VOLUNTEER SURVEYS OF WATERBIRDS OF THE SYDNEY, NOVA SCOTIA AREA, INCLUDING THE SYDNEY TAR PONDS, 1993 - 1996

Katherine A. Bredin, Neil M. Burgess
Canadian Wildlife Service - Atlantic Region, Environment Canada,
P.O. Box 1590, Sackville, New Brunswick E0A 3C0

David B. McCorquodale
Department of Behavioural & Life Sciences, University College of Cape Breton,
P.O. Box 5300, Sydney, Nova Scotia B1P 6L2

David L. Harris
Nova Scotia Department of Natural Resources,
RR #6, Sydney, Nova Scotia B1P 6T2

Canadian Wildlife Service Technical Report Series No. 273

This series may be cited as:

Bredin, K.A., N.M. Burgess, D.B. McCorquodale and D.L. Harris. 1997. Volunteer Surveys of Waterbirds of the Sydney, Nova Scotia Area, Including the Sydney Tar Ponds, 1993 - 1996. Canadian Wildlife Service Technical Report Series No. 273.

Issued under the Authority of the
Minister of the Environment
Canadian Wildlife Service

Catalogue No. CW 69-5/273E
ISBN 0-662-25565-8

Copies may be obtained from:

Neil M. Burgess
Wildlife Toxicologist
Canadian Wildlife Service
Atlantic Region
P.O. Box 1590
Sackville, New Brunswick, Canada
E0A 3C0

Ph.: (506) 364-5044
FAX: (506) 364-5062
e-mail: Neil.Burgess@ec.gc.ca

ABSTRACT

For three years (1993 - 1996), volunteers conducted monthly waterbird surveys at four locations around Sydney, Nova Scotia; 1) at the Sydney Tar Ponds, 2) off the Lingan Power Plant, 3) along the east side of the South Arm of Sydney Harbour, and 4) along the Sydney River under the three bridges. This was part of a joint Canadian Wildlife Service (CWS) - Atlantic Coastal Action Program (ACAP) Cape Breton project to assess the potential risk of exposure of aquatic birds to toxic chemicals and to establish a baseline of information against which to assess the effects of subsequent habitat improvement. In spite of high pollution levels, a total of 26 species of waterbirds were observed at the Sydney Tar Ponds, with this small wetland supporting year-round resident birds (black ducks, crows and Herring Gulls), summer breeders (black ducks, Killdeer and various species of songbirds), fall migrants (shorebirds) and overwintering flocks (black ducks, several species of gulls, and crows). The waters off the Lingan Power Plant, which stay open through the winter due to warm water effluent, were an important overwintering area for gulls and waterfowl. The stretch of water under the three bridges at Sydney River that remained ice-free all winter was also a prime overwintering area for black ducks, Mallards, Common Goldeneye and a number of gull species. The South Arm was a foraging area for summer residents, especially cormorants, Great Blue Herons, and Spotted Sandpipers. A total of 49 different species of waterbirds were observed at all four study areas combined. Based on these survey results, six potential receptor species were identified for ecological risk assessment of contaminants at Sydney Tar Ponds. These species include Herring Gull, American Black Duck, European Starling, American Crow and Lesser Yellowlegs. Volunteer-based wildlife surveys, such as those that form the basis of this project, are potentially a valuable and cost-effective source of ecological monitoring data. To work most effectively, such surveys require an active partnership between local volunteers and wildlife biologists.

RÉSUMÉ

Pendant trois ans (1993-1996), des bénévoles ont effectué un relevé mensuel des oiseaux aquatiques dans quatre localités voisines de Sydney (Nouvelle-Écosse) : (1) les étangs bitumineux de Sydney; (2) la centrale de Lingan; (3) la rive est du bras sud du havre de Sydney; (4) le secteur de la rivière Sydney situé sous les trois ponts. Ces relevés s'inscrivaient dans le cadre d'un projet conjoint du Service canadien de la faune (SCF) et du Programme d'action des zones côtières de l'Atlantique (PAZCA), mené dans l'île du Cap-Breton et visant à établir les risques d'exposition des oiseaux aquatiques aux produits toxiques et à obtenir des données de base en vue d'évaluer les effets de l'amélioration subséquente des habitats. Malgré le degré élevé de pollution des étangs bitumineux, 26 espèces d'oiseaux aquatiques ont été observées dans ce milieu humide de petite superficie; il s'agit d'oiseaux y demeurant toute l'année (canard noir, corneille et goéland argenté), y nichant l'été (canard noir, pluvier kildir et divers oiseaux chanteurs), s'y arrêtant au cours de la migration automnale (oiseaux de rivage) ou y passant l'hiver (canard noir, plusieurs goélands, corneille). L'aspect le plus important des eaux situées au large de la centrale de Lingan, qui demeurent libres de glace tout l'hiver en raison de rejets d'eau chaude, est la présence d'une zone d'hivernage pour les goélands et la sauvagine. Les relevés effectués l'hiver le long de la rivière Sydney ont montré que le secteur situé sous les trois ponts, qui demeure libre de glace tout l'hiver, sont également un excellent milieu d'hivernage, pour le canard noir, le canard colvert, le garrot à œil d'or et plusieurs goélands. Enfin, le bras sud du havre de Sydney était une zone d'alimentation pour les résidents d'été et notamment pour le cormoran, le grand héron et le chevalier grivelé. Dans l'ensemble des quatre localités étudiées, 49 espèces d'oiseaux aquatiques ont été observées. À partir des résultats ainsi obtenus, on a pu identifier les espèces potentiellement réceptrices, en vue d'une évaluation des risques que présentent les polluants des étangs bitumineux. Ces espèces sont le goéland argenté, le canard noir, l'étourneau sansonnet, la corneille d'Amérique et le petit chevalier. Les relevés fauniques effectués par des bénévoles, comme ceux sur lesquels sont fondés le présent projet, pourraient s'avérer une source utile et économique de données pour la surveillance écologique. Pour que de tels relevés soient efficaces, il faut un partenariat actif entre bénévoles locaux et biologistes de la faune.

ACKNOWLEDGEMENTS

We are especially indebted to volunteers John McKay and Daniele Wiseman who contributed their time conducting waterbird surveys. We thank Sydney Tar Ponds Clean-up Incorporated and the Nova Scotia Power Corporation for providing access to the survey sites. The University College of Cape Breton contributed funding towards this project and the Nova Scotia Department of Natural Resources provided in-kind support. Daniele Wiseman and David McCorquodale were supported by National Science and Engineering Research Council operating grants and summer scholarships, respectively. We thank Lee Calkins and Susan Smith for entering data into computer files. Special thanks go to Judy White of ACAP Cape Breton who provided much helpful information and support in getting the project underway and completed. Helpful comments from Judy White, Maria Dober and Richard Elliot improved this report. Finally, thanks are due to the Environmental Protection Branch of Environment Canada for providing funds to produce this report.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION

In 1993 the Wildlife Toxicology Program of the Canadian Wildlife Service (CWS) of Environment Canada initiated a joint CWS - Atlantic Coastal Action Program (ACAP) project to monitor the risk of exposure of aquatic birds to toxic chemical pollution in four ACAP sites: Saint John, the Miramichi, and the St. Croix River Estuary in New Brunswick, and the area around Sydney, Cape Breton in Nova Scotia. Local naturalists and birders were recruited as volunteers to conduct waterbird surveys of local bays, shorelines, rivers and mudflats to determine which species of aquatic birds were potentially being exposed to toxic contaminants. This report describes the results from waterbird surveys of the Sydney area, with special emphasis on the Sydney Tar Ponds.

In general, the role of the volunteers was to collect data through field surveys, while CWS biologists designed the surveys, trained volunteers, screened and analysed data, and compiled reports. At Sydney, biologists from the University College of Cape Breton (third author) and the Nova Scotia Department of Natural Resources (fourth author) helped design surveys and train volunteers, as well as conducting surveys at the Tar Ponds and the Lingan Power Plant. Surveys were conducted once a month at four sites around Sydney: 1) the Sydney Tar Ponds and adjoining sections of Muggah Creek, 2) the eastern side of the South Arm of Sydney Harbour from the mouth of Muggah Creek to South Bar, 3) the Sydney River in the vicinity of the three bridges, and 4) the area to the south and east of the Lingan Power Plant (Figure 1). These survey areas or routes were chosen on the basis of three criteria: they were accessible and convenient for volunteers to monitor, they were likely to be used by aquatic birds, and they were industrial or urban areas which might be sources of chemical pollution.

A large colourful poster has already been produced for the general public from the results of the Sydney waterbird surveys (Waterbirds of Sydney/Les Oiseaux Aquatiques de Sydney 1996). This report presents a more thorough description of the Sydney surveys and analysis of the data, and identifies aquatic bird species that would be best for use as indicators (receptor species) for subsequent ecological risk assessment.

2.0 METHODS

2.1 Field Surveys

Volunteers were asked to conduct surveys once per month but effort varied somewhat among volunteers. Instructions, data sheets and photocopied maps of the observation route were given to each volunteer (Appendix 1). A volunteer completed a survey by conducting a point count of all aquatic birds present at each observation point along the survey route. Survey routes consisted of three to seven observation points at different locations so that all birds present in the survey area could be seen and counted. The duration of point counts and subsequent data recording at each observation point ranged from about five minutes to one hour, depending on the number of birds present and the size and complexity of the area of shoreline to be surveyed. Volunteers conducted surveys at any time of day and month that was convenient, provided visibility was good. Volunteers noted weather and tide conditions as well as the time and duration of their survey.

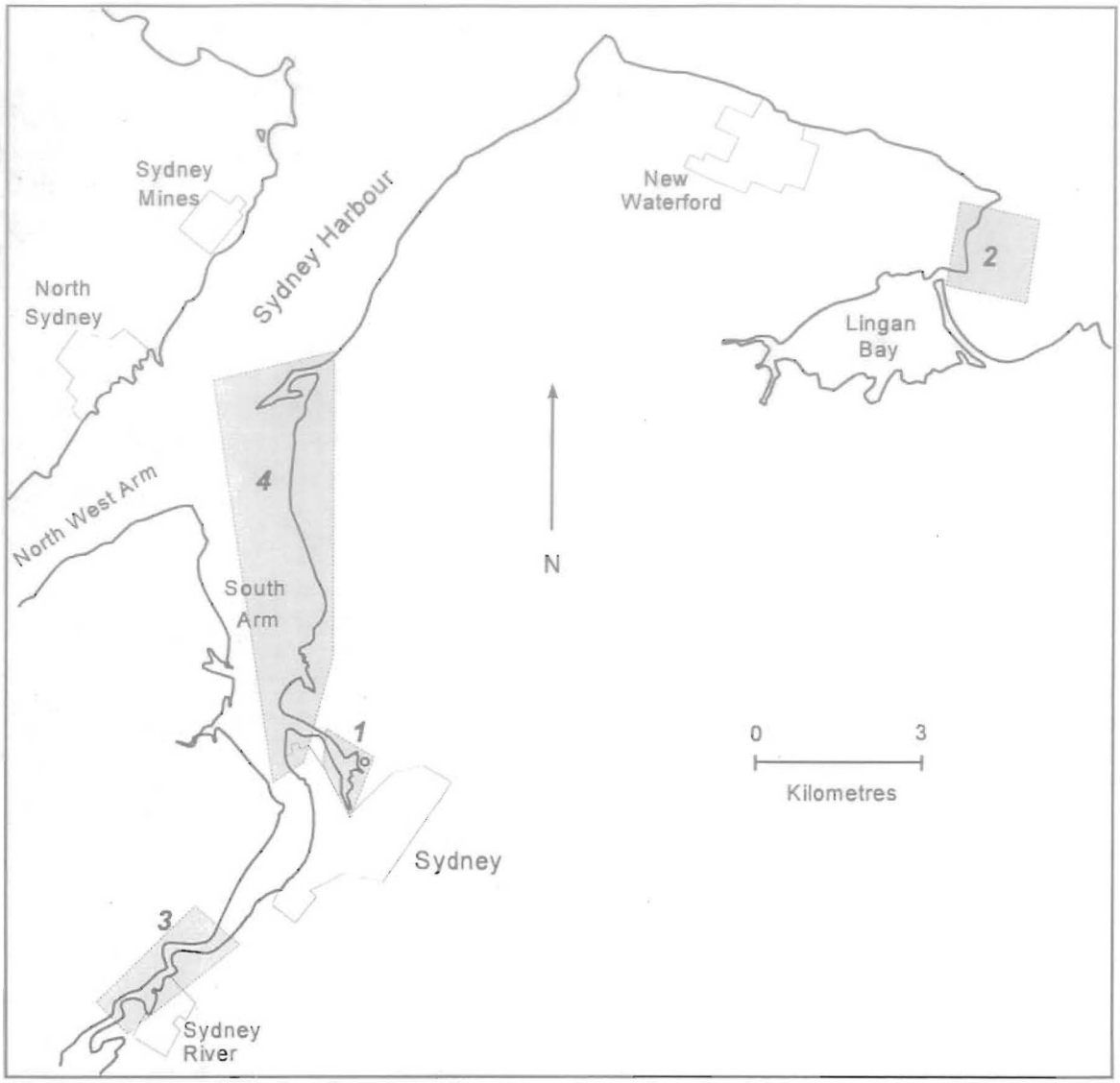

Figure 1. Map of the area around Sydney, Nova Scotia. The shaded areas indicate the four sites where volunteers conducted waterbird surveys: 1 = Sydney Tar Ponds; 2 = Lingan Power Plant; 3 = Sydney River; 4 = South Arm of Sydney Harbour.

