, discharge of effluent, mining of sand and most importantly for saltmarsh, filling and 'reclamation' of tidal lands.

Like many of the terrestrial vegetation communities of Parramatta River-Sydney Harbour, saltmarshes have experienced a major decline in their distribution, area and condition since European settlement. Historical studies based on diaries, reports and artworks of early settlers by McLoughlin (1987, 2000, 2002), suggest that saltmarshes were extensive in many of the embayments, creeks and intertidal flats of the estuary – particularly the upper Parramatta River – during the early years of settlement. Since that time, many landuse changes have taken place throughout the catchment, its shoreline and the waterway itself. It is these changes that have led to the current distribution of saltmarsh reported in this study, and are likely to continue to influence its distribution.

The area of saltmarsh lost since European settlement within the Parramatta River-Sydney Harbour system is likely to be substantial. Much of the middle reaches of the estuary that would have once supported extensive mudflats and saltmarshes has been infilled, with seawalls currently lining most of this shoreline. In places such as Rushcutters Bay no saltmarsh currently exists, despite (or possibly due to) the historical reference of its name. McLoughlin (1987), through her study of accounts of early settlement and of colonial artwork, has highlighted the loss of saltmarsh, mudflats and beaches along the Lane Cove River, with most of these areas having experienced a rapid expansion of mangroves.

The present day saltmarshes of the Parramatta River-Sydney Harbour are highly fragmented, evidenced in part by the large number of small patches recorded throughout the estuary. Fragmentation has resulted from residential and industrial development, the construction of structures such as seawalls and the expansion of mangroves. This fragmentation will have reduced the habitat potential of saltmarsh for many faunal species, including fish, crab, snails and even mammals and birds. In many cases it is also likely to have negatively impacted upon the ecological processes and integrity of the saltmarshes concerned.

Nevertheless, the saltmarsh of Parramatta River-Sydney Harbour has some robustness. The Sydney Olympic Park precinct provides an example of this, with extensive saltmarsh growth in areas that have been highly modified by land reclamation, the dumping of rubbish, chemical pollution, and un-expended munitions. Such modifications may have even favoured opportunistic species such as *S. australis* (see Adam *et al.* 1988) which is most abundant within the upper estuary, including Sydney Olympic Park. In several places throughout the estuary, saltmarsh has colonised seawalls (e.g., Wilson Park foreshore) and in some instances the land behind seawalls (e.g., Wentworth Point), highlighting its occasional tolerance to human modifications.

4.2. Technical implications of mapping saltmarsh

4.2.1. Comparison with previous studies

This study highlights the difference between the interpretation of aerial photographs compared to field efforts to quantify the presence and distribution of saltmarsh wetlands. There were vast contrasts between findings of West *et al*. (1985) and West *et al*. (2004), and the latter study and this study (Table 12). The two former studies were based primarily on the analysis of aerial photographs with attendant fieldwork (ground truth). West *et al*. (1985) located only three large saltmarsh 'meadows', all within the upper Parramatta River and Duck River portion of the estuary. West *et al*. (2004) differentiated these three 'meadows' into 35 smaller patches. In the current investigation, 757 distinct saltmarsh patches were found, and these were located throughout the estuary.

Table 12. Comparison of cover of saltmarsh between West *et al.* (1985), West *et al*. (2004), and this survey.

	Number of patches	Area of saltmarsh (ha)	Locations in which saltmarsh was identified
West *et al*. (1985)	3	7.3	Homebush Bay, Newington, Silverwater (Duck River)
West *et al*. (2004)	45	9.565	Homebush Bay, Newington, Silverwater (Duck River)
This study	757	37.306	entire estuary

The progressive increase in the number and area of saltmarsh across the three studies should not be interpreted to signify any expansion in the on-ground distribution, but instead highlights the better suitability of field surveying for saltmarsh. Indeed, it is likely that, in the time between the three reports, at some places saltmarsh has actually decreased in size and distribution, rather than increased.

One of the main reasons for the difference between the West *et al.* (1985) and West *et al.* (2004) studies was the quality of the aerial photographs used. The photos used in the former investigation were black and white taken at a scale of 1: 16,000. Photos used in the latter study were also at a scale of 1: 16,000 but were in colour. Maps produced in the former study were drawn directly from the photos, using a series of optics, at a scale of 1:25,000. As photos for the latter study were available in digital format, on-screen digitising was carried out at 1:1,500 scale. Spatial resolution of the latter was of the order of 150 mm whereas for the former it was of the order of 2 m.

Even so, limitations of the API technique are apparent. API was unable to determine saltmarsh patches growing completely or partially under mangrove, swamp-oak and terrestrial woodland canopies. Although improved, relative to West *et al.* (1985), the spatial resolution of West *et al.* (2004) was such that small patches of saltmarsh (in the order of 50 m^2) could not be identified (Table 3). Table 6 shows that saltmarsh patches of this size or smaller account for approximately 50% of all the patches mapped in the field. This finding has important ramifications when dealing with the issue of fragmentation of habitat (see below).

Field validation enabled adjustment of the size and shape of many API-defined saltmarsh patches and to correctly identify polygon content. 182 API-defined polygons were wrongly labelled as saltmarsh. These included areas of bare mud, freshwater reedlands, water, grasslands and anthropogenic structures.

Somewhat unexpectedly, field validation also corrected for over-fragmentation within the API process, particularly for larger saltmarsh sites with a complex mangrove interface. Where mangrove canopy cut across a saltmarsh area, API fragmented the saltmarsh area into distinct patches, whereas field observations in many cases showed the saltmarsh to grow continuously under the mangrove canopy.

The implementation of a comprehensive field survey of the estuary shoreline is a major contributing factor in the large number of saltmarsh patches identified. Saltmarshes of all sizes could be located and mapped, regardless of canopy cover and shading, saltmarsh plant density or species composition. The extensive nature of the field survey also meant that saltmarsh species growing in non-typical areas (i.e., other than creek flats and heads of embayments) were identified. For example, saltmarsh was somewhat unexpectedly found on intertidal rock platforms in the bays and 'headlands' of the lower estuary – particularly North Harbour – and occasionally in other parts of the estuary. Importantly, it is in this habitat that three previously unknown occurrences of *W. backhousei* were located.

It should be noted that although fieldwork done in this study was extensive, it should not be considered as complete. Access to some areas of the harbour foreshore was limited due to topography, ownership and land-use. Additionally, like any vegetation community, coastal saltmarsh is a dynamic entity that is likely to change over time. For these reasons, it is important that land managers throughout the Parramatta River-Sydney Harbour catchment carry out subsequent pedestrian surveys to complement this study. Pedestrian surveys are the best way to deal with entities such as small patches of saltmarsh. Surveys based on API have a distinctly different use, and that is for the monitoring of large-scale change.

The area of saltmarsh now known to occur throughout the Parramatta River-Sydney Harbour catchment is extensive compared to previous studies (Table 12). However, when compared to geomorphically similar estuaries, it appears the amount of saltmarsh in the Parramatta River-Sydney Harbour is quite low. Pickthall *et al.* (2004) found 153 ha of saltmarsh along the estuarine portion of the Georges River. In terms of shoreline length, the Georges River is distinctly smaller than the Parramatta River-Sydney Harbour, though it has not experienced the extent of urbanisation (at least along much of its southern shore) as the Parramatta River-Sydney Harbour. The saltmarshes of both estuaries have some similarities. Saltmarshes in both systems include stands dominated by the subshrub *S. quinqueflora* and grasslands of *S. virginicus*. Perhaps the greatest floristic and structural difference between the saltmarshes of the two estuaries is the abundance of *J. kraussii*-dominated rush communities – a common element of saltmarshes in southeast Australia. Pickthall *et al.* (2004) recorded *J. kraussii* in three-quarters of the Georges River saltmarshes, while this plant occurs in just 28% of Parramatta River-Sydney Harbour saltmarshes. Part of the explanation for this lower occurrence is that *J. kraussii* generally grows in the higher elevation zone of saltmarshes, the same area which is most likely to have been lost to land reclamation and infilling.

The saltmarshes of the Georges River and Parramatta River-Sydney Harbour are experiencing similar management issues. The spread of the introduced Sharp Rush *J. acutus* is of major concern in both estuaries, as are the impacts of unauthorised access and recreational use of saltmarshes. The "sensitive species" common to both rivers were also located in the upper portion of the estuary, i.e., in the Riverine Channel and Fluvial Delta.

4.2.2. Geomorphic zones

On the basis of another set of geomorphic principles advanced by Roy (1984), it is possible to assign an evolutionary stage to NSW estuaries. The lack of natural infilling of the Parramatta River-Sydney Harbour puts it in a youthful evolutionary stage (Roy *et al*. 2001). More specifically, the Central Mud Basin elements of the estuary are extensive, and much greater in area than the other three geomorphic zones combined (Figure 2).

Our ability to relate the distribution of saltmarsh to geomorphic zones of the Parramatta River-Sydney Harbour is severely limited by the high degree of human modification to the natural shoreline. The current distribution of saltmarsh may not be representative of pre-European distribution. With this caveat in mind, the relevance to saltmarsh of several statements made by Roy *et al*. (2001) on estuarine geomorphology can be questioned.

Firstly, saltmarsh should be 'rare' along the banks in upper portions of estuaries. The present study shows the Riverine Channel supports the most extensive and numerous saltmarsh patches of any of the geomorphic zones: 461 patches, 60.9% by number; 29.029 ha, 77.8% by area (Table 5). The zone with second highest cover is the next downstream zone, the Fluvial Delta.

By contrast, in the Georges River, extensive cover of saltmarsh was found in the Marine Tidal Delta at Towra Point (Pickthall *et al*. 2004). No such flats as are seen at Towra Point are found with the Parramatta River-Sydney Harbour. Furthermore, Towra Point is a difficult site to access and in the 1980s was dedicated as a Nature Reserve; it therefore is not subject to modification of landuse such as infilling. It therefore appears that local sedimentary environments (determined by geomorphology and geology), and human modifications are the most important factors controlling the distribution of saltmarsh.

Secondly, and on the basis of the Remane principle, Roy *et al*. (2001) suggest that species richness for aquatic animals in tide-dominated, drowned valley estuaries (providing Sydney Harbour as an example) should decline from the mouth to the upper reaches, due mostly to a pronounced salinity

gradient. In regard to saltmarsh plant species, the present study shows a reverse to this trend with highest diversity experienced in the upper estuary zones, particularly the Riverine Channel. Lowest diversity was recorded near the mouth of the estuary in the Marine Tidal Delta. This should be treated with caution however, as it is within lower estuary that the greatest historical loss of saltmarsh through infilling and reclamation is likely to have occurred.

Nevertheless, some floristic and structural differences of saltmarsh in the Parramatta River-Sydney Harbour appear related to estuarine geomorphology. For example, saltmarsh assemblages that remain within North Harbour (Marine Tidal Delta) and Sydney Harbour (Central Mud Basin) are dominated by plants such as *Isolepis nodosa* and *S. virginicus*, often growing in small patches or thin strips along rocky shore areas. These are markedly different from the *S. repens* and *J. kraussii* dominated marshes growing largely under mangrove canopies of Middle Harbour (primarily Fluvial Delta) and the Lane Cove River (Fluvial Delta). These differ again from the more extensive Chenopod-dominated (i.e., *S. quinqueflora, S. australis*) marshes of the upper Parramatta River (Riverine Channel), where many of the sensitive species were located.

The distinct estuary sub-units also differ in terms of their underlying geology. The shoreline areas of North Harbour and Sydney Harbour are dominated by marine and terrestrial sands; the Fluvial Deltas of Lane Cove and Middle Harbour are influenced by Hawkesbury Sandstones and Quaternary Alluvium; the upper Parramatta River is influenced by a combination of Hawkesbury Sandstones, Quaternary Alluvium, and in parts, outcrops of Wianamatta Shales.

The legacy of human modification on the different sub-units of the estuary can also explain the current distribution of saltmarsh. The Sydney Harbour portion of the estuary has the longest history of urbanisation and the smallest amount of saltmarsh. It is within this area that the earliest infilling of tidal land, where saltmarsh would otherwise be present, occurred (McLoughlin 2000). Throughout the rest of the estuary, infilling has also taken place, though not to the extent of in the Sydney Harbour portion. Lane Cove and Garigal National Parks have offered protection from infilling to some significant areas of saltmarsh along Lane Cove River and Middle Harbour, respectively. While the upper Parramatta River has experienced extensive urbanisation, it has not been of the same density as in the lower estuary, with large intertidal areas surviving.

4.3. Threats to saltmarsh

There are clear threats to the survival of saltmarsh throughout all parts of the Parramatta River-Sydney Harbour estuary.

4.3.1. Recreational access

The damage caused by human trampling to the substrata on which saltmarsh grows, to the flora itself, and to associated fauna, is considerable throughout the Parramatta River-Sydney Harbour. Informal walking tracks through saltmarshes are quite common, particularly across smaller and more degraded patches that may be considered by some members of the public as ‘wasteland’ or weeds (examples include Yaralla Bay, Concord; and Scotts Creek, Castle Cove). Trampling is also responsible for the loss of small strips of saltmarsh area along designated National Park walking tracks in Lane Cove and Garigal National Parks. Land managers need to ensure that such walking tracks, formal or otherwise, are diverted so as not to cross sensitive saltmarsh areas. Where that is not possible, the construction of raised boardwalks will limit the impact human traffic has on the wetland ecology.

Damage from recreational vehicles, namely motorised trail bikes, but also BMX bikes, is far more limited, but possibly more devastating, than human trampling. Evidence of damage by BMX was observed at Silverwater Wetland, as well as Bicentennial Park. At the former site this has been

effectively controlled by the erection and maintenance of a chain wire fence. At both sites, BMX activity appears to have extended into the saltmarsh from unvegetated, mudflat areas. The current extent of damage at both these sites, however, is minimal.

The greatest extent of damage from recreational vehicles is concentrated around the southern and eastern boundaries of the Mason Park wetlands at Strathfield (Plate 7). Here, trail bike use has caused a considerable reduction to what was one of the largest stands of *W. backhousei* in the estuary. Vehicle tracks have also been observed through small *L. tegens* stands. If left unchecked, further damage could be done to the remaining *W. backhousei* and *L. tegens* stands, whilst increases in soil erosion and changes to the local hydrology as a result of vehicle use could significantly alter the character of the Mason Park wetland.

Restricting vehicle access to areas that have been damaged, such as Mason Park, as well as sites that are at risk of future damage is essential. Sites most at risk of attracting unauthorised vehicle use include those easily accessed from residential areas (including via fire and access trails) and those with mudflats or unvegetated patches (Kelleway 2005). Any gates, fences, or other mechanisms used to block vehicular access need to be regularly maintained, as they are likely to be subject to vandalism.

Plate 5. Damage to saltmarsh by trail bike riding, Mason Park, Strathfield. (SPR304).

4.3.2. Dumping, mowing and pollution

As part of the legacy of land reclamation throughout the Parramatta River-Sydney Harbour, many saltmarsh areas are bordered by fill and rubble. In some cases these materials extend into the saltmarsh zone, limiting the area available for plant growth and habitat for animals. Where this is the case, it may be possible to remove such materials and restore some of the natural character of the wetland.

Dumped materials were observed throughout the estuary, particularly in easily accessible areas which are out of public view. The worst affected saltmarsh sites included Moon Bay in Iron Cove, Yaralla Bay and behind houses in Meadowbank and Ermington. The most commonly dumped items were garden waste and old building materials. The former is of particular concern with the potential to introduce weeds (particularly lawn species Kikuyu and Buffalo Grass) into the saltmarsh and surrounding areas.

In some cases where private land abuts saltmarsh, mowing, either inadvertently or deliberately, has been undertaken presumably for aesthetic reasons. To counter this practise, the value of saltmarsh should be reinforced via educational programs.

A large percentage of the litter in saltmarsh areas appears to have floated in via waterways on higher tides. Such materials include plastics, foams and wooden products. These can be particularly dangerous to fauna that use saltmarshes, whilst also covering significant areas and stifling plant growth. Better management and design of stormwater outlets throughout the estuary would reduce the amount of litter impacting upon saltmarshes.

Being located within a highly urbanised and industrial waterway, the saltmarshes of the Parramatta River-Sydney Harbour may be at risk of chemical pollution, via stormwater or tidal inundation. Spills from vehicle accidents are another threat. Although such risks were not assessed in this project, the comprehensive maps of saltmarsh should be utilised in the event of major spills to identify areas that need a rapid spill response.

4.3.3. Engineering works

Prior to the construction of the three Parramatta weirs in the 1800s to create a source of freshwater, the tide would have intruded further up the river than at present. Hence, the salinity regime at the upper part of the estuary would have been modified by these structures. Furthermore, engineering works to infill the heads of bays (e.g., Homebush Bay) would also have affected tidal influence and salinity. In addition, many small works, such as stormwater pipes, seawalls and bike paths would have had more localised impacts. In effect, the character of the estuarine portion of the river is now extensively modified compared to what it was 150–200 years ago, and it is not possible to reconstruct the environment that was present prior to white settlement. Management approaches of the future need to recognise and conserve remnants of the original ecosystem, especially saltmarsh, as well as enhance remnants where possible.

4.3.4. Stormwater

The construction over past decades of stormwater canals and drains has severely limited the natural habitat available for saltmarsh within the Parramatta River-Sydney Harbour estuary. Many of the estuary's tributaries are now dominated by concrete stormwater canals, of which very little, if any, is suitable habitat for the growth of saltmarsh and its related fauna. In some cases (e.g., Blackwattle Bay) saltmarsh plants were observed growing along the sides and upper boundary of stormwater canals. The function and habitat value of these small, isolated patches is likely to be very limited.

As stormwater canal walls and foreshore retaining walls come to the end of their practical life-term, it is recommended that the option of vegetating banks and restoring ecological character to these areas is considered.

Stormwater discharge was identified as a feature in 43 of the estuary's saltmarsh patches. The discharge of stormwater into saltmarshes alters the salinity regime, which may facilitate the spread of freshwater and brackish species (Wilton *et al*. 2003, and see above) and weeds. Importantly, one of the three occurrences of the freshwater weed *Alternanthera philoxeroides* (Alligator Weed) in saltmarsh was at a stormwater discharge site. Stormwater discharge can also increase the nutrient levels within a wetland. The consequence of this can be algal blooms, which have impacted on the saltmarshes of Mason Park, Silverwater wetland, and the Bird Sanctuary of Bicentennial Park. The full impact that stormwater discharges have on saltmarsh fauna is not currently known.

4.3.5. Incursion of mangrove

Evidence exists of the invasion of saltmarsh by mangrove across the whole of southeast Australia (Saintilan and Williams 1999, Saintilan and Williams 2000) but the causes are unknown. In the Georges River-Botany Bay ecosystem, invasion has been seen at Towra Point (Mitchell and Adam 1989) and elsewhere along the southern shore of Botany Bay (Fenech 1994, Hughes 1998, Evans and Williams 2001). A well-documented increase in mangrove occurred at Salt Pan Creek (Patterson Britton & Partners 2001). Aerial photographs taken in 1937 show mangroves restricted to small patches along both sides of the creek, but major expansion occurred after a series of civil works including the East Hills Railway Line (mid 1930s), Sydney Water Sewer Aqueduct (late 1950s) and the Henry Lawson Drive road-bridge (early 1970s). These works appear to have enhanced sedimentation and provided new substrata for mangrove growth. There appears to be a time lag of 10–20 years between formation of the mud flats and subsequent colonization by mangrove.

For the Parramatta River, McLoughlin (2002, p. 283) noted that:

> *"In 1788 the most extensive inter-tidal wetlands in upper harbour, Lane Cove River and Parramatta River were saltmarsh and mudflats. Mangroves were in patches and/or fringing creeks but expanded their range significantly in the late 19th and early 20th centuries. Evidence of change is apparent from about 1870 with mangroves appearing in the upper river and increasingly colonizing available mudflats and invading saltmarsh from that time."*

Sydney Olympic Park Authority currently removes mangrove seedlings less than one metre in height from the Wanngal Wetlands at Newington as a way of mediating incursion. Other examples of invasion in Parramatta River are seen at Silverwater Wetland, along the north side of the main channel of the upper Parramatta River (Meadowbank, Melrose Park, Ermington), and Yaralla Bay (Concord).

As mangroves are protected vegetation under the NSW *Fisheries Management Act* (1995), a permit is needed from the Department of Primary Industries to cull them. Culling may be needed at locations of high conservation value.

4.3.6. Incursion of freshwater/brackish species

There is little evidence to suggest that the downslope incursion of freshwater/brackish plant species is currently a major concern for the saltmarshes of the Parramatta River-Sydney Harbour. *Phragmites australis*, which has been reported as expanding in saltmarshes in New South Wales, and North America, was not a major feature of Parramatta River-Sydney Harbour saltmarshes. This

species, often a natural component of saltmarsh vegetation, was present in the river in the early 1980s (P. Adam, unpublished data) although its full distribution was not assessed. In this study, *P. australis* was recorded only in eighteen sites throughout the middle and upper portions of the estuary. In comparison, Pickthall *et al.* (2004) recorded 34 occurrences of *P. australis* within the numerically-fewer saltmarshes and reed habitats of the Georges River.

Two saltmarsh sites within the Parramatta River, however, have been identified to be experiencing low levels of *P. australis* incursion. At the main marsh adjacent to George Kendall Reserve, Ermington (NPR40C) and in one of the marshes adjacent to Shell refinery, Duck River (WDR8) *P. australis* was observed to be growing along the upper margin and protruding downslope into the saltmarsh zone. *P. australis* currently covers 5% and 10% of these respective saltmarsh sites, both of which contain *W. backhousei*.

A similar case occurs with the freshwater/brackish *Typha* sp., which appears to be expanding down into the *Samolus repens* sections of a saltmarsh on Tambourine Creek (ELC3C_D), a tributary of the Lane Cove River. At Sydney Olympic Park, *Bolboschoenus caldwellii* and *Typha* sp. grow extensively in one saltmarsh (SPR149) located near a major freshwater output into Haslams Creek. However, it is currently unknown if these species have replaced other saltmarsh species, or whether they are currently spreading.

The incursion of freshwater/brackish species such as *P. australis*, *Typha* sp. and *B. caldwellii* is most likely to occur along drainage lines, or near stormwater discharge sites, where freshwater enters saltmarsh. Consequently, any modifications to saltmarshes and their surrounds that may increase the input of freshwater should be monitored for the possibility of incursion, and management intervention may be appropriate. The history of the distribution of *P. australis*, *Typha* sp. and *B. caldwellii*, as well as mangrove, could potentially be investigated by a careful analysis of old aerial photographs and records of the NSW Herbarium.

