Health Monitoring in Birds of Prey

John E Cooper[1]

Introduction

Raptors (birds of prey - Orders *Falconiformes and Strigiformes*) are important environmental sentinels, especially insofar as toxic chemicals are concerned (Newton, 1979;[1] Ratcliffe, 1993[2]). Increasingly, attention is being paid to their potential role as indicators of other aspects of ecosystem health, especially the prevalence and spread of infectious agents - micro and macroparasites. At the same time, developments in the field of captive breeding mean that there are important and valuable collections of raptors in zoos, conservation units, rehabilitation centres and private hands: the maintenance of health in such establishments is important not only in terms of the well-being of the captive birds themselves - and of those who come into contact with them - but because some specimens may be returned to the wild (Olsen, 1990[3]).

Health monitoring is of great importance in all work with raptors. In the case of free-living birds of prey, before these species can be fully utilised as environmental sentinels there is a need to establish a) baseline ("normal") data and b) protocols and standard techniques for health monitoring. Work on captive birds can be of value in this respect as well as providing information that is directly relevant to raptors that are maintained for exhibition or other purposes.

Definitions

A number of scientific terms will be used in this paper and need careful defining:-

Introduction — the intentional or accidental dispersal by human agency of a living organism outside its historically known range.

Reintroduction — the intentional movement of an organism into part of its native range from which it has disappeared or become extirpated in historic times as a result of human activities or natural catastrophe.

Restocking — the movement of numbers of plants or animals with the intention of building up the number of individuals of that species in an original habitat.

Translocation — the captive transport and release of free-ranging, wild animals, moving them from one part of their historic range to a different location, but one

[1] Faculty of Veterinary Medicine, Sokoine University of Agriculture, P O Box 3021,Morogoro, Tanzania
Present address: Durrell Institute of Conservation and Ecology, University of Kent, Canterbury, Kent CT2 7NJ, UK.

where the species occurs at present or has historically occurred naturally.

The above are taken from the IUCN Position Statement on the Translocation of Living Organisms, 1987.

Some important definitions relating to health and disease are:-

Disease any impairment of normal physiological function affecting all or part of an organism.

Infection the presence of an organism that is capable of causing disease.

Health freedom from disease; bodily and mentally vigorous.

Macroparasites metazoan (multicellular) organisms that are capable of colonising birds, with or without clinical signs of disease (e.g. cestodes, nematodes, ticks).

Microparasites single-celled organisms that are capable of colonising birds, with or without clinical signs of disease (e.g. bacteria, viruses) (Anderson and May, 1982;[4] Dobson and Hudson, 1986[5]).

Raptors as Hosts of Macro and Microparasites

A bird of prey (or any other living animal) cannot be considered as a single organism. It harbours, either transiently or persistently, a whole range of organisms - both macro and micro parasites. As Nettles (1992)[6] stated:-

"Wildlife veterinarians are aware that each wild animal is actually a biological package that encompasses the microbiologic flora, viruses and endoparasites and ectoparasites of the animal. Therefore the moving of wild animals always holds the potential for relocation of a disease agent as well."

Thus a captive or free-living bird of prey may also be a reservoir for such organisms as:-

Lice	Protozoa
Fleas	Viruses
Ticks	Bacteria
Hippoboscids	Chlamydiae
Leeches	Rickettsiae
Nematodes	Fungi
Cestodes	Algae
Trematodes	

In addition, many other extraneous animals, plants, eggs, seeds, etc. can be transported by raptors and be deposited or disseminated. Carriage of the organisms above may be passive or active and the organisms may or may not be associated with disease.

Detection of the organisms associated with raptors - or detection of changes, such as seroconversion, that may be indicative of exposure to such organisms - is achieved by health monitoring. Although many of the techniques used in health monitoring are similar (sometimes identical) to those used in diagnosis, the approach and rationale are different. Two important distinctions are that:-

1) health monitoring is generally carried out on supposedly normal raptors whereas diagnosis is performed on birds that show clinical signs or are believed to be diseased.

2) the collection of samples and supporting data for health monitoring is often the responsibility of biologists, ornithologists and zoo personnel whereas the veterinarian plays the leading role in diagnosis of disease.

Health Monitoring of Birds

Monitoring can be defined as the surveillance of a group or population. The word comes from the Latin *monere*, meaning to warn, and this is a reminder of the value of monitoring in alerting raptor biologists to abnormalities or changes at an early stage.

