AMC WETLANDS CENTRE
CAPEL, WESTERN AUSTRALIA

No. 1.2 April 1991

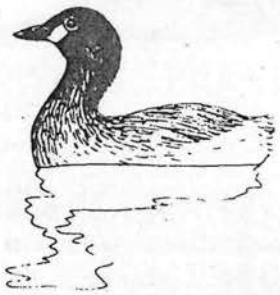
A community project developed by AMC Mineral Sands Ltd (a member of the RGC Group) in association with:

Royal Australasian Ornithologists Union
Department of Conservation and Land Management
The University of Western Australia
Curtin University of Technology
Murdoch University

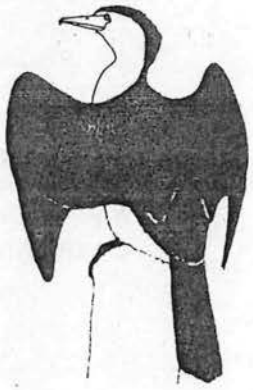
WATERBIRDS ON THE AMC WETLANDS CENTRE

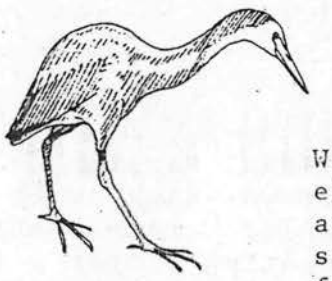
Forty-eight species of waterbird have so far been seen on the AMC Wetlands Centre lakes. The aim of this leaflet is to describe some of the common waterbirds that you will see on your visit and tell you about their place in the ecosystem.

Australasian Grebe - A small (dove sized) dumpy, diving bird, often seen bobbing about on open water. They nest successfully on Swamphen Lake and regularly use Island and Peninsula Lakes. They roost on floating nests in the Typha (bulrush) stands at night and feed on insects and small fish, diving to catch them underwater.



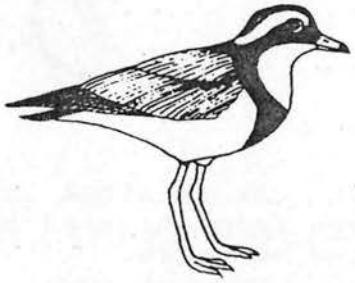
Little Pied Cormorant (right) - A black and white diving bird, about the size of a pigeon. They often perch on prominant branches and spread their wings to dry them after a dive. They feed on insects caught underwater.





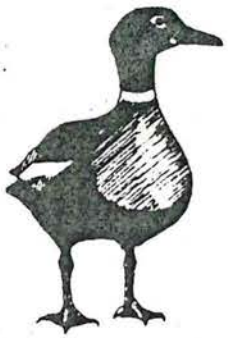
White-faced Heron (left) - An elegant grey bird with long legs and a white face, patiently stalking its prey of tadpoles and fish around the lakes. It does not yet breed at the Centre.

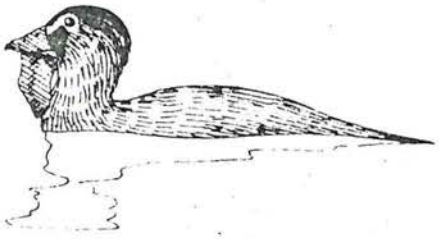
Black Swan - A large, goose sized, black bird with a red bill and white wing tips. Several pairs have reared young on the wetlands to about two months of age; they then move the family to adjacent wetlands until the young fledge. Many visit the lakes in the summer.



Black-fronted Plover - The little brown bird with a bright red bill and black chest band that runs along the edge of the water. It has a sharp, tinkling call and favours sandy shores where it feeds on insects. It often nests on the sandy spits.

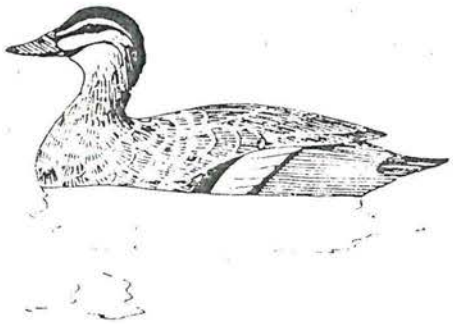
Australian Shelduck - Grunters, as they are sometimes called, are large, Muscovy sized, chestnut ducks. They visit the Centre lakes in summer in large flocks, and their distinctive honking call is a common sound. These ducks graze when feeding and spend much time in shallow, swampy areas of farmers' paddocks.





Musk Duck - A dark diving duck; the male has a prominent dewlap (pouch) beneath his bill. Each lake has at least one resident Musk Duck that can be seen diving in the deep water to feed on shellfish. Male Musk Ducks make their distinctive whistle and plonk mating call early in the morning.

Pacific Black Duck - A medium sized brown duck with a prominent white stripe above the eye. In summer large flocks loaf on the open water or on sandy shores and spits around the lakes. Groups of 2-6 birds have made some of the lakes their home and are almost always upending and dabbling in the shallows where they feed on seeds and vegetable fragments.



Marsh Harrier - A brown hawk with a white rump, often soaring over the rushbed to the alarm of resident birds.

Purple Swamphen - A skulking, bantam-sized bluish-purple bird found mainly in or near the dense fringing rush. Sometimes they graze in nearby pastures. As well as grazing they feed on the roots of water plants, using their feet to hold food while they tear it apart. Swamphens are one of the most successful breeding species.

Clamorous Reed-Warbler - A small brown canary-sized bird, best known for its loud chuckling call given from the reed beds. Many of its cup nests have been found in the wetlands.