For each bird or group of birds seen, volunteers recorded data on location, species, abundance and behaviour. At every observation point, volunteers noted the location of separate groups of birds on the map by indicating the location of each with a unique "map locator number". This number was recorded on the corresponding data sheet, along with the number of birds of each species within the group that were feeding, resting, breeding or travelling through the area. Additional information such as age, sex or noteworthy behaviour was recorded when appropriate as a comment on the data sheet. Appendix 1 contains a copy of the instructions and a sample data sheet and map as provided to volunteers.

At the Sydney Tar Ponds and at the Lingan Power Plant, David McCorquodale and David Harris conducted monthly surveys year-round from October 1993 to January 1996, with only occasional months missed (for example there are no May surveys for Lingan). The surveys along the South Arm of Sydney Harbour were part of a summer student project at the University College of Cape Breton (UCCB), so only summer and early fall surveys were conducted there, by Daniele Wiseman. As part of the same student project, surveys at the Tar Ponds were conducted weekly rather than just monthly during the summers of 1994 and 1995. Surveys of the Sydney River were conducted by John McKay during winter and spring only, to monitor bird use of the small area of brackish water that remained open during the winter.

2.2 Data Analysis

The information on the data sheets and maps submitted by the volunteers to CWS was entered into a computer database. The bird location information from the survey maps was converted to point coordinates using latitude/longitude overlays, and the coordinates for each bird sighting were added to the database. This geocoded database for each bird group is included in the dataset associated with this report (see Appendix 2).

Observations were assigned to one of four seasons, which were based on the migratory and breeding habits of the species observed. Winter included November to March, the months between fall and spring migration. Spring included April and May, the months of spring migration for most bird species in the Maritimes. Summer was comprised of June and July, encompassing the breeding season for most birds in Atlantic Canada. As fall migration occurs from August through October, these months were designated as fall.

The survey data were grouped by site and season. The maximum and mean number of birds of each species 1) observed to be present and 2) observed feeding were calculated for each site. These maximum and mean values were also calculated for each of twelve "species groups", which included similar species. These summarised data are presented in Section 3.0 and contained in a database associated with this report (see Appendix 2).

For each season at the Sydney Tar Ponds, the mean number of each species present and feeding was determined, along with the number of months they were present. From this information, likely receptor (or indicator) species for ecological risk assessment were identified, based on their abundance, food habits, trophic level and probable length of exposure to toxic chemicals. This information is presented in Section 4.0. The dataset associated with this report is described in Appendix 2.

3.0 RESULTS AND DISCUSSION

3.1 Sydney Tar Ponds

Figure 2 shows the areas surveyed in the Sydney Tar Ponds and adjoining Muggah Creek. Inflow to the ponds is from Wash Brook and Coke Oven Brook, and pond outflow to Sydney Harbour is through Muggah Creek. Although the Sydney Steel Corporation coke ovens are no longer operating, by-products from the coking process entering Coke Oven Brook were historically a major source of pollutants to this wetland. Presently the Tar Ponds and downstream areas of Muggah Creek contain high concentrations of polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs) and heavy metals such as cadmium, mercury, lead and zinc (Vandermeulen 1989, Matheson *et al.* 1983, Hildebrand 1982, Sydney Tar Ponds Clean-up 1993).

Table 1 shows the winter survey results for the Sydney Tar Ponds. The first two columns of numbers describe the number of birds **feeding** per survey; the first is the maximum number of birds of that species observed feeding **at any single survey**, the second is the mean number of birds of that species or species group observed feeding **averaged over all surveys**. The third and fourth columns of numbers are the maxima and means for species **present in the area.** These include

Table 1. Winter Survey Results for the Sydney Tar Ponds

		NUMBER FEEDING PER SURVEY		NUMBER PRESENT PER SURVEY	
SPECIES GROUP	SPECIES	Maximum	Mean	Maximum	Mean
	American Crow	28	9.8	28	9.9
	Common Raven	2	0.5	2	0.5
CROWS & RAVENS TOTAL		29	10.3	29	10.5
	American Black Duck	10	3.8	74	25.9
	Mallard	0	0.0	2	0.2
	Northern Pintail	0	0.0	1	0.1
DABBLING DUCKS TOTAL		10	3.8	75	26.2
	Common Black-headed Gull	10	1.0	10	1.0
	Great Black-backed Gull	32	7.4	140	45.7
	Glaucous Gull	1	0.1	2	0.4
	Herring Gull	7	3.1	46	14.2
	Iceland Gull	52	18.9	74	33.6
	Ring-billed Gull	7	0.6	7	0.9
GULLS TOTAL		85	31.1	225	95.8
SHOREBIRDS TOTAL	(Common Snipe)	1	0.1	1	0.1

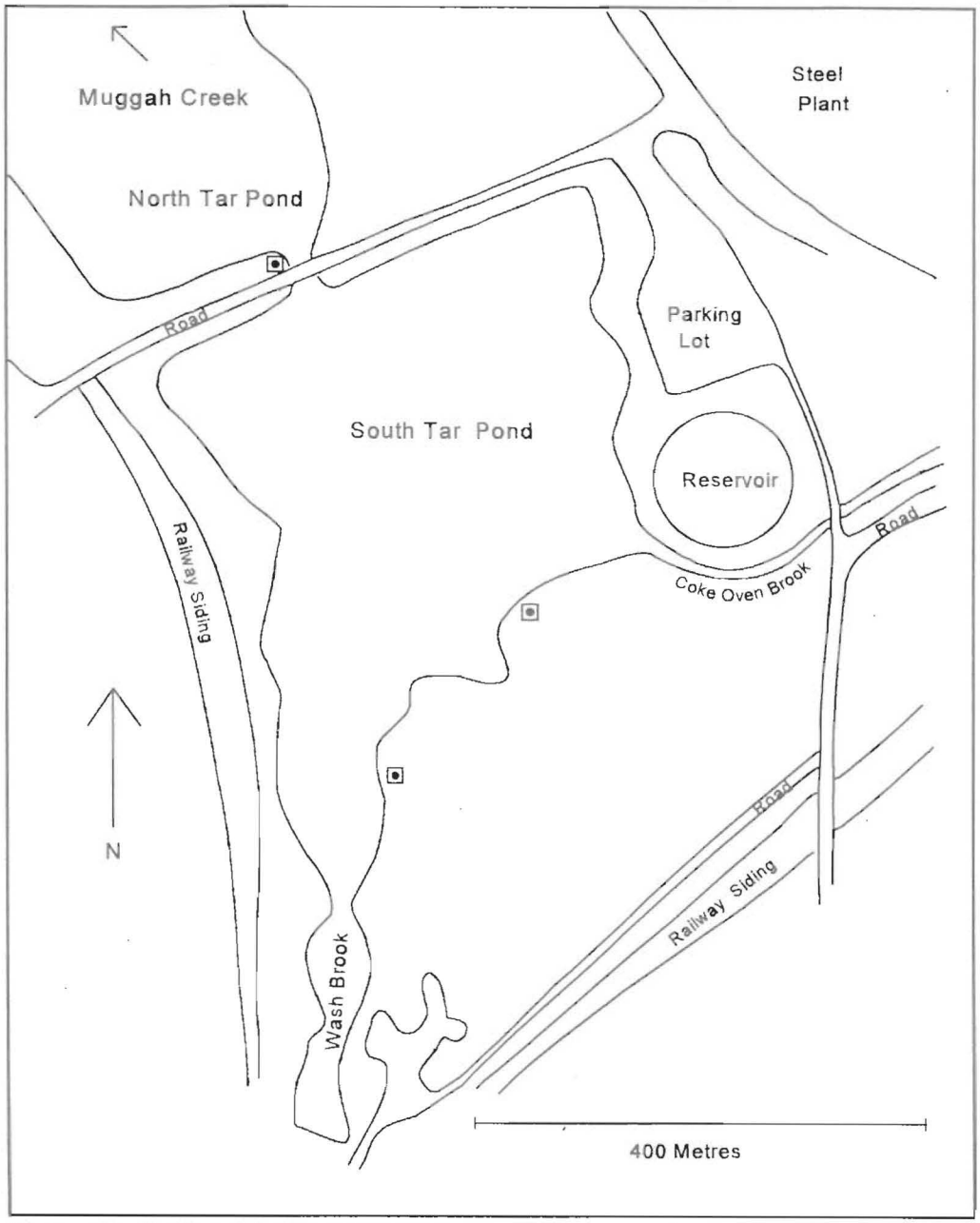

Figure 2. Sydney Tar Ponds survey area. Observation points are indicated with a ⊡.

birds that were feeding, resting or loafing, but excludes birds seen travelling through the survey area. In spite of the high levels of toxic chemicals present in the Tar Ponds, considerable numbers of many bird species use this small wetland year-round. Large numbers of American Crows *(Corvus brachyrhynchos)*, American Black Ducks *(Anas rubripes)*, Great Black-backed Gulls *(Larus marinus)*, Herring Gulls *(Larus argentatus)* and Iceland Gulls *(Larus glaucoides)* overwinter at the Tar Ponds (Table 1).

Although the smallest number of birds and the lowest species diversity were recorded in the spring, gulls, dabbling ducks and crows were observed feeding there then (Table 2).

Table 2. Spring Survey Results for the Sydney Tar Ponds

		NUMBER FEEDING PER SURVEY		NUMBER PRESENT PER SURVEY	
SPECIES GROUP	SPECIES	Maximum	Mean	Maximum	Mean
	American Crow	9	2.3	9	3.0
	Common Raven	0	0.0	1	0.3
CROWS & RAVENS TOTAL		9	2.3	9	3.3
	American Black Duck	2	0.3	2	0.3
	Mallard	2	0.3	4	0.7
DABBLING DUCKS TOTAL		2	0.7	4	1.0
	Common Tern	1	0.3	1	0.3
	Great Black-backed Gull	2	1.0	4	1.7
	Herring Gull	11	3.3	14	4.8
	Iceland Gull	8	2.7	8	3.3
	Ring-billed Gull	7	1.8	7	1.8
GULLS TOTAL		28	9.2	33	12.0

During both summers of this project (1994 and 1995), observers noted the occurrence of nesting black ducks and Killdeer *(Charadrius vociferous)* along the shoreline of the ponds, and at least one brood of black ducks was seen. These species were also recorded feeding and resting in the area (Table 3). Double-crested Cormorants *(Phalacrocorax auritus)*, Common Terns *(Sterna hirundo)* and a Great Blue Heron *(Ardea herodias)* were observed feeding in Tar Ponds waters.

In the fall, small numbers of shorebirds stopped off on their southward migration to forage along the shoreline of the Tar Ponds (Table 4). Although the survey data in the table indicate low shorebird numbers, larger flocks of up to 30 sandpipers were seen feeding there during two site visits in fall. The level of shorebird use may therefore be somewhat higher than the data indicate.

Far from being an ecological wasteland, the Sydney Tar Ponds supported year-round resident birds (black ducks, crows and Herring Gulls), summer breeders (black ducks, Killdeer and various species of songbirds), fall migrants (shorebirds) and overwintering flocks (black ducks, a number of species of gulls, and crows). The implications of this for long-term risks of wildlife exposure to toxic chemical pollution are discussed further in Section 4.0.