4.3.7. Weeds

Because they grow in an intertidal situation saltmarshes may be less prone to invasion by weeds than most vegetation communities. However, they are still susceptible, particularly to salt-tolerant exotic species (see Appendix 7 for a full list of weeds infesting saltmarsh). Of major concern in the Parramatta River-Sydney Harbour is the extensive infestation by *J. acutus*, a species that displaces native saltmarsh species, including the native rush *J. kraussii*. *J. acutus* was identified growing in 89 saltmarsh patches mostly in the upper Parramatta River, often covering significant areas within a patch. It is also thought that *J. acutus* is currently expanding its distribution in Sydney. For this reason, care needs to be taken to avoid the spreading of this species into currently uninhabited saltmarshes. Vehicle tyres and shoes are potential seed vectors that can be mitigated against with appropriate access constraints. The present occurrences of *J. acutus* within each Local Government Area are provided (Table 11, Appendix 6) in order that appropriate restoration and mitigation efforts can be undertaken. Control of this weed is difficult, and is best done with physical removal followed by the use of herbicide (glyphosate).

As *J. acutus* can be readily confused with the native *J. kraussii* (Plate 6), it is important that identification is correct before any removal works are undertaken. Stands of *J. acutus* are taller in height and the stems are of slightly greater diameter. Where uncertainties exist, a sample should be sent to an expert botanist or the Royal Botanic Gardens for confirmation.

Hydrocotyle bonariensis is the most abundant saltmarsh weed in the lower estuary, particularly in areas of high fragmentation. Importantly, *H. bonariensis* was generally observed as a fringing species, rather than a dominant component of saltmarsh vegetation. The two exceptions to this

occur within Sydney Harbour National Park (SPR45, NPR8), the former of which is currently undergoing regeneration that may assist in the control of this weed.

Plate 6. Distinguising features of the native *Juncus kraussii* (left) and introduced *Juncus acutus* (right). (source: NSW Royal Botanic Gardens 'PlantNet').

Baccharis halimifolia is not currently a major threat to the saltmarshes of the Parramatta River-Sydney Harbour. It has been identified as an extensive and problematic weed in northern New South Wales and throughout Queensland saltmarshes. It is possible that future climate change will lead to *B. halimifolia* becoming more widespread within the Sydney region. For this reason, *B. halimifolia* should be targeted for removal and any spread of this species should be carefully monitored.

C. selloana was only observed to be actively growing in two saltmarsh patches within the major wetland complex of Haslams Creek, in Sydney Olympic Park. Elsewhere in Sydney Olympic Park there was evidence of successful control of this species within saltmarsh areas. Such efforts should be continued to ensure that *C. selloana* does not spread to become a major weed within the Parramatta River-Sydney Harbour saltmarshes.

Alternanthera philoxeroides (Alligator Weed) is a major weed of freshwater wetlands, and was found growing in three saltmarsh sites in the Parramatta River-Sydney Harbour. These sites were within the moist areas of saltmarshes at Yaralla Bay (SPR15), west of Kissing Point (NPR58B) and the Pemberton St wetland, Parramatta (NPR60C). In these places it has formed dense, rooted mats which should be removed. Alligator weed is gazetted as a noxious weed (W1) in New South Wales.

An important attribute of many of the weeds that infest saltmarshes is that they can also grow in other, less saline habitats. This has implications for the control of these species as there may be many sites within a catchment that continue to provide seed stocks. The degraded wetland within the Shell Clyde refinery has been identified as one non-saltmarsh site of concern as it supports extensive growth of the major weeds *Juncus acutus* and *Cortaderia selloana*. This site, and others like it, should be actively managed to eliminate a major, potential source of weed infestation throughout the estuary.

4.3.8. Rise of sea level

The forthcoming rise in sea level will have a significant impact on the distribution of estuarine plants along the NSW coast including the Parramatta River-Sydney Harbour (Vanderzee 1988, Williams 1990). Some assemblages such as mangrove will move further upriver as well as upslope when existing shorelines are inundated, and mangrove infiltration of saltmarsh will ensue. Saltmarsh will move upstream and upslope but its distribution will be limited by topography and structures such as roads and buildings. It is therefore important that planning measures are implemented to create buffers that will provide upslope refuge for saltmarsh communities throughout the estuary. The implications of change in sea level are especially significant for the "sensitive" saltmarsh species *S. radicans* and *W. backhousei*. For this reason alone, continuous monitoring of the diversity and distribution of saltmarsh is required.

4.4. Other management issues

For the whole of the Parramatta River there do not appear to be any comprehensice management arrangements for the conservation of saltmarsh. At the subcatchment scale, some arrangements are in place, specifically by the Lane Cove Estuarine Management Committee. Additional effort is needed to cater for the declaration of coastal saltmarsh as an Ecologically Endangered Community (EEC). This response is particularly important given the limited distribution of some saltmarsh species in the Parramatta River estuary.

4.4.1. Reserves

The EEC listing does not explicitly prevent damage to saltmarsh communities. To receive a higher level of protection and to promote the active management of this ecosystem, conservation of saltmarsh within formal reserves is encouraged.

By number (89 of 757 patches), only a small proportion of the saltmarshes in the Parramatta River-Sydney Harbour are located within formal conservation reserves (Table 8). By area, almost 40% of saltmarsh lies within patches that are either completely or partially located within a conservation reserve. Many of these patches are large in size and complex in ecological character.

The vast majority of the area of saltmarsh occurring within conservation reserves lies within the Wanngal Wetland of Newington Nature Reserve. At this location the whole of the wetland is within reserve boundaries. This site is extremely important as it includes many of the largest saltmarsh meadows in the estuary, many of which are in particularly good condition. Saltmarshes here are also home to several patches of the vulnerable species *W. backhousei*, and the culturally significant *L.s tegens* and *H. pergranulata* subsp. *pergranulata.* It is important that Sydney Olympic Park and NSW DEC continue efforts to manage this major wetland area for saltmarsh conservation.

Aside from Wanngal Wetland, only 2.5 hectares of saltmarsh is within, or connected to, a conservation reserve. Saltmarshes at or near Bantry Bay (3,029 m^2), Gordon Creek (6,510 m^2) and Carrolls Creek (2,932 m^2) are incorporated in Garigal National Park; Lane Cove National Park includes the saltmarshes of Kittys Creek (8,427 m^2). Almost all other patches in these national parks are small, with many in poor condition. Some have designated walking tracks going straight through them, with substantial damage from trampling. In other areas, informal tracks have led to the degradation of saltmarsh patches. A revision of general management arrangements, as well as those specifically for access, could improve the status of these saltmarshes.

Sydney Harbour National Park contains a few very small saltmarsh patches along the southern shore of Sydney Harbour and in North Harbour. The ecological value of these patches, due to their limited size, is uncertain.

A wetland of particularly good size and condition occurs on the eastern shore of Lane Cove River (comprised of saltmarsh patches ELC10A, ELC10B, ELC10C_D, ELC10E, ELC10F_G). This saltmarsh includes extensive stands dominated by *Juncus kraussii* and also highlights a mangrove-saltmarsh-Swamp Oak forest transition that is now rare within the Parramatta River-Sydney Harbour estuary. Importantly, this saltmarsh site does not appear to be experiencing the same rate of mangrove expansion that is occurring elsewhere in the estuary. If land tenure allows, this saltmarsh should be considered for inclusion in Lane Cove National Park.

The saltmarshes of the Duck River, many of which are extensive and in fair condition, are not included in the national park estate. These saltmarshes are in the Riverine Channel and are species rich, due possibly to the influence of clay-rich Wianamatta shale substrate and the low gradient of the intertidal lands. Some of the most extensive patches of *W. backhousei* in the estuary occur between the Shell Refinery and encroaching mangroves on the western shore of Duck River (Plate 7). In one location at this site, *W. backhousei* was observed growing continuously from the inundated low marsh to the highest elevation section of the upper saltmarsh. This was the only location where this phenomenon was observed in the entire estuary. Saltmarshes on the western Duck River are also home to the only occurrences of *S. radicans* recorded in this study. The eastern shore of the Duck River includes the Silverwater Wetland (managed by NSW Maritime), which is one of the most extensive in the estuary and contains stands of *W. backhousei* and *H. perganulata* subspecies *pergranulata*.

Plate 7. Saltmarsh bordering the Clyde oil refinery on the Duck River. Species include *Wilsonia backhousei* (dark green, foreground), *Sporobolus virginicus* (grass, left mid-ground), *Halosarcia pergranulata* subsp. *pergranulata* (shrub, right mid-ground), *Juncus kraussii* and *Juncus acutus* (sparse, background) and *Sarcocornia quinqueflora* (throughout). (WDR9).

4.4.2. Sensitive species

Wilsonia backhousei

The results of this study have several implications for the management and conservation of the vulnerable species *W. backhousei* (Plate 8). Firstly, several previously unknown stands of this species were located during field surveys. Several of these stands were located on estuarine rock platforms, mostly further downstream than the more common 'meadow' patches. This new discovery could be expected, given that *W. backhousei* has been previously located on seacliffs in the Sydney region (P. Adam, pers. comm., UNSW, 2006), where substrate conditions are quite similar. Although all of the rock-dwelling patches of *W. backhousei* within Sydney Harbour-Parramatta River were all small in size, their existence may provide a suitable seed stock for establishment of this species elsewhere. It is therefore important that all locations of this species be actively monitored and conserved.

By number and area, the highest proportion of *W. backhousei* was located along the southern shore of the upper estuary, in the Riverine Channel. This result was not unexpected, as this area contains the most extensive areas of saltmarsh, and importantly is the only area dominated by the clay-rich soils of the underlying Wianamatta Shale group. One of the more extensive stands of *W.*

backhousei in the Sydney region occurs along Salt Pan Creek (tributary of Georges River), in an area also influenced by Wianamatta Shale. Subsequent surveys of saltmarsh, particularly in the Sydney region, should focus on similar environments as likely habitats for sensitive species such as *W. backhousei*.

Overall, the size of *W. backhousei* stands encountered throughout the Parramatta River-Sydney Harbour was quite small. With very few exceptions (adjacent to Shell refinery, Duck River; Wanngal Wetland, Newington), none of the 'extensive' stands reported by Hamilton (1919) as occurring early last century appear to remain. It is not known whether the apparent reduction in the distribution and size of *W. backhousei* stands is purely a result of urbanisation, or if phenomena such as sea level rise and interspecific competition are also responsible.

Plate 8. *Wilsonia backhousei* with white flowers. (EDR3).

Selliera radicans

S. radicans (Plate 9) was found in only two saltmarsh patches adjacent to the Shell refinery, on the western shore of Duck River. These patches were in close proximity to one another, with the cover of *S. radicans* being small relative to other saltmarsh species (<5%). Pickthall *et al*. (2004) reported four sites of *S. radicans* growing along the Georges River, but no comment was given as to the extent of cover. In both studies, *S. radicans* was only located in the upper, Riverine Channel portion of the two estuaries. With the exception of *G. filum*, which was not encountered, *S. radicans* was clearly the least common of saltmarsh species recorded throughout the Parramatta River-Sydney Harbour, with reports suggesting it was once more prevalent (Pickthall *et al*. 2004). For these reasons, the conservation status of this species in the Sydney region should be reviewed.

Plate 9. *Selliera radicans.* (WDR10).

Plate 10. *Lampranthus tegens* in flower. (NPR35C).

Lampranthus tegens

L. tegens (Plate 10) should be actively conserved in the Parramatta River/Sydney Harbour as this estuary represents its only known occurrence in coastal saltmarshes in New South Wales (P. Adam, pers. comm., UNSW, 2006). The efforts of Sydney Olympic Park Authority in mapping and managing this species should be emulated by land managers in other locations throughout the estuary. Particular attention should be given to the monitoring of stands of *L. tegens* at Mason Park, Strathfield, and behind the houses of Lancaster Avenue, Melrose Park. It is highly recommended that further research be conducted into the floristics, biogeography and genetics of *L. tegens*, both within and outside of the catchment of the Parramatta River. Subsequent to such studies being carried out, it may be necessary to review the current conservation status of this species.

Halosarcia pergranulata subsp. pergranulata

As for *L. tegens*, *H. pergranulata* subsp. *pergranulata* (Plate 11) should be actively conserved where it occurs in the catchment of the Parramatta River as the species is not known to occurr in any other coastal saltmarshes in NSW (P. Adam, UNSW, 2006). *H. pergranulata* is well represented in the saltmarshes of Duck River, adjacent to the Shell refinery on the western shore, as well as within Silverwater Wetland on the river's eastern shore. Further research is necessary.

Plate 11. *Halosarcia pergranulata subsp. pergranulata*. Distinguished from *Sarcocornia quinqueflora* by its shrubby growth-form. (SPR175).

4.4.3. Condition of sensitive sites

The condition of the saltmarshes containing the four sensitive species is generally medium or good, with just one patch considered to be in excellent condition (see Table 10 and Appendix 5). There is a major exception to this, with most of the patches at Mason Park considered poor. The health of saltmarsh at this wetland has been seriously impacted by unauthorised vehicle use (especially in southern section of the wetland) and blooms of algae. Relatively large areas of *W. backhousei* and *L. tegens* have been destroyed by these factors, which still pose a considerable threat to remaining stands.

Algal blooms may also pose a threat to the *W. backhousei* and *H. pergranulata* subsp. *pergranulata* stands at Silverwater Wetland. At present the damage to saltmarsh plants at this site by algal growth appears limited. Nevertheless, this situation should be monitored and appropriately managed, especially if it poses a risk to the sensitive species.

4.4.4. Hypersaline flats

Despite their prevalence in historical accounts (Hamilton 1919), there is currently very little indication of bare, hypersaline flats within the saltmarshes of Sydney Harbour / Parramatta River. It is likely that 'reclamation' of the upper marsh areas in which these features would naturally occur is a major reason for their decline, along with changes to local hydrology and possibly climate change. The sole, contemporary example of a hypersaline flat in the estuary occurs within Silverwater Wetland on the Duck River (EDR4). Here, the margins of the flat are sparsely vegetated by *H. pergranulata* with algal growth present across the centre of the flat. While little is presently known of the ecology and habitat value of this feature, the land manager, NSW Maritime should ensure its protection for reasons of its rarity and potential for ecological investigation.

4.4.5. Legislative requirements and planning

There are legislative requirements afforded by the listing of coastal saltmarsh as an Endangered Ecological Community (EEC) under the NSW *Threatened Species Conservation Act* (1995). These include the need for all local governments to report annually on the occurrence and status of endangered communities within their boundaries in their State of the Environment reporting (NSW *Local Government Act* (1993) (Section 428(2)(c)). Although the present study provides a major advance on previous mapping efforts in Sydney Harbour, local governments will need to continue to check for saltmarsh as future changes are likely, especially in the event of new activities and developments.

The EEC listing also requires proponents of any development that may impact upon saltmarsh to carry out the 'seven part test' as outlined under s5A of the NSW *Environmental Planning and Assessment Act* (1979). The above legislative requirements apply to all coastal saltmarsh communities, regardless of their size and floristic composition.

Many of the management issues discussed in this report can be mitigated through appropriate land-use decisions and development/activity assessments. An appropriate and informed consideration of saltmarsh within planning policies (State Environmental Planning Policies, Regional Environmental Plans and Local Environmental Plans) will guide this process. In particular, the current review of LGA Local Environment Plans (LEPs) provides opportunities to incorporate the consideration and protection of saltmarsh and other sensitive foreshore ecosystems.

The day-to-day management of estuaries and estuarine vegetation will be most effectively done by the relevant landowners and/or land managers, and at the Local Government level. It is in the context of local government administration that the calculations of saltmarsh area and condition,

and assessments of the status of sensitive and weed species are provided in this report for each Local Government Area (Tables 9, 10 and 11). Activity of a more strategic level will be undertaken by state agencies and the Sydney Metropolitan Catchment Management Authority.

4.4.6. Constructed wetlands

A number of human-modified saltmarsh wetlands were encountered throughout the Parramatta River-Sydney Harbour. These included wetlands with controlled tidal flows, such as Wanngal Wetland and Mason Park wetland, and constructed tidal lands such as Haslam Creek Flats and Federal Park, Glebe. The condition of these wetlands varied from site to site. Any future saltmarsh rehabilitation efforts should carefully assess these sites and consider, among other things, species suitable for planting. It is recommended that the distribution of species identified in this study be recognised in the planning and on-ground works stages of any new constructed wetlands or rehabilitation of current wetland areas. This will ensure that the ecology and health of remnant saltmarshes at any specific locality are considered.

While relatively few saltmarsh planting exercises have been commissioned, commercial contractors with the relevant skills are available.

4.4.7. Education

Education will play an important role in minimising the management threats to saltmarsh discussed above. Landowners, land managers and the general public should be made aware of the value of such wetlands, the impacts of inappropriate access and use of saltmarshes (trampling, vehicle damage, mowing, dumping) and ways in which ecological character can be restored. This report provides a starting point for such education.

Saltmarsh wetlands are valuable education and research resources. They provide insight into aspects of floral and faunal ecology, hydrology, environmental chemistry, and human impact, amongst others. The use of Bicentennial Park boardwalks by Sydney Olympic Park Authority as an educational asset for school groups is a prime example of the way in which saltmarsh and associated mangrove wetlands throughout the Parramatta River-Sydney Harbour can be actively promoted. In specific and appropriate instances, boardwalks through saltmarsh, when accompanied by a tour or interpretive signage, can play an important role in promoting understanding of this habitat type amongst the broader community.

4.5. Final remarks

While there is more saltmarsh in the estuary of the Parramatta River/Sydney Harbour than previously realised, it is very fragmented and there are a number of threats in the form of mangrove and weed incursion, stormwater runoff, and physical damage that need to be managed. It is important that the saltmarsh areas of good and excellent condition be monitored and maintained, and those of poor or average condition be managed in such a way that their ecological function and integrity improves. Monitoring at the fine-scale to assess species and assemblage distributions needs to be done by pedestrian survey; monitoring of the general patterns for large patches of saltmarsh can be done by the analysis of aerial photography.

5. CONCLUSIONS

5.1. Relevant to present distribution of saltmarsh:

- This study provides the first micro-scale depiction of the saltmarsh vegetation of the Parramatta River-Sydney Harbour estuary.
- Saltmarsh was found at 757 sites, covering a total area of 37.306 hectares. Most patches identified were small in size (70% were less 100 m^2).
- Some species of saltmarsh are found throughout the estuary whereas others have limited upstream distribution.
- *Wilsonia backhousei,* declared a "Vulnerable" species under the Threatened Species Conservation Act, was encountered at upstream locations.
- Other species, because of their rarity in the Sydney metropolitan region, are considered to be of high sensitivity and may ultimately need a special conservation priority. These species are *Selliera radicans, Lampranthus tegens* and *Halosarcia pergranulata* subsp. *pergranulata.*
- The detection of sites containing sensitive species highlights the importance of comprehensive field efforts when carrying out saltmarsh mapping.
- *G. filum*, considered "sensitive" because it is at the northern end of its distribution in the Sydney metropolitan region, was not found in this study although it has been recorded in the Georges River.
- *Juncus kraussii*-dominated rushlands, a common feature of saltmarshes throughout southeast Australia, are not common in the Parramatta River-Sydney Harbour.
- Newington Nature Reserve contains the largest extent of saltmarsh in the estuary.
- Land owners/managers, local government authorities and state government agencies have responsibility for the management of saltmarsh in the Parramatta River-Sydney Harbour. A regional scale management approach is desirable and would be best investigated by the Sydney Metropolitan Catchment Management Authority.
- As landholder for much of the intertidal areas of Parramatta River-Sydney Harbour, NSW Maritime has an important role to play in the management of the estuary's saltmarshes.

5.2. Relevant to the historical distribution of saltmarsh:

- Human activity has disturbed the Parramatta River-Sydney Harbour estuarine system over the past 150 years, and activities that have affected estuarine vegetation include catchment clearing, construction of the weirs and land reclamation. The role of any one of these activities in modifying the estuarine structure, and hence the estuarine vegetation of the river is not well understood.
- Some remnants of saltmarsh in place at the time of European colonisation may still exist.
- Even though the saltmarsh of Parramatta River-Sydney Harbour was mapped some years ago (West *et al.* 1985), it is difficult to quantify the extent of change in cover due to the changes in mapping methods over the ensuing years.
- A GIS-based assessment of the meso-scale distribution of saltmarsh based on historical photographs would considerably enhance our understanding of the loss and regrowth of large patches of these plants.
- The relationship of saltmarsh to the mud flats that were present along the river is not known.
- Mangrove has infiltrated saltmarsh over the past 20 years.

5.3. Relevant to the future distribution of saltmarsh:

- Rise of sea level can be expected to have a significant impact on the distribution of estuarine plants along the NSW coast including the Parramatta River-Sydney Harbour. Some

assemblages such as mangrove will move further upriver, as well as upslope, as shorelines are inundated. Mangrove infiltration of saltmarsh will ensue.

- Saltmarsh will also move upstream and upslope but its distribution will be limited by topography and structures such as roads and buildings, and some of the saltmarsh of the Parramatta River-Sydney Harbour system will be inundated and lost.
- The implications of change in sea level are especially significant for the "sensitive" saltmarsh species *Wilsonia backhousei*, *Lampranthus tegens*, *Halosarcia pergranulata* subsp. *pergranulata*, and *Selliera radicans*.
- With additional resources it would be possible to forecast some future condition of saltmarsh for a given rates at which rise in sealevel will take place.

6. RECOMMENDATIONS

- Arrangements should be made to ensure that the data generated in this study can be provided to the appropriate agencies (land owners/managers, LGAs, state agencies and the Sydney Metropolitan Catchment Management Authority), non-geovernment organisations and consultants. Shape files showing the location and attributes of patches of saltmarsh should be maintained by a central organisation and updated regularly.

- The findings of this study should be incorporated in land-use planning processes. The protection of saltmarsh requires that appropriate assessment is undertaken by LGAs and government agencies for all developments and activities.

- To promote the effective protection of saltmarsh, resources need to be provided to land managers and development assessors throughout the estuary. These resources need to include information which helps to recognise saltmarsh wetlands, and to aid in the identification of native and exotic plants species, including those described in this report as "sensitive".

- To assist the conservation response, all sites where the "sensitive" species are located should be afforded special significance.

- To assist the conservation response, all sites in, or in close proximity to, vacant Crown land should be identified in the first instance and assessed in terms of their size and condition.

- Consideration should be given to including the saltmarshes on both sides of the Duck River and the major stand on the eastern shore of the Lane Cove River within the National Parks estate.

- Educational programs and resources are recommended to inform land managers and the broader community of the importance of, and status and threats to, saltmarsh in the Parramatta River-Sydney Harbour estuary.