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INVERTEBRATES OF THE AMC WETLANDS CENTRE

Invertebrates are animals that lack backbones. Macro-invertebrates are those which are visible to the naked eye (larger than 0.25mm). In wetlands macro-invertebrates play an important role in the movement of nutrients between primary producers (the algae and other plants) and the vertebrates (fish, frogs, lizards, birds and mammals). Successful management of wetlands requires a knowledge of the species of invertebrates present and documentation of their seasonal changes in abundance. So far 106 species have been recognised from the many aquatic habitats surrounding the Centre. These range from the very small copepods, 0.25mm long, to the gilgie, Cherax quinquecarinatus, which may measure 100mm in length. Of the invertebrate species that have been collected, most (72) are insects. Some of these species complete their entire life cycle, (adult -> egg -> larva -> pupa -> adult), within the water. These include the aquatic beetles (COLEOPTERA) like Sternopriscus browni and Necterosoma darwini. Many species spend only the juvenile stages within the waters, for example the many non-biting midges (CHIRONOMIDAE), such as Tanytarsus and Polypedilum nubifer, the predatory dragonfly and damsel fly larvae (ODONATA) and the case building caddisfly larvae (TRICHOPTERA).

Many of the species which spend their entire life cycle in the lakes are crustaceans. These include the waterfleas (CLADOCERA) and copepods (COPEPODA) which are collectively termed the micro-crustacea. They form a major part of the plankton, the animals (zooplankton) and plants (phytoplankton) living and feeding in the water. The planktonic algae are the basic food source of micro-crustacea like Daphnia carinata, the most common waterflea at the AMC Wetlands Centre. The planktonic copepods forage on algae and very small invertebrates and on the bacteria which are a major component of healthy ecosystems.

The lake bed is termed the benthos and organisms living immediately on or within the benthos are said to be benthic. The worm-like larval chironomids are the most common macro-invertebrates in the benthos of most lakes. Their lifestyles vary greatly, from predators like Procladius paludicola, to Polypedilum nubifer and species of Tanytarsus which consume organic detritus and the bacteria which cover it. Chironomids may produce many generations each year, with development being dependent upon temperature. The chironomids are particularly important food for water birds. Ducks may collect larvae directly from mud in shallow water, whilst adult chironomid flies are captured as they emerge in large numbers from their pupal cases at the water surface. Orthetrum caledonicum and Hemicordulia tau are dragonflies and their larvae are the two largest invertebrate predators that prowl the

benthos. They can attain a length of 30mm and their prey includes many chironomid larvae. The large size of the dragonfly larva makes it an attractive food item for wetland birds. Consequently, they are camoflaged and secret themselves in the surface layer of benthic mud. By contrast the adults are conspicuous and brightly coloured. The male O. caledonicum is powder blue and frequently seen perching on lake shores, the female is straw yellow. Both sexes are present, as adults, at the AMC Wetlands Centre from September to May.

Another important habitat in the AMC Wetlands Centre is the fringing vegetation. Invertebrate species from both benthos and plankton, in addition to species dependent upon the plants or the shelter they provide, are found amongst the rushes and sedges. The animals actually living on the surface of plants form part of a community which is called the periphyton. These animals are predominantly less than 0.25mm in size. A number of large species prey on these micro-invertebrates or graze the algae that grow in association. These include the aquatic snail Isidorella and the predatory hydrophilid beetles of which there are eight species in the wetlands.

Invertebrates are good indicators of the health and stage of development of an aquatic ecosystem, because of their importance in food webs. For example, the abundance of predators like Orthetrum caledonicum and Necterosoma darwini is linked to the complexity of a food web. The more complex the food web the greater the number of predators it will support. The environmental tolerences of some species can also be used to identify problems in wetlands. Many aquatic beetles and the chironomid Tanytarsus appear to be quite tolerant of acidic water and may be the only species found under these environmental conditions. Chironomus alternans and Chironomus occidentalis, two large chironomid larvae are good indicators that waters are eutrophic, where oxygen concentrations and water clarity might be low. The larvae of O. caledonicum is a predator finding prey by sight, as such it is usually missing from such murky habitats.

The invertebrate community of the AMC Wetlands Centre is diverse and is expected to become more productive as the wetlands are developed and managed. This will enable the wetlands to support a diverse community of waterfowl and other vertebrates.

MAIN GROUPS OF AQUATIC INVERTEBRATES AT THE AMC WETLANDS CENTRE
Number of species from each group given in brackets

HYDROZOA - Hydra
NEMATODA - round worms
ANNELIDA, OLIGOCHAETA - worms
HIRUDINEA - leeches
HYDRACARINA - water mites (5)
INSECTA,
ODONATA - dragonflies (4)
TRICHOPTERA - caddisflies (5)
DIPTERA - flies (4)
COLEOPTERA - beetles (16)
CRUSTACEA,
OSTRACODA - seed shrimps (5)
CLADOCERA - water fleas (5)
COPEPODA - Cyclopoida
Calanoida
CORIXIDAE - waterboatmen (5)
CERATOPOGONIDAE - midges (6)
CHIRONOMIDAE - non-biting midges (27)