Table 3. Summer Survey Results for the Sydney Tar Ponds

SPECIES GROUP	SPECIES	NUMBER FEEDING PER SURVEY Maximum	NUMBER FEEDING PER SURVEY Mean	NUMBER PRESENT PER SURVEY Maximum	NUMBER PRESENT PER SURVEY Mean
CORMORANTS	(Double-crested Cormorant)	13	1.6	16	2.0
	American Crow	4	0.9	7	2.1
	Common Raven	2	0.2	3	0.7
CROWS & RAVENS TOTAL		4	1.1	8	2.8
	American Black Duck	1	0.1	6	0.7
	Mallard	0	0.0	0	0.0
DABBLING DUCKS TOTAL		1	0.1	6	0.7
	Common Tern	3	0.3	3	0.4
	Great Black-backed Gull	0	0.0	0	0.0
	Herring Gull	11	0.9	12	1.1
	Ring-billed Gull	3	0.5	3	0.5
GULLS TOTAL		12	1.7	13	2.0
HERONS TOTAL	(Great Blue Heron)	1	0.1	1	0.1
SHOREBIRDS TOTAL	(Killdeer)	6	0.7	6	0.7

Table 4. Fall Survey Results for the Sydney Tar Ponds.

SPECIES GROUP	SPECIES	NUMBER FEEDING PER SURVEY Maximum	NUMBER FEEDING PER SURVEY Mean	NUMBER PRESENT PER SURVEY Maximum	NUMBER PRESENT PER SURVEY Mean
	American Crow	4	1.8	4	2.4
	Common Raven	0	0.0	0	0.0
CROWS & RAVENS TOTAL		4	1.8	4	2.4
DABBLING DUCKS TOTAL	(American Black Duck)	3	0.5	7	1.9
	Great Black-backed Gull	6	1.3	7	1.8
	Herring Gull	30	5.5	36	7.4
	Ring-billed Gull	33	9.5	33	10.3
GULLS TOTAL		53	16.3	63	19.4
HERONS TOTAL	(American Bittern)	1	0.1	2	0.3
	Black-bellied Plover	2	0.3	2	0.3
	Greater Yellowlegs	2	0.3	2	0.3
	Killdeer	2	0.3	2	0.3
	Lesser Yellowlegs	4	0.5	4	0.5
	Short-billed Dowitcher	1	0.1	1	0.1
	Semipalmated Plover	1	0.1	1	0.1
	Semipalmated Sandpiper	1	0.1	1	0.1
	Stilt Sandpiper	1	0.1	1	0.1
SHOREBIRDS TOTAL		12	1.8	12	1.8

3.2 Lingan Power Plant

Figure 3 depicts the area surveyed off the Lingan Power plant. The area directly offshore from the plant's warm water effluent pipe remained open all winter, although the actual size of the open area varied with weather and sea conditions.

Table 5 shows the winter survey results for the Lingan Power Plant. From November to March, this area of open water attracted huge numbers of overwintering ducks - primarily American Black Ducks (mean birds present per survey = 61, Table 5) and Greater Scaup *(Aythya marila)* (mean birds present per survey = 228) but Bufflehead *(Bucephala albeola)*, Common Goldeneye *(Bucephala clangula)* and Oldsquaw *(Clangula hyemalis)* were also common. Common Loons (*Gavia immer)* and Red-breasted Mergansers *(Mergus serrator)* were usually present in the open waters off Lingan throughout the winter. Considerable numbers of Great Cormorants *(Phalacrocorax carbo)* roosted on the cliffs, and a large flock of Canada Geese *(Branta canadensis)* was observed staging in the area. Various species of gulls concentrated in and around the open waters off Lingan during the winter, especially Great Black-backed Gulls and Arctic-

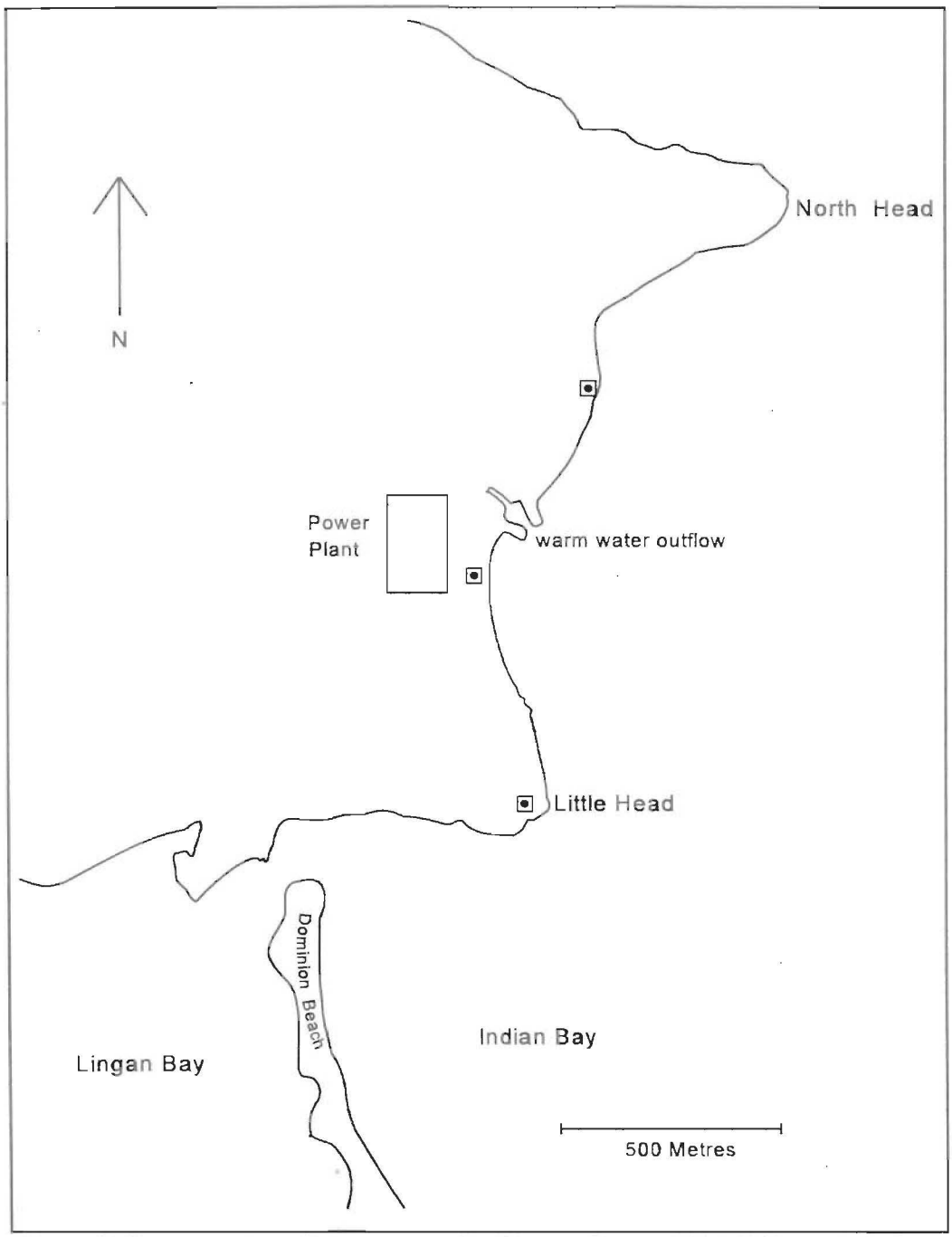

Figure 3. Survey area offshore from the Lingan Power Plant. The points from which observations were conducted are indicated with a □.

Table 5. Winter Survey Results for the Lingan Power Plant

		NUMBER FEEDING PER SURVEY		NUMBER PRESENT PER SURVEY	
SPECIES GROUP	SPECIES	Maximum	Mean	Maximum	Mean
	Double-crested Cormorant	1	0.1	1	0.1
	Great Cormorant	9	1.2	52	19.9
CORMORANTS TOTAL		9	1.3	52	20.0
	American Crow	18	3.0	25	5.3
	Common Raven	2	0.2	2	0.2
CROWS & RAVENS TOTAL		20	3.2	25	5.4
	American Black Duck	210	31.7	254	60.7
	Mallard	3	0.4	9	1.2
DABBLING DUCKS TOTAL		212	32.1	263	61.8
	Bufflehead	16	2.2	16	2.2
	Common Goldeneye	45	7.7	45	8.9
	Greater Scaup	602	55.7	824	228.2
DIVING DUCKS TOTAL		651	65.5	873	239.3
EAGLES TOTAL	(Bald Eagle)	1	0.2	2	0.5
GEESE TOTAL	(Canada Goose)	0	0.0	400	46.7
	Common Black-headed Gull	12	2.4	13	3.0
	Great Black-backed Gull	73	26.3	229	82.7
	Glaucous Gull	1	0.2	3	0.4
	Herring Gull	34	6.2	53	12.3
	Iceland Gull	110	30.8	155	48.3
	Ring-billed Gull	6	0.6	6	0.8
GULLS TOTAL		155	66.4	347	147.3
LOONS TOTAL	(Common Loon)	10	0.8	10	0.8
MERGANSERS TOTAL	(Red-breasted Merganser)	16	1.8	16	1.9
RAPTORS TOTAL	(Northern Harrier)	1	0.1	1	0.1
	Black Scoter	2	0.2	2	0.2
	Oldsquaw	30	2.6	30	2.8
	White-winged Scoter	1	0.1	1	0.1
SEA DUCKS TOTAL		30	2.8	30	3.0
SHOREBIRDS TOTAL	(Purple Sandpiper)	0	0.0	1	0.1

breeding Iceland Gulls. Winter was the only season when Bald Eagles *(Haliaeetus leucocephalus)* were observed in this survey area.

Only two spring surveys were done at Lingan during the project, so the data are not as comprehensive as for other seasons (Table 6). A prominent feature of the spring data was the large number of Red-breasted Mergansers present in the area (mean of 33 birds per survey). Large numbers of Great Cormorants were also present, although few were observed feeding. This probably marks the return of locally-breeding cormorants to the area off the Lingan Power Plant, where Great Cormorants and a few Double-Crested Cormorants nest on cliffs along the coast. Gulls continued to be the most prominent group in spring, although the number of Iceland Gulls decreased markedly from its winter high. A few Black Guillemots *(Cepphus grille)* were seen, also indicating the return of locally breeding birds (Erskine 1992).

Table 6. Spring survey results for Lingan Power Plant.

		NUMBER FEEDING PER SURVEY		NUMBER PRESENT PER SURVEY	
SPECIES GROUP	SPECIES	Maximum	Mean	Maximum	Mean
CORMORANTS TOTAL	(Great Cormorant)	4	2.5	67	54.5
	Great Black-backed Gull	8	5.0	49	34.0
	Herring Gull	5	2.5	17	15.0
	Iceland Gull	7	3.5	42	23.0
	Ring-billed Gull	2	1.0	9	4.5
GULLS TOTAL		16	12.0	83	76.5
LOONS TOTAL	(Common Loon)	0	0.0	1	0.5
MERGANSERS TOTAL	(Red-breasted Merganser)	2	1.0	67	33.5
SEABIRDS TOTAL	(Black Guillemot)	2	1.0	2	1.0

Species observed during the summer were almost entirely restricted to those that breed locally (Table 7). Large numbers of both species of cormorants were recorded and groups of up to 18 Great Cormorants were seen feeding. This reflects the fact that they were raising young nearby during the summer. Except for the occasional Iceland Gull, the only gull species observed (Table 7) were those that nest in nearby coastal habitats (Erskine 1992). Moderate numbers of Black Guillemots were observed, evidence of their breeding status in this area. Summer was the only season that loons were not observed off Lingan, when most adults were nesting on inland lakes.

The number of species observed off the Lingan Power Plant approximately doubled from summer to fall (Table 8). Most of the summer resident species remained during fall but there was an influx of species that had finished breeding elsewhere. Although the locally-breeding gulls were still the most numerous, Bonaparte's *(Larus philadelphia)* and Ring-billed *(L. delawarensis)* Gulls were recorded both feeding and resting in the area. Common and Red-throated *(Gavia stellata)* Loons were seen fishing in the deeper waters off the coast. There were occasional sightings of sea ducks, as they

began migrating towards wintering areas. There was also an influx of American Black Ducks, as adults and young-of-the-year moved away from summer breeding areas.