- A protection plan for the species *Wilsonia backhousei*, *Lampranthus tegens*, *Halosarcia pergranulata* subsp. *pergranulata* and *Selliera radicans* is needed. The protection status of the latter three species should be reviewed.

- A prioritisation of areas requiring management actions is needed. This will allow for a strategic approach towards management issues such as weed removal, access management and restoration works to be undertaken throughout the estuary.

- To refine the techniques used to monitor and hence manage saltmarsh, the following arrangements are needed:

    i. Broad-scale temporal assessments of change along the whole of the river by analysis of aerial photographs should be undertaken at three-year intervals. This analysis should also determine the extent of mangrove and seagrass,
    ii. Fine-scale assessments of change are needed to assess the degree of fragmentation or regrowth of saltmarsh. At present, such assessments are best carried out by pedestrian survey, but future advances in technology may make remote sensing technology, such as the compact airborne spectral imager, cost-effective in such endeavours,
    iii. Locally sponsored fine-scale assessments of saltmarsh, particularly for the species *Wilsonia backhousei*, *Lampranthus tegens*, *Halosarcia pergranulata* subsp.

pergranulata, and *Selliera radicans*, should be initiated. The possibility of finding *Gahnia filum* growing in the Parramatta River-Sydney Harbour estuary in future assessments should not be discounted.

iv. A workshop to resolve the frequency of monitoring should be scheduled.

- To put the dynamics of change in saltmarsh in context, a chronology of land-use activities along the river that have impacted on water flow, depth, nutrient and sediment input and other relevant factors should be constructed.

- To better assess past change, albeit at a broad scale, in the extent of saltmarsh in the Parramatta River-Sydney Harbour, it is necessary to analyse historical aerial photographs with GIS facilities. Such an exercise would resolve the accuracy of anecdotal accounts about the presence of extensive mudflats in the estuary many decades ago that have since been colonised by mangrove.

- Any proposals to construct saltmarsh wetlands must consider the existing distribution of species within the estuary and select and plant accordingly.

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8. APPENDICES

Appendix 1. NSW Scientific Committee: Coastal saltmarsh final determination.

Coastal saltmarsh in the NSW North Coast, Sydney Basin and South East Corner bioregions – endangered ecological community listing

NSW Scientific Committee – final determination

Final Determination

The Scientific Committee, established by the Threatened Species Conservation Act, has made a Final Determination to list the Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions, as an ENDANGERED ECOLOGICAL COMMUNITY in Part 3 of Schedule 1 of the Act. Listing of endangered ecological communities is provided for by Part 2 of the Act.

The Scientific Committee has found that:

1. Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions is the name given to the ecological community occurring in the intertidal zone on the shores of estuaries and lagoons including when they are intermittently closed along the NSW coast. Coastal saltmarsh has been recorded from sites along the NSW coast. (NSW North Coast, Sydney Basin and South East Corner Bioregions).

2. Characteristic vascular plant species of Coastal Saltmarsh are:

Baumea juncea	*Isolepis nodosa*
Juncus kraussii	*Samolus repens*
Sarcocornia quinqueflora	*Selliera radicans*
Sporobolus virginicus	*Suaeda australis*
Triglochin striata	*Zoysia macrantha*

The total list of species is larger, with many species present in low abundance or at few sites. A more extensive list of species is provided by Adam *et al.* (1988). The sediment surface may support a diversity of both micro-algae and macro-algae.

3. Communities with similar floristic composition, but with a different fauna, are found supratidally on exposed headlands (Adam *et al.* 1988). These headland communities and those of inland saline areas are not included within this Determination of the Coastal Saltmarsh Ecological Community.

4. Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions provide habitat for a diverse invertebrate fauna, which includes both marine (crabs and molluscs) and terrestrial (insects and spiders) elements. During tidal flooding a number of fish species utilise saltmarsh habitats. Grazing by macropods may occur between tidal events. Some coastal saltmarshes provide important high tide roosts for migratory wading birds, and a range of other birds also utilise coastal saltmarsh as habitat. Diversity of macrofauna in mangrove forests adjacent to saltmarsh has been found to be greater than in mangroves that do not border saltmarsh (Yerman & Ross 2004)

5. Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions is frequently found as a zone landward of mangrove stands. Occasional scattered mature *Avicennia marina* trees occur through saltmarsh at some sites, and

Avicennia (and less frequently *Aegiceras corniculatum*) seedlings may occur throughout saltmarsh. In brackish areas dense stands of tall reeds (*Phragmites australis*, *Bulboschoenus* spp., *Schoenoplectus* spp., *Typha* spp.) may occur as part of the community.

6. West *et al.* (1985) estimated the total area of coastal saltmarsh in NSW was approximately 5700 hectares distributed in fragmented patches mostly less than 100 hectares. Since this estimate, further reduction and fragmentation have occurred.

7. Species composition within Coastal Saltmarsh varies with elevation. *Sarcocornia quinqueflora* dominates at lower, and hence more frequently flooded, levels than *Sporobolus virginicus* which dominates the mid saltmarsh, while *Juncus kraussii* and *Baumea juncea* are upper saltmarsh species. There is also geographic variation, with much more extensive stands of *Sporobolus virginicus* being found in northern NSW, and conversely more extensive *Sarcocornia quinqueflora* stands in the south. Coastal Saltmarsh in southern NSW is generally more species rich than further north, with *Austrostipa stipoides*, *Gahnia filum*, *Limonium australe* and *Sclerostegia arbuscula* forming a characteristic southern suite of species. A number of other species with restricted distribution in Coastal Saltmarsh include *Distichlis distichophylla* (endangered), *Halosarcia pergranulata* subsp. *pergranulata, Wilsonia backhousei* (vulnerable) and *Wilsonia rotundifolia* (endangered).

8. Saltmarshes are globally threatened, and many of the threatening processes identified by Adam (2002) operate in NSW including infilling, modified tidal flow, weed invasion, damage by domestic and feral animals, human disturbance, altered fire regimes and climate change.

9. Historically, substantial areas of saltmarsh have been infilled for roads and aerodromes and for residential, recreational, waste disposal, industrial and agricultural purposes. With increased recognition of the ecological value of saltmarshes, the threat of further large-scale reclamation is less, but smaller scale infilling still occurs (Harty and Cheng 2003).

10. Patterns of tidal flow have been restricted by artificial structures in many NSW saltmarshes (Williams and Watford 1997), while discharge of stormwater alters salinity regimes, increases nutrient levels and facilitates the spread of *Phragmites* and weeds.

11. In recent decades there has been widespread invasion of saltmarsh in southeast Australia by mangroves (Mitchell and Adam 1989, Saintilan and Williams 1999, 2000). The factors driving mangrove invasion are still unclear. The mangrove invasion limits the use of saltmarshes by birds that would normally make use of this habitat and has been a factor in their decline (Saintilan 2003, Straw 1999, 2000).

12. A large number of weed species occur in NSW saltmarshes (Adam 1981, Adam *et al.* 1988). In terms of change to the community structure and function, the most serious weed is *Juncus acutus*; other major weeds include *Baccharis halimifolia, Cortaderia selloana* and *Hydrocotyle bonariensis*. The upper saltmarsh zone may be dominated by introduced annuals or shortlived perennials, including *Parapholis incurva, Plantago coronopus* and *Polypogon monspeliensis*.

13. Damage to saltmarshes by recreational vehicles, including four wheel drives, is widespread, and deep wheel ruts persist for many years even after exclusion of vehicles. Use of BMX and mountain bikes is increasing, and even saltmarshes within conservation reserves have been seriously damaged (Adam 2002).

14. Grazing and trampling by domestic stock and feral herbivores occurs at a number of sites. Stock grazing has been shown to substantially change the vegetation composition and structure (Adam 1990), while on muddy substrates trampling can cause loss of plant cover and modify drainage patterns.

15. Saltmarshes have frequently been used for casual rubbish dumping and are at risk from waterborne pollution – including oil and chemical spills, both from shipping and road accidents, and catchment runoff of nutrients and agricultural chemicals.

16. Upper saltmarsh stands dominated by *Juncus kraussii* and *Baumea juncea* have high flammable fuel loads. While the natural incidence of fire in saltmarshes is likely to have been low, a number of saltmarshes have been burnt in recent years. The recovery of these sites is relatively slow and the long-term impacts of burning are uncertain.

17. Global warming and increased relative sea level are likely to pose an increasing threat to the survival of many areas of Coastal Saltmarsh (Adam 2002, Hughes 2003).

18. Coastal Saltmarsh occurs in a number of conservation reserves including the Ramsar listed sites at Towra Point and Kooragang Island Nature Reserves. Reserve status, however, does not confer protection from mangrove and weed invasion, recreational vehicles, pollution, fire or sea level rise without active management.

19. In view of the above the Scientific Committee is of the opinion that the Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions is likely to become extinct in nature in New South Wales unless the circumstances and factors threatening its survival cease to operate.

Dr Lesley Hughes
Deputy Chairperson
Scientific Committee

Proposed Gazettal date: 04/06/04
Exhibition period: 04/06/04 – 16/07/04

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Appendix 2. The Royal Botanic Gardens Vegetation Recording Form used for field assessment in this study.

VEGETATION RECORDING FORM

Royal Botanic Gardens
Mrs Macquaries Road, SYDNEY 2000

Quadrat size _____

Recorder (s) _____ Date _____ Site No._____

LOCATION: _____

Present land use:

Tenure (if known): _____ Zoning (if known) _____

Municipality/Shire:_____

Map Name/Scale: _____ AMG Ref. Zone ___ ___ E ___ ___ ___ ___ ___ ___ N ___ ___ ___ ___ ___ ___ ___
or
GPS Reading: Lat. _____ S Long. _____ E

Slope: ____
Aspect: ____
Elevation ____

Soil: Colour _____
drainage - waterlogged/damp/well drained(moist)/well drained (dry)
texture - sand/loam/clay/peat
depth - deep/shallow/skeletal

Geology: Map code _____
Observation _____
Comment _____

Air Photo No _____
Air Photo Run _____
Air Photo Print _____
Air Photo Type _____

Horizontal Elevation(.)

N	NE	E	SE	S	SW	W	NW

Landform morphological type: _____

Disturbance (1-3): grazing ___ clearing ___ ploughing ___ erosion ___ weeds ___ feral animals ___ logging ___ pollution ___ other _____

Overall condition: excellent ___ good ___ average ___ poor ___

Burning: Last fire if known, _____ fire history _____

STRUCTURE:

Stratum	Growth form	Height (m)	% Cover	Dominant Species

Non-vascular cover: _____ % rock _____ % litter _____ % crypto's _____ % total

Total No. of species: _____ No. Exotic species: _____ (%)

Significant species: _____

Comments: _____

Threats: _____

Fauna: _____ Ground Photos: Film No. ____ Photo No. ____

FLORISTIC COMPOSITION

Date ________ Site No. ______ __________

QUADRAT SIZE: ______________________________

SPECIES	C	N	D	B	E

SPECIES	C	N	D	B	E

SPECIES RECORDED OUTSIDE QUADRAT	C	N	D	B	E

COVER SCALE		
1. < 1%	3. 5 - 25%	5. 50 - 75%
2. 1 - 5%	4. 25 - 50%	6. 75 - 100%

C = cover N = number D = determined
B = databased E = exotic

Appendix 3a. Sites on the northern shoreline where saltmarsh was located in the Parramatta River-Sydney Harbour, 2006.

NORTHERN SHORELINE

Patch No.	Field ID No.	Condition	Area (m^2)	Sub-Catchment	Location	Local Government Area
1	NPR1	Average	8.8	North Harbour	Collins Beach	Manly
2	NPR2	Average	3.3	North Harbour	Delwood Beach, Manly	Manly
3	NPR3	Poor	1.0	North Harbour	Fairlight Beach	Manly
4	NPR3	Poor	1.0	North Harbour	Fairlight Beach	Manly
5	NPR3	Poor	0.6	North Harbour	Fairlight Beach	Manly
6	NPR4	Poor	34.5	North Harbour	below Wellings Reserve	Manly
7	NPR5	Average	2.6	North Harbour	below Wellings Reserve	Manly
8	NPR6	Average	3.9	North Harbour	near Forty Baskets Beach	Manly
9	NPR7	Good	52.3	North Harbour	Reef Beach, Sydney Harbour NP	Manly
10	NPR8	Average	41.4	North Harbour	Reef Beach, Sydney Harbour NP	Manly
11	NPR9	Good	85.2	North Harbour	Reef Beach, Sydney Harbour NP	Manly
12	NPR10	Poor	4.4	Middle Harbour	Castle Rock Beach	Manly
13	NPR11	Average	5.0	Middle Harbour	Sandy Beach, Clontarf Pt	Manly
14	NPR12	Good	119.5	Middle Harbour	head of Fisher Bay, Clontarf	Manly
15	EMH1	Good	3028.8	Middle Harbour, Bantry Bay	Bantry Bay, Garigal NP	Warringah
16	EMH2	Good	7.7	Middle Harbour, Bates Bay	Bates Ck, Garigal NP	Warringah
17	EMH2	Good	32.3	Middle Harbour, Bates Bay	Bates Ck, Garigal NP	Warringah
18	EMH2	Good	844.6	Middle Harbour, Bates Bay	Bates Ck, Garigal NP	Warringah
19	EMH3	Poor	6.0	Middle Harbour	Gooseberry Flat, Garigal NP	Warringah
20	EMH4	Poor	3.2	Middle Harbour	Gooseberry Flat, Garigal NP	Warringah
21	EMH6A	Average	118.1	Middle Harbour	Forestville, Garigal NP	Warringah
22	EMH6B	Poor	17.3	Middle Harbour	Forestville, Garigal NP	Warringah
23	EMH6C	Poor	9.1	Middle Harbour	Forestville, Garigal NP	Warringah
24	EMH7A	Poor	0.8	Middle Harbour	Forestville, Garigal NP	Warringah
25	EMH7B	Poor	1.4	Middle Harbour	Forestville, Garigal NP	Warringah
26	EMH7C	Poor	0.5	Middle Harbour	Forestville, Garigal NP	Warringah
27	EMH15B	Poor	6.7	Middle Harbour	Forestville, Garigal NP	Warringah
28	EMH15C	Poor	107.2	Middle Harbour	Forestville, Garigal NP	Warringah
29	EMH8A	Poor	19.7	Middle Harbour	Forestville, Garigal NP	Warringah
30	EMH8B	Poor	4.2	Middle Harbour	Forestville, Garigal NP	Warringah
31	EMH9	Good	2002.2	Middle Harbour, Carroll Ck	Forestville, Garigal NP	Warringah
32	EMH10	Good	663.2	Middle Harbour, Carroll Ck	Forestville, Garigal NP	Warringah
33	EMH10	Good	266.4	Middle Harbour, Carroll Ck	Forestville, Garigal NP	Warringah
34	EMH11A	Poor	6.4	Middle Harbour, Middle Harbour Ck	Forestville, Garigal NP	Warringah
35	EMH11B	Poor	4.0	Middle Harbour, Middle Harbour Ck	Forestville, Garigal NP	Warringah
36	EMH11C	Poor	5.6	Middle Harbour, Middle Harbour Ck	Forestville, Garigal NP	Warringah
37	EMH11D	Poor	4.4	Middle Harbour, Middle Harbour Ck	Forestville, Garigal NP	Warringah

Appendix 3a. Continued

Patch No.	Field ID No.	Condition	Area (m^2)	Sub-Catchment	Location	Local Government Area
38	EMH12A	Average	6.6	Middle Harbour, Middle Harbour Ck	Forestville, Garigal NP	Warringah
39	EMH12B	Average	7.8	Middle Harbour, Middle Harbour Ck	Forestville, Garigal NP	Warringah
40	EMH12C	Average	8.5	Middle Harbour, Middle Harbour Ck	Forestville, Garigal NP	Warringah
41	EMH13	Average	44.3	Middle Harbour, Middle Harbour Ck	Forestville, Garigal NP	Warringah
42	EMH14	Poor	26.7	Middle Harbour, Middle Harbour Ck	Forestville, Garigal NP	Warringah
43	WMH1	Average	122.9	Middle Harbour, Middle Harbour Ck	East Killara, Garigal NP	Ku-ring-gai
44	WMH2	Poor	58.0	Middle Harbour, Middle Harbour Ck	East Killara, Garigal NP	Ku-ring-gai
45	WMH3	Average	283.0	Middle Harbour, Middle Harbour Ck	Lockley Pt, Garigal NP	Ku-ring-gai
46	WMH4	Average	63.2	Middle Harbour	S of Lockley Pt, Garigal NP	Ku-ring-gai
47	WMH5A	Good	733.2	Middle Harbour	Garigal NP	Ku-ring-gai
48	WMH6A	Good	378.3	Middle Harbour	creek mouth opposite Forestville Bend, Garigal NP	Ku-ring-gai
49	WMH6A	Good	63.0	Middle Harbour	creek mouth opposite Forestville Bend, Garigal NP	Ku-ring-gai
50	WMH6B	Good	8.6	Middle Harbour	creek mouth opposite Forestville Bend, Garigal NP	Ku-ring-gai
51	WMH9	Average	14.4	Middle Harbour	N of Gordon Ck, Garigal NP	Ku-ring-gai
52	WMH7	Excellent	2533.6	Middle Harbour, Gordon Ck	Garigal NP	Ku-ring-gai
53	WMH8A	Good	1523.1	Middle Harbour, Gordon Ck	Garigal NP	Ku-ring-gai
54	WMH8B	Average	6.2	Middle Harbour, Gordon Ck	Garigal NP	Ku-ring-gai
55	WMH8C	Average	4.6	Middle Harbour, Gordon Ck	Garigal NP	Ku-ring-gai
56	WMH10A	Average	10.7	Middle Harbour, Gordon Ck	Garigal NP	Ku-ring-gai
57	WMH10B_C	Good	2432.4	Middle Harbour, Gordon Ck	Garigal NP	Ku-ring-gai
58	WMH11A	Average	10.1	Middle Harbour, Gordon Ck	Garigal NP	Ku-ring-gai
59	WMH12A	Average	224.0	Middle Harbour	S of Gorgon Ck, Garigal NP	Ku-ring-gai
60	WMH16A	Excellent	6300.4	Middle Harbour	Roseville Chase	Ku-ring-gai
61	WMH13A	Good	400.7	Middle Harbour, Moores Ck	N side of creek	Ku-ring-gai
62	WMH13B	Good	13.1	Middle Harbour, Moores Ck		Ku-ring-gai
63	WMH14A_C	Good	2244.9	Middle Harbour, Moores Ck	S side of creek	Ku-ring-gai
64	WMH14D	Average	5.0	Middle Harbour, Moores Ck		Ku-ring-gai
65	WMH14E	Average	5.0	Middle Harbour, Moores Ck		Ku-ring-gai
66	WMH15	Average	60.2	Middle Harbour	Roseville Chase	Ku-ring-gai
67	WMH17	Average	235.0	Middle Harbour	N of Roseville Bridge	Ku-ring-gai
68	WMH17	Average	5.2	Middle Harbour	N of Roseville Bridge	Ku-ring-gai
69	WMH17	Average	25.9	Middle Harbour	N of Roseville Bridge	Ku-ring-gai
70	WMH18A	Average	5.6	Middle Harbour	Echo Pt, Roseville Chase	Ku-ring-gai
71	WMH18A	Average	43.5	Middle Harbour	Echo Pt, Roseville Chase	Ku-ring-gai
72	WMH18B	Average	4.1	Middle Harbour	Echo Pt, Roseville Chase	Ku-ring-gai
73	WMH18B	Average	2.2	Middle Harbour	Echo Pt, Roseville Chase	Ku-ring-gai
74	WMH18C	Average	3.3	Middle Harbour	Echo Pt, Roseville Chase	Ku-ring-gai
75	WMH19A	Poor	206.1	Middle Harbour, Scotts Ck		Willoughby
76	WMH19B	Poor	2.2	Middle Harbour, Scotts Ck		Willoughby
77	WMH19C_D	Poor	3.9	Middle Harbour, Scotts Ck		Willoughby
78	WMH19C_D	Poor	1.0	Middle Harbour, Scotts Ck		Willoughby
79	WMH19C_D	Poor	1.1	Middle Harbour, Scotts Ck		Willoughby

Appendix 3a. Continued

Patch No.	Field ID No.	Condition	Area (m^2)	Sub-Catchment	Location	Local Government Area
80	WMH19C_D	Poor	1.0	Middle Harbour, Scotts Ck		Willoughby
81	WMH19C_D	Poor	1.0	Middle Harbour, Scotts Ck		Willoughby
82	WMH19C_D	Poor	0.8	Middle Harbour, Scotts Ck		Willoughby
83	WMH19E	Average	28.3	Middle Harbour, Scotts Ck		Willoughby
84	WMH19E	Average	9.1	Middle Harbour, Scotts Ck		Willoughby
85	WMH19F	Poor	49.1	Middle Harbour, Scotts Ck		Willoughby
86	WMH19G	Poor	18.4	Middle Harbour, Scotts Ck		Willoughby
87	WMH20	Good	5018.4	Middle Harbour, Scotts Ck		Willoughby
88	WMH21	Average	94.5	Middle Harbour, Scotts Ck		Willoughby
89	WMH22A	Average	40.6	Middle Harbour, Sugarloaf Ck		Willoughby
90	WMH22B	Average	216.2	Middle Harbour, Sugarloaf Ck		Willoughby
91	WMH23A	Poor	3.1	Middle Harbour, Sailors Bay	next to marina	Willoughby
92	WMH23B	Average	313.2	Middle Harbour, Sailors Bay	head of bay	Willoughby
93	NPR13	Average	6.8	Sydney Harbour, Balls Head Bay	western shore	North Sydney
94	NPR14	Poor	37.2	Sydney Harbour, Berry Ck	NW corner	North Sydney / Lane Cove
95	NPR15	Average	39.0	Sydney Harbour, Gore Cove	NE corner	North Sydney / Lane Cove
96	ELC1A	Poor	94.1	Lane Cove River, Tambourine Bay	beach near baths	Lane Cove
97	ELC1B	Poor	21.5	Lane Cove River, Tambourine Bay	beach near baths	Lane Cove
98	ELC2A	Poor	0.8	Lane Cove River, Tambourine Bay	near baths sheds	Lane Cove
99	ELC2B	Poor	2.9	Lane Cove River, Tambourine Bay	near baths sheds	Lane Cove
100	ELC2C	Poor	1.5	Lane Cove River, Tambourine Bay	near baths sheds	Lane Cove
101	ELC2D	Poor	3.9	Lane Cove River, Tambourine Bay	near baths sheds	Lane Cove
102	ELC3A	Average	65.0	Lane Cove River, Tambourine Ck		Lane Cove
103	ELC3B	Average	57.9	Lane Cove River, Tambourine Ck		Lane Cove
104	ELC3C_D	Good	1021.2	Lane Cove River, Tambourine Ck		Lane Cove
105	ELC3E	Average	77.2	Lane Cove River, Tambourine Ck		Lane Cove
106	ELC3E	Average	47.8	Lane Cove River, Tambourine Ck		Lane Cove
107	ELC3E	Average	0.6	Lane Cove River, Tambourine Ck		Lane Cove
108	ELC3E	Average	1.1	Lane Cove River, Tambourine Ck		Lane Cove
109	ELC4	Poor	0.9	Lane Cove River, Burns Bay	E side of bay	Lane Cove
110	ELC4	Poor	4.6	Lane Cove River, Burns Bay	E side of bay	Lane Cove
111	ELC4	Poor	24.5	Lane Cove River, Burns Bay	E side of bay	Lane Cove
112	ELC5A	Poor	10.5	Lane Cove River, Tannery Ck		Lane Cove
113	ELC5B	Poor	3.1	Lane Cove River, Tannery Ck		Lane Cove
114	ELC5C	Poor	18.3	Lane Cove River, Tannery Ck		Lane Cove
115	ELC22A	Average	341.3	Lane Cove River	opposite Buffalo Ck	Lane Cove
116	ELC22B	Average	361.8	Lane Cove River	opposite Buffalo Ck	Lane Cove
117	ELC6A	Average	173.8	Lane Cove River	Blackman Park	Lane Cove
118	ELC6B	Average	2.4	Lane Cove River	Blackman Park	Lane Cove
119	ELC6B	Average	0.7	Lane Cove River	Blackman Park	Lane Cove
120	ELC6B	Average	14.4	Lane Cove River	Blackman Park	Lane Cove
121	ELC6C	Average	19.0	Lane Cove River	Blackman Park	Lane Cove