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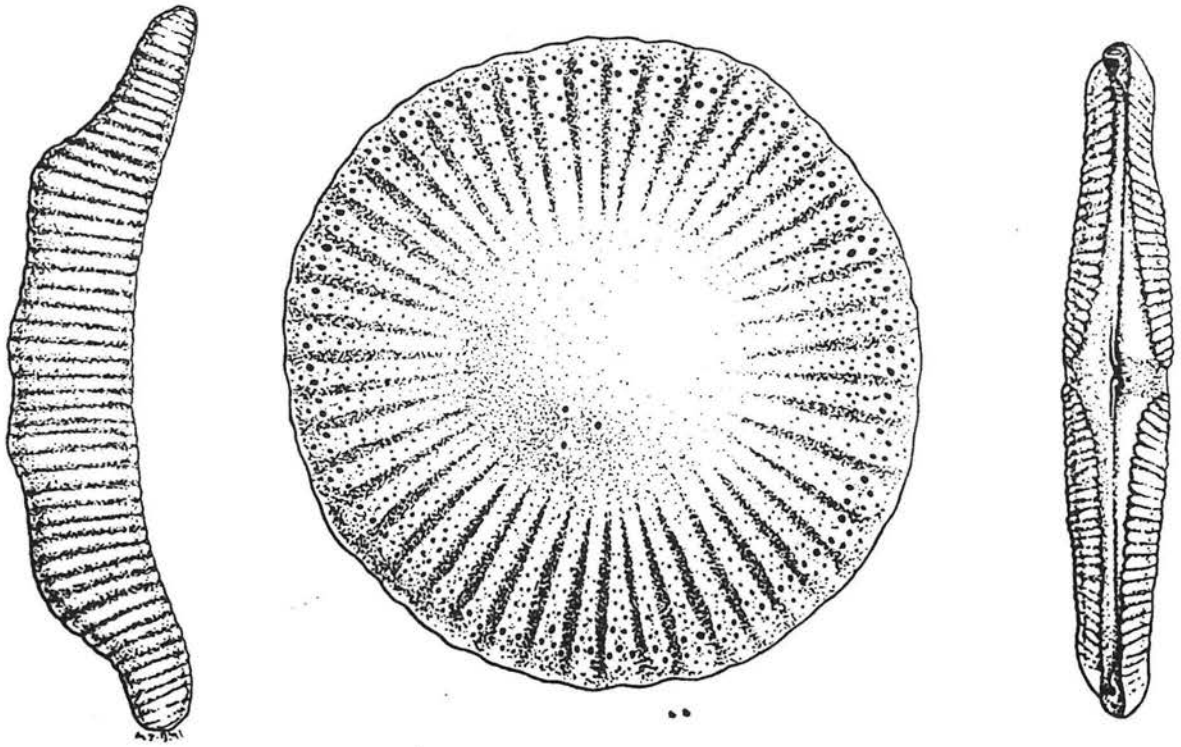
ALGAE - DIATOMS AND OTHER TINY PLANTS OF THE AMC WETLANDS CENTRE

Seldom do we appreciate the importance of algae in forming the basis of the food chain in aquatic ecosystems. Every self-sustaining aquatic ecosystem harbours a diversity of algae, often unicellular and microscopic, displaying an array of life forms. Newly formed lakes are initially colonised by bacteria and tiny algae paving the way for large green plants and consumer animals like protozoa, zooplankton and other invertebrates. These animals in turn are the food of fish and birds. It is the algae and the water plants that drive the wheel of diversity in any aquatic system. Stressful environmental conditions such as acidity, salinity or high temperatures all restrict the diversity of algae and, in turn, the diversity of other aquatic life. The artificial lakes at the AMC Wetlands Centre provide a unique opportunity for investigating the turn-over and succession of algal communities as they develop into the basis for a self-sustaining ecosystem. Algae are excellent organisms with which to monitor the development and change in this and other wetland ecosystems because they are at the base of most food-webs.



L to R: Eunotia camelus; Cyclotella meneghiniana; Pinnularia gibba

The algal communities at the AMC Wetlands Centre are dominated by a group of tiny, single celled algae with silica walls called DIATOMS. Prolific primary producers that recycle minerals, diatoms are very sensitive to physical and chemical changes in the environment. Diatoms are true mirrors of water quality. At the beginning of rehabilitation diatom communities in these lakes were of low diversity and were dominated by species which preferred acid conditions, because the pH was low, between 3 and 4. Since 1988 the pH has increased to between 6 and 7 as the inflow from the processing plant improved in quality, and there has been a transition to the dominance of species preferring neutral pH. Concomittantly there has been a substantial increase in species diversity indicating the potential of the system to sustain a great diversity of consumer species, including vertebrates.

In shallow water bodies the sediments are colonised by tiny algae and the bethic (bottom) community dominates the systems. The shallow parts of the lakes at the AMC Wetlands Centre, especially those without steep banks, have thriving benthic diatom communities and are more productive than the deep parts of the lakes. Phytoplankton (floating algae) blooms have only been seen in the AMC Wetland Centre lakes since 1989, but when they occur they are dominated by DINOFLAGELLATES - single celled algae with flagellae - and planktonic diatoms. The occurrence of these blooms is a reflection of the increasing diversity of the algal community. The benthic communities remain relatively stable throughout the year except for the winter whereas the planktonic blooms occur during autumn and spring. The diversity of species correlates well with the water chemistry and generally the greatest diversity in species is seen in the lake at the far end of the chain. The lakes are at present in a transitional state as the balance of the ecosystem improves. With increasing numbers of waterbirds using the lakes, the nutrient status of the lakes, particularly the free phosphate, should improve, facilitating further increases in diversity and density of algae, thereby steering the systems towards a self-sustaining wetland. BLUE GREEN ALGAE and DESMIDS are still very rare, restricted to the oldest of the lakes. In the last three years representatives of twenty-eight genera have been recorded from the AMC Wetlands Centre (number of species in brackets after each genus):

DIATOMS

Achnanthes (3)
Amphora (1)
Anomoeoneis (2)
Caloneis (1)
Comphonema (1)
Cymbella (1)
Cyclotella (2)
Frustulia (1)
Navicula (8)
Nitzschia (3)
Pinnularia (6)
Neidium (1)
Synedra (2)
Stauroneis (2)

DINOFLAGELLATES

Glenodinium (1)
Peridinium (1)

DESMIDS

Cosmarium (1)
Netrium (1)

BLUE GREEN ALGAE

Anabaena (1)
Oscillatoria (1)
Lyngbya (1)
Spirulina (1)
Gloeocapsa (1)

FILAMENTOUS GREEN ALGAE

Mougeotia (1)
Ulothrix (1)
Zygnema (1)

TYPES OF HABITATS

NO 7

The classification used here follows that used in the RAOU Atlas of Australian Birds which is in turn modified from that of Specht.