Table 7. Summer Survey Results for Lingan Power Plant

SPECIES GROUP	SPECIES	NUMBER FEEDING PER SURVEY Maximum	NUMBER FEEDING PER SURVEY Mean	NUMBER PRESENT PER SURVEY Maximum	NUMBER PRESENT PER SURVEY Mean
	Double-crested Cormorant	6	3.0	40	31.0
	Great Cormorant	18	9.3	140	120.7
CORMORANTS TOTAL		24	12.3	174	151.7
CROWS & RAVENS TOTAL	(American Crow)	10	6.7	10	6.7
	Great Black-backed Gull	17	7.3	50	35.3
	Herring Gull	34	15.7	110	44.0
	Iceland Gull	2	0.7	2	0.7
GULLS TOTAL		53	23.7	153	80.0
HERONS TOTAL	(Great Blue Heron)	1	0.3	1	0.3
SEABIRDS TOTAL	(Black Guillemot)	16	7.0	16	8.3
RAPTORS TOTAL	(Northern Harrier)	1	0.7	1	0.7
SHOREBIRDS TOTAL	(Spotted Sandpiper)	3	1.0	3	1.0

Because warm-water effluent from the power plant kept this area ice-free throughout the winter, its major significance was as an overwintering area for waterfowl and gulls. Both species diversity and overall numbers of birds were greatest in winter, as indicated by the large numbers of many overwintering species seen (black ducks, scaup, Canada Geese and Iceland Gulls). In summer, the waters and cliffs off Lingan served as breeding habitat for cormorants, gulls and Black Guillemots. The only major migration through this area seemed to be of Red-breasted Mergansers in the spring, although many species of shorebirds stopped off at nearby Dominion Beach (see Figure 3) on their fall migration (Hicklin 1994; Hicklin 1996).

Table 8. Fall Survey Results for Lingan Power Plant

SPECIES GROUP	SPECIES	NUMBER FEEDING PER SURVEY Maximum	Mean	NUMBER PRESENT PER SURVEY Maximum	Mean
	Double-crested Cormorant	8	4.1	48	18.4
	Great Cormorant	5	1.0	185	96.9
CORMORANTS TOTAL		9	5.1	233	115.3
CROWS & RAVENS TOTAL	(American Crow)	14	6.6	14	6.6
	American Black Duck	28	7.0	37	12.3
	Mallard	0	0.0	1	0.1
DABBLING DUCKS TOTAL		28	7.0	38	12.4
	Bonaparte's Gull	9	2.4	16	5.0
	Common Black-headed Gull	0	0.0	2	0.3
	Common Tern	11	1.9	11	1.9
	Great Black-backed Gull	10	4.4	100	29.9
	Herring Gull	32	9.6	84	31.1
	Ring-billed Gull	12	5.3	16	6.7
GULLS TOTAL		61	23.6	203	74.9
	Common Loon	1	0.3	1	0.3
	Red-throated Loon	1	0.1	1	0.1
LOONS TOTAL		1	0.4	1	0.4
	Black Guillemot	24	3.4	24	3.4
	Northern Gannet	2	0.3	2	0.3
SEABIRDS TOTAL		24	3.7	24	3.7
RAPTORS TOTAL	(Northern Harrier)	1	0.1	1	0.1
	Common Eider	1	0.1	1	0.1
	Surf Scoter	1	0.1	1	0.1
	White-winged Scoter	1	0.1	1	0.1
SEA DUCKS TOTAL		2	0.4	2	0.4

3.3 Sydney River

All surveys along the Sydney River (Figure 4) were conducted in the winter months (November to March) with the exception of one spring survey in April. The stretch of river under the three main bridges usually remained open all winter, partly due to the incoming tide forcing warm bottom water to the surface, and partly due to urban and industrial effluent. Although data on pollution levels for this section of river are sparse, levels of PAHs and metals in harbour sediments and biota generally decrease with increasing distance from the mouth of Muggah Creek, the major pollution source for

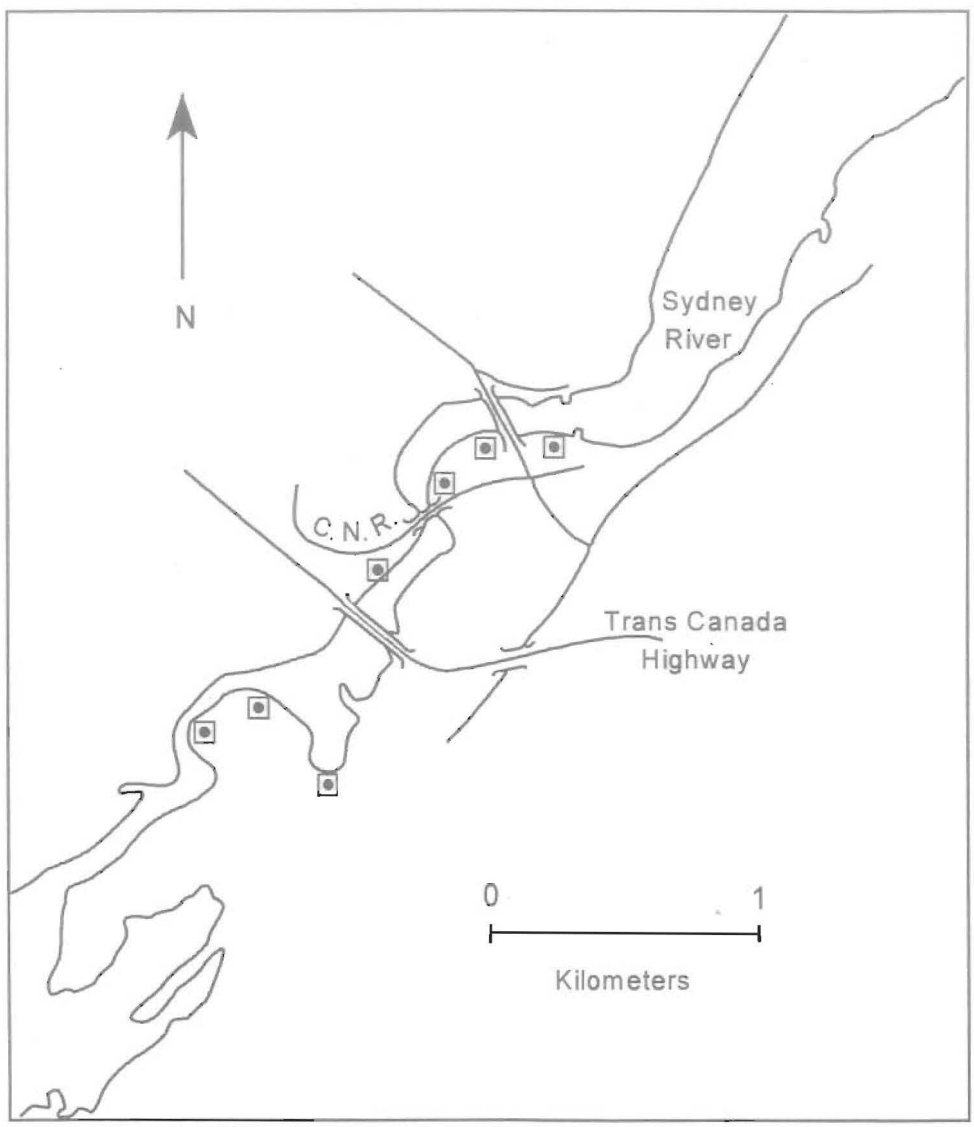

Figure 4. The area of Sydney River in the vicinity of the three bridges where surveys were conducted. Observation points are indicated with a □.

Sydney Harbour (Vandermeulen 1989, Matheson *et al.* 1983, Kieley *et al.* 1988). Circulation data for Sydney Harbour indicate that water from Muggah Creek may be transported to the inner reaches of the South Arm, and hence up the Sydney River, on the incoming tide and in spring when the wind direction is predominantly from the north (Hildebrand 1982, Matheson *et al.* 1983). During most of the year circulation is generally in the other direction (see Section 3.4). A number of minor point sources of pollution also exist in this area of river (P. Lane and Associates Ltd. 1991).

Because this part of the Sydney River is relatively sheltered and ice-free, substantial numbers of various species of ducks overwintered there. American Black Ducks, Mallards *(Anas platyrhynchos)* and Common Goldeneye were especially abundant (Table 9). It was also a prime overwintering area for Great Black-backed, Herring and Iceland Gulls as well as American Crows (Table 9). Common Mergansers *(Mergus merganser)* were regularly observed foraging in this part of the river throughout the winter and Bald Eagles were occasionally seen.

Table 9. Winter Survey Results for the Sydney River

		NUMBER FEEDING PER SURVEY		NUMBER PRESENT PER SURVEY	
SPECIES GROUP	SPECIES	Maximum	Mean	Maximum	Mean
CROWS & RAVENS TOTAL (American Crow)		7	1.8	11	5.3
	American Black Duck	33	20.5	120	58.3
	American Green-winged	1	0.3	1	0.3
	Mallard	60	39.0	118	70.0
DABBLING DUCKS TOTAL		91	59.8	233	128.7
	Barrow's Goldeneye	3	1.0	3	1.0
	Bufflehead	15	9.0	15	9.0
	Common Goldeneye	61	30.2	61	30.2
DIVING DUCKS TOTAL		70	40.2	70	40.2
TOTAL EAGLES	(Bald Eagle)	0	0.0	2	0.3
	Great Black-backed Gull	12	3.5	24	12.5
	Glaucous Gull	1	0.2	1	0.2
	Herring Gull	52	26.8	96	57.0
	Iceland Gull	11	4.0	28	14.5
GULLS TOTAL		65	34.5	143	84.2
MERGANSERS	(Common Merganser)	9	1.8	9	2.7

Although spring survey data are sparse, many of the overwintering species were still present during the single survey on 30 April 1994 (Table 10).

Table 10. Spring Survey Results for the Sydney River

		NUMBER FEEDING PER SURVEY		NUMBER PRESENT PER SURVEY	
SPECIES GROUP	SPECIES	Maximum	Mean	Maximum	Mean
CORMORANTS	Double-crested Cormorant	5	5.0	5	5.0
CROWS & RAVENS TOTAL	(American Crow)	2	2.0	4	4.0
	American Black Duck	2	2.0	2	2.0
	Mallard	4	4.0	7	7.0
DABBLING DUCKS TOTAL		6	6.0	9	9.0
DIVING DUCKS TOTAL	(Common Goldeneye)	0	0.0	4	4.0
EAGLES TOTAL	(Bald Eagle)	1	1.0	1	1.0
	Great Black-backed Gull	2	2.0	2	2.0
	Herring Gull	4	4.0	10	10.0
	Iceland Gull	2	2.0	2	2.0
	Ring-billed Gull	4	4.0	5	5.0
GULLS TOTAL		12	12.0	19	19.0

3.4 Sydney Harbour

Volunteers conducted weekly surveys along the east coast of the South Arm of Sydney Harbour (including the outermost stretch of Sydney River) from the Department of National Defence Dry Dock to South Bar (see Figure 5) from 23 June to 3 August 1994. A total of seven summer surveys and one fall survey were completed. The primary source of pollutants into Sydney Harbour has been from Sydney Steel Corporation (SYSCO) operations via Muggah Creek. Water circulation data showed that effluent from Muggah Creek flowed generally seaward into the South Arm, resulting in decreased pollution levels with increasing distance from Muggah Creek (Vandermeulen 1989, Matheson *et al.* 1983, Kieley *et al.* 1988, P. Lane and Associates Ltd. 1986). The diversity of benthic communities showed the opposite geographical trend, with the least diversity in Muggah Creek and progressively more diverse communities at increasing distances from SYSCO (Vandermeulen 1989).

