Preliminary assessment of the possible use of birds as bio-monitors in and around the Bromley Oxidation Ponds, Christchurch

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1 Introduction

1.1 Background

The Avon-Heathcote Estuary and the adjacent Bromley Oxidation Ponds constitute a wintering site of national significance for a range of indigenous bird species (Cromarty & Scott 1996). Large numbers of waterfowl use the ponds and estuary in late summer and autumn (Crossland 1992), and the estuary was recently identified as one of 19 wintering sites of national importance for indigenous shorebirds (Dowding & Moore 2006). The area is estimated to provide seasonal habitat for up to 30,000 birds, and hold 1% or more of the New Zealand populations of 16 bird species (Crossland 1992). It can therefore be considered to constitute significant habitat of indigenous fauna in terms of the RMA and New Zealand Coastal Policy Statement.

Any toxic substance in the Bromley Oxidation Ponds, or discharged into the estuary, has the potential to have negative impacts on large numbers of birds. A number of studies of sediments in New Zealand estuaries (including Avon-Heathcote) have shown that there are often relatively high levels of some heavy metals, particularly in estuaries surrounded by urban areas (e.g. Ministry for the Environment 1997). However, there has been little study of the impact of these contaminants on biota using the estuaries. Given that sediments in the Avon-Heathcote Estuary are known to contain heavy metals (Rodrigo 1989), and that there will be discharges from the Bromley Ponds for at least a further 5 years, it appears appropriate to test for potential contaminants in biota that are using these areas.

This report was produced in response to a request from Canterbury Conservancy of the Department of Conservation for a preliminary evaluation of the feasibility of using birds to test for certain contaminants in and around the Bromley Ponds.

1.2 Use of birds for toxicity testing

There has been relatively little use of birds for non-lethal toxicity testing in New Zealand. Blood samples were successfully used to measure heavy metal levels in pied oystercatchers in the Manukau Harbour (Thompson & Dowding 1999) and the authors suggested that this species was a useful bio-monitor for heavy metals in New Zealand estuaries.

One advantage of using animals such as birds is that they may reflect intake of contaminants over a period. If there is a short-term spike of a contaminant and this is not detected by other techniques (such as monitoring outfall water quality), there may be accumulation in birds (of heavy metals, for example), that will show up with periodic testing.

While there are clear ethical advantages in the use of non-lethal tests for contaminants in principle, there may be a number of practical problems in collecting samples regularly from live, wild birds. These include the following:

1. Bird location can be affected by a wide variety of environmental factors, and bird behaviour can be unpredictable. There is therefore no guarantee that obtaining required samples to a given timetable will be possible, i.e. there is no certainty that a given species can be captured, in sufficient numbers, and at the planned time.
2. Birds may learn to recognise capture techniques quite quickly, making repeated sampling progressively more difficult.
3. Cost and the effort required may be limiting factors. Thompson & Dowding (1999) undertook only two capture sessions, but one of these involved cannon-netting and required relatively large numbers of people for capture and processing. In that instance, the labour was provided

by volunteers. Securing that level of volunteer input on a regular basis is very unlikely, and paying for it would be expensive (assuming the expertise was available).

These areas of concern suggest that an initial assessment should at least consider a wide range of possible sampling techniques.

2 Sampling at Avon-Heathcote Estuary

2.1 Possible contaminants

Initially, tests should be undertaken to detect:

1. Heavy metals. As noted above, a number of studies have shown that sediment heavy metal levels are often high in estuaries surrounded by urban areas in New Zealand. Lead levels in oystercatchers wintering in the upper Manukau Harbour were elevated, with several individuals having levels at which deleterious sub-lethal effects were likely (Thompson & Dowding 1999).
2. Malathion. This is an organophosphorus insecticide used for control of midges at Bromley. Birds may come into contact with malathion directly (from the sprayed substrate) or may ingest insects containing the compound.

The possibility that other potentially toxic contaminants are present in or being discharged from the ponds should be investigated before a monitoring programme is finalised. Pollutants might include herbicides and any toxins used for pest control, such as anticoagulant rodenticides.

