Environmental Impact Assessment Ordinance, Cap.499
Guidance Note

Methodologies for Terrestrial and Freshwater Ecological Baseline Surveys

(Important Note :

The guidance note is intended for general reference only. You are advised to refer to and follow the requirements in the Environmental Impact Assessment Ordinance (Cap 499) and the Technical Memorandum on the Environmental Impact Assessment (EIA) Process. Each case has to be considered on individual merits. This guidance note serves to provide some good practices on EIA and was developed in consultation with the EIA Ordinance Users Liaison Groups and the Advisory Council on the Environment. This guidance note is subject to revision without prior notice. You are advised to make reference to the guidance note current to the date. Any enquiry on this guidance note should be directed to the EIA Ordinance Register Office of EPD on 27th Floor, Southorn Centre, 130 Hennessy Road, Wan Chai, Hong Kong. (Telephone: 2835-1835, Faxline: 2147-0894), or through the EIA Ordinance web site (www.epd.gov.hk/eia/)

1. Purpose

According to section 5, Annex 16 of the Technical Memorandum on Environmental Impact Assessment Process (TM), sound and scientific methods should be employed in conducting ecological baseline survey[1] to obtain accurate and representative baseline information for ecological impact assessment. This guidance note aims at introducing some methodologies in conducting terrestrial and freshwater ecological baseline surveys[2] for reference. This guidance note should be read in conjunction with *EIAO Guidance Note No. 7/2002: Ecological Baseline Survey For Ecological Assessment*, which provides general guidelines for conducting an ecological baseline survey.

2. Survey Methodology

2.1 There are a wide range of surveys or sampling methods for investigating different types of habitats, flora and fauna groups. Each method has its own merits and limitations. In addition, each site to be studied has its specific condition, which may render certain survey methods more suitable. Sometimes, it may be necessary to use a combination of different methods or even specifically designed methods in some extreme cases. Taking into account the findings of literature review and preliminary investigations, the ecological surveyors should use their professional judgements to choose the most appropriate survey methodology according to the site conditions, ecological components to be studied and type of impacts expected.

2.2 Where appropriate, it is advisable to adopt standard survey methodologies, which are widely accepted so that baseline information gathered could be easily verified and results of different studies compared. In all cases, the details of the baseline surveys including the methodologies adopted, locations, time, frequency and duration of surveys should be stated clearly in the EIA report for reference.

[1] Ecological baseline survey used in this guidance note is a collective term referring to habitat survey, field survey, baseline survey and other similar terms appear in the Annex 16 of the TM or in the study briefs for EIA studies, which aim at collecting field data of flora, fauna and habitats of a study area.

[2] Survey methodology for marine ecological baseline survey is covered by a separate Guidance Note.

2.3 Attention should be drawn to section 5.1.3 of Annex 16 of TM that all field surveys carried out must not cause unnecessary stress or damage to the existing habitats and wildlife. Relevant permits under the Forests and Countryside Ordinance (Cap. 96), the Wild Animals Protection Ordinance (Cap. 170) or the Fisheries Protection Ordinance (Cap. 171) for collecting specimens and setting up traps must be obtained from the Agriculture, Fisheries and Conservation Department prior to the survey. As a general principle, the surveyors should avoid taking specimens in a manner that will damage or endanger the survival of any species. For instance, if a plant specimen is required for identification or record purpose, only a small portion of a plant individual should be collected with the main stem and root system remain intact. All animals trapped or collected alive should be released immediately after identification unless in circumstances where voucher specimens must be kept for scientific purpose.

3. Terrestrial Habitat Survey

The purpose of a terrestrial habitat survey is to identify different types of habitats found within a study area and to delineate their coverage. The results are usually consolidated in form of a habitat map with various legends showing the locations of different types of habitats on the map. The habitat map could be further annotated with target notes, which provide further information on specific locations with conservation interest or ecological importance.

3.1 Aerial Photos / Satellite Images interpretation

Aerial photos or satellite images can provide useful basic information on habitat type/land use of the study area. Through interpretation of an updated aerial photo or satellite image, the general conditions (e.g., vegetation cover, land use) of the study area and its vicinity could be readily visualized and translated into a preliminary habitat map. However, in local context, some habitats (e.g. shrubland/grassland) would be subject to high mapping error during the interpretation and ground truthing on selected sample units is necessary to verify the site conditions and provide more detailed information that could not be obtained from remote sensing technique.