The aim of monitoring is to ascertain as accurately as possible the health status of apparently normal birds or groups of birds and to specify (describe and quantify) this status. Monitoring also permits the collection and recording of biological data on the individual, group or species.

Monitoring of raptors can be of two main types:-

a) clinical monitoring of live bird(s)

b) *post-mortem* monitoring of dead bird(s)

In addition environmental monitoring - for example, examination and analysis of water, soil and nest sites - is possible (see later).

Screening is usually an integral part of health monitoring. Screening is necessary when a group or population is being monitored and detailed examination of all birds is impracticable or impossible. In this case sampling is carried out rather than examination of each individual. The term "sampling" can also be used when an individual raptor is being monitored but only a limited number of tests or samples is possible - for instance, because of the cost involved or because the raptor is free-living.

The results of monitoring provide a specification (profile) for that bird or group of birds. The reliability of the results depends upon the quality of monitoring procedures (clinical, *post-mortem*, environmental) - quality assurance - and a programme of quality control (internal or external review and critical assessment) is advisable.

Why is Health Monitoring Important?

1) to provide background data on the individual, population or species

2) to reduce the risk of spreading disease or organisms to other populations of the species or the environment in which the species lives (Wolff and Seal, 1993[7])

3) to minimise health risks to the individual bird or its species if it is translocated

4) to protect the health of:-

   a) other animals - domestic or free-living
   b) humans

5) to satisfy legal requirements e.g. animal health and welfare laws (Cooper, 1993[8])

Detailed information on the health monitoring of wild birds was first given in "Disease and Threatened Birds" (Cooper, 1989a[9]); the books and papers listed as "Further Reading" provide other references.

How Do We Monitor Health?

1) by analysing history, especially clinical and *post-mortem* records, and published and unpublished data

2) by routine observation and clinical examination of live birds

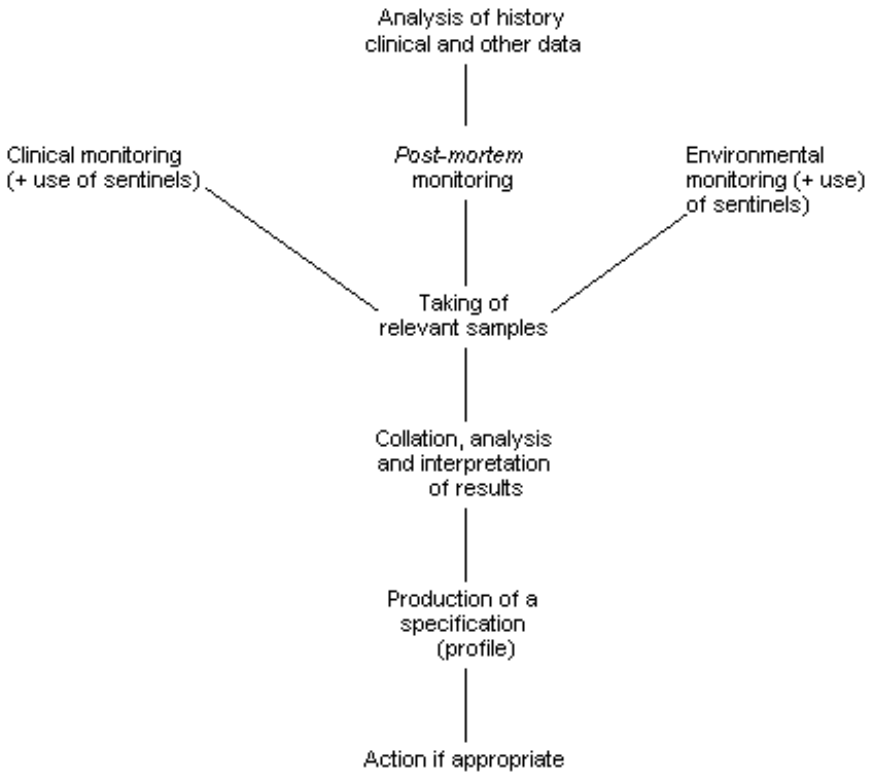
3) by routine *post-mortem* and pathological examination of dead birds

4) by use of standard techniques, that are subject to high standards of quality control, to monitor live birds, dead birds and the environment

5) by introducing "sentinels" (susceptible birds) into the captive or wild environment to see if clinical or subclinical changes occur or parasites and other organisms are acquired (Rocke and Brand, 1994;[10] Savidge, 1986[11]).