Most species observed in the South Arm were summer residents, except during late July and early August when an influx of migrating shorebirds was recorded. This section of Sydney Harbour was

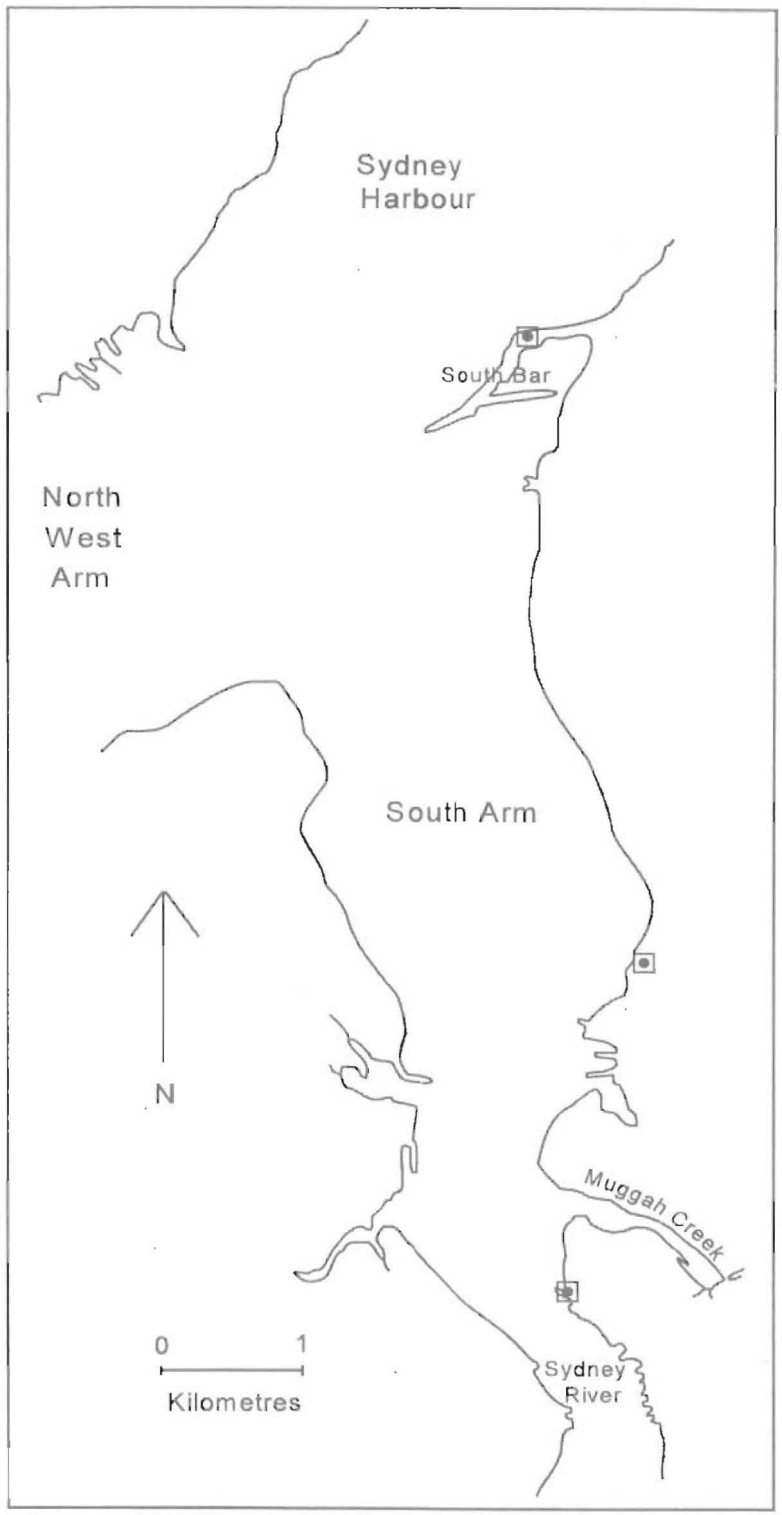

Figure 5. Survey area along the east side of the South Arm of Sydney Harbour. Observation points are indicated with a □

a regular foraging area for Double-crested Cormorants and Great Blue Herons (Table 11). A number of other fish-eating species such as a Bald Eagle, Razorbill *(Alca Torda)*, Common Loon, and American Bittern *(Botaurus lentiginous)* were also observed.

Table 11. Summer Survey Results for the South Arm of Sydney Harbour

		NUMBER FEEDING PER SURVEY		NUMBER PRESENT PER SURVEY	
SPECIES GROUP	SPECIES	Maximum	Mean	Maximum	Mean
CORMORANTS TOTAL	(Double-crested Cormorant)	23	9.3	31	16.9
	American Crow	6	1.7	6	2.1
	Common Raven	3	0.4	3	0.6
CROWS & RAVENS TOTAL		7	2.1	8	2.7
	American Black Duck	2	0.3	2	0.3
	Mallard	0	0.0	0	0.0
DABBLING DUCKS TOTAL		2	0.3	2	0.3
EAGLES TOTAL	(Bald Eagle)	1	0.1	1	0.1
	Common Tern	3	1.1	4	1.3
	Great Black-backed Gull	3	1.0	28	6.4
	Herring Gull	30	5.9	105	18.0
	Ring-billed Gull	0	0.0	10	1.4
GULLS TOTAL		33	8.0	133	27.1
	American Bittern	0	0.0	1	0.1
	Great Blue Heron	12	2.1	12	2.3
HERONS TOTAL		12	2.1	12	2.4
LOONS TOTAL	(Common Loon)	1	0.1	1	0.1
SEABIRDS TOTAL	(Razorbill)	0	0.0	1	0.1
	Greater Yellowlegs	4	0.6	4	0.6
	Least Sandpiper	2	0.3	2	0.3
	Lesser Yellowlegs	4	0.6	4	0.6
	Piping Plover	1	0.1	1	0.1
	Semipalmated Plover	0	0.0	2	0.3
	Spotted Sandpiper	25	6.3	25	7.0
SHOREBIRDS TOTAL		33	8.3	33	9.3

Gulls were the most numerous species group, especially the locally-breeding Great Black-backed and Herring Gulls. Common Terns were also observed, primarily at Southeast Bar where formerly there was a small tern colony. Spotted Sandpipers *(Actitis macularia)* were especially common (Table 11) and the gravelly shoreline of the South Arm is ideal habitat for this species (Erskine 1992). Small numbers of a few species of shorebirds were seen at Southeast Bar in late July (Table 11) and early August (Table 12), including a Piping Plover *(Chradrius melodus)*, classified as an endangered species in Canada (Flemming 1994).

Table 12. Fall Survey Results for the South Arm of Sydney Harbour (one survey only).

		NUMBER FEEDING PER SURVEY		NUMBER PRESENT PER SURVEY	
SPECIES GROUP	SPECIES	Maximum	Mean	Maximum	Mean
CORMORANTS TOTAL	(Double-crested Cormorant)	1	1.0	10	10.0
	Great Black-backed Gull	6	6.0	15	15.0
	Herring Gull	16	16.0	34	34.0
GULLS TOTAL		22	22.0	49	49.0
HERONS TOTAL	(Great Blue Heron)	3	3.0	3	3.0
SHOREBIRDS TOTAL	(Greater Yellowlegs)	4	4.0	4	4.0

4.0 BIRD SPECIES FOR ECOLOGICAL RISK ASSESSMENT OF THE SYDNEY TAR PONDS

Ecological Risk Assessment (ERA) is a method of estimating the risks that toxic chemicals in the environment pose to a selected component of an ecosystem, such as wildlife. An ERA of Sydney Tar Ponds would serve two purposes: 1) to assess the potential risks of current contamination levels to local wildlife; and 2) to provide guidance on the level of remediation required to protect wildlife in the future. Details on the objectives and methods of ERA are provided in Suter (1993), Canadian Council of Ministers of the Environment (1994), Gaudet *et al.* (1994) and United States Environmental Protection Agency (1992).

An initial step in conducting an ERA is choosing particular species that will be used in the assessment, known as receptor (or indicator) species. To best assess risks to wildlife from persistent, bioaccumulative toxic chemicals, specific criteria are used to select the most appropriate receptor species. The species most at risk tend to be those that are long-lived, are high in the food chain, eat highly contaminated prey and spend much of the year in a contaminated area.

The waterbird surveys were initiated to identify which bird species were present and feeding at the Tar Ponds, during which months of the year and in what numbers. The mean number of each bird species present and feeding per survey is shown for each season in Tables 13 - 16. Each table also indicates the number of months per season that each species was present and observed feeding. From these data it can be seen that the most abundant species present year-round were American Crow, American Black Duck, Herring Gull and European Starling. Iceland Gulls were common in winter and spring. Double-crested Cormorants and Great Blue Herons fed in the Tar Ponds in the summer. Several shorebirds species were present and feeding for one month in the fall during their southward migration.

Table 13. Bird species observed at the Sydney Tar Ponds in the five winter months (November - March); average per survey and number of months feeding and present. The five most abundant species are bolded. Eleven surveys were conducted.

SPECIES	Mean # Feeding per Survey	Number of Months Feeding	Mean # Present per Survey	Number of Months Present
American Crow	**9.8**	**5**	**9.9**	**5**
Common Raven	0.5	2	0.5	3
American Black Duck	**3.8**	**5**	**25.9**	**5**
Mallard	0.0	0	0.2	1
Northern Pintail	0.0	0	0.1	1
Common Black-headed Gull	1.0	2	1.0	2
Great Black-backed Gull	**7.4**	**4**	**45.7**	**5**
Glaucous Gull	0.1	1	0.4	3
Herring Gull	3.1	4	14.2	5
Iceland Gull	**18.9**	**5**	**33.6**	**5**
Ring-billed Gull	0.6	1	0.9	1
Common Snipe	0.1	1	0.1	1
Common Redpoll	0.7	1	0.7	1
European Starling	**25.5**	**4**	**35.2**	**5**
House Sparrow	0.2	1	0.2	1
Rock Dove	0	0	2.1	4

Table 14. Bird species observed at the Sydney Tar Ponds in the two spring months (April and May); average per survey and number of months feeding and present. The five most abundant species are in bold. Six surveys were conducted.

SPECIES	Mean # Feeding per Survey	Number of Months Feeding	Mean # Present per Survey	Number of Months Present
American Crow	**2.3**	**2**	**3.0**	**2**
Common Raven	0.0	0	0.3	1
American Black Duck	0.3	1	0.3	2
Mallard	0.3	1	0.7	1
Common Tern	0.3	1	0.3	1
Great Black-backed Gull	1.0	2	1.7	2
Herring Gull	**3.3**	**2**	**4.8**	**2**
Iceland Gull	**2.7**	**2**	**3.3**	**2**
Ring-billed Gull	**1.8**	**2**	**1.8**	**2**
American Goldfinch	0.0	0	0.7	2
European Starling	1.0	1	5.2	2
House Sparrow	0.3	1	0.3	1
Mourning Dove	0.0	0	0.2	1
Song Sparrow	**1.3**	**1**	**5.8**	**2**
Tree Sparrow	0.0	0	0.8	1
Rock Dove	0.0	0	3.0	2

Table 15. Bird species observed at the Sydney Tar Ponds in the two summer months (June and July); average per survey and number of months feeding and present. The five most abundant species are in bold. Sixteen surveys were conducted.

SPECIES	Mean # Feeding per Survey	Number of Months Feeding	Mean # Present per Survey	Number of Months Present	Evidence of Breeding
Double-crested Cormorant	**1.6**	**2**	**2.0**	**2**	**no**
American Crow	**0.9**	**2**	**2.1**	**2**	**no**
Common Raven	0.2	2	0.7	2	no
American Black Duck	0.1	2	0.7	2	yes
Common Tern	0.3	2	0.4	2	no
Herring Gull	**0.9**	**2**	**1.1**	**2**	**no**
Ring-billed Gull	0.5	2	0.5	2	no
Great Blue Heron	0.1	2	0.1	1	no
Killdeer	**0.7**	**1**	**0.7**	**1**	**yes**
Rock Dove	0.5	1	0.5	1	no
Tree Swallow	0	0	0.2	2	yes
European Starling	**3.8**	**2**	**8.6**	**2**	**no**
Song Sparrow	0.1	1	3.4	2	yes

Table 16. Bird species observed at the Sydney Tar Ponds in the three fall months (August to October); average per survey and number of months feeding and present. The five most abundant species are in bold. Eight surveys were conducted.

SPECIES	Mean # Feeding per Survey	Number of Months Feeding	Mean # Present per Survey	Number of Months Present
American Crow	**1.8**	**3**	**2.4**	**3**
American Black Duck	0.5	2	1.9	2
Great Black-backed Gull	**1.3**	**2**	**1.8**	**3**
Herring Gull	**5.5**	**2**	**7.4**	**3**
Ring-billed Gull	**9.5**	**3**	**10.3**	**3**
American Bittern	0.1	1	0.3	1
Black-bellied Plover	0.3	1	0.3	1
Greater Yellowlegs	0.3	1	0.3	1
Killdeer	0.3	1	0.3	1
Lesser Yellowlegs	0.5	1	0.5	1
Short-billed Dowitcher	0.1	1	0.1	1
Semipalmated Plover	0.1	1	0.1	1
Semipalmated Sandpiper	0.1	1	0.1	1
Stilt Sandpiper	0.1	1	0.1	1
Mourning Dove	0.3	1	0.3	1
European Starling	0.6	1	1.9	2
American Goldfinch	0.3	1	0.4	2
Song Sparrow	**2.6**	**2**	**3**	**2**

Figures 6 - 9 show the precise locations within the Tar Ponds where the most birds of each species group were observed in each season. Most birds were observed along the south and east margins of the pond, where mud flats emerge at low tide. In mid-winter, small areas of open water were usually present near the mouth of Coke Oven Brook and in the east section of the main Tar Pond. Dabbling ducks, gulls and crows used these ice-free areas. In spring, the greatest number of birds of all species groups were recorded along the eastern margin of the main pond. In summer, Killdeer nested near the eastern edge of the pond and a brood of American Black Ducks was frequently seen along the southwest shoreline. Double-crested Cormorants and a Great Blue Heron fed close to the south and east pond margins. In fall, shorebirds frequented the exposed flats along the pond's east boundary and up to two American Bitterns were observed near the mouth of Wash Brook at the southern tip of the pond.