3.2 Ground Truthing

This refers to surveying the study area on ground with a systematic routing and recording all ecological resources that the surveyor comes across, and is applicable to relatively small and accessible sites. It is often used as a preliminary survey for a specific area or habitat where a more focused survey will then be conducted to collect further details.

4. Vegetation and Plant Species Survey

Vegetation surveys focus on vegetation types in the study area while plant species surveys aim to provide information on plant species diversity and identify plant species of conservation concern. Vegetation surveys for ecological impact assessment studies are usually restricted to description of physiognomy or the growth form (e.g. forest, shrub or grassland) of the vegetation and conducted in conjunction with the general habitat surveys. A detailed vegetation survey of the study area with floristic analyses at plant community level is very time consuming and is normally not required in the context of ecological impact assessment. A more direct approach is to produce a plant species list by direct observation (and subsequent identification in the herbarium if necessary) while surveying representative parts of the study area. The presence of rare, protected and threatened plant species and other species of conservation concern should be noted as they are usually the main

focus. More attention should be given to the locations, which will be directly affected by the proposed development. In certain circumstances where collection of quantitative data is essential (e.g. establishment of quantitative baseline for subsequent monitoring), the use of quadrats and transect are simple and widely adopted methods.

4.1 Frame Quadrat

Frame quadrats, or often simply called quadrats, are used to define sample area within the study site. Plant species inside the quadrats are identified and their abundance estimated to work out the densities of various species. In some cases, their percentage covers are also estimated. Quadrats could be square or rectangular in shape and the size to be adopted depends on the type of plant communities to be surveyed and the extent of the study area. For example, the area of the quadrat used for surveying vascular plants in a shrubland or forest in Hong Kong ranged from $25m^2$ to $400m^2$ while quadrat used in grassland could be as small as $1m^2$. The locations of the quadrat chosen should be representative to various vegetation types present within the study area and usually several quadrats are sampled to obtain more representative results. In some cases, permanent quadrats are established for monitoring the change in vegetation over a period of time.

4.2 Transects

Transects are usually used to survey changes in vegetation along an environmental gradient, from a source of impact or through different habitats. The transect line should be laid to cover representative plant communities within the study area as far as possible or along an environmental gradient. The Line Transect method is to count the plant species and their abundance that touch the transect line. A vegetation profile could then be generated for illustrating changes in vegetation along the transect line. The Belt Transect method involves laying of quadrats of a certain size next to each other or contiguously along a transect line and data in each quadrats is recorded as mentioned above.

5. Terrestrial Mammal Survey

Terrestrial mammals vary widely in ease of observation and different survey methods may be applied for different species. Conspicuous and large mammals may simply be counted by direct observation. However, mammals in Hong Kong which are of conservation concern are mostly secretive and nocturnal. Other techniques such as searching for traits, trapping, camera trapping or mist netting (for bats) can be employed where necessary for surveying mammals which are difficult to directly observe.

5.1 Searching for Traits

Traits such as dung, feeding signs, footprints, burrows and dens are evidence of the presence of mammals. For any observed burrow and den, it is also important to assess whether they are still active or have long been abandoned. Mammal tracks, which can often be found in wet or muddy areas near ponds and streams where animals come to feed or drink, or associated feeding signs such as partially eaten vegetation or carcasses may provide evidence of traits of mammals. However, as not many local mammals can be reliably detected by these traits, this method may need to be supplemented by other survey efforts.

5.2 Trapping

Capturing of different mammal species requires different trapping techniques. Generally, there are many kinds of traps for trapping small terrestrial mammals. Box trap with appropriate bait is an effective means for trapping small terrestrial mammals unharmed. Pitfall traps (i.e., a container placed below the ground with the opening flush or just below the ground surface) could also be used to trap small mammals (e.g. shrews) when they fall through the opening into the container. Traps should be regularly checked and food, water and bedding should be provided to ensure that the caught individual can sustain during the interval between checks. However, trapping is an intrusive and potentially harmful technique for the target mammals. The application of this technique should only be handled by experienced personnel with proper authorization. Moreover, it should be justified whether the trapping exercise would yield any meaningful result for the ecological impact assessment before this method is to be applied.