Appendix 3a. Continued

Patch No.	Field ID No.	Condition	Area (m^2)	Sub-Catchment	Location	Local Government Area
122	ELC7A	Average	84.5	Lane Cove River	N of Blackman Park	Lane Cove
123	ELC7B	Average	2.4	Lane Cove River	N of Blackman Park	Lane Cove
124	ELC7C	Average	6.8	Lane Cove River	N of Blackman Park	Lane Cove
125	ELC8A_B	Good	203.6	Lane Cove River	N of Blackman Park	Lane Cove
126	ELC8C	Good	3.1	Lane Cove River	N of Blackman Park	Lane Cove
127	ELC9	Good	569.4	Lane Cove River	eastern shore	Lane Cove
128	ELC10A	Excellent	137.4	Lane Cove River	eastern shore	Lane Cove
129	ELC10B	Excellent	8531.6	Lane Cove River	eastern shore	Lane Cove
130	ELC10C_D	Excellent	1207.4	Lane Cove River	eastern shore	Lane Cove
131	ELC10E	Excellent	972.4	Lane Cove River	eastern shore	Lane Cove
132	ELC10F_G	Excellent	2900.9	Lane Cove River	eastern shore	Lane Cove
133	ELC11A	Average	75.5	Lane Cove River	eastern shore	Lane Cove
134	ELC11B	Average	14.7	Lane Cove River	eastern shore	Lane Cove
135	ELC11C	Average	66.1	Lane Cove River	eastern shore	Lane Cove
136	ELC11D	Average	9.7	Lane Cove River	eastern shore	Lane Cove
137	ELC12E	Average	9.2	Lane Cove River	S of Stringybark Ck	Lane Cove
138	ELC12A_1	Average	114.7	Lane Cove River	S of Stringybark Ck	Lane Cove
139	ELC12A_2	Average	72.6	Lane Cove River	S of Stringybark Ck	Lane Cove
140	ELC12A_3	Average	149.6	Lane Cove River	S of Stringybark Ck	Lane Cove
141	ELC12D	Average	40.1	Lane Cove River, Stringybark Ck	S side of creek	Lane Cove
142	ELC13A	Poor	3.2	Lane Cove River, Stringybark Ck	N side of creek	Lane Cove
143	ELC13A	Poor	1.1	Lane Cove River, Stringybark Ck	N side of creek	Lane Cove
144	ELC13A	Poor	1.1	Lane Cove River, Stringybark Ck	N side of creek	Lane Cove
145	ELC13A	Poor	2.0	Lane Cove River, Stringybark Ck	N side of creek	Lane Cove
146	ELC13B	Poor	4.9	Lane Cove River	N of Stringybark Ck	Lane Cove
147	ELC14A	Average	1.1	Lane Cove River	near Mowbray Park	Lane Cove
148	ELC14A	Average	6.8	Lane Cove River	near Mowbray Park	Lane Cove
149	ELC14A	Average	45.2	Lane Cove River	near Mowbray Park	Lane Cove
150	ELC14B	Average	68.7	Lane Cove River	near Mowbray Park	Lane Cove
151	ELC14C	Average	18.2	Lane Cove River	near Mowbray Park	Lane Cove
152	ELC14D	Average	19.6	Lane Cove River	near Mowbray Park	Lane Cove
153	ELC15A	Average	217.2	Lane Cove River	near Mowbray Park	Willoughby
154	ELC15B	Average	21.2	Lane Cove River	near Mowbray Park	Willoughby
155	ELC17A	Poor	4.8	Lane Cove River	near Mowbray Park	Willoughby
156	ELC17B	Poor	5.1	Lane Cove River	near Mowbray Park	Willoughby
157	ELC18A	Average	105.2	Lane Cove River		Willoughby
158	ELC18B	Average	7.0	Lane Cove River		Willoughby
159	ELC18C	Average	12.5	Lane Cove River		Willoughby
160	ELC19A	Average	9.5	Lane Cove River		Willoughby
161	ELC20	Poor	0.2	Lane Cove River	S of Little Blue Gum Ck	Willoughby
162	ELC21A	Poor	4.8	Lane Cove River, Little Blue Gum Ck	Lane Cove NP	Ku-ring-gai
163	ELC21B	Poor	4.5	Lane Cove River, Little Blue Gum Ck	Lane Cove NP	Ku-ring-gai

Appendix 3a. Continued

Patch No.	Field ID No.	Condition	Area (m^2)	Sub-Catchment	Location	Local Government Area
164	ELC21C	Poor	8.5	Lane Cove River, Little Blue Gum Ck	Lane Cove NP	Ku-ring-gai
165	ELC21D	Poor	4.9	Lane Cove River, Little Blue Gum Ck	Lane Cove NP	Ku-ring-gai
166	ELC23	Good	663.1	Lane Cove River, Pages Ck	southern end of wetland, near river	Lane Cove
167	ELC24A	Average	893.4	Lane Cove River, Pages Ck	northern end of wetland, near river	Lane Cove
168	ELC24B	Poor	91.1	Lane Cove River, Pages Ck	between mangrove and Phragmites stands	Lane Cove
169	ELC24C	Poor	14.9	Lane Cove River, Pages Ck	northern end of wetland, near river	Lane Cove
170	ELC25	Average	104.5	Lane Cove River	"Fairyland" property within Lane Cove NP	Lane Cove
171	ELC26	Poor	19.4	Lane Cove River	"Fairyland" property within Lane Cove NP	Lane Cove
172	WLC1A	Poor	11.8	Lane Cove River	near Fullers Bridge	Ryde
173	WLC1B	Poor	7.4	Lane Cove River	near Fullers Bridge	Ryde
174	WLC2A	Average	2.6	Lane Cove River	N of Kittys Ck	Ryde
175	WLC2B	Average	1.9	Lane Cove River	N of Kittys Ck	Ryde
176	WLC3	Good	8427.2	Lane Cove River, Kittys Ck	Lane Cove NP	Ryde
177	WLC6A	Poor	9.8	Lane Cove River	Sugarloaf Pt, Lane Cove NP	Ryde
178	WLC6A	Poor	10.8	Lane Cove River	Sugarloaf Pt, Lane Cove NP	Ryde
179	WLC6A	Poor	9.7	Lane Cove River	Sugarloaf Pt, Lane Cove NP	Ryde
180	WLC6B	Average	380.4	Lane Cove River	Sugarloaf Pt, Lane Cove NP	Ryde
181	WLC5A	Average	11.0	Lane Cove River, Buffalo Ck	N side of creek, Lane Cove NP	Ryde
182	WLC5B	Average	38.1	Lane Cove River, Buffalo Ck	N side of creek, Lane Cove NP	Ryde
183	WLC5C	Average	9.0	Lane Cove River, Buffalo Ck	N side of creek, Lane Cove NP	Ryde
184	WLC5D	Good	849.1	Lane Cove River, Buffalo Ck	N side of creek, Lane Cove NP	Ryde
185	WLC5F	Average	10.6	Lane Cove River, Buffalo Ck	N side of creek, Lane Cove NP	Ryde
186	WLC7A	Average	282.2	Lane Cove River, Strangers Ck	Field of Mars Wildlife Refuge	Ryde
187	WLC7B	Average	52.0	Lane Cove River, Strangers Ck	Field of Mars Wildlife Refuge	Ryde
188	WLC7C	Average	104.1	Lane Cove River, Strangers Ck	Field of Mars Wildlife Refuge	Ryde
189	WLC7D	Excellent	291.5	Lane Cove River, Strangers Ck	Field of Mars Wildlife Refuge	Ryde
190	WLC7E	Average	439.2	Lane Cove River, Strangers Ck	Field of Mars Wildlife Refuge	Ryde
191	WLC7F_1	Average	39.8	Lane Cove River, Strangers Ck	Field of Mars Wildlife Refuge	Ryde
192	WLC7F_2	Average	39.3	Lane Cove River, Strangers Ck	Field of Mars Wildlife Refuge	Ryde
193	WLC4A	Good	2217.5	Lane Cove River, Buffalo Ck	S side of creek	Hunters Hill
194	WLC4B	Average	58.3	Lane Cove River, Buffalo Ck	S side of creek	Hunters Hill
194	WLC4C	Poor	24.4	Lane Cove River, Buffalo Ck	S side of creek	Hunters Hill
196	WLC4C	Poor	89.9	Lane Cove River, Buffalo Ck	S side of creek	Hunters Hill
197	WLC4D	Poor	17.8	Lane Cove River, Buffalo Ck	S side of creek	Hunters Hill
198	WLC4E	Poor	21.0	Lane Cove River, Buffalo Ck	S side of creek	Hunters Hill
199	WLC4G	Average	51.6	Lane Cove River, Buffalo Ck	S side of creek	Hunters Hill
200	WLC4I	Poor	9.5	Lane Cove River, Buffalo Ck	S side of creek	Hunters Hill
201	WLC9	Average	14.7	Lane Cove River	S of Buffalo Ck	Hunters Hill
202	WLC9	Average	5.0	Lane Cove River	S of Buffalo Ck	Hunters Hill
203	WLC8A	Average	2.6	Lane Cove River, Brickmakers Ck	near Boronia Park	Hunters Hill
204	WLC8B	Average	8.9	Lane Cove River, Brickmakers Ck	near Boronia Park	Hunters Hill
205	WLC8C	Average	30.9	Lane Cove River, Brickmakers Ck	near Boronia Park	Hunters Hill

Appendix 3a. Continued

Patch No.	Field ID No.	Condition	Area (m^2)	Sub-Catchment	Location	Local Government Area
206	WLC8D	Average	82.5	Lane Cove River, Brickmakers Ck	near Boronia Park	Hunters Hill
207	WLC8E	Poor	9.5	Lane Cove River, Brickmakers Ck	near Boronia Park	Hunters Hill
208	WLC8F	Poor	3.8	Lane Cove River, Brickmakers Ck	near Boronia Park	Hunters Hill
209	WLC8G	Poor	16.8	Lane Cove River, Brickmakers Ck	near Boronia Park	Hunters Hill
210	WLC12	Average	3.8	Lane Cove River	Ferdinand St Reserve	Hunters Hill
211	WLC10	Poor	0.8	Lane Cove River	Ferdinand St Reserve	Hunters Hill
212	WLC11	Average	138.8	Lane Cove River	Ferdinand St Reserve	Hunters Hill
213	WLC13	Poor	182.2	Lane Cove River	St Josephs school grounds, Hunters Hill	Hunters Hill
214	WLC14	Poor	0.2	Lane Cove River	Hunters Hill	Hunters Hill
215	WLC15	Poor	0.5	Lane Cove River	Hunters Hill	Hunters Hill
216	WLC16	Poor	0.5	Lane Cove River	Hunters Hill	Hunters Hill
217	WLC17	Poor	1.1	Lane Cove River	Hunters Hill	Hunters Hill
218	WLC18	Poor	0.3	Lane Cove River	Hunters Hill	Hunters Hill
219	NPR61A	Poor	1.9	Parramatta River, Tarban Bay		Hunters Hill
220	NPR62	Average	9.0	Parramatta River, Tarban Ck		Hunters Hill
221	NPR63	Average	16.7	Parramatta River, Tarban Ck		Hunters Hill
222	NPR64	Good	286.5	Parramatta River, Tarban Ck		Hunters Hill
223	NPR65	Poor	0.8	Parramatta River, Tarban Ck		Hunters Hill
224	NPR66	Poor	9.1	Parramatta River, Tarban Ck		Hunters Hill
225	NPR16A	Poor	1.6	Parramatta River, Tarban Bay		Hunters Hill
226	NPR16B	Poor	3.7	Parramatta River, Tarban Bay		Hunters Hill
227	NPR17A	Average	8.0	Parramatta River, Wallumatta Bay	Gladesville Reserve	Hunters Hill
228	NPR17B	Average	71.9	Parramatta River, Wallumatta Bay	Gladesville Reserve	Hunters Hill
229	NPR17C	Average	0.2	Parramatta River, Wallumatta Bay	Gladesville Reserve	Hunters Hill
230	NPR17D	Average	0.9	Parramatta River, Wallumatta Bay	Gladesville Reserve	Hunters Hill
231	NPR18A	Average	25.1	Parramatta River, Wallumatta Bay	Gladesville Reserve	Hunters Hill
232	NPR18B	Poor	1.1	Parramatta River, Wallumatta Bay	Gladesville Reserve	Hunters Hill
233	NPR19A	Average	44.5	Parramatta River, Wallumatta Bay	Gladesville Reserve	Hunters Hill
234	NPR20A	Average	63.2	Parramatta River, Looking Glass Bay	head of bay	Ryde
235	NPR20B	Average	16.7	Parramatta River, Looking Glass Bay	head of bay	Ryde
236	NPR20C	Average	7.3	Parramatta River, Looking Glass Bay	head of bay	Ryde
237	NPR20D	Average	18.2	Parramatta River, Looking Glass Bay	head of bay	Ryde
238	NPR21A	Poor	17.9	Parramatta River, Looking Glass Bay	eastern shore	Ryde
239	NPR21B	Poor	3.5	Parramatta River, Looking Glass Bay	eastern shore	Ryde
240	NPR21C	Poor	0.7	Parramatta River, Looking Glass Bay	eastern shore	Ryde
241	NPR21D	Poor	1.1	Parramatta River, Looking Glass Bay	eastern shore	Ryde
242	NPR22A	Average	26.5	Parramatta River, Glades Bay	eastern shore	Ryde
243	NPR22B	Average	27.1	Parramatta River, Glades Bay	eastern shore	Ryde
244	NPR22C	Average	103.4	Parramatta River, Glades Bay	eastern shore	Ryde
245	NPR22D	Average	4.3	Parramatta River, Glades Bay	eastern shore	Ryde
246	NPR23A	Poor	27.4	Parramatta River, Glades Bay	NE corner of bay	Ryde
247	NPR23B	Poor	9.3	Parramatta River, Glades Bay	NE corner of bay	Ryde

Appendix 3a. Continued

Patch No.	Field ID No.	Condition	Area (m^2)	Sub-Catchment	Location	Local Government Area
248	NPR24	Poor	4.7	Parramatta River, Glades Bay		Ryde
249	NPR25A	Average	10.4	Parramatta River, Morrisons Bay	NE corner of bay	Ryde
250	NPR25B	Average	8.9	Parramatta River, Morrisons Bay	NE corner of bay	Ryde
251	NPR25C	Average	0.6	Parramatta River, Morrisons Bay	NE corner of bay	Ryde
252	NPR25D	Average	8.8	Parramatta River, Morrisons Bay	NE corner of bay	Ryde
253	NPR25E	Average	2.0	Parramatta River, Morrisons Bay	NE corner of bay	Ryde
254	NPR26B	Poor	1.7	Parramatta River, Kissing Point Bay		Ryde
255	NPR26C	Poor	1.0	Parramatta River, Kissing Point Bay		Ryde
256	NPR27A	Average	14.0	Parramatta River, Kissing Point Bay		Ryde
257	NPR27B	Poor	9.1	Parramatta River, Kissing Point Bay		Ryde
258	NPR27C	Average	7.4	Parramatta River, Kissing Point Bay		Ryde
259	NPR28A_1	Poor	3.7	Parramatta River	Putney	Ryde
260	NPR28A_2	Poor	9.7	Parramatta River	Putney	Ryde
261	NPR28B	Poor	3.5	Parramatta River	Putney	Ryde
262	NPR29A	Poor	105.1	Parramatta River	Putney	Ryde
263	NPR29B	Poor	10.1	Parramatta River	Putney	Ryde
264	NPR30A	Average	30.9	Parramatta River	E of Ryde Bridge	Ryde
265	NPR30A	Average	2.2	Parramatta River	E of Ryde Bridge	Ryde
266	NPR31A	Poor	4.9	Parramatta River	Meadowbank	Ryde
267	NPR31B	Poor	9.0	Parramatta River	Meadowbank	Ryde
268	NPR31C	Poor	4.7	Parramatta River	Meadowbank	Ryde
269	NPR31D	Poor	4.8	Parramatta River	Meadowbank	Ryde
270	NPR31E	Poor	10.2	Parramatta River	Meadowbank	Ryde
271	NPR32A	Poor	45.2	Parramatta River	Meadowbank	Ryde
272	NPR32B	Poor	14.7	Parramatta River	Meadowbank	Ryde
273	NPR33	Poor	29.4	Parramatta River	Meadowbank	Ryde
274	NPR34A	Average	158.9	Parramatta River	Melrose Park, behind Crowley Cr	Ryde
275	NPR34B	Average	136.3	Parramatta River	Melrose Park, behind Crowley Cr	Ryde
276	NPR34C	Poor	119.1	Parramatta River	Melrose Park, behind Crowley Cr	Ryde
277	NPR34D	Poor	54.8	Parramatta River	Melrose Park, behind Crowley Cr	Ryde
278	NPR34E	Poor	8.6	Parramatta River	Melrose Park, behind Crowley Cr	Ryde
279	NPR34F	Poor	15.8	Parramatta River	Melrose Park, behind Crowley Cr	Ryde
280	NPR35A	Poor	18.1	Parramatta River	Melrose Park, behind Lancaster Ave	Ryde
281	NPR35B	Average	187.2	Parramatta River	Melrose Park, behind Lancaster Ave	Ryde
282	NPR35C	Poor	86.7	Parramatta River	Melrose Park, behind Lancaster Ave	Ryde
283	NPR35D	Poor	16.0	Parramatta River	Melrose Park, behind Lancaster Ave	Ryde
284	NPR35E_1	Poor	4.6	Parramatta River	Melrose Park, behind Lancaster Ave	Ryde
285	NPR35E_2	Poor	4.6	Parramatta River	Melrose Park, behind Lancaster Ave	Ryde
286	NPR35F_1	Poor	2.8	Parramatta River	Melrose Park, behind Lancaster Ave	Ryde
287	NPR35F_2	Poor	3.1	Parramatta River	Melrose Park, behind Lancaster Ave	Ryde
288	NPR36A_B	Average	1407.6	Parramatta River	Melrose Park	Ryde
289	NPR36C	Average	82.7	Parramatta River	Melrose Park	Ryde

Appendix 3a. Continued

Patch No.	Field ID No.	Condition	Area (m^2)	Sub-Catchment	Location	Local Government Area
290	NPR36D	Average	6.6	Parramatta River	Melrose Park	Ryde
291	NPR37A	Average	0.6	Parramatta River		Ryde
292	NPR37A	Average	9.2	Parramatta River		Ryde
293	NPR37B_C	Average	322.6	Parramatta River		Ryde
294	NPR37D	Poor	37.4	Parramatta River		Ryde
295	NPR37E	Poor	35.1	Parramatta River		Ryde
296	NPR38A	Poor	246.0	Parramatta River		Parramatta
297	NPR39A	Poor	79.5	Parramatta River		Parramatta
298	NPR39B	Average	449.1	Parramatta River		Parramatta
299	NPR39C	Average	113.7	Parramatta River		Parramatta
300	NPR39E	Poor	1.2	Parramatta River		Parramatta
301	NPR39F	Poor	7.2	Parramatta River		Parramatta
302	NPR39G	Poor	4.8	Parramatta River		Parramatta
303	NPR40A	Average	123.4	Parramatta River	Ermington, east of George Kendall Reserve	Parramatta
304	NPR40B	Average	1492.6	Parramatta River	Ermington, east of George Kendall Reserve	Parramatta
305	NPR40C	Poor	342.0	Parramatta River	Ermington, east of George Kendall Reserve	Parramatta
306	NPR41A	Poor	22.4	Parramatta River	Ermington, George Kendall Reserve	Parramatta
307	NPR41B	Poor	7.0	Parramatta River	Ermington, George Kendall Reserve	Parramatta
308	NPR42A	Poor	145.8	Parramatta River	Ermington, George Kendall Reserve	Parramatta
309	NPR42B	Poor	1.0	Parramatta River	Ermington, George Kendall Reserve	Parramatta
310	NPR43A	Poor	407.8	Parramatta River	Ermington, George Kendall Reserve	Parramatta
311	NPR44A	Average	226.3	Parramatta River	Ermington, George Kendall Reserve navigation marker	Parramatta
312	NPR44B	Poor	4.7	Parramatta River	Ermington, George Kendall Reserve navigation marker	Parramatta
313	NPR44C	Poor	6.4	Parramatta River	Ermington, George Kendall Reserve navigation marker	Parramatta
314	NPR44D	Poor	0.9	Parramatta River	Ermington, George Kendall Reserve navigation marker	Parramatta
315	NPR45A_1	Poor	1.8	Parramatta River	Ermington, George Kendall Reserve	Parramatta
316	NPR45A_2	Poor	1.8	Parramatta River	Ermington, George Kendall Reserve	Parramatta
317	NPR47A	Poor	187.7	Parramatta River	Rydalmere, end of Jean St	Parramatta
318	NPR48	Poor	38.8	Parramatta River	Rydalmere, end of Park Rd	Parramatta
319	NPR50A	Average	8.2	Parramatta River	Rydalmere, behind Pyke St factories	Parramatta
320	NPR50B	Average	107.2	Parramatta River	Rydalmere, behind Pyke St factories	Parramatta
321	NPR50C	Average	3.3	Parramatta River	Rydalmere, behind Pyke St factories	Parramatta
322	NPR50D	Average	5.0	Parramatta River	Rydalmere, behind Pyke St factories	Parramatta
323	NPR50F	Average	3.3	Parramatta River	Rydalmere, behind Pyke St factories	Parramatta
324	NPR50G	Average	1.9	Parramatta River	Rydalmere, behind Pyke St factories	Parramatta
325	NPR49A	Average	123.7	Parramatta River	Rydalmere, behind Pyke St factories	Parramatta
326	NPR51A	Average	7.9	Parramatta River, Subiaco Ck	west side of creek	Parramatta
327	NPR51B	Average	1.0	Parramatta River, Subiaco Ck	east side of creek	Parramatta
328	NPR52A	Average	10.6	Parramatta River	W of Subiaco Ck	Parramatta
329	NPR52B	Average	3.7	Parramatta River	W of Subiaco Ck	Parramatta
330	NPR52C	Average	3.7	Parramatta River	W of Subiaco Ck	Parramatta
331	NPR52D	Average	8.5	Parramatta River	W of Subiaco Ck	Parramatta