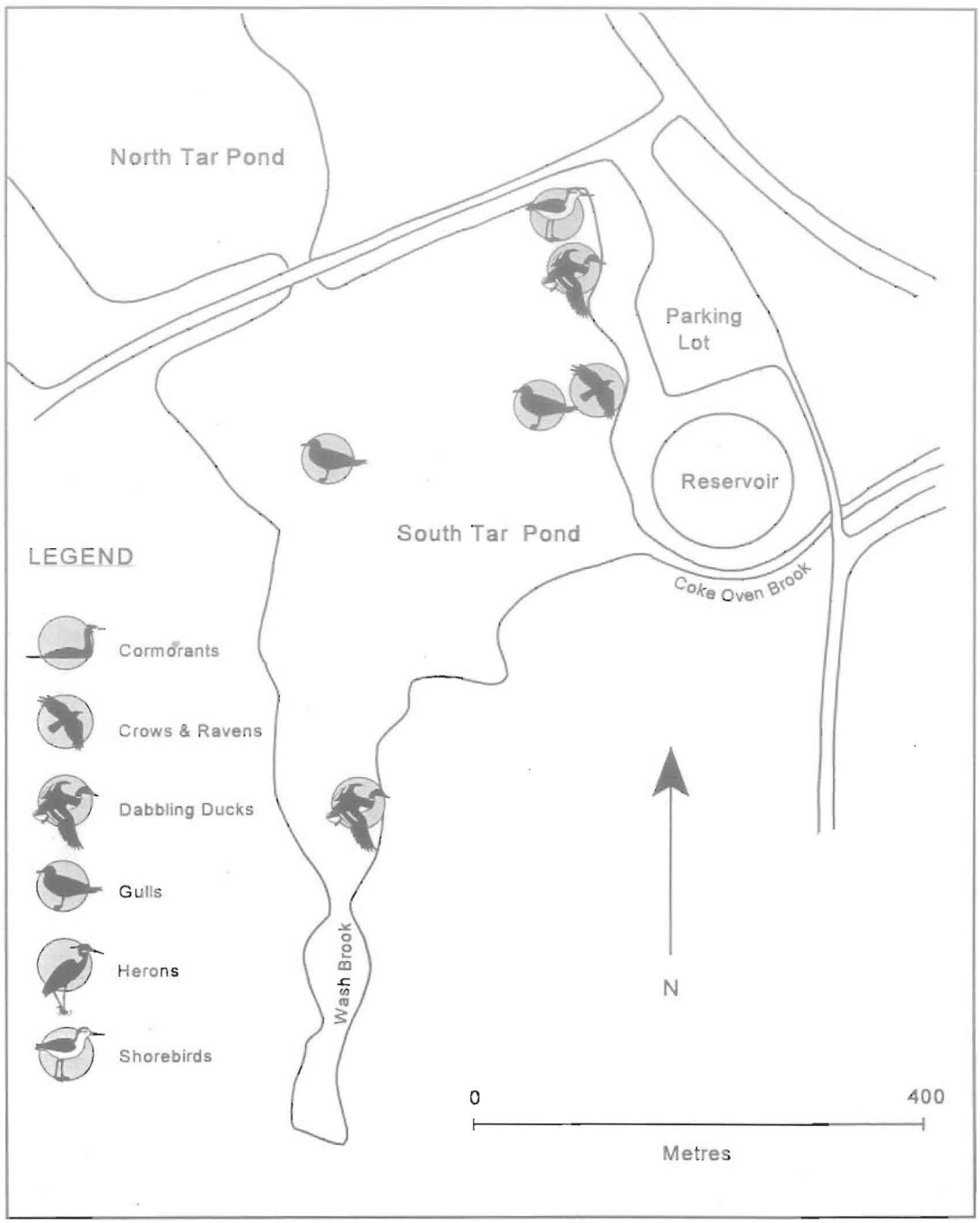

Figure 6. Location of species groups at the Sydney Tar Ponds during the winter. A symbol on the map indicates where the greatest numbers of birds of that species group were observed.

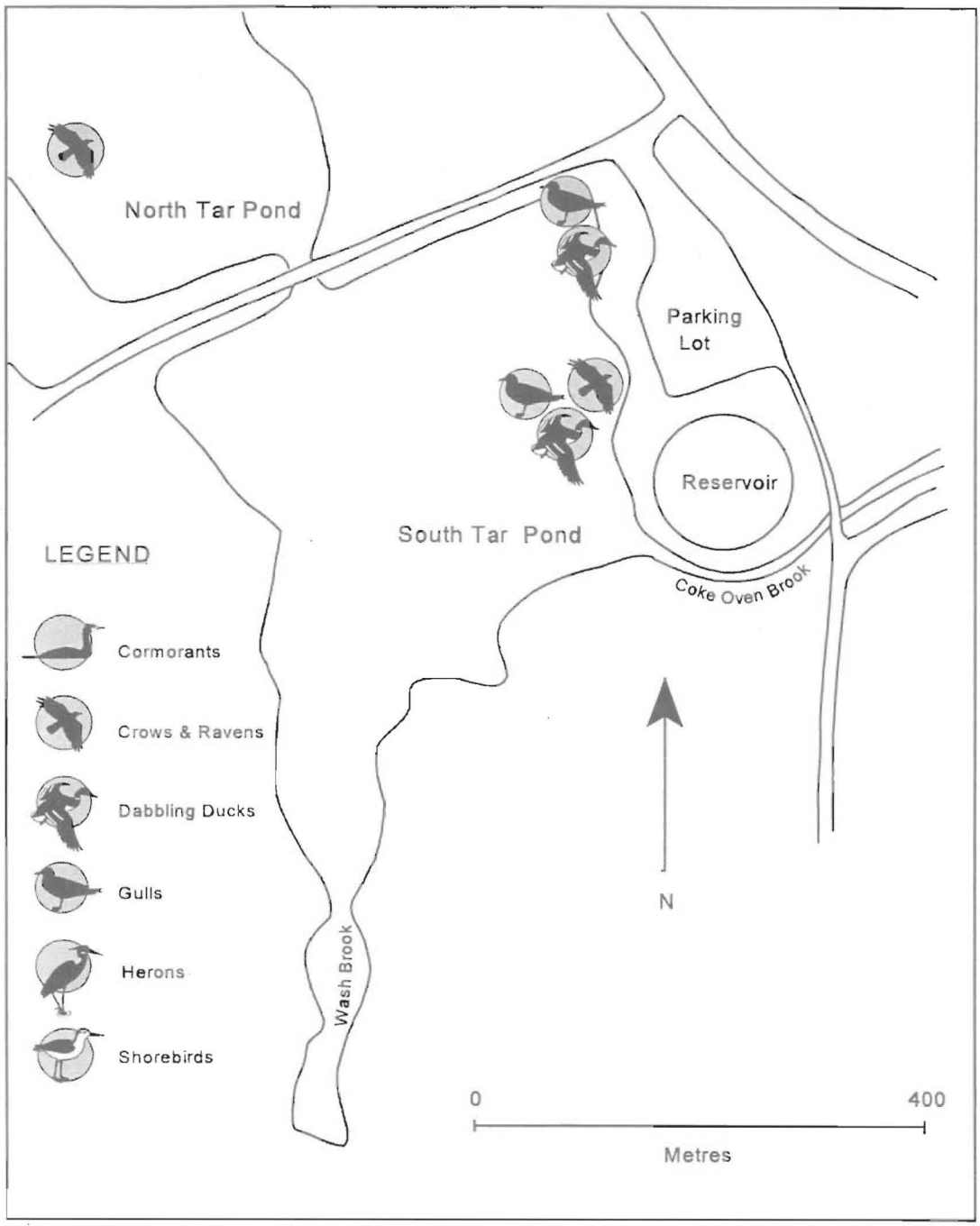

Figure 7. Location of species groups at the Sydney Tar Ponds during the spring. A symbol on the map indicates where the greatest numbers of birds of that species group were observed.

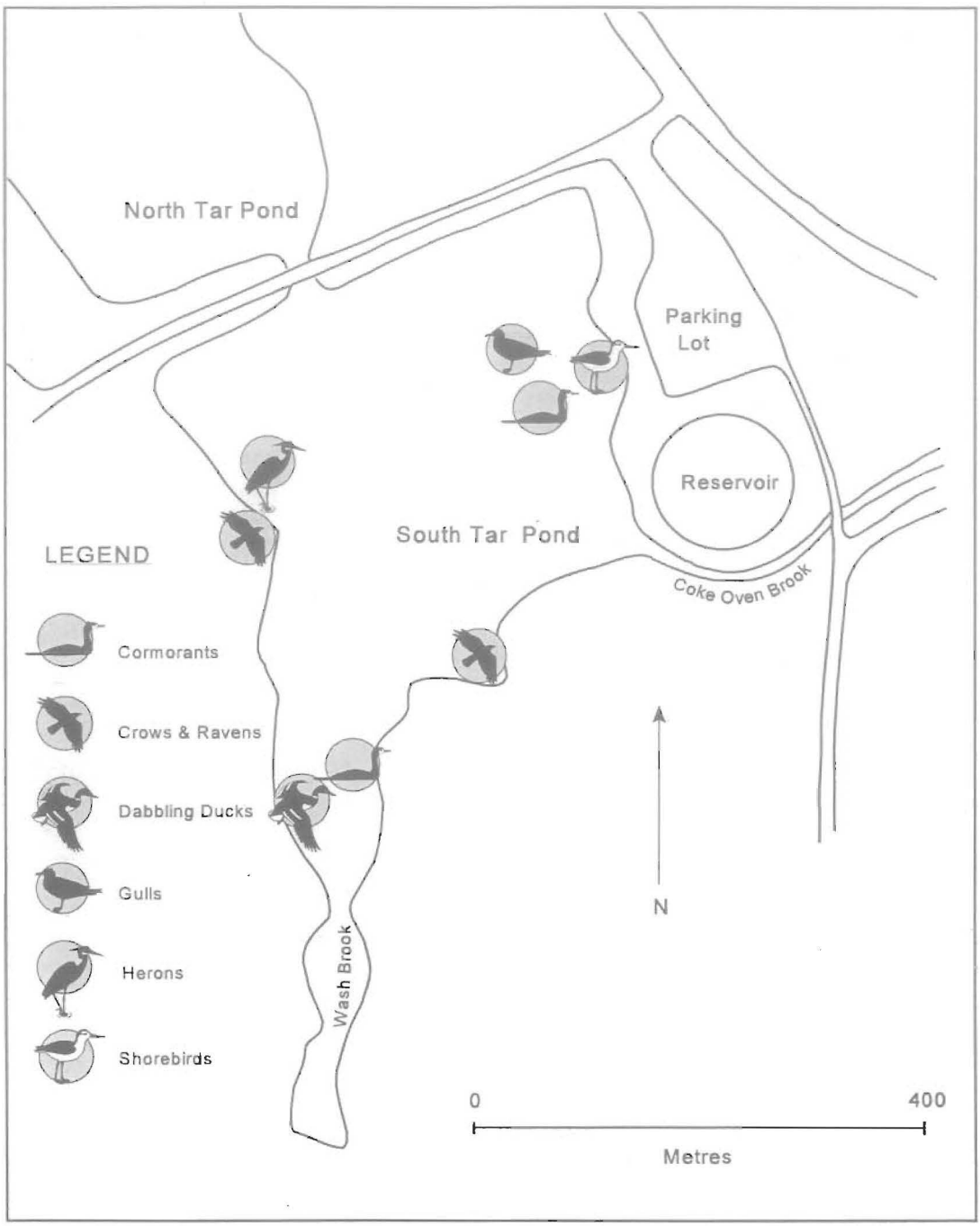

Figure 8. Location of species groups at the Sydney Tar Ponds during the summer. A symbol on the map indicates where the greatest numbers of birds of that species group were observed.