The emphasis in this paper is on 4) - standard health monitoring techniques. These are applicable to both captive and free-living raptors and suggested protocols are provided as Appendices 1, 2 and 3.

A general outline of health monitoring is as follows:



General Outline of Health Monitoring

All data must be systematically collated for analysis and interpretation. Quantitative methods should be used whenever possible including scoring systems for (e.g.) the bird's condition and histopathological findings.

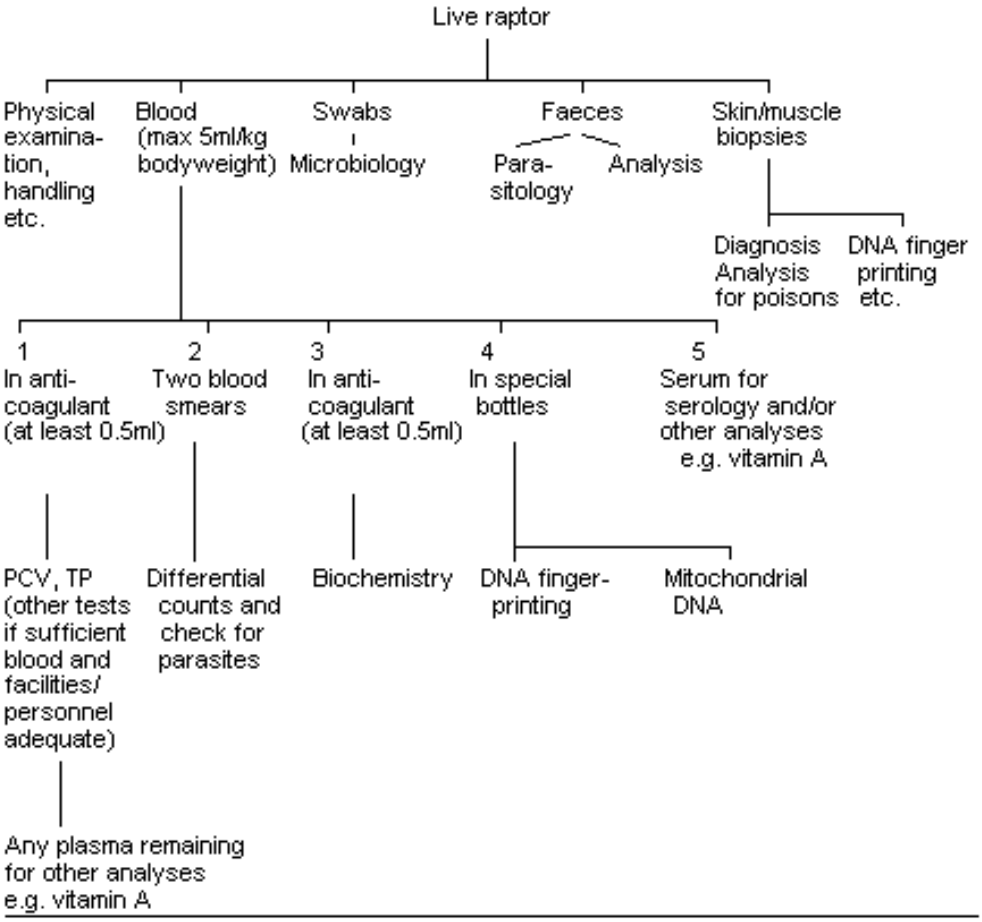
Action is not always necessary. Awareness of the situation is important: an informed decision can then be made.

Pre-planned health monitoring programmes for captive or free-living raptors should be supplemented by the "opportunistic" collection of samples whenever this is possible - for example, clinical samples when birds have to be handled or moved, *post-mortem* samples whenever a bird is found dead or has to be culled. Any sample may provide useful information and in the case of free-living birds may be the only one available.

Important considerations in health monitoring include:-
a) Risk (e.g. of injury) - to animal and personnel
b) Financial implications
c) Facilities available
d) Expertise available
e) Practicability
f) Reliability of results - relates to quality and numbers of samples and numbers of birds sampled; facilities, procedures and staff; numbers of samples/sample frequency necessary to detect.