Appendix 3a. Continued

Patch No.	Field ID No.	Condition	Area (m^2)	Sub-Catchment	Location	Local Government Area
332	NPR53A	Poor	20.5	Parramatta River, Vineyard Ck		Parramatta
333	NPR53B	Poor	42.5	Parramatta River, Vineyard Ck		Parramatta
334	NPR53C	Poor	1.8	Parramatta River, Vineyard Ck		Parramatta
335	NPR53D	Poor	1.0	Parramatta River, Vineyard Ck		Parramatta
336	NPR54A	Average	17.1	Parramatta River, Vineyard Ck	eastern side of mouth	Parramatta
337	NPR54B	Average	11.0	Parramatta River, Vineyard Ck	eastern side of mouth	Parramatta
338	NPR55A	Average	184.0	Parramatta River, Vineyard Ck	western side of mouth	Parramatta
339	NPR55B	Poor	9.6	Parramatta River, Vineyard Ck	western side of mouth	Parramatta
340	NPR55C	Poor	10.9	Parramatta River, Vineyard Ck	western side of mouth	Parramatta
341	NPR55D	Poor	9.4	Parramatta River, Vineyard Ck	western side of mouth	Parramatta
342	NPR56A	Poor	20.2	Parramatta River	UWS campus	Parramatta
343	NPR56B	Poor	77.6	Parramatta River	UWS campus	Parramatta
344	NPR57	Poor	51.2	Parramatta River	UWS campus	Parramatta
345	NPR58A	Average	14.0	Parramatta River	Parramatta, near Pemberton St	Parramatta
346	NPR58B	Good	1045.8	Parramatta River	Parramatta, near Pemberton St	Parramatta
347	NPR58D	Good	338.4	Parramatta River	Parramatta, near Pemberton St	Parramatta
348	NPR58E	Average	8.4	Parramatta River	Parramatta, near Pemberton St	Parramatta
349	NPR58F	Average	195.3	Parramatta River	Parramatta, near Pemberton St	Parramatta
350	NPR59A	Poor	96.9	Parramatta River	Parramatta, near Pemberton St	Parramatta
351	NPR59B	Poor	31.2	Parramatta River	Parramatta, near Pemberton St	Parramatta
352	NPR59C	Average	66.4	Parramatta River	Parramatta, near Pemberton St	Parramatta
353	NPR60A	Average	319.0	Parramatta River	Parramatta, end of Morton St	Parramatta
354	NPR60B	Poor	145.3	Parramatta River	Parramatta, end of Morton St	Parramatta
355	NPR60C	Poor	97.0	Parramatta River	Parramatta, end of Morton St	Parramatta
356	NPR60D	Poor	54.5	Parramatta River	Parramatta, end of Morton St	Parramatta
357	NPR60E	Average	875.2	Parramatta River	Parramatta, end of Morton St	Parramatta
358	NPR60E	Average	9.9	Parramatta River	Parramatta, end of Morton St	Parramatta
Subtotal			7,7295.8			

Appendix 3b. Sites on the southern shoreline where saltmarsh was located in the Parramatta River-Sydney Harbour, 2006.

SOUTHERN SHORELINE

Patch No.	Field ID No.	Condition	Area (m^2)	Sub-Catchment	Location	Local Government Area
1	SPR1	Poor	0.8	Parramatta River	Parramatta – wall of Charles St Ferry jetty	Parramatta
2	SPR2	Poor	97.4	Parramatta River	Parramatta – between Charles St and Queens Wharf Reserve	Parramatta
3	SPR50	Poor	9.3	Parramatta River	Camellia – 30m West of 2 bridges	Parramatta
4	SPR51	Poor	5.6	Parramatta River	Camellia – between 2 bridges	Parramatta
5	SPR52	Poor	7.3	Parramatta River	Camellia – east of 2 bridges	Parramatta
6	SPR49	Poor	12.2	Parramatta River	Camellia – behind Collex site	Parramatta
7	WDR3	Average	37.4	Duck River	western shore, bordering Shell refinery	Parramatta
8	WDR4	Average	35.1	Duck River	western shore, bordering Shell refinery	Parramatta
9	WDR5	Average	281.7	Duck River	western shore, bordering Shell refinery	Parramatta
10	WDR6	Poor	10.1	Duck River	western shore, bordering Shell refinery	Parramatta
11	WDR7	Poor	52.2	Duck River	western shore, bordering Shell refinery	Parramatta
12	WDR8	Good	841.3	Duck River	western shore, bordering Shell refinery	Parramatta
13	WDR9	Good	2263.4	Duck River	western shore, bordering Shell refinery	Parramatta
14	WDR10	Good	2498.0	Duck River	western shore, bordering Shell refinery	Parramatta
15	WDR11	Average	287.4	Duck River	western shore, bordering Shell refinery	Parramatta
16	WDR12	Poor	18.8	Duck River	western shore, bordering Shell refinery	Parramatta
17	WDR13	Poor	50.3	Duck River	western shore, bordering Shell refinery	Parramatta
18	WDR14	Poor	13.7	Duck River	western shore, bordering Shell refinery	Parramatta
19	WDR15	Average	395.0	Duck River	western shore, bordering Shell refinery	Parramatta
20	WDR16	Poor	43.4	Duck River	western shore, bordering Shell refinery	Parramatta
21	WDR17	Average	337.0	Duck River	western shore, bordering Shell refinery	Parramatta
22	WDR18	Average	230.5	Duck River	western shore, bordering Shell refinery	Parramatta
23	WDR19	Poor	10.9	Duck River	western shore, bordering Shell refinery	Parramatta
24	WDR20	Poor	70.7	Duck River	western shore, bordering Shell refinery	Parramatta
25	WDR21	Poor	19.9	Duck River	western shore, bordering Shell refinery	Parramatta
26	WDR22	Average	378.6	Duck River	western shore, bordering Shell refinery	Parramatta
27	WDR23	Poor	153.8	Duck River	western shore, bordering Shell refinery	Parramatta
28	WDR24	Poor	9.0	Duck River	western shore, bordering Shell refinery	Parramatta
29	WDR25	Poor	99.3	Duck River	western shore, bordering Shell refinery	Parramatta
30	WDR26	Poor	33.7	Duck River	western shore, bordering Shell refinery	Parramatta
31	WDR27	Poor	108.2	Duck River	western shore, adjoining Typha wetland	Parramatta
32	WDR1	Poor	21.8	Duck River, Duck Ck	Granville – bordering factory estate development	Parramatta
33	WDR1	Poor	22.7	Duck River, Duck Ck	Granville – bordering factory estate development	Parramatta
34	WDR1	Poor	8.4	Duck River, Duck Ck	Granville – bordering factory estate development	Parramatta
35	WDR1	Poor	18.9	Duck River, Duck Ck	Granville – bordering factory estate development	Parramatta
36	WDR1	Poor	29.7	Duck River, Duck Ck	Granville – bordering factory estate development	Parramatta
37	WDR1	Poor	87.4	Duck River, Duck Ck	Granville – bordering factory estate development	Parramatta
38	EDR18	Average	169.5	Duck River	eastern shore, near M4 bridge	Auburn
39	EDR19	Poor	35.0	Duck River	eastern shore	Auburn
40	EDR1	Average	20.4	Duck River	Silverwater – end of Derby St	Auburn

Appendix 3b. Continued

Patch No.	Field ID No.	Condition	Area (m^2)	Sub-Catchment	Location	Local Government Area
41					Silverwater Wetland – stormwater creek behind	
	EDR2	Poor	55.3	Duck River	Millenium Court factories	Auburn
42	EDR3	Good	329.0	Duck River	Silverwater Wetland – behind Millenium Court factories	Auburn
43	EDR4	Good	11476.0	Duck River	Silverwater Wetland – behind Millenium Court factories	Auburn
44	EDR6	Good	188.4	Duck River	Silverwater Wetland – behind Millenium Court factories	Auburn
45	EDR7	Good	128.9	Duck River	Silverwater Wetland – behind Millenium Court factories	Auburn
46	EDR8	Average	2119.2	Duck River	Silverwater Wetland – behind Millenium Court factories	Auburn
47	EDR9	Average	789.4	Duck River	Silverwater Wetland – behind Millenium Court factories	Auburn
48	EDR10	Poor	13.3	Duck River	Silverwater Wetland – behind Millenium Court factories	Auburn
49	EDR11	Poor	7.6	Duck River	Silverwater Wetland – behind Millenium Court factories	Auburn
50	EDR12	Poor	11.2	Duck River	Silverwater Wetland – behind Millenium Court factories	Auburn
51	EDR13	Poor	9.8	Duck River	Silverwater Wetland – behind Millenium Court factories	Auburn
52	EDR14	Poor	16.2	Duck River	Silverwater Wetland – behind Millenium Court factories	Auburn
53	EDR15	Poor	21.3	Duck River	Silverwater Wetland – behind Millenium Court factories	Auburn
54	SPR58	Poor	0.8	Parramatta River	Wilson Park / Newington seawall	Sydney Olympic Park
55	SPR59	Poor	6.0	Parramatta River	Wilson Park / Newington seawall	Sydney Olympic Park
56	SPR60	Poor	1.5	Parramatta River	Wilson Park / Newington seawall	Sydney Olympic Park
57	SPR61	Poor	0.6	Parramatta River	Wilson Park / Newington seawall	Sydney Olympic Park
58	SPR62	Poor	91.8	Parramatta River	Wilson Park / Newington seawall	Sydney Olympic Park
59	SPR63	Poor	3.7	Parramatta River	Wilson Park / Newington seawall	Sydney Olympic Park
60	SPR64	Poor	13.8	Parramatta River	Wilson Park / Newington seawall	Sydney Olympic Park
61	SPR65	Poor	4.3	Parramatta River	Wilson Park / Newington seawall	Sydney Olympic Park
62	SPR66	Poor	8.8	Parramatta River	Wilson Park / Newington seawall	Sydney Olympic Park
63	SPR67	Poor	5.0	Parramatta River	Wilson Park / Newington seawall	Sydney Olympic Park
64	SPR68	Poor	2.2	Parramatta River	Wilson Park / Newington seawall	Sydney Olympic Park
65	SPR69	Poor	7.3	Parramatta River	Wilson Park / Newington seawall	Sydney Olympic Park
66	SPR70	Poor	1.5	Parramatta River	Wilson Park / Newington seawall	Sydney Olympic Park
67	SPR71	Poor	8.2	Parramatta River	Wilson Park / Newington seawall	Sydney Olympic Park
68	SPR72	Poor	9.7	Parramatta River	Wilson Park / Newington seawall	Sydney Olympic Park
69	SPR73	Poor	13.3	Parramatta River	Wilson Park / Newington seawall	Sydney Olympic Park
70	SPR74	Poor	30.9	Parramatta River	Wilson Park / Newington seawall	Sydney Olympic Park
71	SPR75	Poor	6.7	Parramatta River	Wilson Park / Newington seawall	Sydney Olympic Park
72	SPR76	Poor	2.2	Parramatta River	Wilson Park / Newington seawall	Sydney Olympic Park
73	SPR77	Poor	2.1	Parramatta River	Wilson Park / Newington seawall	Sydney Olympic Park
74	SPR78	Poor	10.7	Parramatta River	Wilson Park / Newington seawall	Sydney Olympic Park
75	SPR79	Poor	3.9	Parramatta River	Wilson Park / Newington seawall	Sydney Olympic Park
76	SPR80	Poor	2.2	Parramatta River	Wilson Park / Newington seawall	Sydney Olympic Park
77	SPR81	Poor	4.4	Parramatta River	Wilson Park / Newington seawall	Sydney Olympic Park
78	SPR82	Poor	2.0	Parramatta River	Wilson Park / Newington seawall	Sydney Olympic Park
79	SPR83	Poor	2.6	Parramatta River	Wilson Park / Newington seawall	Sydney Olympic Park
80	SPR84	Poor	1.6	Parramatta River	Wilson Park / Newington seawall	Sydney Olympic Park
81	SPR85	Poor	9.3	Parramatta River	Wilson Park / Newington seawall	Sydney Olympic Park
82	SPR86	Poor	1.0	Parramatta River	Wilson Park / Newington seawall	Sydney Olympic Park
83	SPR87	Poor	0.5	Parramatta River	Wilson Park / Newington seawall	Sydney Olympic Park
84	SPR88	Poor	17.7	Parramatta River	Wilson Park / Newington seawall	Sydney Olympic Park
85	SPR89	Poor	101.7	Parramatta River	Wilson Park / Newington seawall	Sydney Olympic Park

Appendix 3b. Continued

Patch No.	Field ID No.	Condition	Area (m^2)	Sub-Catchment	Location	Local Government Area
86	SPR90	Poor	8.3	Parramatta River	Wilson Park / Newington seawall	Sydney Olympic Park
87	SPR91	Poor	2.1	Parramatta River	Wilson Park / Newington seawall	Sydney Olympic Park
88	SPR92	Poor	3.7	Parramatta River	Wilson Park / Newington seawall	Sydney Olympic Park
89	SPR93	Good	59776.1	Parramatta River	Wanngal Wetland, Newington Nature Reserve	Sydney Olympic Park
90	SPR94	Good	4057.1	Parramatta River	Wanngal Wetland, Newington Nature Reserve	Sydney Olympic Park
91	SPR95	Poor	69.4	Parramatta River	foreshore near Wanngal Wetland	Sydney Olympic Park
92	SPR96	Average	469.1	Parramatta River	Wanngal Wetland, Newington Nature Reserve	Sydney Olympic Park
93	SPR99	Average	7821.8	Parramatta River	Wanngal Wetland, Newington Nature Reserve	Sydney Olympic Park
94	SPR100	Good	10722.0	Parramatta River	Wanngal Wetland, Newington Nature Reserve	Sydney Olympic Park
95	SPR101	Average	421.9	Parramatta River	Wanngal Wetland, Newington Nature Reserve	Sydney Olympic Park
96	SPR102	Poor	244.6	Parramatta River	Wanngal Wetland, Newington Nature Reserve	Sydney Olympic Park
97	SPR103	Poor	470.3	Parramatta River	Wanngal Wetland, Newington Nature Reserve	Sydney Olympic Park
98	SPR104	Good	1780.0	Parramatta River	Wanngal Wetland, Newington Nature Reserve	Sydney Olympic Park
99	SPR106	Excellent	16658.9	Parramatta River	Wanngal Wetland, Newington Nature Reserve	Sydney Olympic Park
100	SPR107	Average	887.2	Parramatta River	Wanngal Wetland, Newington Nature Reserve	Sydney Olympic Park
101	SPR108	Average	1914.3	Parramatta River	Wanngal Wetland, Newington Nature Reserve	Sydney Olympic Park
102	SPR109	Good	1255.6	Parramatta River	Wanngal Wetland, Newington Nature Reserve	Sydney Olympic Park
103	SPR110	Poor	593.5	Parramatta River	east of Wanngal Wetland	Sydney Olympic Park
104	SPR111	Average	430.1	Parramatta River	Wanngal Wetland, Newington Nature Reserve	Sydney Olympic Park
105	SPR112	Good	1215.3	Parramatta River	Wanngal Wetland, Newington Nature Reserve	Sydney Olympic Park
106	SPR113	Average	6992.6	Parramatta River	Wanngal Wetland, Newington Nature Reserve	Sydney Olympic Park
107	SPR114	Average	4228.4	Parramatta River	Wanngal Wetland, Newington Nature Reserve	Sydney Olympic Park
108	SPR115	Good	1822.0	Parramatta River	Wanngal Wetland, Newington Nature Reserve	Sydney Olympic Park
109	SPR116	Average	516.8	Parramatta River	Wanngal Wetland, Newington Nature Reserve	Sydney Olympic Park
110	SPR309	Poor	6.2	Parramatta River	Wentworth Point	Auburn
111	SPR310A	Poor	3.0	Parramatta River	Wentworth Point	Auburn
112	SPR310B	Poor	2.4	Parramatta River	Wentworth Point	Auburn
113	SPR310C	Poor	3.0	Parramatta River	Wentworth Point	Auburn
114	SPR312	Poor	2820.5	Parramatta River	Wentworth Point	Auburn
115	SPR313	Poor	275.8	Parramatta River	Wentworth Point	Auburn
116	SPR314	Poor	36.9	Parramatta River	Wentworth Point	Auburn
117	SPR315	Poor	11.7	Parramatta River	Wentworth Point	Auburn
118	SPR117	Poor	45.8	Parramatta River, Homebush Bay, Haslams Ck	near mouth of creek	Sydney Olympic Park
119	SPR118	Poor	3.6	Parramatta River, Homebush Bay, Haslams Ck	near mouth of creek	Sydney Olympic Park
120	SPR119	Poor	1.8	Parramatta River, Homebush Bay, Haslams Ck	near mouth of creek	Sydney Olympic Park
121	SPR120	Poor	23.5	Parramatta River, Homebush Bay, Haslams Ck	near mouth of creek	Sydney Olympic Park
122	SPR121	Poor	45.1	Parramatta River, Homebush Bay, Haslams Ck	Archery Park precinct	Sydney Olympic Park
123	SPR122	Poor	42.6	Parramatta River, Homebush Bay, Haslams Ck	Archery Park precinct	Sydney Olympic Park
124	SPR123	Poor	8.0	Parramatta River, Homebush Bay, Haslams Ck	Archery Park precinct	Sydney Olympic Park
125	SPR124	Poor	2.5	Parramatta River, Homebush Bay, Haslams Ck	Archery Park precinct	Sydney Olympic Park
126	SPR125	Average	70.2	Parramatta River, Homebush Bay, Haslams Ck	southern shore wetland	Sydney Olympic Park
127	SPR126	Good	984.7	Parramatta River, Homebush Bay, Haslams Ck	southern shore wetland	Sydney Olympic Park
128	SPR127	Poor	68.2	Parramatta River, Homebush Bay, Haslams Ck	southern shore wetland	Sydney Olympic Park
129	SPR128	Poor	1519.8	Parramatta River, Homebush Bay, Haslams Ck	southern shore wetland	Sydney Olympic Park
130	SPR129	Poor	8.8	Parramatta River, Homebush Bay, Haslams Ck	2SM wetland	Sydney Olympic Park
131	SPR130	Poor	37.8	Parramatta River, Homebush Bay, Haslams Ck	2SM wetland	Sydney Olympic Park