	COMMUNITY	SITE	USE
WETLANDS			
Woodland			
1.1 Paperbark	*Melaleuca* spp mixed with myrtles and sedges	Fringes, wet woodland	Colonially nesting waterbirds, coots, ducks, swans
1.2 Flooded gum	*Eucalyptus rudis* with grass and sedges	Shores of swamps	Tree-nesting waterbirds, honeyeaters
1.3 She oak	*Casuarina* as a fringe	Shelter belts, shores	Shelter
1.4 Stream zones	Tea tree, wattles, *Banksia littoralis*	Channels	Water rats, firetails, rails
Heath			
2.1 *Astartea*	*Astartea fascicularis*, sedges, *Melaleuca teretifolia*, *M laterita*	Shelter belts, shores	Shelter for nesting waterbirds
2.2 Bottlebrush	*Calothamnus* mixed with myrtles, (eg *Hypocalymma angustifolium*, *Beaufortia sparsa*) seasonally flooded	Mosaics	Honeyeaters, shelter for nesting waterbirds

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Woodland			
6.1 **Peppermint**	*Agonis* with understorey of grass and myrtles	Mosaics, uplands	**Bushbirds, ring-tailed possums**
6.2 ***Acacia***	*Acacia saligna, cyclops* and other species with myrtles	Shelter belts, shores, uplands	**Pigeons, shelter**
6.3 ***Banksia***	*Banksia grandis, B attenuata* myrtles and peas (eg *Viminaria*)	Mosaics, uplands	**Honeyeaters, reptiles, pygmy and honey possums**
Heath			
7.1 ***Kunzea***	*Kunzea* with other myrtles and ground cover (eg *Kennedia*)	Banks	**Stabilisation, wrens and honeyeaters**
7.2 ***Verticordia***	*Verticordia* with ground cover	Rocky banks	**Stabilisation, wildflowers**
7.3 ***Kingia***	*Kingia* with myrtles, *Isopogon, Beaufortia* and kangaroo paws	Mosaics	**Wrens, bushbirds, reptiles**
7.4 ***Dryandra***	*Dryandra sessilis* and *D nivea*	Mosaics, uplands	**Honeyeaters, parrots**
7.5 **Kangaroo paws**	Kangaroo paws with sedges and grasses	Mosaics	**Honeyeaters, wildflowers**
Grassland			
8.1 **Upland meadows**	Veldt grass and other tussock grasses	Uplands	**Stabilisation, shoveler nesting**

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SPECIES LIST - WETLAND BIRDS NO 8

Hoary-headed Grebe	*Poliocephalus poliocephalus*
Australasian Grebe	*Tachybaptus novaehollandiae* (Little Grebe)
Darter	*Anhinga melanogaster*
Little Black Cormorant	*Phalacrocorax sulcirostris*
Little Pied Cormorant	*Phalacrocorax melanoleucos*
White-faced Heron	*Ardea novaehollandiae*
Great Egret	*Egretta alba*
Rufous Night Heron	*Nycticorax caledonicus*
Sacred Ibis	*Threskiornis aethiopica*
Straw-necked Ibis	*Threskiornis spinicollis*
Yellow-billed Spoonbill	*Platalea flavipes*
Black Swan	*Cygnus atratus*
Australian Shelduck	*Tadorna tadornoides* (Mountain Duck)
Pacific Black Duck	*Anas superciliosa*
Grey Teal	*Anas gibberifrons*
Australasian Shoveler	*Anas rhynchotis*
Pink-eared Duck	*Malacorhynchus membranaceus*
Hardhead	*Aythya australis*
Maned Duck	*Chenonetta jubata* (Wood Duck)
Blue-billed Duck	*Oxyura australis*
Musk Duck	*Biziura lobata*
Osprey	*Pandion haliaetus*
Marsh Harrier	*Circus aeruginosus*
Spotless Crake	*Porzana tabuensis*
Black-tailed Native-hen	*Gallinula ventralis*
Dusky Moorhen	*Gallinula tenebrosa*
Purple Swamphen	*Porphyrio porphyrio*
Eurasian Coot	*Fulica atra*
Red-capped Plover	*Charadrius ruficapillus*

Black-fronted Plover	*Charadrius melanops*
Common Sandpiper	*Tringa hypoleucos*
Greenshank	*Tringa nebularia*
Gallinago Snipe	*Gallinago sp.*
Clamorous Reed-Warbler	*Acrocephalus stentoreus*
Little Grassbird	*Megalurus gramineus*