2.2 Possible sampling techniques

Given the potential problems outlined in section 1.2 above, a range of sampling techniques may need to be employed. These can be divided into non-lethal and lethal sampling.

Non-lethal

1. Live capture of birds. Blood samples and feathers can be taken and the birds released.
   Comments: Blood sample sizes depend on the mass of the bird, and some samples would be small; the number of feathers that can be taken is limited. This method is non-lethal and would almost certainly be publicly acceptable. In the case of heavy metals, blood samples reveal relatively recent exposure. However, it may prove increasingly difficult or impossible to catch the required number of each species at the required time. Selecting appropriate (more easily caught) species may reduce this problem. The effort that may be required could make this a relatively time-consuming option.

2. Collection of moulted feathers
   Comments: Thousands of waterfowl moult on the ponds each summer and autumn, and it may be possible to collect sufficient quantities of moulted flight feathers for testing. The suitability of these feathers (and the sample sizes required) for heavy metal testing need to be determined, but this technique would provide another acceptable, non-lethal option. Given that moulted feathers could come into contact with malathion (on water or on the ground) independently of the bird that shed them, this technique would probably not provide a reliable indicator of bird exposure to malathion.

3. Collection of birds found freshly dead.
   Comments: Any birds found dead and reasonably fresh should be bagged, labelled and frozen. This will not provide a regular or predictable source of material, but would provide additional samples that may reveal contaminants and should not be overlooked.

Lethal

1. Shooting of birds. Small numbers of birds could be shot specifically for sampling.
   Comments: This would clearly be far less acceptable to the public than non-lethal sampling. It would probably be relatively cost-efficient however. It should certainly be possible to avoid all fully protected species, as many of the birds using the ponds in large numbers are either on the game list (and are shot in large numbers elsewhere) or are not protected. Adverse effects at the population level are remote. Individual samples would be large, allowing for the testing of liver, muscle tissue, etc for a range of contaminants.

2. Collection of eggs. Eggs could be collected from birds nesting around pond margins,
   Comments: While this is technically lethal sampling, it would have even less impact at the population level than shooting of adults, and would probably be more acceptable publicly. Finding nests is not normally difficult, particularly when using a vehicle as a hide. This technique is clearly restricted to the breeding season. Pukeko are an obvious candidate – they lay sizable clutches of relatively large eggs. If this option is considered further, a list of birds known to breed in reasonably numbers around the ponds should be consulted to determine which other species might be suitable. Again, using game birds may make it possible to avoid collection of eggs from fully protected species. One obvious disadvantage is that results from egg samples may not be comparable with results from blood or tissue samples.

Sampling invertebrates

Contaminants detected in organisms eaten by birds would provide indirect evidence that birds were being exposed to pollutants. In the estuary for example, contaminants in bivalves could be ingested by oystercatchers, in polychaete worms by long-billed scolopacids (e.g. godwits), and in small crabs by a wide range of surface- and probe-feeding shorebirds, kingfishers and herons.

2.3 Maximising the probability of detecting contaminants

The primary aim of the sampling programme should be to maximise the chance of detecting contaminants, while minimising impacts on protected species and reducing effort and cost. Reducing effort when using non-lethal testing such as blood sampling will almost certainly result in sampling small numbers of birds. To maximise the probability of detecting contaminants in a small number of samples, consideration needs to be given to a number of factors.

Sample type and amount.

With some types of samples, detectability may be an issue, and some basic research on the suitability of certain material would be required before proceeding. Are heavy metals, for example, sequestered in the adult female bird or are they transferred to eggs in detectable amounts? Is the relationship between egg concentration and adult tissue concentration known? In whole birds, which tissues normally have the highest concentrations of a given contaminant?

Numbers of samples

If contaminants such as heavy metals are at levels of concern in birds in the area, they will be detected easily. It is therefore sufficient to sample relatively small numbers (I suggest 3-7 individuals of 2-3 species as a rough guide) at each session. As noted above however, the number of samples collected non-lethally may well be limited by the ability to capture sufficient birds. It should also be remembered that results will accumulate, and even 20 samples per year will result in a substantial dataset containing 100 samples in five years.