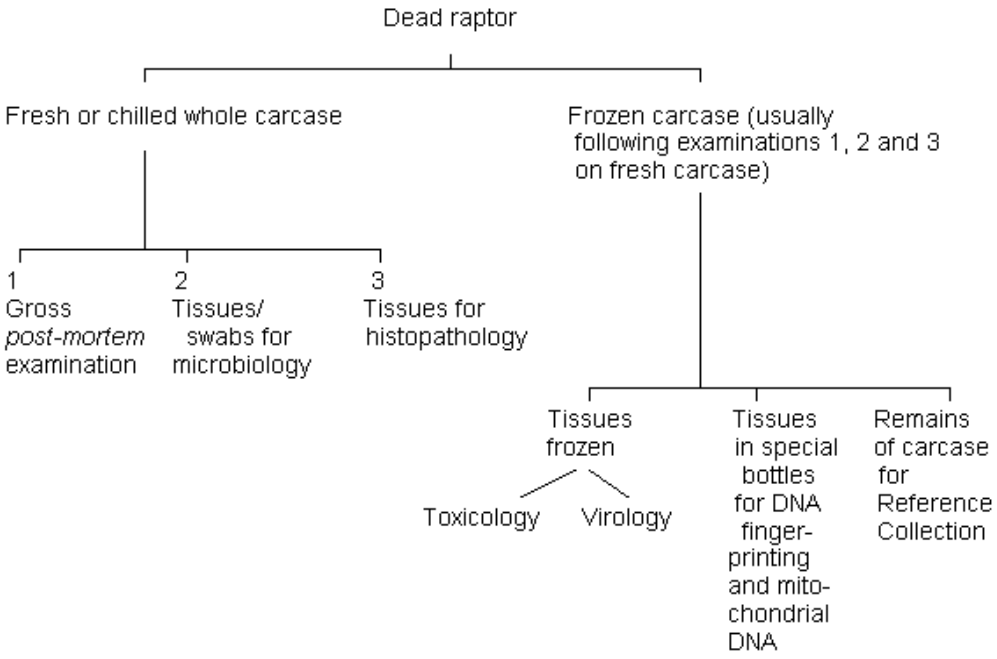
A cost : benefit analysis is always needed.

Figure 1



Material should be retained for re-testing and reference - for example, blood smears and parasites. Serum can be stored for subsequent investigation.

Figure 2



Material should be retained for reference whenever feasible. If a Reference Collection exists, the carcase should be fixed in formalin or ethanol other then small portions of tissue for DNA work, e.g., liver, which should be frozen.

Discussion

Health monitoring provides an opportunity to develop databases on the health of captive and free-living raptors. It is an integral part of raptor management whether the birds are in captivity or free-living and should be routine before birds are translocated, introduced or reintroduced. Some general rules pertain to health monitoring and these are:-

1) Some monitoring is better than none

2) Plan carefully and involve colleagues from other disciplines as appropriate

3) Be prepared to be selective - a cost : benefit analysis is usually necessary

4) Standardise techniques, following recognised protocols and procedures (see Appendices) and consider a system of quality control

5) Adhere to all relevant conservation, animal health and welfare legislation and obtain necessary licences or authority for birds and samples, including CITES permits for derivatives if material is to be sent from one country to another

6) Collect and collate data systematically and quantitatively; submit to central databases where these are available

7) Analyse and interpret results carefully - especially those that are negative.

8) Produce a written specification (profile) for the bird(s) in the form of a report, printout or "medical passport"

9) Save material where possible - for re-testing and subsequent research. In the case of rare species or unusual findings, consider establishment of a Reference Collection

10) Repeat monitoring if possible - for example, if a free-living or released raptor is recaptured or is later found dead

11) Disseminate results: encourage others to follow similar techniques and promote the concept of standard monitoring protocols.

Monitoring of free-living raptors has already been advocated and, to a certain extent, used as a means of assessing the health status of these birds (Cooper, 1989b[12]). Migrating raptors have attracted particular attention, partly because they provide the opportunity for large numbers to be captured and handled but also because, by definition, they are birds of prey that are on the move and thus may have been in contact with toxic chemicals or pathogenic organisms. Most work on migrating birds has been carried out in Israel and North America. There are, however, many other migration routes - for example, the Indus River Plains, Eastern Tibet/Trans-Himalaya and the Manchuria/Eastern China Plains - that warrant attention and research. A concerted international approach could result in the establishment of health monitoring programmes for raptors in America, Europe, Africa, the Middle East, Central Asia and the Far East. The potential using migrating birds of prey for

monitoring chemicals, pathogens and environmental change would appear to be enormous.