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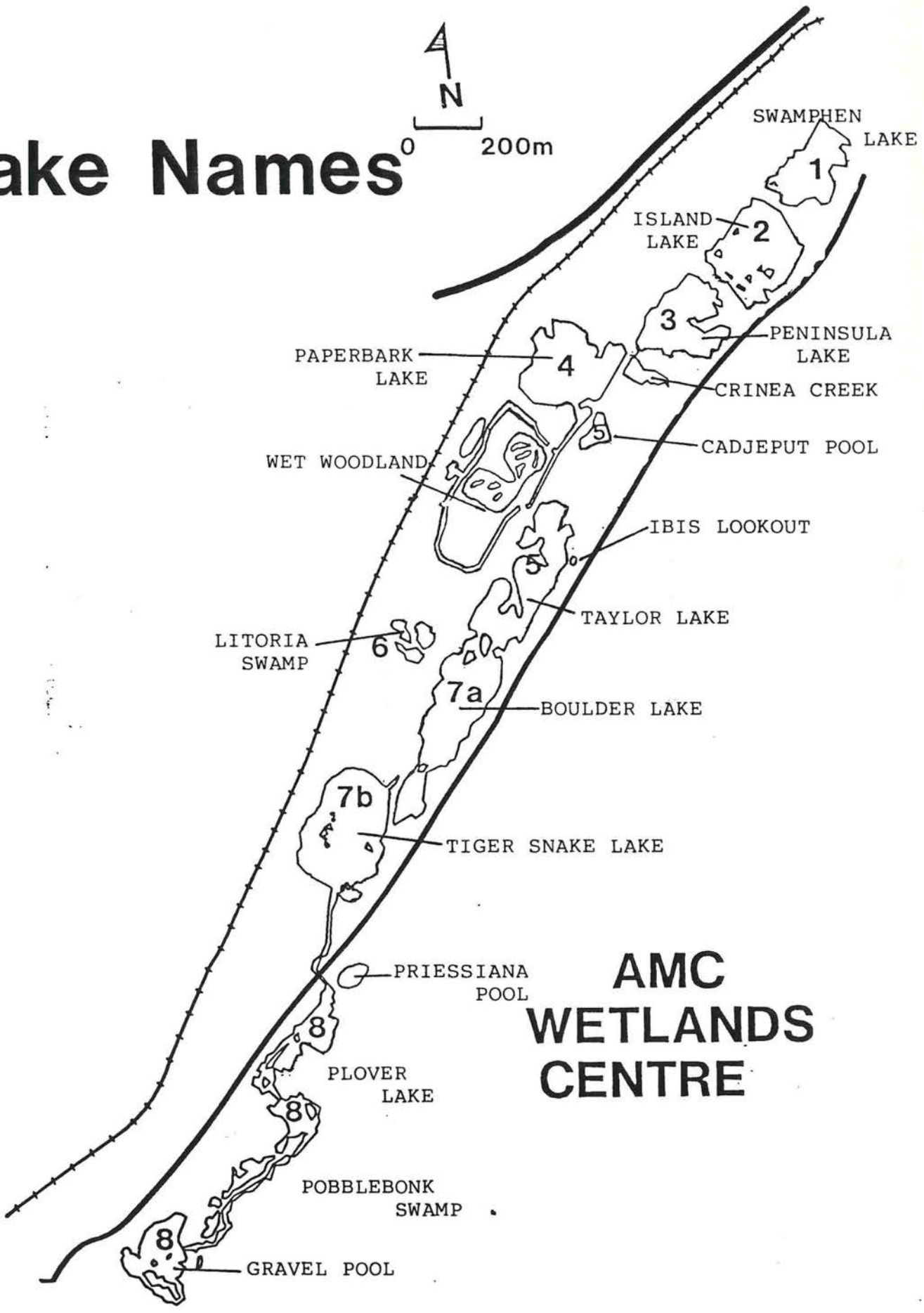
SPECIES LIST - NON WETLAND BIRDS

Emu	*Dromaius novaehollandiae*
Black-shouldered Kite	*Elanus notatus*
Whistling Kite	*Haliastur sphenurus*
Collared Sparrowhawk	*Accipiter cirrhocephalus*
Wedge-tailed Eagle	*Aquila audax*
Little Eagle	*Hieraaetus morphnoides*
Peregrine Falcon	*Falco peregrinus*
Australian Hobby	*Falco longipennis*
Brown Falcon	*Falco berigora*
Australian Kestrel	*Falco cenchroides*
Common Bronzewing	*Phaps chalcoptera*
Baudin's Cockatoo	*Calyptorhynchus baudinii*) White-tailed
Carnaby's Cockatoo	*Calyptorhynchus latirostris*) Black-Cockatoo
Purple-crowned Lorikeet	*Glossopsitta porphyrocephala*
Regent Parrot	*Polytelis anthopeplus*
Red-capped Parrot	*Purpureicephalus spurius*
Port Lincoln Ringneck	*Barnardius zonarius* (Twenty-eight Parrot)
Elegant Parrot	*Neophema elegans*
Barn Owl	*Tyto alba*
Laughing Kookaburra	*Dacelo novaeguineae*
Rainbow Bee-eater	*Merops ornatus*
Welcome Swallow	*Hirundo neoxena*
Tree Martin	*Cecropis nigricans*
Richard's Pipit	*Anthus novaeseelandiae*
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*
Rufous Whistler	*Pachycephala rufiventris*
Grey Shrike-thrush	*Colluricincla harmonica*
Grey Fantail	*Rhipidura fuliginosa*
Willie Wagtail	*Rhipidura leucophrys*
Splendid Fairy-wren	*Malurus splendens*

White-browned Scrubwren	*Sericornis frontalis*
Western Gerygone	*Gerygone fusca* (Western Warbler)
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*
Red Wattlebird	*Anthochaera carunculata*
Brown Honeyeater	*Lichmera indistincta*
Western Spinebill	*Acanthorhynchus superciliosus*
White-fronted Chat	*Ephthianura albifrons*
Silvereye	*Zosterops lateralis*
Australian Magpie-lark	*Grallina cyanoleuca* (Mudlark, Pee Wee)
Black-faced Woodswallow	*Artamus cinereus*
Grey Butcherbird	*Cracticus torquatus*
Australian Magpie	*Gymnorhina tibicen*
Australian Raven	*Corvus coronoides*

RAOU common names are used in this list (other common names in brackets)

Lake Names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0
200m
SWAMPHEN LAKE
1
ISLAND LAKE
2
3
PENINSULA LAKE
PAPERBARK LAKE
4
CRINEA CREEK
5
CADJEPUT POOL
WET WOODLAND
IBIS LOOKOUT
5
TAYLOR LAKE
LITORIA SWAMP
6
7a
BOULDER LAKE
7b
TIGER SNAKE LAKE
PRIESSIANA POOL
AMC WETLANDS CENTRE
8
PLOVER LAKE
8
POBBLEBONK SWAMP
8
GRAVEL POOL

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WETLAND REHABILITATION TECHNIQUES - REHABILTAION AT CAPEL

Where to start

The lakes of the AMC Wetlands Centre are entirely man-made. Anyone can dig a hole, fill it with water and call it a wetland but to get birds and other animals live there requires time, effort, skill, knowledge and money. Once the decision to create the AMC Wetlands Centre had been made, the Management Committee drew up a Concept Plan setting out specifications and a timetable of development. Priority in design was given to attracting waterbirds to live and breed on the site. The Concept Plan was the basis on which earthworks, planting, planning and construction of buildings and pathways began. Research programmes were established to provide guidance for the rehabilitation, to collect baseline data and monitor changes in the system. Recommendations from these studies determined the habitats required and how best to establish them.