Sampling locations

It seems likely that concentrations of contaminants in the estuary will decline with increasing distance from the outfalls. Individual birds often have predictable routines, feeding and roosting

in the same parts of an estuary from day to day. Together, these facts suggest that detection of contaminants is likely to be maximised by taking samples from birds around the ponds themselves and from the estuary around the outfalls in front of the ponds. Capture of shorebirds in particular may be easier on the South Brighton Spit (where there are major high-water roosts), but there is no certainty that birds sampled there have been feeding close to the ponds.

Frequency and timing of sampling

Determining an appropriate frequency for sampling is extremely difficult. Clearly the larger the number of samples collected, the higher the probability of detecting contaminants, but this must be offset against the higher cost involved. Given that the levels of contaminants in birds using the area are currently unknown, it would appear sensible to retain some flexibility in frequency of sampling and in numbers sampled in each session. I would suggest that three sampling sessions per year should be adequate initially. If early results suggest localised contamination for example, additional samples may be required to pin-point the source. If results are consistently negative or show low concentrations, it may be possible to reduce sampling frequency. However, I believe at least two sessions per year are an absolute minimum, one to sample birds wintering on the estuary and/or ponds, and one to sample birds breeding in and around the ponds. If two sessions were undertaken annually, numbers sampled in each session should be higher.

Possible species

A wide range of bird species is potentially available for the various types of sampling outlined above. Initial decisions about which sample techniques to use and which species to sample will entail balancing many factors, including:

Status under the Wildlife Act
Threat status
Ease of capture
Numbers using the area
Timing of use of the area
Feeding ecology
Parts of the estuary and ponds used

If sampling were to proceed, a first step would be to compile a table of species, with these variables, then assess the advantages and disadvantages of each species-sampling technique combination, and produce a short-list. The production of such a list has not been possible in the time available for the production of this report. Limited field trials would probably be useful for identifying suitable species and determining feasibility of various capture techniques. However, some species or guilds are obvious candidates:

Black swan, Canada goose, paradise shelduck, mallard and other waterfowl (game species, not threatened; some breed locally; present in large numbers after breeding; may be easier to catch while moulting; candidates for egg collection, non-lethal or lethal sampling)

Pukeko (game species, not threatened; breeds locally; candidate for egg collection, non-lethal or lethal sampling).

Pied oystercatcher (protected species, not threatened; present on the estuary in very large numbers annually; candidate for non-lethal sampling).

Pied stilt (protected species, not threatened; breeds locally; candidate for egg collection or non-lethal sampling)

Red-billed gull (protected species, chronically threatened; high numbers present; may be relatively simple to catch by baiting; candidate for non-lethal sampling)

Black-backed gull (not protected, not threatened; candidate for egg collection, non-lethal or lethal sampling)

The range of species tested may not have to remain constant from year to year. For example, if one species consistently shows very low concentrations of contaminants (or cannot be caught reliably), another could be substituted, as long as a suitable range of feeding types and locations is maintained. Within limits, sampling a wider range of species may be advantageous if levels of contaminants do not prove to be consistent between species.

2.4 Possible sampling regime

It is possible that the most practicable sampling regime will involve a combination of different species and sampling techniques at different times. For example:

1. Waterfowl could be sampled in January-February while moulting (possible techniques: collection of shed feathers, live capture, shooting)
2. Wintering shorebirds could be sampled in April-June when they have been on the estuary for several months (possible techniques: live capture)
3. Breeding birds (e.g. pukeko, pied stilts and black-backed gulls) could be sampled in September-December (possible techniques: egg collection, live capture, shooting)

Such a regime would provide a spread of times, species, locations and feeding types. As noted above, it suggests three sampling sessions per year initially, although some flexibility in sampling frequency may be required. The time required for one person to undertake capture and sampling would be in the order of 1-2 days per session, once the target species, capture techniques, and locations had been identified.