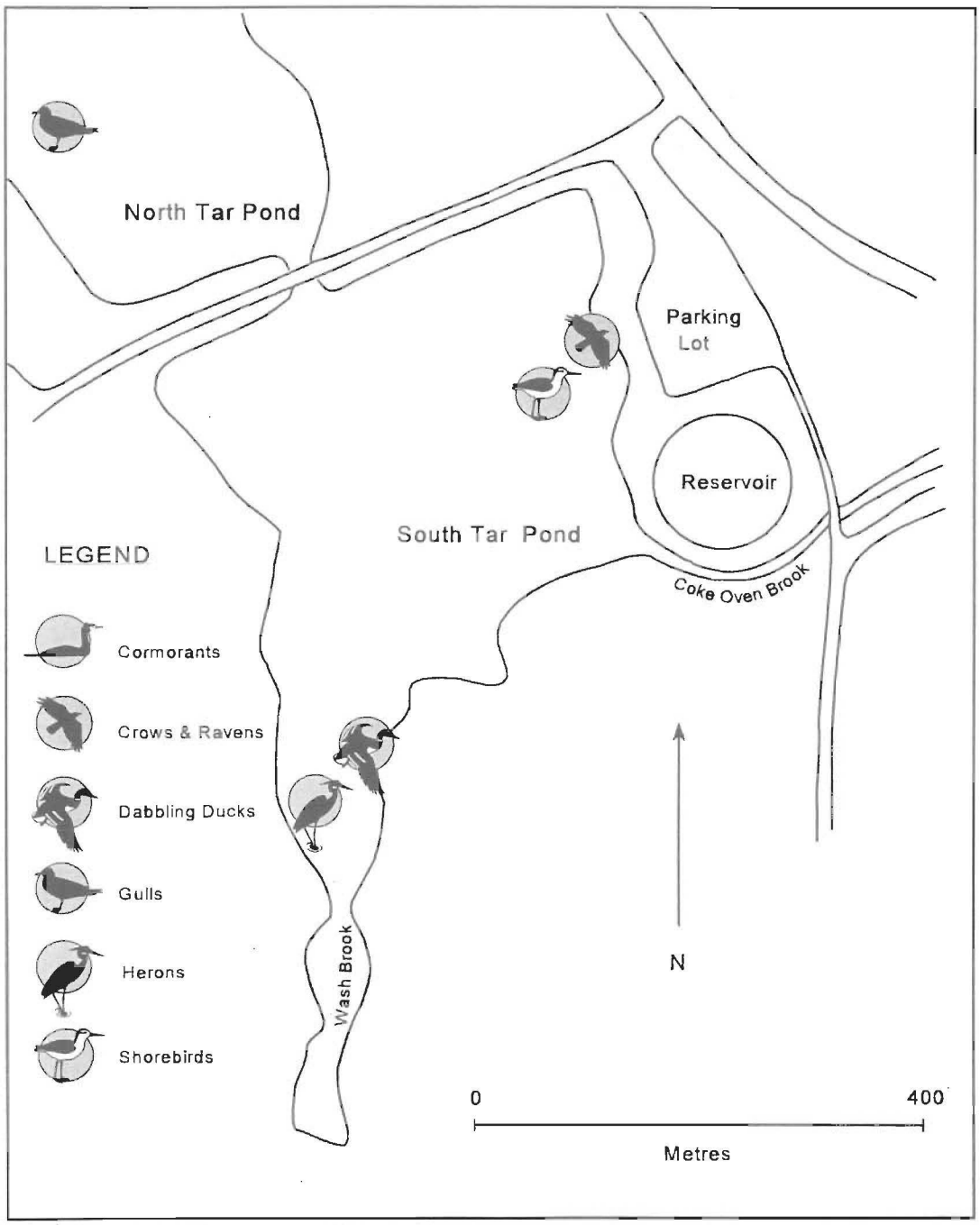

Figure 9. Location of species groups at the Sydney Tar Ponds during the fall. A symbol on the map indicates where the greatest numbers of birds of that species group were observed.

These data confirm that several species meet the criteria to be considered as receptor species for an ERA of Sydney Tar Ponds (Table 17). Depending on the data available on contaminant levels in different environmental media (sediment, soil, etc.) and biota (plants, aquatic invertebrates, fish, small mammals, etc.), receptor species could be chosen to reflect the different food webs involved, e.g. Herring Gull or Iceland Gull for a fish-eating bird, American Black Duck or Lesser Yellowlegs for an aquatic invertebrate-feeding bird, and European Starling or Song Sparrow for a terrestrial-feeding bird.

Table 17. Potential receptor species for ecological risk assessment of Sydney Tar Ponds

SPECIES	# Months Feeding per Year	# Months Present per Year	FORAGING HABITAT	FOOD HABITS
Double-crested Cormorant	2	2	aquatic	fish
American Crow	12	12	terrestrial, aquatic	omnivorous
American Black Duck	10	11	aquatic	invertebrates, plants
Great Black-backed Gull	8	10	aquatic	fish and birds
Iceland Gull	7	7	aquatic	fish, scavenged material
Ring-billed Gull	8	8	terrestrial, aquatic	fish, scavenged material
Herring Gull	10	12	terrestrial, aquatic	fish, scavenged material
European Starling	8	11	terrestrial	invertebrates, plants
Song Sparrow	4	6	terrestrial	invertebrates, plants
Lesser Yellowlegs	1	1	terrestrial, aquatic	invertebrates

Since the Tar Ponds is a relatively small area, it is doubtful that many of the larger bird species spent all their time there during the months they were present. Nevertheless, for the purposes of a preliminary or screening level ERA, worst-case assumptions would be used to assess whether there was any potential for adverse effects in the receptor species. These worst case assumptions could include feeding only at the Tar Ponds, feeding only on contaminated prey, feeding only on the most contaminated prey and feeding at the Tar Ponds for several months. If, given these worst case assumptions, the ERA found no risks to wildlife receptors, their safety would be reasonably certain. On the other hand, indications of serious risks to wildlife from an initial screening-level ERA would identify those species and contaminants deserving more detailed assessment.

5.0 SUMMARY AND CONCLUSIONS

In spite of high pollution levels and extensive urban and industrial development, the waters around Sydney supported a rich diversity and abundance of waterbirds. Throughout the course of a year, a total of 24 species of waterbirds fed and rested at the Sydney Tar Ponds, the most contaminated of the four survey sites. The Tar Ponds provided overwintering habitat for American Black Ducks, gulls and crows and summer breeding habitat for black ducks, Killdeer and Song Sparrows. Species diversity was greatest (15 species) in the fall when there was an influx of migrating shorebirds.

The greatest species diversity of all four survey areas was recorded at the Lingan Power Plant, where a total of 33 species of waterbirds were recorded. The ice-free conditions maintained by the plant's warm-water effluent make these waters especially important as overwintering habitat for waterfowl and gulls, particularly American Black Ducks, Greater Scaup, Great Black-backed Gulls and Iceland Gulls. Both species diversity (24 species) and overall numbers of birds were greatest in winter. In summer, the cliffs and waters near the power plant supported breeding cormorants, gulls and Black Guillemots.

Winter surveys along the Sydney River demonstrated that areas of river that were kept ice-free as a result of urban and industrial effluent were also heavily used by overwintering ducks, especially American Black Ducks, Mallards, Common Goldeneye, Bufflehead and Common Mergansers, and gulls, primarily Great Black-backed, Herring and Iceland Gulls. A total of 14 species of waterbirds were recorded between November and April of 1994 and 1995.

Many locally-breeding fish-eating species including Double-crested Cormorants, Common Loons, Great Black-backed and Herring Gulls, Common Terns and Great Blue Herons foraged regularly along the east side of the South Arm of Sydney Harbour throughout the summer. Twenty-one species of waterbirds were recorded in just six weeks (late June to early August) during the summer of 1994.

Volunteer-based surveys such as those that form the basis of this project are an invaluable way to carry out labour intensive aspects of ecological monitoring. Surveys conducted by volunteers are a cost effective way to gather large quantities of ecological data over long time periods and at dispersed geographic locations. They provide a means by which local residents can become involved in the study and protection of their environment. Increased public participation in environmental monitoring ultimately fosters increased awareness of local as well as global environmental issues. Without an initial degree of local concern for the environment and the willing participation of local citizens, however, volunteer-based monitoring projects are difficult to get started. For example, to conduct waterbird surveys, we depended upon the participation of local naturalists, who were already skilled bird-watchers.

In order for volunteer-based monitoring projects to be successful, volunteers must be adequately trained and they should be motivated through regular feedback. Coordination and supervision of volunteers by a wildlife biologist is necessary to maintain data quality and to prevent duplication of effort or gaps in the resulting database. Survey methods need to be well organised and data collection tasks precisely defined, so volunteers can conduct wildlife surveys without uncertainty about what to do and when to do it. This way, the data submitted by volunteers are consistent in quality and format, and form a vital and useful part of the overall scientific project, and the contributions of volunteers will be maximized. It is also important that sufficient data are collected in order for ecological monitoring to produce representative results. Volunteers thus need to be committed to long-term monitoring. We considered that two years of data were the minimum necessary to develop reliable baseline information on bird use of the waters around Sydney.

The survey data collected in this study demonstrated that the waters off the Lingan Power Plant and the Sydney Tar Ponds were used by many species of aquatic birds throughout the year, that open areas of the Sydney River were important overwintering habitat for ducks and gulls and that the South Arm of Sydney Harbour served as foraging habitat for resident fish-eating species. This information establishes a baseline against which to assess the effects of any habitat improvement as a result of the implementation ACAP Cape Breton's comprehensive environmental management plan, or of any further habitat degradation. The significance of the Sydney Tar Ponds as waterbird habitat may be overshadowed by the high levels of toxic contaminants present. This could be determined by conducting an Ecological Risk Assessment. Despite pollution, development and past habitat loss, the waters around Sydney still support a diverse community of waterbirds. There is a need to protect and remediate existing habitat if this diversity is to be preserved, or if there is to be any recovery toward historical wildlife population levels.

6.0 LITERATURE CITED

Canadian Council of Ministers of the Environment. 1994. A Framework for Ecological Risk Assessment: General Guidance. The National Contaminated Sites Remediation Program. Final Report, 51 p.

Canadian Wildlife Service - Atlantic Region. 1996. Waterbirds of Sydney/Les Oiseaux Aquatiques de Sydney. 1996. (Poster) Environment Canada, Sackville, NB.

Erskine, A.J. 1992. Atlas of Breeding Birds of the Maritime Provinces. Nova Scotia Museum and Nimbus Publishing Ltd., Halifax, N.S.

Fleming, S.P. (ed.) 1994. The 1991 International Piping Plover Census in Canada. Can. Wildl. Serv. Occ. Pap. No. 82.

Gaudet, C., EVS Environmental Consultants, and Environment and Social Systems Analysts. 1994. A Framework for Ecological Risk Assessment at Contaminated Sites in Canada: Review and Recommendations. Ecosystem Conservation Directorate, Evaluation and Interpretation Branch. Ottawa, Ontario. Scientific Series No. 199.

Hicklin, P.W. (ed.) 1994. Calidris, The Maritimes Shorebird Survey Newsletter. No. 2, April 1994. Can. Wildl. Serv., Atlantic Region. 13 p.

Hicklin, P.W. (ed.) 1996. Calidris, The Maritimes Shorebird Survey Newsletter. No. 4, 1996. Can. Wildl. Serv., Atlantic Region. 13 p.

Hildebrand, L.P. 1982. Environmental Quality in Sydney and Northeast Industrial Cape Breton, Nova Scotia. Env. Canada, Env. Prot. Serv. Surveillance Report EPS-5-AR-82-3. 89 p.

Kieley, K.M., P.A. Hennigar, R.A.F. Matheson, and W.R. Ernst. 1988. Polynuclear Aromatic Hydrocarbons and Heterocyclic Aromatic Compounds in Sydney Harbour, Nova Scotia, A 1986 Survey. Env. Canada, Env. Prot. Serv. Surveillance Report, EPS-5-AR-88-7. 41p.

Matheson, R.A.F., G.L. Trider, W.R. Ernst, K.G. Hamilton and P.A. Hennigar. 1983. Investigation of Polynuclear Aromatic Hydrocarbon Contamination of Sydney Harbour, Nova Scotia. Env. Canada, Env. Prot. Serv. Surveillance Report, EPS-5-AR-83-6. 86 p.

P. Lane and Associates, Ltd. 1986. Risks to Migratory Birds: Industrial Point Sources of Toxic Chemicals in Atlantic Canada. Prepared for Can. Wildl. Serv., Atlantic Region, Sackville, NB.

P. Lane and Associates Ltd. 1991. Sources and Releases of Toxic substances in the Atlantic Region, Final Report. Prepared for the Conservation and Protection Service, Environment Canada, Dartmouth, NS.

Suter, Glenn W. II. 1993. Ecological Risk Assessment. Lewis Publishers, Chelsea, Michigan.

Sydney Tar Ponds Clean-up. 1993. PCB Contamination Interim Report No.2. ACRES International Ltd., Halifax, NS.