Earthmoving

Starting with deep, steep-sided lakes and little fringing vegetation, it was necessary to decrease the angle of slope at the edges by battering the banks down. Most of the lakes have had the shores remodelled in this way. It was often possible to create islands by digging channels around a section of bank, by dumping sand into shallow water or by cutting through causeways on both sides. The earthworks rearranged the materials on the site - sand, clay (slimes), gravel and rock - into a coherent landscape of varied form and texture to provide a basis for the development of environments representative of the South-west.

Planting

As the landscaping of each section was completed planting could begin. Different plant species were selected for different areas to give each a distinctive plant community. Most plantings were of small seedlings; some areas were covered with seed-bearing branches; fringing vegetation was transplanted as root stock from wetlands in the mine path. Research projects helped to pinpoint the requirements of each species because some plants grew only in deep water, some only in shallow water, some only in areas that were seasonally covered by shallow water and still others grew only near but not in water. Certain aquatic plants will dominate an area for one or two years then begin to fade out; others may dominate for many years before they too are replaced by a new succession. Pioneering or colonising species will stabilise fragile areas rapidly but can form undesirable monocultures. For example Typha, a very aggressive coloniser species, has had to be actively removed from some areas to allow slow establishing

species to gain a foothold. In other areas Typha has its place; large reedbeds of it are desirable for certain waterbirds.

Creating special habitats

Shallow, seasonally inundated swamps are an important habitat for some animals, for example breeding frogs, young ducklings and waders. At the AMC Wetlands Centre an area called the Wet Woodland was designed as such a winter-wet swamp with a dense woodland of paperbark trees. Sand was removed down to just below winter water level, using a scraper. The sand from the Wet Woodland was used for landscaping elsewhere, for example to build spits in a nearby lake and a flooded water meadow in another lake. Sand from other earthworks has been used to build islands and mounds to separate the wetlands from a neighbouring road. Other small, shallow, seasonally flooded ponds were made as 'frog ponds'. Frogs and tadpoles are invaluable food for young waterbirds. These frog ponds only hold water during winter and thus have no mosquito fish Gambusia in them to prey on tadpoles. Frogs will breed in these ponds even in the first winter after construction before any vegetation has established.

Improving the food supply

The lakes at the AMC Wetlands Centre were created as part of a mining operation. There were no places suitable as nest sites and few suitable roosting sites for birds. Nor was there any protective cover in the lakes for fish, frogs and insects. These were supplied artificially to enable the ecosystem to start operating before the trees, shrubs, fringing plants and aquatics matured to a stage where they could sustain the ecosystem naturally. Organic matter, in the form of straw, was added to the shallow parts of the lakes to supply carbon and structure in which invertebrates could hide.

Too many animals

To our surprise one of the main problems in developing the AMC Wetlands Centre has been too many animals of certain kinds - rabbits, foxes and kangaroos. Rabbits are well established on and around the site. Many seedlings and small trees have been defoliated, dug up or ringbarked by rabbits. Baiting and warren fumigation had limited success. The only successful strategy was to place a tree guard around each tree until it was sufficiently large to be beyond damage. Foxes come after the rabbits but will attack waterbirds just as readily and are probably a major source of chick predation. Baiting was carried out with little success. Islands and deep moats deter foxes.

Rehabilitating other wetlands

Some of the operations that have contributed to the success of the AMC Wetlands Centre could be applied in other places, but success will not come without a thorough understanding of the local system. Staff at the AMC Wetlands Centre will be happy to discuss possibilities for similar developments elsewhere with you during your visit to Capel.

AMC WETLANDS CENTRE
CAPEL, WESTERN AUSTRALIA

No. 2.2 April 1991

A community project developed by AMC Mineral Sands Ltd (a member of the RGC Group) in association with

Royal Australasian Ornithologists Union
Department of Conservation and Land Management
The University of Western Australia
Curtin University of Technology
Murdoch University

ECOLOGY OF THE LAKES AT THE AMC WETLANDS CENTRE

Our aim is to provide food webs which will sustain waterbird populations, providing them with food and shelter from an ecosystem that is essentially self-sustaining. To do this we must answer the question: "How do wetland ecosystems work?" Any ecosystem must have primary producers, which lock away energy from the sun and carbon and nutrients from the environment, making them available for their own use, and supplying the animals which depend upon them. A fundamental question for understanding any ecosystem is "what are the primary producers?". Several kinds of primary producers live in the AMC Wetlands.

First there are the MICROSCOPIC PLANTS - cells and chains of cells which may be suspended in the water and are known as phytoplankton; or lie on the surface of the sediment, and have the impressive name of 'microphytobenthos'. Then there are the large plants, or 'MACROPHYTES', which fall into three groups - the algae, the aquatic plants, and the fringing plants. In marine situations there may be very large populations of massive algae, but in the AMC Wetlands Centre they are not prominent and consist of clumps of filamentous algae, loosely attached to the bottom or entangled in other plants and debris. Nor are there many completely aquatic plants at Capel, plants which are rooted in the sediments with their leaves either below or floating on the water surface; a few are entirely floating. The most prominent macrophytes are the fringing plants, tall sedges and bulrushes which establish in shallow water but have their leaves poking out above the water surface.