Appendix 3b. Continued

Patch No.	Field ID No.	Condition	Area (m^2)	Sub-Catchment	Location	Local Government Area
132	SPR131	Average	289.1	Parramatta River, Homebush Bay, Haslams Ck	2SM wetland	Sydney Olympic Park
133	SPR132	Average	570.1	Parramatta River, Homebush Bay, Haslams Ck	2SM wetland	Sydney Olympic Park
134	SPR133	Poor	2.3	Parramatta River, Homebush Bay, Haslams Ck	2SM wetland	Sydney Olympic Park
135	SPR134	Average	65.2	Parramatta River, Homebush Bay, Haslams Ck	2SM wetland	Sydney Olympic Park
136	SPR135	Average	8.8	Parramatta River, Homebush Bay, Haslams Ck	2SM wetland	Sydney Olympic Park
137	SPR136	Poor	31.4	Parramatta River, Homebush Bay, Haslams Ck	2SM wetland	Sydney Olympic Park
138	SPR137	Poor	35.5	Parramatta River, Homebush Bay, Haslams Ck	2SM wetland	Sydney Olympic Park
139	SPR138	Poor	4.6	Parramatta River, Homebush Bay, Haslams Ck	2SM wetland	Sydney Olympic Park
140	SPR139	Average	188.9	Parramatta River, Homebush Bay, Haslams Ck	2SM wetland	Sydney Olympic Park
141	SPR140	Poor	684.4	Parramatta River, Homebush Bay, Haslams Ck	2SM wetland	Sydney Olympic Park
142	SPR141	Poor	184.3	Parramatta River, Homebush Bay, Haslams Ck	2SM wetland	Sydney Olympic Park
143	SPR142	Average	130.1	Parramatta River, Homebush Bay, Haslams Ck	2SM wetland	Sydney Olympic Park
144	SPR143	Poor	41.6	Parramatta River, Homebush Bay, Haslams Ck	2SM wetland	Sydney Olympic Park
145	SPR144	Poor	83.6	Parramatta River, Homebush Bay, Haslams Ck	2SM wetland	Sydney Olympic Park
146	SPR145	Poor	7.6	Parramatta River, Homebush Bay, Haslams Ck	northern shore	Sydney Olympic Park
147	SPR146	Good	424.1	Parramatta River, Homebush Bay, Haslams Ck	southern shore wetland	Sydney Olympic Park
148	SPR147	Good	210.7	Parramatta River, Homebush Bay, Haslams Ck	southern shore wetland	Sydney Olympic Park
149	SPR148	Average	42.7	Parramatta River, Homebush Bay, Haslams Ck	southern shore wetland	Sydney Olympic Park
150	SPR149	Poor	119.2	Parramatta River, Homebush Bay, Haslams Ck	southern shore wetland	Sydney Olympic Park
151	SPR150	Average	527.1	Parramatta River, Homebush Bay, Haslams Ck	southern shore wetland	Sydney Olympic Park
152	SPR151	Average	211.9	Parramatta River, Homebush Bay, Haslams Ck	southern shore wetland	Sydney Olympic Park
153	SPR152	Average	604.5	Parramatta River, Homebush Bay, Haslams Ck	southern shore wetland	Sydney Olympic Park
154	SPR153	Average	146.9	Parramatta River, Homebush Bay, Haslams Ck	southern shore wetland	Sydney Olympic Park
155	SPR154	Poor	31.6	Parramatta River, Homebush Bay, Haslams Ck	northern shore	Sydney Olympic Park
156	SPR155	Poor	14.5	Parramatta River, Homebush Bay, Haslams Ck	northern shore	Sydney Olympic Park
157	SPR156	Poor	4.1	Parramatta River, Homebush Bay, Haslams Ck	northern shore	Sydney Olympic Park
158	SPR157	Poor	5.1	Parramatta River, Homebush Bay, Haslams Ck	northern shore	Sydney Olympic Park
159	SPR158	Poor	11.4	Parramatta River, Homebush Bay, Haslams Ck	northern shore	Sydney Olympic Park
160	SPR159	Poor	87.7	Parramatta River, Homebush Bay, Haslams Ck	northern shore	Sydney Olympic Park
161	SPR160	Poor	3.4	Parramatta River, Homebush Bay, Haslams Ck	southern shore	Sydney Olympic Park
162	SPR161	Average	585.0	Parramatta River, Homebush Bay, Haslams Ck	northern shore	Sydney Olympic Park
163	SPR162	Average	259.2	Parramatta River, Homebush Bay, Haslams Ck	northern shore	Sydney Olympic Park
164	SPR163	Average	44.1	Parramatta River, Homebush Bay, Haslams Ck	northern shore	Sydney Olympic Park
165	SPR164	Average	14.8	Parramatta River, Homebush Bay, Haslams Ck	northern shore	Sydney Olympic Park
166	SPR165A	Poor	94.7	Parramatta River, Homebush Bay, Haslams Ck	northern shore	Sydney Olympic Park
167	SPR165B	Poor	57.7	Parramatta River, Homebush Bay, Haslams Ck	northern shore	Sydney Olympic Park
168	SPR166	Good	9235.2	Parramatta River, Homebush Bay, Haslams Ck	northern shore	Sydney Olympic Park
169	SPR167	Poor	99.3	Parramatta River, Homebush Bay, Haslams Ck	southern shore	Sydney Olympic Park
170	SPR168	Poor	17.4	Parramatta River, Homebush Bay, Haslams Ck	southern shore	Sydney Olympic Park
171	SPR169	Poor	63.0	Parramatta River, Homebush Bay, Haslams Ck	southern end of freshwater wetlands	Sydney Olympic Park
172	SPR170	Average	1316.9	Parramatta River, Homebush Bay, Haslams Ck	Haslam Creek Flats	Sydney Olympic Park
173	SPR171	Average	446.5	Parramatta River, Homebush Bay, Haslams Ck	Haslam Creek Flats	Sydney Olympic Park
174	SPR172	Poor	616.8	Parramatta River, Homebush Bay, Haslams Ck	Haslam Creek Flats	Sydney Olympic Park
175	SPR173	Average	1792.9	Parramatta River, Homebush Bay, Haslams Ck	Haslam Creek Flats	Sydney Olympic Park
176	SPR174	Average	416.4	Parramatta River, Homebush Bay, Haslams Ck	Haslam Creek Flats	Sydney Olympic Park
177	SPR175	Average	5707.8	Parramatta River, Homebush Bay, Haslams Ck	Haslam Creek Flats	Sydney Olympic Park

Appendix 3b. Continued

Patch No.	Field ID No.	Condition	Area (m^2)	Sub-Catchment	Location	Local Government Area
178	SPR176	Average	594.7	Parramatta River, Homebush Bay, Haslams Ck	Haslam Creek Flats	Sydney Olympic Park
179	SPR177	Average	1466.2	Parramatta River, Homebush Bay, Haslams Ck	Haslam Creek Flats	Sydney Olympic Park
180	SPR178	Average	1019.2	Parramatta River, Homebush Bay, Haslams Ck	Haslam Creek Flats	Sydney Olympic Park
181	SPR179	Poor	1.3	Parramatta River, Homebush Bay, Haslams Ck	Haslam Creek Flats	Sydney Olympic Park
182	SPR180	Poor	1.6	Parramatta River, Homebush Bay, Haslams Ck	Haslam Creek Flats	Sydney Olympic Park
183	SPR181	Poor	2.1	Parramatta River, Homebush Bay, Haslams Ck	Haslam Creek Flats	Sydney Olympic Park
184	SPR182	Average	1072.1	Parramatta River, Homebush Bay, Haslams Ck	Haslam Creek Flats	Sydney Olympic Park
185	SPR183	Poor	14.9	Parramatta River, Homebush Bay	north of Waterbird Refuge, Badu Mangroves	Sydney Olympic Park
186	SPR184	Poor	24.4	Parramatta River, Homebush Bay	north of Waterbird Refuge, Badu Mangroves	Sydney Olympic Park
187	SPR185	Poor	3392.7	Parramatta River, Homebush Bay	Waterbird Refuge, Badu Mangroves	Sydney Olympic Park
188	SPR186	Good	2016.7	Parramatta River, Homebush Bay	Waterbird Refuge, Badu Mangroves	Sydney Olympic Park
189	SPR187	Poor	111.1	Parramatta River, Homebush Bay	east of Waterbird Refuge, Badu Mangroves	Sydney Olympic Park
190	SPR188	Good	1945.9	Parramatta River, Homebush Bay	Waterbird Refuge, Badu Mangroves	Sydney Olympic Park
191	SPR189	Poor	59.8	Parramatta River, Homebush Bay	Waterbird Refuge, Badu Mangroves	Sydney Olympic Park
192	SPR191	Poor	152.9	Parramatta River, Homebush Bay	Waterbird Refuge, Badu Mangroves	Sydney Olympic Park
193	SPR192	Average	315.9	Parramatta River, Homebush Bay	Waterbird Refuge, Badu Mangroves	Sydney Olympic Park
194	SPR193	Poor	28.9	Parramatta River, Homebush Bay	Waterbird Refuge, Badu Mangroves	Sydney Olympic Park
194	SPR194	Poor	15.7	Parramatta River, Homebush Bay	east of Waterbird Refuge, Badu Mangroves	Sydney Olympic Park
196	SPR194	Poor	8.0	Parramatta River, Homebush Bay	east of Waterbird Refuge, Badu Mangroves	Sydney Olympic Park
197	SPR194	Poor	4.1	Parramatta River, Homebush Bay	east of Waterbird Refuge, Badu Mangroves	Sydney Olympic Park
198	SPR194	Poor	27.8	Parramatta River, Homebush Bay	east of Waterbird Refuge, Badu Mangroves	Sydney Olympic Park
199	SPR195	Poor	69.8	Parramatta River, Homebush Bay	Waterbird Refuge, Badu Mangroves	Sydney Olympic Park
200	SPR196	Poor	62.2	Parramatta River, Homebush Bay	Waterbird Refuge, Badu Mangroves	Sydney Olympic Park
201	SPR197	Poor	20.6	Parramatta River, Homebush Bay	Waterbird Refuge, Badu Mangroves	Sydney Olympic Park
202	SPR198	Poor	14.1	Parramatta River, Homebush Bay	Waterbird Refuge, Badu Mangroves	Sydney Olympic Park
203	SPR198	Poor	0.9	Parramatta River, Homebush Bay	Waterbird Refuge, Badu Mangroves	Sydney Olympic Park
204	SPR198	Poor	1.3	Parramatta River, Homebush Bay	Waterbird Refuge, Badu Mangroves	Sydney Olympic Park
205	SPR198	Poor	70.8	Parramatta River, Homebush Bay	Waterbird Refuge, Badu Mangroves	Sydney Olympic Park
206	SPR199	Poor	8.8	Parramatta River, Homebush Bay	Waterbird Refuge, Badu Mangroves	Sydney Olympic Park
207	SPR200	Poor	27.3	Parramatta River, Homebush Bay	Waterbird Refuge, Badu Mangroves	Sydney Olympic Park
208	SPR201	Poor	3.6	Parramatta River, Homebush Bay	Waterbird Refuge, Badu Mangroves	Sydney Olympic Park
209	SPR202	Poor	23.6	Parramatta River, Homebush Bay	Waterbird Refuge, Badu Mangroves	Sydney Olympic Park
210	SPR203	Poor	17.1	Parramatta River, Homebush Bay	Waterbird Refuge, Badu Mangroves	Sydney Olympic Park
211	SPR204A	Poor	3.2	Parramatta River, Homebush Bay	Waterbird Refuge, Badu Mangroves	Sydney Olympic Park
212	SPR204B	Poor	1.6	Parramatta River, Homebush Bay	Waterbird Refuge, Badu Mangroves	Sydney Olympic Park
213	SPR204C	Poor	3.4	Parramatta River, Homebush Bay	Waterbird Refuge, Badu Mangroves	Sydney Olympic Park
214	SPR205	Average	66.9	Parramatta River, Homebush Bay	east of Waterbird Refuge, Badu Mangroves	Sydney Olympic Park
215	SPR206	Average	100.0	Parramatta River, Homebush Bay	Waterbird Refuge, Badu Mangroves	Sydney Olympic Park
216	SPR207	Poor	509.0	Parramatta River, Homebush Bay	eastern shore of bay	Sydney Olympic Park
217	SPR208	Average	46.9	Parramatta River, Homebush Bay	Badu Mangroves wetland	Sydney Olympic Park
218	SPR209	Average	45342.2	Parramatta River, Homebush Bay	Badu Mangroves wetland	Sydney Olympic Park
219	SPR210	Poor	9.1	Parramatta River, Homebush Bay	eastern shore	Sydney Olympic Park
220	SPR210	Poor	2.8	Parramatta River, Homebush Bay	eastern shore	Sydney Olympic Park
221	SPR211	Poor	44.9	Parramatta River, Homebush Bay	eastern shore	Sydney Olympic Park
222	SPR212	Poor	1.7	Parramatta River, Homebush Bay	Badu Mangroves wetland	Sydney Olympic Park
223	SPR213	Poor	1.3	Parramatta River, Homebush Bay	Badu Mangroves wetland	Sydney Olympic Park

Appendix 3b. Continued

Patch No.	Field ID No.	Condition	Area (m^2)	Sub-Catchment	Location	Local Government Area
224	SPR214	Poor	1.0	Parramatta River, Homebush Bay	Badu Mangroves wetland	Sydney Olympic Park
225	SPR215	Poor	2.4	Parramatta River, Homebush Bay	Badu Mangroves wetland	Sydney Olympic Park
226	SPR216	Average	8.1	Parramatta River, Homebush Bay	Badu Mangroves wetland	Sydney Olympic Park
227	SPR217	Poor	34.5	Parramatta River, Homebush Bay	Badu Mangroves wetland	Sydney Olympic Park
228	SPR218	Average	450.9	Parramatta River, Homebush Bay	Badu Mangroves wetland	Sydney Olympic Park
229	SPR219	Average	1292.2	Parramatta River, Homebush Bay	Badu Mangroves wetland	Sydney Olympic Park
230	SPR220	Average	377.3	Parramatta River, Homebush Bay	Badu Mangroves wetland	Sydney Olympic Park
231	SPR221	Poor	4.4	Parramatta River, Homebush Bay	Badu Mangroves wetland	Sydney Olympic Park
232	SPR222	Poor	4.6	Parramatta River, Homebush Bay	Badu Mangroves wetland	Sydney Olympic Park
233	SPR222	Poor	3.7	Parramatta River, Homebush Bay	Badu Mangroves wetland	Sydney Olympic Park
234	SPR223	Poor	2.1	Parramatta River, Homebush Bay	Badu Mangroves wetland	Sydney Olympic Park
235	SPR224	Average	4.5	Parramatta River, Homebush Bay	Badu Mangroves wetland	Sydney Olympic Park
236	SPR225	Good	5549.2	Parramatta River, Homebush Bay, Powells Ck	eastern shore	Sydney Olympic Park
237	SPR226	Poor	4.0	Parramatta River, Homebush Bay, Powells Ck	eastern shore	Sydney Olympic Park
238	SPR227	Average	6.8	Parramatta River, Homebush Bay, Powells Ck	eastern shore	Sydney Olympic Park
239	SPR227	Average	215.6	Parramatta River, Homebush Bay, Powells Ck	eastern shore	Sydney Olympic Park
240	SPR228	Average	7.0	Parramatta River, Homebush Bay, Powells Ck	eastern shore	Sydney Olympic Park
241	SPR229	Average	40.7	Parramatta River, Homebush Bay, Powells Ck	eastern shore	Sydney Olympic Park
242	SPR230	Average	15.4	Parramatta River, Homebush Bay, Powells Ck	eastern shore	Sydney Olympic Park
243	SPR231	Average	1.0	Parramatta River, Homebush Bay, Powells Ck	eastern shore	Sydney Olympic Park
244	SPR232A	Average	480.4	Parramatta River, Homebush Bay, Powells Ck	eastern shore	Sydney Olympic Park
245	SPR232B	Average	6.7	Parramatta River, Homebush Bay, Powells Ck	eastern shore	Sydney Olympic Park
246	SPR233	Average	17.1	Parramatta River, Homebush Bay, Powells Ck	eastern shore	Sydney Olympic Park
247	SPR234	Poor	107.7	Parramatta River, Homebush Bay, Powells Ck	eastern shore	Sydney Olympic Park
248	SPR235	Poor	37.9	Parramatta River, Homebush Bay, Powells Ck	eastern shore	Sydney Olympic Park
249	SPR236A	Average	344.6	Parramatta River, Homebush Bay, Powells Ck	eastern shore	Sydney Olympic Park
250	SPR236B	Average	3.0	Parramatta River, Homebush Bay, Powells Ck	eastern shore	Sydney Olympic Park
251	SPR236C	Average	3.3	Parramatta River, Homebush Bay, Powells Ck	eastern shore	Sydney Olympic Park
252	SPR237	Poor	79.3	Parramatta River, Homebush Bay, Powells Ck	eastern shore	Sydney Olympic Park
253	SPR238	Poor	100.0	Parramatta River, Homebush Bay, Powells Ck	eastern shore	Sydney Olympic Park
254	SPR239	Poor	23.5	Parramatta River, Homebush Bay, Powells Ck	eastern shore	Sydney Olympic Park
255	SPR240	Poor	24.1	Parramatta River, Homebush Bay, Powells Ck	eastern shore	Sydney Olympic Park
256	SPR241	Poor	21.8	Parramatta River, Homebush Bay, Powells Ck	eastern shore	Sydney Olympic Park
257	SPR242	Average	311.1	Parramatta River, Homebush Bay, Powells Ck	eastern shore	Sydney Olympic Park
258	SPR243	Poor	650.0	Parramatta River, Homebush Bay, Powells Ck	eastern shore	Sydney Olympic Park
259	SPR244	Poor	12.8	Parramatta River, Homebush Bay, Powells Ck	eastern shore	Sydney Olympic Park
260	SPR245	Average	78.1	Parramatta River, Homebush Bay, Powells Ck	eastern shore	Sydney Olympic Park
261	SPR246	Average	351.6	Parramatta River, Homebush Bay, Powells Ck	eastern shore	Sydney Olympic Park
262	SPR247A	Average	3.0	Parramatta River, Homebush Bay	Badu Mangroves wetland	Sydney Olympic Park
263	SPR247B	Average	79.1	Parramatta River, Homebush Bay	Badu Mangroves wetland	Sydney Olympic Park
264	SPR248	Average	299.9	Parramatta River, Homebush Bay	Badu Mangroves wetland	Sydney Olympic Park
265	SPR249	Poor	2.0	Parramatta River, Homebush Bay	Badu Mangroves wetland	Sydney Olympic Park
266	SPR250	Poor	1.0	Parramatta River, Homebush Bay	Badu Mangroves wetland	Sydney Olympic Park
267	SPR251	Poor	0.8	Parramatta River, Homebush Bay	Badu Mangroves wetland	Sydney Olympic Park
268	SPR252	Poor	1.4	Parramatta River, Homebush Bay	Badu Mangroves wetland	Sydney Olympic Park
269	SPR253	Poor	3.2	Parramatta River, Homebush Bay	Badu Mangroves wetland	Sydney Olympic Park

Appendix 3b. Continued

Patch No.	Field ID No.	Condition	Area (m^2)	Sub-Catchment	Location	Local Government Area
270	SPR254	Poor	8.9	Parramatta River, Homebush Bay	Badu Mangroves wetland	Sydney Olympic Park
271	SPR255	Poor	3.5	Parramatta River, Homebush Bay	Badu Mangroves wetland	Sydney Olympic Park
272	SPR256	Average	436.9	Parramatta River, Homebush Bay	Badu Mangroves wetland	Sydney Olympic Park
273	SPR257	Average	40.1	Parramatta River, Homebush Bay	Badu Mangroves wetland	Sydney Olympic Park
274	SPR258	Average	59.2	Parramatta River, Homebush Bay	Badu Mangroves wetland	Sydney Olympic Park
275	SPR259	Average	753.9	Parramatta River, Homebush Bay	Badu Mangroves wetland	Sydney Olympic Park
276	SPR260	Average	40.0	Parramatta River, Homebush Bay	Badu Mangroves wetland	Sydney Olympic Park
277	SPR261	Average	722.8	Parramatta River, Homebush Bay	Badu Mangroves wetland	Sydney Olympic Park
278	SPR261	Average	40.1	Parramatta River, Homebush Bay	Badu Mangroves wetland	Sydney Olympic Park
279	SPR262	Poor	132.6	Parramatta River, Homebush Bay	Badu Mangroves wetland	Sydney Olympic Park
280	SPR263	Average	426.1	Parramatta River, Homebush Bay	Badu Mangroves wetland	Sydney Olympic Park
281	SPR264	Poor	98.6	Parramatta River, Homebush Bay	Badu Mangroves wetland	Sydney Olympic Park
282	SPR265	Poor	237.0	Parramatta River, Homebush Bay	Badu Mangroves wetland	Sydney Olympic Park
283	SPR266	Average	2206.1	Parramatta River, Homebush Bay	Badu Mangroves wetland	Sydney Olympic Park
284	SPR267	Average	768.7	Parramatta River, Homebush Bay	Badu Mangroves wetland	Sydney Olympic Park
285	SPR268	Average	16.6	Parramatta River, Homebush Bay	Badu Mangroves wetland	Sydney Olympic Park
286	SPR269	Poor	27.0	Parramatta River, Homebush Bay, Powells Ck	western shore	Sydney Olympic Park
287	SPR270	Poor	10.8	Parramatta River, Homebush Bay, Powells Ck	western shore	Sydney Olympic Park
288	SPR271	Average	251.7	Parramatta River, Homebush Bay, Powells Ck	western shore	Sydney Olympic Park
289	SPR272	Poor	8.2	Parramatta River, Homebush Bay, Powells Ck	western shore	Sydney Olympic Park
290	SPR273	Good	3950.9	Parramatta River, Homebush Bay, Powells Ck	western shore	Sydney Olympic Park
291	SPR274	Poor	40.0	Parramatta River, Homebush Bay, Powells Ck	western shore	Sydney Olympic Park
292	SPR275	Poor	100.2	Parramatta River, Homebush Bay, Powells Ck	western shore	Sydney Olympic Park
293	SPR276	Poor	3.4	Parramatta River, Homebush Bay, Powells Ck	western shore	Sydney Olympic Park
294	SPR277	Poor	7.9	Parramatta River, Homebush Bay, Powells Ck	western shore	Sydney Olympic Park
295	SPR278	Poor	73.0	Parramatta River, Homebush Bay, Powells Ck	western shore	Sydney Olympic Park
296	SPR279	Average	1467.6	Parramatta River, Homebush Bay, Powells Ck	western shore	Sydney Olympic Park
297	SPR280	Average	134.9	Parramatta River, Homebush Bay, Powells Ck	western shore	Sydney Olympic Park
298	SPR281	Poor	2.4	Parramatta River, Homebush Bay, Powells Ck	western shore	Sydney Olympic Park
299	SPR282	Average	2.2	Parramatta River, Homebush Bay, Powells Ck	western shore	Sydney Olympic Park
300	SPR282	Average	57.0	Parramatta River, Homebush Bay, Powells Ck	western shore	Sydney Olympic Park
301	SPR283	Average	20.9	Parramatta River, Homebush Bay, Powells Ck	western shore	Sydney Olympic Park
302	SPR284	Average	276.4	Parramatta River, Homebush Bay, Powells Ck	western shore	Sydney Olympic Park
303	SPR285	Poor	96.2	Parramatta River, Homebush Bay, Powells Ck	western shore	Sydney Olympic Park
304	SPR286	Good	280.4	Parramatta River, Homebush Bay, Powells Ck	western shore	Sydney Olympic Park
305	SPR287	Poor	4.4	Parramatta River, Homebush Bay, Powells Ck	western shore	Sydney Olympic Park
306	SPR288	Average	782.7	Parramatta River, Homebush Bay, Powells Ck	western shore	Sydney Olympic Park
307	SPR289	Poor	35.0	Parramatta River, Homebush Bay, Powells Ck	western shore	Sydney Olympic Park
308	SPR290	Good	1570.2	Parramatta River, Homebush Bay, Powells Ck	Mason Park wetland	Strathfield
309	SPR291	Average	398.3	Parramatta River, Homebush Bay, Powells Ck	Mason Park wetland	Strathfield
310	SPR292	Poor	21.4	Parramatta River, Homebush Bay, Powells Ck	Mason Park wetland	Strathfield
311	SPR293	Poor	11.2	Parramatta River, Homebush Bay, Powells Ck	Mason Park wetland	Strathfield
312	SPR294A	Poor	4.1	Parramatta River, Homebush Bay, Powells Ck	Mason Park wetland	Strathfield
313	SPR294B	Poor	27.5	Parramatta River, Homebush Bay, Powells Ck	Mason Park wetland	Strathfield
314	SPR294C	Poor	5.8	Parramatta River, Homebush Bay, Powells Ck	Mason Park wetland	Strathfield
315	SPR294D	Poor	5.5	Parramatta River, Homebush Bay, Powells Ck	Mason Park wetland	Strathfield