It is clearly impossible to predict the precise number of samples that would be collected for testing each year, but the following estimates show approximate minimum and maximum values:

Lowest desirable: 2 sessions x 3 species x 4 individuals = 24 samples
Probable maximum: 3 sessions x 4 species x 5 individuals = 60 samples

It would probably therefore be wise to seek an agreement that allowed for testing of up to 50 samples per year. While this may appear to be a large number of samples, it is unlikely to be achieved; it is also worth noting that it represents less than 0.2% of the birds that use the estuary annually.

Initially, the primary aim of the sampling programme should be to screen for unacceptably high levels of contaminants in individuals of any species. Sampling the same numbers of birds of the same species at the same times of year is therefore not the highest priority. It is highly unlikely that sample sizes will be large enough to allow robust comparisons of contaminant levels between (for example) species or locations, at least in the short term. Clearly however, if levels are consistently high and further sampling is undertaken, it may be useful to standardise the sampling regime to permit such analyses.

In the longer term, it would clearly be of benefit to continue sampling after discharges from the ponds to the estuary have ceased, in order to determine:
(a) the overall extent to which pond outflow contributed to the heavy metal burden in the estuary,
(b) the time taken for heavy metal levels to fall in the estuary, and
(c) whether any changes occur in the relative amounts of different metals in the estuary.

3 Summary and recommendations

- The Avon-Heathcote Estuary and Bromley Oxidation ponds constitute a wetland of national and international significance, providing wintering habitat for thousands of waterfowl and shorebirds. These birds could be at risk from toxic contaminants released to the estuary. Heavy metals are known to be present in sediments in the estuary.

- Birds appear to provide an appropriate bio-monitoring system to detect certain contaminants in the ponds and the estuary. The Department should seek an agreement in principle for a monitoring programme to be funded. The aim of such a programme should be to maximise the chance of detecting contaminants, while minimising impacts on protected species and reducing effort and cost.

- At a minimum, testing should be carried out for heavy metals and for malathion. Consideration should also be given to other potential contaminants that might be used in or around the ponds and/or be present in material processed and discharged by the plant.

- A range of non-lethal and lethal sampling techniques is outlined. Non-lethal testing would clearly be desirable if practicable. However, live-capture of target species in sufficient numbers at defined times for collection of blood samples could be difficult and time-consuming, and may sometimes be unsuccessful. A combination of non-lethal and lethal sampling may be required.

- If a monitoring programme is to proceed, the Department should plan a more detailed sampling regime. Initially, this would involve identifying suitable species and evaluating techniques where necessary.

- A suggested sampling regime would involve 2-3 sampling sessions per year, with samples from 3-5 individuals of 2-4 species in each session (estimate range 24-60 samples per year).

4 References

Cromarty, P. & Scott, D.A. 1996. *A Directory of Wetlands in New Zealand*. Department of Conservation, Wellington.

Crossland, A.C. 1992. Birds of the estuary. Pp. 63-97 *in* S-J. Owen (ed) *The Estuary: Where our Rivers Meet the Sea: Christchurch's Avon-Heathcote Estuary and Brooklands Lagoon*. Parks Unit, Christchurch City Council, Christchurch.

Dowding, J.E.; Moore, S.J. 2006. Habitat networks of indigenous shorebirds in New Zealand. *Science for Conservation 261*. Department of Conservation, Wellington.

Ministry for the Environment 1997. The State of New Zealand's Environment 1997. Ministry for the Environment, Wellington.

Rodrigo, A.G. 1989. Surficial sediment-heavy metal associations in the Avon-Heathcote Estuary, New Zealand. *New Zealand Journal of Marine and Freshwater Research 23*: 255-262.

Thompson, D.R.; Dowding, J.E. 1999. Site-specific heavy metal concentrations in blood of South Island pied oystercatchers *Haematopus ostralegus finschi* from the Auckland region, New Zealand. *Marine Pollution Bulletin 38*: 202-206.