What do these primary producers need? This is an important question because if we are to encourage them we must know what to provide. The lakes at the AMC Wetlands Centre were originally bare depressions maintained by groundwater, with water from the processing plant flowing through them. First the plants must have water of suitable 'quality' - a reasonable pH and tolerable concentrations of dissolved chemicals; these features have been achieved. Secondly, submerged plants require light, and so the water should not be turbid. The fringing plants have an edge here because any plant with its leaves above the water surface is not troubled by the colour or turbidity of the water. The fringing plants can grow in shallow water and on waterlogged soil, but if their roots dry out they may not survive. There is clearly a relationship between seasonal changes in water level and the growth of these plants, and this has been an important area of research for us. With knowledge of this relationship we can manipulate the slope of the lake shore to optimise the opportunities for these plants to grow. The plants require a source of carbon dioxide (either from the air itself or from

dissolved CO2 or bicarbonate in the water); this provides the carbon skeletons for the construction of sugar molecules during photosynthesis. Sometimes available carbon is short underwater and again the fringing plants have the edge because they can tap atmospheric carbon dioxide. Finally, plants require nutrients, and phosphorus and nitrogen are needed in high concentrations compared with the other elements which could potentially be at growth-limiting concentrations. At Capel there is abundant dissolved nitrogen in the form of ammonium ions, but very little phosphorus; we need to supplement the phosphorus supply to achieve a reasonable level of primary production.

Which are the most important producers? Phytoplankton does not appear to be as important as some other primary producers, partly because in some of the lakes the water is being exchanged at too high a rate to allow large populations to build up, and partly because the concentration of phosphorus available in the water is low; any free phosphate is quickly bound to the sediments. On the other hand the small algae which coat the nutrient-rich sediment are very important, and when nutrients are added it is these benthic populations which increase. The fringing plants which are such a prominent feature of the wetlands have high production rates, and their leaves and stems decompose in shallow water, supporting food webs. In addition they provide nesting sites and shelter for many animals associated with the wetlands. Clearly they are very important indeed.

What happens to primary production? Two things. First the plants may be grazed directly - invertebrates may consume phytoplankton and graze on microscopic benthic algae, while waterbirds take aquatic plants and the seedlings of emergent species. Even so there is comparatively little grazing. Most of the production of these primary producers goes through a "detrital pathway"; the organic material is decomposed by fungi and bacteria and the small particles so formed, rich in microorganisms and in the remains of plants, are packages of energy and nutrients which can be used by invertebrates, supporting the food webs which feed fish and bird populations. Even so, invertebrates use only a small part of the primary production - most of the nutrients released in decomposition are 'recycled', and used in the growth of other primary producers.

The conditions allowing sterile lakes to develop into functional ecosystems are clear.

1. The water quality must be good.

2. Light must penetrate the water well.

3. Nutrients must be supplied if they are deficient.

4. The water levels and bank slopes must be right for the establishment and survival of the fringing plants.

5. Fringing plants will provide shelter for other organisms, but until they are established it may be necessary to provide other forms of shelter.

AMC WETLANDS CENTRE
CAPEL, WESTERN AUSTRALIA

No. 3.2 April 1991

A community project developed by AMC Mineral Sands Ltd (a member of the RGC Group) in association with:

Royal Australasian Ornithologists Union
Department of Conservation and Land Management
The University of Western Australia
Curtin University of Technology
Murdoch University

RESEARCH OPPORTUNITIES AT THE AMC WETLANDS CENTRE AT CAPEL

The AMC Wetlands Centre at Capel is a series of eight rehabilitated sand mining ponds. The ponds are interconnected, at present receiving waste water from the mineral sands treatment plant at one end and passing it out to the Ludlow River at the other. The rehabilitation has been based on research work and aims to make the Centre a focus for the breeding, feeding and resting of waterbirds - ducks, swans, herons, ibis, egrets, spoonbills, grebes, rails, plovers and terns.

Research at the AMC Wetlands Centre has already touched on water quality and dynamics, phytoplankton production, the establishment of fringing vegetation, zooplankton production, distribution of frogs and reptiles and the breeding, diversity and movements of waterbirds. Much remains to be done and many other facets of the wetland ecosystem need study. The Centre offers opportunities for research at all levels - honours projects, higher degree research and post-doctoral work. Long-term studies will be particularly welcome because only in that way can we learn how the ecosystem behaves under different climatic patterns.

Here are some studies that might follow up research already undertaken, or investigate aspects so far neglected.

Water Research

Initial studies by Lloyd Townley and Simon Nield (University of Western Australia) led to the development of a model of water behaviour in the system once the waste flow from the processing plant ceased. When this happens the system will depend on rainfall and groundwater. Examination of how far the system is behaving in the ways Townley and Nield predicted would be valuable for future planning. For example where to build the Visitor Centre. The extent to which nutrients are held in the sediments of the ponds is not known, nor do we know the detail of their behaviour as water quality and temperature change. The system offers many opportunities to study the exchange of water and dissolved materials between the ponds and the groundwater.

Aquatic Life

Arthur McComb and Jane Chambers (Murdoch University) are studying the plants, Jacob John (Curtin University) the diatoms and Don

Edward and David Cale (University of Western Australia) the animals of the ponds. These studies have concentrated on describing the diversity of the organisms, seasonal and other changes in diversity and the effects of artificial changes in levels of nutrients and the provision of shelter. These baseline studies open the doors for detailed research on how individual species use the ponds and what their specific requirements might be. We need information of how to grow sheltering plants to encourage bird breeding, how to grow benthic plants to enable many kinds of animal to feed and how to boost the invertebrate fauna to provide abundant food for the waterbirds. Many aspects of fresh water biology can easily be studied at the Centre where it is possible to undertake experimental manipulations in isolated parts without disrupting the whole system. A useful piece of work would be the development of methods of identifying what plants and organisms are eaten by the waterbirds from an examination of droppings. Research on the value of shelter of different kinds to aquatic organisms would also help the ponds to be managed for sustainable production of food for waterbirds.