United States Environmental Protection Agency, 1992. Framework for Ecological Risk Assessment. Risk Assessment Forum. EPA/630/R-92/001.

Vandermeulen, J.H. 1989. Polynuclear Aromatic Hydrocarbon and Heavy Metal Pollution of the Sydney Estuary: Summary and Review of Studies to 1987. Can. Tech. Rep. Hydrography and Ocean Sciences. No. 108.

8.0 APPENDICES

Appendix 1.

Survey instructions as given to volunteers

EXPOSURE OF WILDLIFE TO TOXIC POLLUTION AT ACAP SITES
MONITORING WILDLIFE USE OF ACAP AREAS

Instructions for Conducting Avifaunal Surveys 1994 - 1995

INTRODUCTION

Purpose of the Project

This project will help determine the degree to which birds are exposed to toxic pollution at each ACAP site. Year round monitoring of birds using waterways within ACAP areas will help identify which species may be most at risk from exposure to toxic chemical pollution and will provide an indication of any changes in habitat use that might result from an increase in pollution or clean-up efforts associated with an ACAP environmental management plan. As it would be impossible to exhaustively survey most ACAP sites due to their size and the complexity of the coastlines, we will concentrate on monitoring bird species using waterways with the greatest degree of toxic pollution. The surveys are designed to enable us to determine the species and number of birds present in well defined areas.

Data Analysis

The data you gather will eventually be put into a Geographic Information System Database. This will permit spatial mapping of bird concentrations that can be superimposed upon maps of toxic sediment deposition or correlated with the location of a proposed new development that may interfere with wildlife use of an area. The surveys will thus help identify unique locations or habitats within an ACAP site that are in need of protection or remedial environmental measures because of their importance to wildlife.

What do the Surveys Involve

Volunteers should choose a survey area that is convenient for them to monitor on a regular basis. An area close to where you live, work or commute or an area where you especially enjoy birding would be ideal. Locations are monitored for birds a minimum of once per month. (This my vary depending on the location and/or species surveyed.) If you are able to monitor a location more frequently your degree of commitment would be especially welcome as the data for that location would be more complete. Each survey should take only about one hour since a survey simply involves counting the number of birds of each species present and mapping the area in which they were seen. The nature of the surveys requires the ability to identify species of local waterbirds. If you are uncertain of your birding ability, first familiarize yourself with the species you are likely to see and use a bird guide for species you are unsure of. Surveys are a great way to improve your birding skills.

DETAILED INSTRUCTIONS FOR CONDUCTING SURVEYS

Mapping Bird Concentrations

Because we require precise geographic information on bird concentrations and habitat use it is necessary to indicate on a map the locations of groups of birds that you observe. You will be provided with data sheets and photocopies of maps specific for your observation location. It will not be possible to record all the detailed information required on the map, so this can be done on a data sheet that is completed to correspond to the map in the following way. Each time that you survey birds at one location you must complete one map sheet and one (or more, if necessary) corresponding data sheet(s). Enter the number "1" on the map at the exact location where the first distinct group of birds are seen. Then, on the data sheet, under the column titled *map locator number*, enter the number "1" and beside it add the detailed information about the birds in the correct columns as outlined in the following sections of these instructions. For the location of the second of group of birds seen, enter a number "2" on the map and beside "2" on the data sheet add the detailed information, and so on for each group of birds seen at that site on that date. (See the sample data sheet and map.)

Birds Using a Distinct Area - Zone of Use

If a group of birds is using (e.g. feeding or resting in) a sizeable area, please indicate this by drawing on the map an outline of the zone being used by the birds. Then, in the comments section, on the same line of data corresponding to the map locator number for that group of birds, note that you have drawn this zone of use on the map. Do not forget to put a map locator number inside or next to the outline of the zone of use that you have drawn on the map.

Total Area Surveyed

It is also necessary to standardize the total area that is monitored for birds during each survey. Always carry out observations from the same point each time and try to keep the boundaries of the area observed constant (for example, count only birds seen between the same two points each time). Indicate the total area surveyed by drawing boundaries around it on the map.

Number of Birds Engaged in Different Behaviours

The data sheets are set up so that you record the number of birds seen that are engaged in three different behaviours: feeding, resting or travelling. (Refer to the data sheets and to the sheet outlining behaviour categories.) The behaviour categories are broad enough so that all birds that you see should fit into a category. Scan the total observation area for birds; count all birds that you see but do not count any birds twice. If the number of birds engaged in a particular category of activity is between 1 - 25, count them and enter the number on the data sheet in the correct column. If there are more than 25 birds engaged in that behaviour, estimate the number according to the categories listed at the bottom of the data sheet, and then enter the **category letter** (not the estimated number of birds) on the data sheet.

Bird Behaviour

How the birds are using the habitat can determine the degree of exposure to toxic chemicals in the environment. That is why it is important to determine whether birds are feeding, loafing, staging or simply passing through an area. It will not always be possible to determine how the birds that you are observing are behaving and it can be even more difficult to decide how to define their behaviour and record it. Estimate as best you can how the birds are behaving and enter the number of birds engaged in that behaviour in the appropriate column on the data sheet. For the same reason it is also important to determine whether or not a species is breeding in a polluted area. If you see clear evidence of breeding behaviour, as outlined in the section on "BEHAVIOUR CATEGORIES", enter "YES" in the *evidence of breeding* column. If you are able to determine how many pairs of that species are breeding, record this information in the *Comments* column beside the "YES".

Species

Use the standard four letter codes for each species as per the attached table of alpha-codes. If you are unable to determine the species, please provide some indication of the group or category to which the birds belong. For example, classifications such as small shorebirds, large shorebirds, diving ducks or dabbling ducks can be used to approximate species when precise identification is not possible, because the birds are too far away or you did not see them well enough. If you are able to distinguish immature birds from adults please record the number of immature of each species in that particular group of birds in the *Comments* column.

Recording Data During Surveys

Most observers find it more convenient to write out the name of the species and the exact number of birds in the group directly onto the data sheets while conducting a survey. The species and number codes can be filled in or added later when there is time to look them up. The primary purpose of the codes is to facilitate computer data entry.

Other Information to Record on the Data Sheet

Location

Record the survey location on the data sheet by name, including a short description of the location as necessary. Indicate on the map the point from which you made observations.

Date, Time, Observer

Record your name, the date and the time of day (the time you started your survey) on the data sheet and record date and observer on the corresponding map.

Visibility, Tide

Record the visibility by completing the blank under "visibility" on the data sheet. Use the categories of Excellent, Good, Fair and Poor for visibility. If the visibility is poor or less than poor the survey should not be conducted at that time. Record the tide (high - H, low - L, rising - R, or falling - F) in the appropriate blank. Refer to the tide tables if necessary.

Habitat, Substrate

An indication of the habitat or substrate that each bird or group of birds is using should be noted in the *Comments* column on the same line as, or immediately below, the rest of the data for that group of birds.

When to Survey

Bird surveys must be carried out in good weather with light winds and good visibility, when birds can be easily observed and counted. In open water locations moderate to strong winds (even in clear weather) will produce wave action that can make it difficult to see birds on the water, so surveys should be conducted in light wind conditions. Fine weather monitoring will also eliminate situations where birds are roosting inland due to bad weather or otherwise engaging in atypical weather induced behaviour. Rivers and streams can probably be surveyed in moderate winds.

BEHAVIOUR CATEGORIES

RESTING

Use this behaviour category for situations where birds are loafing or resting on land, shore, rocks, island, pilings or on the water.

TRAVELLING

Use this behaviour category for situations where birds are flying overhead and probably travelling through the area.

FEEDING BEHAVIOURS

Use FEEDING for situations where you are sure the birds are feeding such as:
-kingfishers, ospreys, terns or gannets diving into the water
-shorebirds feeding on mudflats
-great blue herons stalking in the water
-cormorants swimming and diving
-ducks dabbling or diving
-swallows or other species (e.g. gulls) aerial feeding

EVIDENCE OF SPECIES BREEDING IN THE AREA - YES OR NO

Use YES for situations where you are FAIRLY CERTAIN that the birds ARE breeding in the area, such as:
-birds are associated with a nest
-birds are seen feeding young
-birds are seen at a nest incubating eggs
-obvious courtship behaviour between a pair is seen
-birds are seen carrying nesting material

NUMBER OF BIRDS - **CATEGORY LETTER**

1 - 25 :	enter exact number on data sheet
25 - 50 :	**A**
50 - 100 :	**B**
100 - 200 :	**C**
200 - 400 :	**D**
400 - 800 :	**E**
800 - 1500:	**F**
1500 - 3000:	**G**
3000 - 5000:	**H**
5000 - 10,000:	**J**
10,000 - 50,000:	**K**
50,000 - 100,000:	**L**

Observer: _____ Date: Day ____ / Month ____ / Year ____

Observation Location: _____

ACAP site: _____ Tide: _____ Visibility: _____

Observation Start Time: _____ End Time: _____ Duration: _____

UTM	Map Locator Number	Species	No. Feeding	No. Resting	No. Travelling	Evidence of Breeding YES or NO	Comments

Appendix 2.

Structure of Database for Cape Breton waterbird survey observations

SYDNEY.DBF

This database contains the raw survey data for the four observation routes in Cape Breton. Each row represents one sighting of a waterbird or group of waterbirds at a unique location, together with pertinent geographical and behavioural information. The database is available from the Canadian Wildlife Service in Sackville, NB or ACAP Cape Breton in Sydney, NS.

Database structure:

Field	Field Name	Type	Width	Decimals
1	LAT	Numeric	8	6
2	LON	Numeric	8	6
3	RECORDNUM	Numeric	6	
4	ACAPSITE	Character	2	
5	OBSROUTE	Character	8	
6	OBSINITIAL	Character	3	
7	DATE	Numeric	8	
8	MONTH	Numeric	2	
9	SEASON	Numeric	1	
10	TIDE	Character	1	
11	VISIBILITY	Character	1	
12	STARTTIME	Numeric	4	
13	ENDTIME	Numeric	4	
14	DURATION	Numeric	4	
15	MAPLOCNUM	Numeric	2	
16	SPECIES	Character	4	
17	SPECIESGP	Character	10	
18	NUMFEEDING	Numeric	4	
19	NUMRESTING	Numeric	4	
20	NUMUSING	Numeric	4	
21	NUMTRAVEL	Numeric	4	
22	NUMTOTAL	Numeric	4	
23	EVIDBREED	Character	1	
324	COMMENTS	Character	70	

Data Dictionary:

LAT	The latitude of the observed bird or group of birds in decimal degrees.
LON	The longitude of the observed bird or group of birds, in decimal degrees.
RECORDNUM	The record number of each line of data entry; record numbers start over again at one for each different observation route.
ACAPSITE	The ACAP site where the observations were conducted, in a two character abbreviation. (CB = Cape Breton)
OBSROUTE	The observation route as an abbreviation of up to ten characters. The routes for Cape Breton are: tarponds = Sydney Tar Ponds; lingan = Lingan Power Plant, sydriver = Sydney River; sydharbour = Sydney Harbour.
OBSINITIAL	The observers initials.
DATE	Date of the survey.
MONTH	Month of the survey.
SEASON	Season of the survey. 1 = winter (November to March); 2 = spring (April and May); 3 = summer (June and July); 4 = fall (August to October).
TIDE	Tide level at the time of the survey; h = high, l = low, r = rising, f = falling
VISIBILITY	Visibility for that survey; e = excellent, g = good, f = fair, p = poor.
STARTTIME	The time the survey commenced.
ENDTIME	The time the survey was completed.
DURATION	The duration of the survey in hours and minutes.
MAPLOCNUM	The map locator number entered on the map at the position of each bird or group of birds seen during a survey. This number was included in the data record for that waterbird observation for subsequent geographical referencing.
SPECIES	The unique four-letter code of the American Ornithologists Union for the bird species seen.
SPECIESGP	Each species of waterbird was grouped into one of eighteen categories called species groups.
NUMFEEDING	The number of birds of each species observed feeding for each data record at each unique geographic position. Category letters for large group sizes were converted to numeric values (see Appendix 1).
NUMRESTING	The number of birds of each species observed resting for each data record at each unique geographic position.
NUMUSING	The sum of NUMFEEDING and NUMRESTING.
NUMTRAVEL	The number of birds of each species observed travelling through the area for each data record at each unique geographic location.
NUMTOTAL	The sum of NUMFEEDING and NUMRESTING and NUMTRAVEL.
EVIDBREED	Evidence of that species breeding in the area entered as *y* (yes) or *n (no)*. See Appendix 1 for the criteria used by observers for determining evidence of breeding.