Appendix 3b. Continued

Patch No.	Field ID No.	Condition	Area (m^2)	Sub-Catchment	Location	Local Government Area
316	SPR294E	Poor	2.5	Parramatta River, Homebush Bay, Powells Ck	Mason Park wetland	Strathfield
317	SPR294F	Poor	4.9	Parramatta River, Homebush Bay, Powells Ck	Mason Park wetland	Strathfield
318	SPR294G	Poor	13.0	Parramatta River, Homebush Bay, Powells Ck	Mason Park wetland	Strathfield
319	SPR294H	Poor	68.6	Parramatta River, Homebush Bay, Powells Ck	Mason Park wetland	Strathfield
320	SPR294I	Poor	169.6	Parramatta River, Homebush Bay, Powells Ck	Mason Park wetland	Strathfield
321	SPR295	Average	118.9	Parramatta River, Homebush Bay, Powells Ck	Mason Park wetland	Strathfield
322	SPR296	Average	127.9	Parramatta River, Homebush Bay, Powells Ck	Mason Park wetland	Strathfield
323	SPR297A	Poor	5.3	Parramatta River, Homebush Bay, Powells Ck	Mason Park wetland	Strathfield
324	SPR297B	Poor	1145.0	Parramatta River, Homebush Bay, Powells Ck	Mason Park wetland	Strathfield
325	SPR298	Poor	46.4	Parramatta River, Homebush Bay, Powells Ck	Mason Park wetland	Strathfield
326	SPR299	Average	1140.3	Parramatta River, Homebush Bay, Powells Ck	Mason Park wetland	Strathfield
327	SPR300	Average	1932.7	Parramatta River, Homebush Bay, Powells Ck	Mason Park wetland	Strathfield
328	SPR301	Poor	532.8	Parramatta River, Homebush Bay, Powells Ck	Mason Park wetland	Strathfield
329	SPR302	Poor	145.0	Parramatta River, Homebush Bay, Powells Ck	Mason Park wetland	Strathfield
330	SPR303A	Poor	6.5	Parramatta River, Homebush Bay, Powells Ck	Mason Park wetland	Strathfield
331	SPR303B	Poor	3.5	Parramatta River, Homebush Bay, Powells Ck	Mason Park wetland	Strathfield
332	SPR303C	Poor	11.1	Parramatta River, Homebush Bay, Powells Ck	Mason Park wetland	Strathfield
333	SPR303D	Poor	5.2	Parramatta River, Homebush Bay, Powells Ck	Mason Park wetland	Strathfield
334	SPR303E	Poor	7.1	Parramatta River, Homebush Bay, Powells Ck	Mason Park wetland	Strathfield
335	SPR303F	Poor	6.6	Parramatta River, Homebush Bay, Powells Ck	Mason Park wetland	Strathfield
336	SPR303G	Poor	5.1	Parramatta River, Homebush Bay, Powells Ck	Mason Park wetland	Strathfield
337	SPR303H	Poor	23.1	Parramatta River, Homebush Bay, Powells Ck	Mason Park wetland	Strathfield
338	SPR304	Poor	2009.4	Parramatta River, Homebush Bay, Powells Ck	Mason Park wetland	Strathfield
339	SPR305	Average	19.3	Parramatta River, Homebush Bay, Powells Ck	Mason Park wetland	Strathfield
340	SPR305	Average	23.8	Parramatta River, Homebush Bay, Powells Ck	Mason Park wetland	Strathfield
341	SPR305	Average	14.8	Parramatta River, Homebush Bay, Powells Ck	Mason Park wetland	Strathfield
342	SPR305	Average	3.5	Parramatta River, Homebush Bay, Powells Ck	Mason Park wetland	Strathfield
343	SPR305	Average	7.7	Parramatta River, Homebush Bay, Powells Ck	Mason Park wetland	Strathfield
344	SPR306	Poor	158.3	Parramatta River, Homebush Bay, Powells Ck	Mason Park wetland	Strathfield
345	SPR307	Poor	32.1	Parramatta River, Homebush Bay, Powells Ck	Mason Park wetland	Strathfield
346	SPR307	Poor	14.4	Parramatta River, Homebush Bay, Powells Ck	Mason Park wetland	Strathfield
347	SPR307	Poor	111.9	Parramatta River, Homebush Bay, Powells Ck	Mason Park wetland	Strathfield
348	SPR308	Average	713.0	Parramatta River, Homebush Bay, Powells Ck	Mason Park wetland	Strathfield
349	SPR4	Poor	3.4	Parramatta River	Rhodes Pt boat ramp	Auburn
350	SPR5	Average	194.0	Parramatta River, Brays Bay	western shore	City of Canada Bay
351	SPR6	Good	223.9	Parramatta River, Brays Bay	western shore	City of Canada Bay
352	SPR7	Good	5957.3	Parramatta River, Brays Bay	southern shore	City of Canada Bay
353	SPR8	Average	179.8	Parramatta River, Brays Bay	southern shore	City of Canada Bay
354	SPR9	Poor	143.2	Parramatta River, Brays Bay		City of Canada Bay
355	SPR10	Average	199.0	Parramatta River, Brays Bay	near Rocky Pt	City of Canada Bay
356	SPR11	Poor	165.6	Parramatta River	East of Rocky Pt	City of Canada Bay
357	SPR12	Poor	108.2	Parramatta River, Yaralla Bay	northern head	City of Canada Bay
358	SPR13	Poor	224.5	Parramatta River, Yaralla Bay	adjacent to Concord hospital	City of Canada Bay
359	SPR14	Poor	155.4	Parramatta River, Yaralla Bay	western end	City of Canada Bay
360	SPR15	Average	10061.0	Parramatta River, Yaralla Bay	southern shore	City of Canada Bay
361	SPR16	Poor	185.1	Parramatta River, Yaralla Bay	southern shore	City of Canada Bay

Appendix 3b. Continued

Patch No.	Field ID No.	Condition	Area (m^2)	Sub-Catchment	Location	Local Government Area
362	SPR17	Poor	95.2	Parramatta River, Majors Bay	northern head	City of Canada Bay
363	SPR18	Average	258.1	Parramatta River, Majors Bay	behind Deakin St	City of Canada Bay
364	SPR19	Average	33.9	Parramatta River, Majors Bay	end of Kingston St	City of Canada Bay
365	SPR20	Poor	78.3	Parramatta River, Kendall Bay	south-east shore	City of Canada Bay
366	SPR21	Average	71.1	Parramatta River, Kendall Bay	western shore – Cabarita Park	City of Canada Bay
367	SPR22	Average	3.2	Parramatta River, Kendall Bay	Cabatita Park rock platform	City of Canada Bay
368	SPR23	Average	57.6	Parramatta River	Cabarita Park – northern shore	City of Canada Bay
369	SPR24	Good	626.8	Parramatta River, Hen and Chicken Bay	Harmony Point	City of Canada Bay
370	SPR25	Poor	4.6	Parramatta River, Hen and Chicken Bay	Point at end of Burwood Rd	City of Canada Bay
371	SPR26	Poor	22.3	Parramatta River, Iron Cove	NE corner of Sisters Bay	City of Canada Bay
372	SPR27	Poor	110.6	Parramatta River, Iron Cove	SW corner of Sisters Bay	City of Canada Bay
373	SPR28	Poor	583.4	Parramatta River, Iron Cove	Half Moon Bay	City of Canada Bay
374	SPR29	Poor	40.2	Parramatta River, Iron Cove	western shore – 70m south of Half Moon Bay	City of Canada Bay
375	SPR30	Average	30.1	Parramatta River, Iron Cove	western shore –150m south of Half Moon Bay	City of Canada Bay
376	SPR31	Average	69.7	Parramatta River, Iron Cove	western shore – 200m south of Half Moon Bay	City of Canada Bay
377	SPR32	Average	6.6	Parramatta River, Iron Cove	western shore	City of Canada Bay
378	SPR33	Poor	3.4	Parramatta River, Iron Cove	western shore	City of Canada Bay
379	SPR34	Average	546.9	Parramatta River, Iron Cove	western shore	City of Canada Bay
380	SPR35	Average	353.4	Parramatta River, Iron Cove	northern side of Rodd Point	City of Canada Bay
381	SPR36	Poor	7.6	Parramatta River, Iron Cove	northern side of Rodd Point	City of Canada Bay
382	SPR37	Poor	4.8	Parramatta River, Iron Cove	southern side of Rodd Point	City of Canada Bay
383	SPR38	Poor	5.0	Parramatta River, Iron Cove	southern side of Rodd Point	City of Canada Bay
384	SPR39	Poor	29.2	Parramatta River, Iron Cove	southern side of Rodd Point	City of Canada Bay
385	SPR40	Average	87.6	Parramatta River, Iron Cove	western shore	City of Canada Bay
386	SPR41	Average	7.8	Parramatta River, Iron Cove	western shore – opposite Brisbane Ave	City of Canada Bay
387	SPR42	Average	433.2	Parramatta River, Iron Cove	western shore – between Princess & Dutchess Avenues	City of Canada Bay
388	SPR53	Poor	146.3	Sydney Harbour, Blackwattle Bay	Bicentennial Park stormwater drain, Glebe	City of Sydney
389	SPR54	Poor	136.7	Sydney Harbour, Blackwattle Bay	Bicentennial Park stormwater drain, Glebe	City of Sydney
390	SPR55	Poor	6.8	Sydney Harbour, Blackwattle Bay	Bicentennial Park stormwater drain, Glebe	City of Sydney
391	SPR56	Poor	0.5	Sydney Harbour, Blackwattle Bay	Bicentennial Park stormwater drain, Glebe	City of Sydney
392	SPR57	Average	1022.9	Sydney Harbour, Blackwattle Bay	Federal Park, Leichhardt	City of Sydney
393	SPR57	Average	614.9	Sydney Harbour, Blackwattle Bay	Federal Park, Leichhardt	City of Sydney
394	SPR43	Poor	19.4	Sydney Harbour, Rose Bay	Rose Bay Park	Woollahra
395	SPR44	Poor	9.0	Sydney Harbour, Hermit Bay	Hermit Bay	Woollahra
396	SPR45	Poor	19.2	Sydney Harbour	Milk Beach – Strickland House	Woollahra
397	SPR46	Poor	19.0	Sydney Harbour	Cove north of Milk Beach	Woollahra
398	SPR47	Poor	3.8	Sydney Harbour, Vaucluse Bay	Vaucluse House Beach	Woollahra
399	SPR48	Poor	8.7	Sydney Harbour, Parsley Bay	northern side	Woollahra
Subtotal			295,765.9			

Appendix 4a. Number of meadows of saltmarsh and area of saltmarsh for the Parramatta River-Sydney Harbour by sub-unit of estuary, geomorphic zone, and Local Government Area, 2006.

Sub–unit of estuary	Geomorphic zone	Number if salmarsh patches	Subtotal	Area of saltmarsh patches (ha)	Subtotal
Parramatta River	Riverine Channel	442		28.319	
	Fluvial Delta	22		1.835	
	Centre Mud Basin	63		0.406	
			527		**30.560**
Lane Cove River	Fluvial Delta	123		3.393	
			123		**3.393**
Sydney Harbour	Centre Mud Basin	15		0.209	
			15		**0.209**
Middle Harbour	Riverine Channel	19		0.710	
	Fluvial Delta	37		1.406	
	Centre Mud Basin	22		0.992	
	Marine Tidal Delta	3		0.013	
			81		**3.121**
North Harbour	Marine Tidal Delta	11		0.023	
			11		**0.023**
Total		757	**757**	37.306	**37.306**

Appendix 4b. Number of meadows of saltmarsh along the northern shore of the Parramatta River-Sydney Harbour by estuary sub-unit, geomorphic zone, and Local Government Area, 2006.

Shoreline	Sub-unit of estuary (after NSW Maritime 2004)	Geomorphic zone (after Roy 1984 and Mesley 2003)	Local government area	Number of saltmarsh patches
North shore	Parramatta River	Riverine Channel	Parramatta	63
			Ryde	30
		Fluvial Delta	Ryde	7
		Central Mud Basin	Ryde	25
			Hunters Hill	15
	Lane Cove River	Fluvial Delta	Ryde	21
			Ku-ring-gai	4
			Lane Cove	63
			Hunters Hill	26
			Willoughby	9
		Central Mud Basin	Hunters Hill	0
			Lane Cove	0
	Sydney Harbour	Central Mud Basin	Lane Cove	2
			North Sydney	3
			Mosman	0
		Marine Tidal Delta	Mosman	0
			Manly	0
	Middle Harbour	Riverine Channel	Ku-ring-gai	10
			Warringah	9
		Fluvial Delta	Ku-ring-gai	22
			Warringah	15
			Manly	0
		Central Mud Basin	Willoughby	18
			Warringah	4
			Manly	0
		Marine Tidal Delta	Manly	3
	North Harbour	Marine Tidal Delta	Manly	11
			overlaps	*-2*
Subtotal				358

Appendix 4c. Number of meadows of saltmarsh along the southern shore of the Parramatta River-Sydney Harbour by estuary sub-unit, geomorphic zone, and Local Government Area, 2006.

Shoreline	Sub-unit of estuary (after NSW Maritime 2004)	Geomorphic zone (after Roy 1984 and Mesley 2003)	Local Government Area	Number of saltmarsh patches
South shore	Parramatta River	Riverine Channel	Parramatta	37
			Auburn	25
			Sydney Olympic Park	246
			Strathfield	41
		Fluvial Delta	Canada Bay	15
		Central Mud Basin	Canada Bay	23
			Leichhardt	0
	Sydney Harbour	Central Mud Basin	Leichhardt	0
			Sydney	6
			Woollahra	6
		Marine Tidal Delta	Woollahra	0
Subtotal				399

Appendix 5. Sites in the Parramatta River-Sydney Harbour containing "sensitive" species of saltmarsh, 2006.

Local Gov. Area	Geomorphic Zone	Location	Polygon	*Wilsonia backhousei*	*Lampranthus tegens*	*Halosarcia pergranulata* subsp. *pergranulata*	*Selliera radicans*	Total Saltmarsh Area (m^2)	Saltmarsh Condition	Comments
Parra-matta	Riverine Channel	Duck River (western shore)	WDR10	15		2	5	2497.984	Good	*Juncus acutus* present
	Riverine Channel	Duck River (western shore)	WDR15			2	1	395.028	Average	
	Riverine Channel	Duck River (western shore)	WDR17	20				337.004	Average	
	Riverine Channel	Duck River (western shore)	WDR22			2		378.590	Average	adjacent to Shell refinery
	Riverine Channel	Duck River (western shore)	WDR8			5		841.278	Good	several large bare areas in saltmarsh; possible site of *Phragmites* expansion
	Riverine Channel	Duck River (western shore)	WDR9	25		5		2263.361	Good	Extensive patches of *Wilsonia* in low, middle and upper marsh areas; *Juncus acutus* present
	Riverine Channel	Ermington, east of George Kendall Reserve	NPR40B	1				1492.643	Average	small patch
	Riverine Channel	Ermington, east of George Kendall Reserve	NPR40C	4				342.025	Poor	*Juncus acutus* present; possible expansion of *Phragmites australis* into saltmarsh
	Riverine Channel	Ermington, George Kendall Reserve	NPR44B	5				4.703	Poor	growing in crevices of rock; some trampling
Auburn	Riverine Channel	Duck River (eastern shore), Derby St wetlands	EDR3	7				329.033	Good	
	Riverine Channel	Duck River (eastern shore), Derby St wetlands	EDR4	2		4		11476.017	Good	*Halosarcia* growing in driest part of saltmarsh; some algae covered areas nearby
	Riverine Channel	Duck River (eastern shore)	EDR8			1		2119.197	Average	*Juncus acutus* present
	Riverine Channel	Wentworth Point	SPR313	2				275.785	Poor	*Juncus acutus* dominates; above sea wall; fill in substrate
Sydney Olympic Park	Riverine Channel	Newington *	SPR100	10	1	20		10721.968	Good	tidal flushing controlled by weir; *Juncus acutus* present
	Riverine Channel	Newington *	SPR106			<1		16658.882	Excellent	tidal flushing controlled by weir
	Riverine Channel	Newington *	SPR109	14		30		1255.568	Good	tidal flushing controlled by weir
	Riverine Channel	Newington	SPR110		20			593.469	Poor	*Juncus acutus* abundant
	Riverine Channel	Newington *	SPR116	2				516.808	Average	Tidal flushing controlled by weir; *Juncus acutus* present
	Riverine Channel	Newington *	SPR94	5				4057.112	Good	tidal flushing controlled by weir; mangrove expansion occurring
	Riverine Channel	Newington	SPR95	10	5			69.403	Poor	growing above rock retaining wall
	Riverine Channel	Newington	SPR96	5	15			469.105	Average	most of saltmarsh is bare salt scald
	Riverine Channel	Newington *	SPR93		<1			59776.053	Good	tidal flushing controlled by weir; 1 *Juncus acutus* plant nearby

Appendix 5. Continued

Local Gov. Area	Geomorphic Zone	Location	Polygon	*Wilsonia backhousei*	*Lampranthus tegens*	*Halosarcia pergranulata* subsp. *pergranulata* / *Selliera radicans*	Total Saltmarsh Area (m^2)	Saltmarsh Condition	Comments
	Riverine Channel	Newington *	SPR99			1	7821.801	Average	tidal flushing controlled by weir; *Juncus acutus* present; mangrove expansion occurring
	Riverine Channel	Homebush Bay, Haslams Ck	SPR126		5		984.732	Good	
	Riverine Channel	Homebush Bay, Haslams Ck	SPR152		10		604.498	Average	*Juncus acutus* present
	Riverine Channel	Homebush Bay, Haslams Ck	SPR153		4		146.863	Average	
	Riverine Channel	Homebush Bay, Haslams Ck	SPR161	15			585.022	Average	
	Riverine Channel	Homebush Bay, Haslams Ck	SPR162			3	259.183	Average	
	Riverine Channel	Homebush Bay, Haslams Ck	SPR166	4	1	3	9235.205	Good	Some trampling; Algae growth in parts of saltmarsh; *Juncus acutus* present
	Riverine Channel	Homebush Bay, Haslams Ck	SPR173	<1		<1	1792.912	Average	growing behind gabion wall
	Riverine Channel	Homebush Bay, Haslams Ck	SPR175	1	2	4	5707.820	Average	growing behind gabion wall; high level of rubbish
	Riverine Channel	Homebush Bay	SPR186	18			2016.747	Good	some trampling
	Riverine Channel	Homebush Bay	SPR188	10			1945.933	Good	*Juncus acutus* present
	Riverine Channel	Homebush Bay	SPR192			20	315.910	Average	*Juncus acutus* present
	Riverine Channel	Homebush Bay	SPR209	<1			45342.187	Average	A very large saltmarsh; Extensive cover of *Juncus acutus* in parts of the saltmarsh
	Riverine Channel	Homebush Bay	SPR232A	5			480.442	Average	mostly under mangrove canopy
	Riverine Channel	Homebush Bay	SPR232B	5			6.654	Average	mostly under mangrove canopy
	Riverine Channel	Homebush Bay	SPR233	5			17.066	Average	*Juncus acutus* present; mostly under mangrove canopy
	Riverine Channel	Homebush Bay	SPR236A		5		344.634	Average	
	Riverine Channel	Homebush Bay	SPR236B		5		2.998	Average	
	Riverine Channel	Homebush Bay	SPR236C		5		3.321	Average	
	Riverine Channel	Homebush Bay	SPR238		3		100.029	Poor	bordered by weeds
	Riverine Channel	Homebush Bay	SPR240		5		24.132	Poor	some trampling and bike damage
	Riverine Channel	Homebush Bay	SPR241		50		21.830	Poor	surrounded by bare ground; susceptible to trampling
	Riverine Channel	Homebush Bay	SPR243		1		650.023	Poor	trampling and bike tracks present
	Riverine Channel	Homebush Bay	SPR244		5		12.754	Poor	growing along track; trampling
	Riverine Channel	Homebush Bay	SPR246		3		351.576	Average	some trampling; vulnerable to access and damage by bikes
	Riverine Channel	Homebush Bay	SPR247A		20		3.028	Average	
	Riverine Channel	Homebush Bay	SPR247B		20		79.057	Average	
	Riverine Channel	Homebush Bay, Powells Ck	SPR267		3		768.690	Average	trampling and bike tracks through middle of saltmarsh
	Riverine Channel	Homebush Bay, Powells Ck	SPR273		1		3950.917	Good	
	Riverine Channel	Homebush Bay, Powells Ck	SPR278		20		73.024	Poor	mowing at upper saltmarsh margin; *Lampranthus* potentially at risk

Appendix 5. Continued

Local Gov. Area	Geomorphic Zone	Location	Polygon	*Wilsonia backhousei*	*Lampranthus tegens*	*Halosarcia pergranulata* subsp. *pergranulata* / *Selliera radicans*	Total Saltmarsh Area (m^2)	Saltmarsh Condition	Comments
	Riverine Channel	Homebush Bay, Powells Ck	SPR279		2		1467.615	Average	mowing at upper saltmarsh margin; *Lampranthus* potentially at risk; *Juncus acutus* present in low abundance
	Riverine Channel	Homebush Bay, Powells Ck	SPR288		5		782.720	Average	Possibly planted here; *Juncus acutus* present
Strath-field	Riverine Channel	Homebush Bay, Powells Ck, Mason Park	SPR291		2		398.280	Average	
	Riverine Channel	Homebush Bay, Powells Ck, Mason Park	SPR294A		15		4.081	Poor	saltmarsh is patchy due to damage by vehicles; dieback of other species nearby caused by algal bloom
	Riverine Channel	Homebush Bay, Powells Ck, Mason Park	SPR294B		15		27.519	Poor	saltmarsh is patchy due to damage by vehicles; dieback of other species nearby caused by algal bloom
	Riverine Channel	Homebush Bay, Powells Ck, Mason Park	SPR294C		15		5.803	Poor	saltmarsh is patchy due to damage by vehicles; dieback of other species nearby caused by algal bloom
	Riverine Channel	Homebush Bay, Powells Ck, Mason Park	SPR294D		15		5.478	Poor	saltmarsh is patchy due to damage by vehicles; dieback of other species nearby caused by algal bloom
	Riverine Channel	Homebush Bay, Powells Ck, Mason Park	SPR294E		15		2.489	Poor	saltmarsh is patchy due to damage by vehicles; dieback of other species nearby caused by algal bloom
	Riverine Channel	Homebush Bay, Powells Ck, Mason Park	SPR294F		15		4.873	Poor	saltmarsh is patchy due to damage by vehicles; dieback of other species nearby caused by algal bloom
	Riverine Channel	Homebush Bay, Powells Ck, Mason Park	SPR294G		15		13.034	Poor	saltmarsh is patchy due to damage by vehicles; dieback of other species nearby caused by algal bloom
	Riverine Channel	Homebush Bay, Powells Ck, Mason Park	SPR294H		15		68.629	Poor	saltmarsh is patchy due to damage by vehicles; dieback of other species nearby caused by algal bloom
	Riverine Channel	Homebush Bay, Powells Ck, Mason Park	SPR294I		15		169.574	Poor	saltmarsh is patchy due to damage by vehicles; dieback of other species nearby caused by algal bloom
	Riverine Channel	Homebush Bay, Powells Ck, Mason Park	SPR297A		13		5.323	Poor	high level of vehicle damage
	Riverine Channel	Homebush Bay, Powells Ck, Mason Park	SPR297B		13		1145.004	Poor	high level of vehicle damage
	Riverine Channel	Homebush Bay, Powells Ck, Mason Park	SPR301	2	20		532.842	Poor	vehicle damage in parts of saltmarsh
	Riverine Channel	Homebush Bay, Powells Ck, Mason Park	SPR302		4		144.952	Poor	high level of vehicle damage
	Riverine Channel	Homebush Bay, Powells Ck, Mason Park	SPR303A		5		6.485	Poor	saltmarsh islands fragmented by water and algae
	Riverine Channel	Homebush Bay, Powells Ck, Mason Park	SPR303B		5		3.488	Poor	saltmarsh islands fragmented by water and algae
	Riverine Channel	Homebush Bay, Powells Ck, Mason Park	SPR303C		5		11.137	Poor	saltmarsh islands fragmented by water and algae
	Riverine Channel	Homebush Bay, Powells Ck, Mason Park	SPR303D		5		5.228	Poor	saltmarsh islands fragmented by water and algae
	Riverine Channel	Homebush Bay, Powells Ck, Mason Park	SPR303E		5		7.111	Poor	saltmarsh islands fragmented by water and algae
	Riverine Channel	Homebush Bay, Powells Ck, Mason Park	SPR303F		5		6.564	Poor	saltmarsh islands fragmented by water and algae
	Riverine Channel	Homebush Bay, Powells Ck, Mason Park	SPR303G		5		5.081	Poor	saltmarsh islands fragmented by water and algae
	Riverine Channel	Homebush Bay, Powells Ck, Mason Park	SPR303H		5		23.103	Poor	saltmarsh islands fragmented by water and algae