5.3 Camera Trapping

It is a camera in which the animal itself triggers the shutter by various trigger mechanisms, such as mechanical trips, trip-plates, photic cells, infrared beams and passive infrared sensors. Passive infrared cameras are found to be the most popular camera traps, and it is composed by an auto-focus camera with a passive infrared sensor enclosed in a protective housing. Camera traps are placed at representative locations at the study area and the infrared sensor of the camera would be triggered when there are passing-by animals. The animals could then be identified from the photos taken. Moreover, relative abundance, distribution pattern and activity patterns for various species could also be revealed from the records taken. This sampling method could be used to detect cryptic terrestrial species that are difficult to observe and trap and it is relatively less intrusive when compared with trapping. However, it is less accurate and efficient in surveying arboreal and flying species or those live underground most of the time.

5.4 Surveys for bats

In general, surveys of bats can be done by direct counting at their roosting sites or foraging areas. Direct counting of bats is to determine community composition, species richness, and abundance and it can be done at their roost sites (e.g. counts at winter roosting site and maternity colonies) or when they are leaving their roost (e.g. nightly emergence counts and dispersal counts.) If roosting sites are not known, surveying efforts should be directed toward expected or potential commuting, foraging, and drinking sites. If capturing of bats is required for a more detailed study, mist nets are the most effective devices for capturing flying bats, and nets were placed in travel lanes of bats in probable foraging locations above water or ground and below the tree canopy. Nets were opened at dusk and should be tended constantly and captured bats must be removed individually. Due to difficulty of handling bats properly, investigators must exercise with particular caution to avoid injury of bats during their surveys. However, as mist netting is potentially intrusive to the bats, it has seldom been applied in ecological impact assessment. It should only be employed when it is fully justified and proper authorization must be obtained.

6. Bird Survey

Identification of bird species can be done visually or aurally by recognition of unique songs and calls. In addition to identifying the bird species under observation, it is also important to

record any notable behaviours of the bird such as feeding, nesting, or breeding and the associated habitats where it has such behaviour. Survey carried out at different seasons and time of day will significantly affect the survey results. In general, early mornings are usually the best time of the day for bird survey unless some nocturnal species or behaviours are to be studied. Survey season for bird is often a matter of concern particularly when the target bird species are migratory (see *EIAO Guidance Note 7/2002: Ecological Baseline Survey for Ecological Assessment*). Moreover, tide level may also have an influence on bird distribution in coastal habitats. There are many bird survey methods and the choice depends largely on the habitat type and the target bird species to be surveyed.

6.1 Point Count

Point count provides an estimation of the relative abundance of each species present. Counts are undertaken from fixed locations for a fixed period of time (e.g. 2 to 20 minutes). The locations could be laid out systematically or selected randomly within the study area. A well-spaced sample series of points in an area provide more representative data. Counting should be started a few minutes after arrival of the observers to allow birds to settle down from any disturbance caused. To generate indices of relative abundance of various bird species, all birds seen or heard should be counted from the fixed point up to a distance where birds are still detectable or within a fixed distance from the observer.

6.2 Transect Count

Transect count is more suitable for large open areas of relatively uniform habitat. Transects should be randomly selected as far as practicable and to avoid possible influences from the linear features such as road and river on the bird populations. Care should be taken to avoid bias as a result of selecting an easy access to the study area. All birds seen or heard on either sides of the transects are identified and counted up to a distance where birds are still detectable or within a fixed distance from the observer.

6.3 Mist-netting

Standard lengths and types of mist nets are erected in standard locations for a fixed period of time and individual birds are caught, identified and counted. It is often combined with ringing exercise where all birds caught are identified, physical dimensions measured, weighted, ringed and with the estimated age and sex recorded. This survey method is adopted to gather demographic information of bird populations and to monitor the long-term changes. The mist net could also be applied to survey birds in situations where direct bird observation is impractical. However, as the method is potentially intrusive to the birds and can only be practised by qualified ringers, it has seldom been applied in ecological impact assessment studies in Hong Kong.

6.4 Radio-tracking

Under very special circumstance, radio-tracking for species-specific survey could be applied. The radio-tracking system consists of a radio-transmitter fixed to the target bird, a multi-channel receiver detecting the signal emitted by the transmitter and a portable directional or fixed antennae. This method may collect useful details of specific bird species such as their home-range, spatial distribution and habitat preference. This method has been applied locally in the studies on the Black-faced Spoonbill and the Greater Painted Snipe.