Under certain circumstances it may be impossible or unwise to capture and restrain free-living raptors in order to obtain samples for monitoring. In such cases non-invasive techniques will be necessary, for example, the collection of voided faeces and pellets (castings) and examination of nest remains (Cooper, 1997[13]).

The importance of monitoring raptors prior to release, reintroduction, introduction or translocation has also been stressed (Cooper, 1993,[14] 1995[15]). Awareness of the danger of spreading pathogens has emphasised this need (Cooper, 1989a;[9] May, 1988;[16] Wolff and Seal, 1993[7]). For long the danger presented by the introduction of "exotic" organisms has been recognised (Courtenay and Robins, 1975[17]); only relatively recently has this concept been extended to macro and microparasites (Anderson and May, 1982[4]).

Captive raptors should be monitored regardless of whether or not they are destined for release (Cooper, 1978;[18] Cooper and Greenwood, 1981[19]). Such an approach is particularly important on health and welfare grounds but also provides information to accumulate data on the biology of these birds and to contribute to the debate on, for example, host-parasite relations (Loye and Zuk, 1991[20]).

Health monitoring serves many purposes and is a potent tool in raptor biology (Cooper and Greenwood, 1981;[19] Cooper, 1987,[21] 1989b[12]). At its most basic, it is a form of "preventive medicine" since it can permit the detection of potential pathogens and provide early warning of ill health. In this respect it reflects the advice given to falconers by Richard Blome (1686)[22] over three hundred years' ago:-

"Diseases are easier prevented than cured: everyone therefore that intends to keep Hawks should be well advised in the first place how to preserve them from Sickness and Maladies, which is of greater concern than to cure them when distempered."

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References and Further Reading

1. Newton, I. (1979). "Population Ecology of Raptors". T. & A.D. Poyser, Berkhamstead, UK.

2. Ratcliffe, D. (1993). "The Peregrine Falcon". 2nd edition. T. & A.D. Poyser, London.

3. Olsen, J. (1990). Caring for Birds of Prey. Wild Ones in Animal Books, California.

4. Anderson, R.M. and May, R.M. (1982). Editors "The Population Biology of Infectious Diseases". Springer-Verlag.

5. Dobson, A.P. and Hudson, P.J. (1986). Parasites, disease and the structure of ecological communities. TREE **1**(1), 11-14.

6. Nettles, V.F. (1992). Wildlife diseases and population medicine. Journal of the American Veterinary Medical Association **200**, 648-652.

7. Wolff, P.L. and Seal, U.S. (1993). Editors, Proceedings Issue International Conference on Implications of Infectious Disease for Captive Propagation and Reintroduction of Threatened Species. Journal of Zoo and Wildlife Medicine **24**, 229-408.

8. Cooper, M.E. (1993). Legal implications for the management of infectious disease in captive breeding and reintroduction programs. Journal of Zoo and Wildlife Medicine **24**(3), 296-303.

9. Cooper, J.E. (1989a). Editor "Disease and Threatened Birds". ICBP Technical Publication No. 10. International Council for Bird Preservation, Cambridge.

10. Rocke, T.E. and Brand, C.J. (1994). Use of sentinel mallards for epizootiologic studies of avian botulism. Journal of Wildlife Diseases **30**(4), 514-522.

11. Savidge, J.A. (1986). "The Role of Disease and Predation in the Decline of Guam's Avifauna." Dissertation, University of Illinois.

12. Cooper, J.E. (1989b). The importance of health monitoring of migrating raptors. In "Raptors in the Modern World" edited by B.-U. Meyburg and R.D. Chancellor. WWGBP, Berlin, London and Paris.

13. Cooper, J.E. (1997). Minimally invasive health monitoring of wildlife. Animal Welfare (in press).

14. Cooper, J.E. (1993). Historical survey of disease in birds. Journal of Zoo and Wildlife Medicine **24**(3), 256-264.

15. Cooper, J.E. (1995). Biomedical considerations of falcon reintroduction programmes. Proceedings of Middle East Falcon Research Group Specialist Workshop, Abu Dhabi, UAE.