Appendix 5. Continued

Local Gov. Area	Geomorphic Zone	Location	Polygon	*Wilsonia backhousei*	*Lampranthus tegens*	*Halosarcia pergranulata subsp. pergranulata*	*Selliera radicans*	Total Saltmarsh Area (m^2)	Saltmarsh Condition	Comments
	Riverine Channel	Homebush Bay, Powells Ck, Mason Park	SPR304	18				2009.395	Poor	large stands of *Wilsonia*; high level of vehicle damage
	Riverine Channel	Homebush Bay, Powells Ck, Mason Park	SPR306	25	5			158.267	Poor	high level of vehicle damage; *Juncus acutus* present
Ryde	Riverine Channel	Melrose Park, behind Crowley Cr	NPR34B	3				136.302	Average	some trampling
	Riverine Channel	Melrose Park, behind Lancaster Ave	NPR35C		20			86.729	Poor	between mangroves and residential fences; some mowing by residents; remains healthy
	Central Mud Basin	Looking Glass Bay	NPR21C	10				0.659	Poor	
	Central Mud Basin	Looking Glass Bay	NPR21D	20				1.057	Poor	growing in rock crevices; some trampling
City of Canada Bay	Fluvial Delta	Brays Bay	SPR7	1				5957.262	Good	relatively small patch at border of saltmarsh and Swamp Oak forest
	Central Mud Basin	Kendall Bay, Cabatita Park rock platform	SPR22	20				3.196	Average	small patch growing on rock platform near ferry wharf

** Conservation Reserve = Newington Nature Reserve*

Appendix 6. Sites in the Parramatta River-Sydney Harbour containing the invasive *Juncus acutus*, 2006.

Local Government Area	Geomorphic Zone	Location	Polygon	Cover of *Juncus acutus* (%) *	Total Saltmarsh Area (m^2)	Saltmarsh Condition	Comments
Parramatta	Riverine Channel	Parramatta River (northern shore)	NPR38A	1	246.044	Poor	mostly on rock or skeletal soils; some trampling; 1 small *Juncus acutus* plant to be removed
	Riverine Channel	Parramatta River (northern shore)	NPR39A	1	79.454	Poor	mostly on rock; bordered by weeds; some trampling
	Riverine Channel	Parramatta River (northern shore)	NPR39B	10	449.051	Average	partly under mangrove and Swamp Oak canopy; bordered by weeds
	Riverine Channel	Parramatta River (northern shore)	NPR40A	1	123.429	Average	mostly under mangrove canopy
	Riverine Channel	Parramatta River (northern shore)	NPR40C	8	342.025	Poor	much of upper substrate is fill, some rock substrate; bordered by weeds; evidence of possible *Phragmites* expansion into saltmarsh
	Riverine Channel	Parramatta River (northern shore)	NPR41A	60	22.425	Poor	between mangroves and slope
	Riverine Channel	Parramatta River (northern shore)	NPR42A	70	145.799	Poor	between mangroves and weedy slope; high level of rubbish; weedy
	Riverine Channel	Parramatta River (northern shore)	NPR43A	65	407.826	Poor	between mangrove and weedy slope; weedy; evidence of previous weeding – cut & burn
	Riverine Channel	Parramatta River (northern shore)	NPR44A	5	226.276	Average	partly under mangrove canopy; rocky and skeletal substrate; some trampling
	Riverine Channel	Parramatta River (northern shore)	NPR44B	5	4.703	Poor	in crevices of rock; some trampling
	Riverine Channel	Parramatta River (northern shore)	NPR44C	10	6.423	Poor	
	Riverine Channel	Parramatta River (northern shore)	NPR45A1	20	1.783	Poor	mostly under mangrove canopy; stormwater drain; one *J.acutus* plant present
	Riverine Channel	Parramatta River (northern shore)	NPR45A2	20	1.841	Poor	mostly under mangrove canopy; stormwater drain; one *J.acutus* plant present
	Riverine Channel	Parramatta River (northern shore)	NPR47A	50	187.711	Poor	creek connected to river by culvert; saltmash partly under *Avicennia* and *Aegiceras* mangrove canopy
	Riverine Channel	Parramatta River (northern shore)	NPR60B	1	145.257	Poor	under mangrove canopy; *Aegiceras* mangrove understory; retaining wall behind saltmarsh in some areas
	Riverine Channel	Parramatta River (northern shore)	NPR60C	x	97.034	Poor	under mangrove canopy*; Aegiceras* mangrove understory; *Alternanthera* and *J.acutus* to be removed
	Riverine Channel	Parramatta River (southern shore)	SPR2	x	97.443	Poor	under mangrove canopy; weedy
	Riverine Channel	Duck River (western shore)	WDR10	1	2497.984	Good	partly under mangrove canopy; some weeds in upper fringe; molluscs in lower marsh
	Riverine Channel	Duck River (western shore)	WDR11	5	287.423	Average	under mangrove canopy; *Avicennia* seedlings present in saltmarsh

Appendix 6. Continued

Local Government Area	Geomorphic Zone	Location	Polygon	Cover of *Juncus acutus* (%) *	Total Saltmarsh Area (m^2)	Saltmarsh Condition	Comments
	Riverine Channel	Duck River (western shore)	WDR20	5	70.736	Poor	partly under mangrove canopy; rockwall present; fence and slope at upper margin
	Riverine Channel	Duck River (western shore)	WDR23	15	153.772	Poor	under mangrove and Swamp Oak canopy
	Riverine Channel	Duck River (western shore)	WDR25	70	99.325	Poor	partly under mangrove and Swamp Oak canopy
	Riverine Channel	Duck River (western shore)	WDR26	50	33.650	Poor	Tussocks previously cut down – new growth on old tussocks
	Riverine Channel	Duck River (western shore)	WDR27	4	108.212	Poor	mostly under mangrove canopy; *Aegiceras* mangrove understory
	Riverine Channel	Duck River (western shore)	WDR9	5	2263.361	Good	partly under mangrove canopy; extensive patches of *Wilsonia* in low, middle and upper marsh areas; some plant dieback in drier areas; lots of mollusc shells; crab holes in lower marsh
Auburn	Riverine Channel	Duck River (eastern shore)	EDR8	5	2119.197	Average	part under mangrove canopy; few *Aegiceras* mangrove present; *J.acutus* to be removed
	Riverine Channel	Parramatta River, Wentworth Pt	SPR309	45	6.153	Poor	exotic species dominates; above sea wall
	Riverine Channel	Parramatta River, Wentworth Pt	SPR310A	70	2.993	Poor	exotic species dominates; above sea wall
	Riverine Channel	Parramatta River, Wentworth Pt	SPR310B	70	2.375	Poor	exotic species dominates; above sea wall
	Riverine Channel	Parramatta River, Wentworth Pt	SPR310C	70	2.986	Poor	exotic species dominates; above sea wall
	Riverine Channel	Parramatta River, Wentworth Pt	SPR312	80	2820.514	Poor	exotic species dominates; above sea wall; seedlings present in small part (species unknown)
	Riverine Channel	Parramatta River, Wentworth Pt	SPR313	70	275.785	Poor	exotic species dominates; above sea wall; fill in substrate
	Riverine Channel	Parramatta River, Wentworth Pt	SPR314	60	36.851	Poor	exotic species dominates; above sea wall
	Riverine Channel	Parramatta River, Wentworth Pt	SPR315	70	11.686	Poor	exotic species dominates; above sea wall
Sydney Olympic Park	Riverine Channel	Newington, Wanngal Wetland	SPR93	<1	59776.053	Good	tidal flushing controlled by weir; partly under Swamp Oak canopy; 1 *J.acutus* plant present
	Riverine Channel	Newington, Wanngal Wetland	SPR99	5	7821.801	Average	tidal flushing controlled with weir; high level of mangrove transgression; assessed from nearest fenceline
	Riverine Channel	Newington, Wanngal Wetland	SPR100	1	10721.968	Good	tidal flushing controlled with weir; assessed from northern half of polygon
	Riverine Channel	Newington, Wanngal Wetland	SPR108	10	1914.349	Average	tidal flushing controlled with weir;
	Riverine Channel	Newington, Wanngal Wetland	SPR110	30	593.469	Poor	partly under Swamp Oak canopy
	Riverine Channel	Newington, Wanngal Wetland	SPR112	x	1215.330	Good	tidal flushing controlled with weir;
	Riverine Channel	Newington, Wanngal Wetland	SPR113	5	6992.608	Average	tidal flushing controlled by weir; assessed from southern end and eastern fenceline
	Riverine Channel	Newington, Wanngal Wetland	SPR114	5	4228.381	Average	tidal flushing controlled by weir; assessed from southern end and eastern fenceline
	Riverine Channel	Newington, Wanngal Wetland	SPR116	20	516.808	Average	tidal flushin controlled by weir; under Swamp Oak canopy 34D1
	Riverine Channel	Homebush Bay, Haslams Ck	SPR122	2	42.630	Poor	between mangroves and steep landfill slope; lawn and mowing at upper margin
	Riverine Channel	Homebush Bay, Haslams Ck	SPR127	5	68.158	Poor	partly under mangrove and Swamp Oak canopy; fill in substrate; mangrove seedlings present
	Riverine Channel	Homebush Bay, Haslams Ck	SPR128	30	1519.829	Poor	partly under mangrove and Swamp Oak canopy; large *J. acutus* patch; evidence of previous J.acutus removal; snails and crabs present; some fill in substrate

Appendix 6. Continued

Local Government Area	Geomorphic Zone	Location	Polygon	Cover of *Juncus acutus* (%) *	Total Saltmarsh Area (m^2)	Saltmarsh Condition	Comments
	Riverine Channel	Homebush Bay, Haslams Ck	SPR140	5	684.426	Poor	growing between mangroves and fenceline/slope; stormwater and litter; some Suaeda dieback
	Riverine Channel	Homebush Bay, Haslams Ck	SPR141	25	184.295	Poor	assessed from fenceline and/or bridge; weedy; partly under mangrove canopy; mangrove seedlings present
	Riverine Channel	Homebush Bay, Haslams Ck	SPR146	1	424.070	Good	partly under mangrove and Swamp Oak canopy; good tidal flow; some fill; crab holes and snails present
	Riverine Channel	Homebush Bay, Haslams Ck	SPR150	x	527.093	Average	partly under mangrove canopy; mangrove seedlings present; some fill in substrate
	Riverine Channel	Homebush Bay, Haslams Ck	SPR151	8	211.914	Average	partly under mangrove canopy; mangrove seedlings present; some fill in substrate
	Riverine Channel	Homebush Bay, Haslams Ck	SPR152	5	604.498	Average	partly under mangrove canopy; mangrove seedlings present; some fill in substrate; several weed species of low cover
	Riverine Channel	Homebush Bay, Haslams Ck	SPR165A	2	94.747	Poor	surrounding small pool; poor flushing/ water quality; weedy slopes
	Riverine Channel	Homebush Bay, Haslams Ck	SPR165B	2	57.742	Poor	surrounding small pool; poor flushing/ water quality; weedy slopes
	Riverine Channel	Homebush Bay, Haslams Ck	SPR166	2	9235.205	Good	above low rock retaining wall; part under mangrove and Swamp Oak canopy; some trampling; algae in parts; fill in parts of substrate; shale outcrops
	Riverine Channel	Homebush Bay	SPR185	1	3392.689	Poor	mangroves previously removed; *J.acutus* extensive and should be removed
	Riverine Channel	Homebush Bay	SPR188	2	1945.933	Good	*Wilsonia* is extensive; partly under Swamp Oak canopy; no mangroves present; some trampling and bare areas; old bike track
	Riverine Channel	Homebush Bay	SPR191	x	152.946	Poor	under mangrove and Swamp Oak canopy; steep slope with fill substrate
	Riverine Channel	Homebush Bay	SPR192	10	315.910	Average	small 'island' in Bird Sanctuary;s *J.acutus* should be removed
	Riverine Channel	Homebush Bay	SPR193	5	28.923	Poor	partly under mangrove canopy; mangrove seedlings present; some *Suaeda* dieback in lower areas
	Riverine Channel	Homebush Bay	SPR203	x	17.077	Poor	under Swamp Oak and mangrove canopy; on slope
	Riverine Channel	Homebush Bay	SPR204A	5	3.180	Poor	under Swamp Oak and mangrove canopy; on slope
	Riverine Channel	Homebush Bay	SPR204B	5	1.620	Poor	under Swamp Oak and mangrove canopy; on slope
	Riverine Channel	Homebush Bay	SPR204C	5	3.413	Poor	under Swamp Oak and mangrove canopy; on slope
	Riverine Channel	Homebush Bay	SPR206	5	100.027	Average	part under mangrove and Swamp Oak canopy; slope at upper margin with fill substrate
	Riverine Channel	Homebush Bay	SPR209	26	45342.187	Average	some extensive parts under mangrove canopy; extensive patches of *J.acutus* to be removed; crabs and snails present; some trampling and bike tracks
	Riverine Channel	Homebush Bay	SPR214	60	0.998	Poor	1 plant of *Juncus acutus*, should be removed
	Riverine Channel	Homebush Bay	SPR217	24	34.515	Poor	under mangrove canopy
	Riverine Channel	Homebush Bay	SPR219	2	1292.204	Average	under mangrove canopy; slope and walkway at upper margin
	Riverine Channel	Homebush Bay	SPR220	5	377.280	Average	brackish species growing alongside mangroves
	Riverine Channel	Homebush Bay	SPR232A	5	480.442	Average	mostly under mangrove canopy; bordered by slope with fill substrate; stormwater drain running through part of polygon

Appendix 6. Continued

Local Government Area	Geomorphic Zone	Location	Polygon	Cover of *Juncus acutus* (%) *	Total Saltmarsh Area (m^2)	Saltmarsh Condition	Comments
	Riverine Channel	Homebush Bay	SPR232B	5	6.654	Average	mostly under mangrove canopy; bordered by slope with fill substrate; stormwater drain running through part of polygon
	Riverine Channel	Homebush Bay	SPR233	5	17.066	Average	mostly under mangrove canopy; bordered by slope with fill substrate; stormwater drain running through part of polygon
	Riverine Channel	Homebush Bay	SPR237	2	79.329	Poor	mostly under mangrove and Swamp Oak canopy; adjacent to walkway; fill in substrate
	Riverine Channel	Homebush Bay	SPR262	20	132.628	Poor	thin strip along reclaimed bunt; *J.acutus* to be removed
	Riverine Channel	Homebush Bay	SPR263	5	426.111	Average	part saltmarsh – part fresh/brackish wetland plants; under mangrove canopy; weedy in parts
	Riverine Channel	Homebush Bay	SPR264	x	98.598	Poor	weedy
	Riverine Channel	Homebush Bay	SPR265	x	237.044	Poor	weedy; assessed from behind fence
	Riverine Channel	Homebush Bay	SPR266	x	2206.092	Average	mostly brackish / freshwater species; assessed from perimeter only
	Riverine Channel	Homebush Bay, Powells Ck	SPR275	2	100.172	Poor	under mangrove canopy; fill and rocks in substrate; track at upper border
	Riverine Channel	Homebush Bay, Powells Ck	SPR279	1	1467.615	Average	most under mangrove canopy; some fill in substrate; some *Sueada* dieback; mowing at upper margin – *Lampranthus* at risk
	Riverine Channel	Homebush Bay, Powells Ck	SPR288	20	782.720	Average	possibly planted; no mangroves present; *Juncus acutus* to be removed
Strathfield	Riverine Channel	Homebush Bay, Powells Ck, Mason Park	SPR291	5	398.280	Average	large bare area bordering lower marsh; some fill in substrate; mangrove seedlings in low marsh
	Riverine Channel	Homebush Bay, Powells Ck, Mason Park	SPR304	1	2009.395	Poor	high level of vehicle damage; clayey soils; relatively large stands of *Wilsonia*
	Riverine Channel	Homebush Bay, Powells Ck, Mason Park	SPR306	15	158.267	Poor	some vehicle damage; fence limiting upper expansion; *Wilsonia* appears quite healthy
Ryde	Fluvial Delta	Parramatta River (northern shore)	NPR28A_1	10	3.686	Poor	behind mangroves, partly on rock; 1 *Juncus acutus* plant present
	Fluvial Delta	Parramatta River (northern shore)	NPR28A_2	10	9.686	Poor	behind mangroves, partly on rock; 1 *Juncus acutus* plant present
	Fluvial Delta	Parramatta River (northern shore)	NPR29A	5	105.126	Poor	under mangrove canopy; upper marsh weeds; stormwater input
Warringah	Central Mud Basin	Middle Harbour, Bantry Bay (Garigal NP)	EMH1	1	3028.846	Good	mostly under mangrove canopy; evidence of mangrove transgression in some areas

** x = % cover not determined*

Appendix 7a. Introduced plant species (saltmarsh weeds) infesting saltmarsh in the Parramatta River-Sydney Harbour, 2006, with background notes.

Species	Common Name	No. of Sites Infested	Description
Juncus acutus	Sharp Rush	89	The growth of Juncus acutus is a major threat to saltmarshes throughout the Sydney region. A native of Europe, the Mediterranean and SW Asia, this rush often competes with and displaces the native *Juncus kraussii* as well as other native saltmarsh species. It also grows as a weed in non-salty places with the disturbed freshwater wetland of the Shell Clyde refinery providing an example and potential seed stock for much of the upper Parramatta River and Duck River. Removal of this weed is difficult, with physical removal and the use of herbicide (glyphosate) generally the most successful options.
Spergularia marina	Lesser Sea-spurrey	31	A naturalised species, native of Europe. Was well developed at Homebush Bay growing with Sarcocornia early in the 20th Century (Robinson, 2003). Was found mostly around the Homebush Bay area in this study, and almost exclusively in the Riverine Channel. Rarely abundant.
Plantago coronopus	Buck's-horn Plantain	27	Small perennial or annual herb. Recorded growing in the highest zone of saltmarsh, often in areas of sparse growth or disturbance. Widespread across the estuary but never dominant or abundant.
Hydrocotyle bonariensis	Kurnell Curse	18	Native of South America. More abundant in the most seaward saltmarshes of the estuary (especially North Harbour), though also present along several creeks in Middle Harbour and Sydney Olympic Park. Occurs more commonly as colonizer of coastal dunes and on sandy soil on cliff faces.
Polypogon monspeliensis	Annual Beardgrass	6	Native of Mediterranean Region. Occasionally grows in damp, disturbed areas of saltmarshes. Not extensive at any sites.
Baccharis halimifolia	Groundsel Bush	5	Perennial shrub, 1–6 m high. Native of eastern North America. Was not widespread or abundant in this study, but should be monitored as it has the potential to displace native species.
Alternanthera philoxeroides	Alligator Weed	3	Normally a major weed of freshwater wetlands, Alligator weed was found growing in moist areas of saltmarshes at Yaralla Bay (SPR15), west of Kissing Point (NPR58B) and the Pemberton St wetland, Parramatta (NPR60C). It these places it has formed dense, rooted mats which should be removed. Alligator weed is gazetted as a noxious weed (W1) in NSW
Cortaderia spp.	Pampas Grass	2	Large perennial growing to 4m high, native of South America. Can displace saltmarsh species at higher elevations. Evidence of successful control at several sites at Sydney Olympic Park. As with *Juncus acutus*, a large seed stock exists in freshwater wetland of the Shell Clyde refinery

Appendix 7b. Introduced plant species (upper fringe weeds) infesting saltmarsh in the Parramatta River-Sydney Harbour, 2006, with background notes.

Species	Common Name	No. of Sites Infested	Description
Protasparagus aethiopicus	Asparagus 'Fern'	38	Native of South Africa. Introduced garden plant that has become a serious weed in bushland. Found growing in the highest saltmarsh zone in a few places, but more commonly occurs as an upper border preventing any upslope growth of saltmarsh species. Quite common in disturbed fringe areas.
Aster subulatus	Wild Aster	30	Native of North America. Common in the upper fringe of disturbed saltmarshes. Whilst widespread, *A. subulatus* is rarely dominant and may not constitute a major threat (however, see Keith *et al*. 2007).
Stenotaphrum secundatum	Buffalo Gass	24	Native of America & Africa. A common lawn grass that can displace native species in the upper saltmarsh fringe.
Lantana camara	Lantana	15	Native of South America. Whilst most of this weed grows above the upper saltmarsh boundary, its wide-spreading foliage can hang over saltmarsh areas and therefore exclude the growth of native species. Occurs as dense thickets in disturbed areas.
Senecio madagascariensis	Fireweed, Variable Grounsel	3	Native of South Africa. An opportunistic weed of disturbed sites, uncommon along the Parramatta River. Gazetted as a noxious weed in NSW (W2, W3p)

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