Frogs and Reptiles

Michael Bamford has described the fauna of these two groups and provided some information about how they use the ponds. Frogs and tadpoles are valuable as waterbird food and we need to know how to encourage them to breed in large numbers. The fish Gambusia is at large in some of the ponds and we suspect that it preys on tadpoles. Research into how to enable the tadpoles to evade this predator would be welcome. The uplands seem to be a stronghold for the reptiles. Studies of their movements to and from the wetlands would help us to understand that aspect of the ecosystem. Frogs are also known to move considerable distances and tracing their nightly excursions could provide material for an undergraduate camp.

Birds

Mandy Bamford and Frank Doyle (RAOU) have studied the breeding, distribution and seasonal occurence of birds on the wetlands. Some banding of waterbirds has been done but much research is needed on the exact requirements, food and nesting preferences of individual species. The ponds give excellent locations for studies of behaviour, feeding, preening, roosting and courtship. For some species parental behaviour studies are already possible and we anticipate increasing opportunities for such studies in the future when additional breeding species have been encouraged to use the Centre.

Information

Information about the research facilities and opportunities available at the AMC Wetland Centre can be obtained from Fiona Nicholls (Phone (09) 389 1222) or Frank Doyle (097 272 009).

AMC WETLANDS CENTRE
CAPEL, WESTERN AUSTRALIA

No. 3.3 April 1991

A community project developed by AMC Mineral Sands Ltd (a member of the RGC Group) in association with:

Royal Australasian Ornithologists Union
Department of Conservation and Land Management
The University of Western Australia
Curtin University of Technology
Murdoch University

COMMUNITY INVOLVEMENT IN THE AMC WETLANDS CENTRE AT CAPEL

The rehabilitation of the former sand-mining pits at Capel to the AMC Wetlands Centre is an expression of the Company's recognition that it does not operate in isolation, but has responsibilities to the community at large as well as to its customers and workforce. The Centre is designed to be both a waterbird refuge and an area for passive recreation. AMC intends that by contributing to the development of the Centre, Western Australians should feel involved in its activites from the beginning, and share with the Company pride in its achievements. Public involvement is already taking place in five different ways:

Displays: For many of the public their first contact with the AMC Wetlands Centre is through a display at one of the local shows or festivals. These displays contain boards of information on the AMC Wetlands Centre, backed up with displays of some of the wildlife found at the Centre. The wildlife displays include fish, insects, reptiles and frogs. There are small information boards giving details about each animal. These displays are often incorporated in an overall Mineral Sands Industry display showing all aspects of sand mining and processing. The information contained in the display is an easy way to become familiar with the AMC Wetlands Centre and understand its main aims. The Centre has an expanding library of slides illustrating the rehabilitation process and arrangements can be made for talks about the Centre to be given to interested groups.

Voluntary Work at the Centre: Much of the fine grain rehabilitation work at the Centre has been done by groups of volunteers. Joining one of these work parties is an excellent way to get to know what is involved in creating a waterfowl refuge. The edges of the lakes are made attractive to waterbirds by planting shrub seedlings, by transplanting rushes, by scattering straw and logs in the shallow water and by undertaking small scale habitat manipulation. Such things as digging small diversionary drains, building up the organic matter in artificial frog-breeding ponds or landscaping the sides of existing channels provide hours of creative entertainment to volunteer parties as well as making a valuable addition to the diversity of the area. Members of the Western Australian Conservation Volunteers (WACV) and the Royal Australasian Ornithologists Union (RAOU) have been the principal contributors. They can be contacted at:

Western Australian Conservation Volunteers,
Winter House,
1 Johanna Street,
North Fremantle,
Western Australia 6160

P.O. Box 492,
Fremantle 6160

Phone (09) 335 5508

Royal Australasian Ornithologists Union,
Headquarters
21 Gladstone Street,
Moonee Ponds,
Victoria 3039

Phone (03) 370 1422

W.A. Group
218/15 Ogilvie Road,
Canning Bridge,
Western Australia 6153

Phone (09) 364 6202

Tours: The AMC Wetlands Centre, with the two other sand-mining companies in the Capel area, conduct organised tours of the rehabilitation. If you have only time for a short stay in the area, joining one of these tours is an excellent way to see the Wetlands Centre. Tours bookings can be arranged through AMC Mineral Sands', Capel office, phone (097) 272 009.

Research: Much research work is in progress at the AMC Wetlands Centre. Community involvement is welcome in some aspects of it. Interested members of the public can arrange to visit the Centre when bird-banding is taking place. Bird banding involves the catching of wild birds to place numbered metal rings (bands) on their legs so that they can be individually identified when caught again as part of the continual study of the life histories of local birds. Much information about the biology of birds comes from such banding. After some experience helping with the maintenance and surveillance of trapping gear, visitors can be trained to assist with the banding of the birds and the recording of data. Regular participants in the banding operations can seek endorsement as assistant (B Class) banders, making a great contribution to the study of the increasing bird populations of the Centre. The information that we can obtain from banding studies is a vital contribution to management of the Wetlands Centre, enabling us to measure our success in attracting and keeping a diversity of species.

At the AMC Wetlands Centre we are continually monitoring the success of the habitat manipulation that we are undertaking. An important part of this monitoring involves observing the daily activity cycles of waterbirds using the lakes. Interested members of the community can be trained to undertake one or two hour watches as part of this programme and make significant individual contributions to the research work.

Groups or individuals interested in contributing to the research programme should contact the RAOU Project Officer at Capel, Frank Doyle (Phone (097) 272 009) to arrange suitable times for their visit.

School Projects: As well as taking part in guided tours, provision can be made for school groups to visit the AMC Wetlands Centre to undertake their own studies, provided they are accompanied by a teacher. The projected study should be discussed first with the RAOU Project Officer on the site (Frank Doyle, phone (097) 272 009) to ensure that it is suitable for the present stage of rehabilitation.