16. May, R.M. (1988). Conservation and disease. Conservation Biology **2**, 28-36.

17. Courtenay, W.R. and Robins, C.R. (1975). Exotic organisms: an unsolved, complex problem. BioScience **25**(6), 306-313.

18. Cooper, J.E. (1978). "Veterinary Aspects of Captive Birds of Prey". Standfast Press, Gloucester.

19. Cooper, J.E. and Greenwood, A.G. (1981). Conclusions in "Recent Advances in the Study of Raptor Disease" edited by J.E. Cooper and A.G. Greenwood. Chiron Publications, Keighley.

20. Loye, J.E. and Zuk, M. (1991). "Bird-Parasite Interactions". Oxford University Press, Oxford.

21. Cooper, J.E. (1987). Pathology. In "Raptor Management Techniques Manual" edited by
Pendleton, Millsop, Cline and Bird. National Wildlife Federation, Washington D.C.

22. Blome, R. (1686). "The Gentleman's Recreation". S. Roycroft, London.

23. OIE (1991). "Animals, Pathogens and the Environment". Office International des Epizooties Scientific and Technical Review **10**(3).

Appendix 1

Clinical Monitoring (Live Raptors)

Basic

Analysis of history and records

Observation and examination

1) Presence or absence of:
   a. clinical signs of disease
   b. injuries or external lesions
   c. ectoparasites

2) a. bodyweight — coupled with standard
   b. measurements — data on sex, age
   c. condition score — and reproductive status

3) Gross appearance of:
   a. faeces
   b. pellets (castings)

Laboratory tests

1) Presence or absence of protozoan and metazoan parasites in faeces

2) PCV (haematocrit) and total blood protein

3) Differential blood counts plus presence or absence of parasites or cellular abnormalities in blood smears

Additional investigations, if personnel and facilities permit

1) Bacteriological examination of swabs from:
   a. trachea
   b. cloaca

2) Blood tests - complete haematology and biochemistry

3) Examination of serum for antibodies (serology)

Whenever possible - and always if a bird appears to be unwell - a full clinical examination should be carried out and supporting laboratory tests performed. In this case a standard clinical sheet should be completed.

Figure 1 indicates the different samples which may need to be taken as part of, or at the same time as, clinical monitoring.

Appendix 2

Post-Mortem Monitoring (Dead Raptors)

Basic

Analysis of history and records

Post-mortem examination

1) Gross examination:

   a. bodyweight coupled with

   b. measurements data on sex, age

   c. condition score and reproductive status

   d. appearance of internal organs

   e. presence or absence of fat

   f. presence or absence of ectoparasites

   g. presence or absence of endoparasites in alimentary or respiratory tract

2) Basic microscopical examination:

   a. wet preparations of faeces or gut contents

   b. cytology of any organs or tissues showing abnormality

3) Toxicology - submission or retention (frozen) of carcase or tissues for analysis (e.g. for chlorinated hydrocarbon pesticides, heavy metals).

Additional investigations, if personnel and facilities permit

1) Bacteriology:

   a. heart blood

   b. intestinal contents

   c. any significant lesions

2) Histopathology:

   a. lung

   b. liver

   c. kidney

   d. any significant lesions

3) Other tests - submission or retention (frozen/fixed) of tissues for virology, mycoplasmology, electronmicroscopy, etc.

Whenever possible a full *post-mortem* examination should be carried out and supporting laboratory tests performed. In this case a standard *post-mortem* sheet should be completed.

Figure 2 indicates the different samples which may need to be taken as part of, or at the same time as, pathological examination. It is important to follow a protocol. When time is short, or facilities limited, a decision will need to be made as to which samples take priority.

Appendix 3

Environmental Monitoring

Methods of environmental monitoring are at present imprecise and urgently need refining and standardising (OIE, 1991[23]). However, the following have proved useful when working with captive and free-living birds.

1) Analysis of existing data (published and unpublished) e.g. climate, soil types, health records

2) Clinical and *post-mortem* health monitoring, including microbiological and toxicological investigation of other animal species in the vicinity

3) Examination and analysis of water, soil, nest sites, perches and other samples
Use of bacteriological settle plates

4) Use of sentinel birds which may be of the same or other species, immunocompetent or immunosuppressed and examined clinically, *post mortem* or both