Theoretically, this method could also be applied to other animal groups such as mammals. However, as the technique is intrusive to the target species, it should only be applied when it is fully justified. The technique should only be undertaken by trained professionals with proper authorization in advance.

7. Herpetofauna (Amphibians & Reptiles) Survey

The activities of amphibians and reptiles are highly seasonal and are influenced by the variation of weather even on a daily basis due to their ectothermic and cryptic nature. It is more fruitful to survey them during their active periods. Amphibians are usually most active just after dusk during their breeding seasons while many diurnal reptiles such as skinks or lizards are active in mid-morning. However, many other nocturnal reptiles such as certain snakes, geckos and most turtles would only be active at night time.

On the other hand, most amphibians and reptiles would go into hibernation during the cold and dry winter season. They would be under-estimated if surveys are carried out during this time. As such, it would be essential to survey herpetofauna at appropriate timings in order to collect a representative baseline for assessment. Indeed, many reptiles such as snakes and lizards are timid, secretive, fast-moving and cryptically coloured which render survey on reptiles difficult and therefore reptiles tend to be under-represented in ecological surveys in general. More intensive surveys with appropriate survey methodologies would rectify such limitation.

7.1 Active Searching

An effective way to survey amphibians and reptiles is by active searching, particularly during the daytime. This method is applicable for both nocturnal and diurnal species. The study area should be actively searched by the surveyors for potential breeding areas of amphibians (e.g. marsh, small water pools, water channels) and suitable microhabitats for both amphibians and reptiles (e.g. stones, pond bunds, crevices, leaf litter/debris, rotten log). It would be necessary to examine or uncover these places deliberately to search for the eggs and tadpoles of amphibians in aquatic habitats or to reveal the presence of the amphibians and reptiles hiding under these covers. Active searching can be applied along a transect line or in general surveys of the whole site with focus on suitable microhabitats.

For night surveys, when the nocturnal species of amphibians and reptiles come out of their hiding places, searching could be carried out in exposed areas of their potential habitats on the ground, along the path or the pond/stream bank. For frogs and toads, auditory detection of mating calls at their breeding sites could be considered an efficient method to find out the species present particularly the more vocal species.

7.2 Trapping

Pitfall traps can be used for survey of terrestrial amphibians and reptiles. Pitfall traps can be placed among habitat features, which are frequented by the animals to increase trapping success. The use of drift fences, along which traps are placed, would guide the animals to fall into the traps for better results.

To enhance trapping effectiveness, the trap could be filled with preservative such as formalin to prevent the trapped animals from jumping out of the trap or being eaten by other animal inside the trap. However, this is not recommended from nature conservation point of view, as

it kills indiscriminately all animals that have fallen into the trap. On the other hand, some leaf litter could be put in the set trap to provide cover and moisture for any amphibians and reptiles trapped inside. It should be noted that traps should be checked regularly within a reasonable time period, say, once per day, to avoid stress and death of trapped animals. The pitfall traps should also be de-activated or removed after the completion of the survey.

8. Butterflies and Dragonflies Survey

Life cycles of metamorphic butterflies and dragonflies consist of distinct stages. Their characteristics and habitat requirements change at different stages of the life cycle. The survey methods for butterflies and dragonflies vary depending on the site conditions and the stages of life cycle. The activity of butterflies and dragonflies is also strongly influenced by weather conditions and time of the day. To obtain representative information, survey should be conducted during daytime and under fine weather when most butterflies and dragonflies are active. For optimal survey seasons, please refer to *EIAO Guidance Note 7/2002: Ecological Baseline Survey for Ecological Assessment*. While it is difficult to detect butterfly larvae, it should be noted that some butterfly species only rely on certain plant species as their specific larval food source. When such plant species is recorded in the survey location, it may be worthwhile checking whether the corresponding butterfly species is also present in the vicinity. The survey of dragonfly larvae is covered in the section on stream invertebrate survey.

8.1 Transect Count

A transect route with an imaginary belt of certain width, which should be approximately 5 metres, is fixed within the study area. During the survey, all butterflies or dragonflies observed within the belt are identified and counted. The route selected should encompass different habitats within the study area as far as possible. For survey of dragonflies along a stream, the transect belt should cover vegetation of the riparian zone. A pair of binoculars with short focal length could significantly assist in the identification.

8.2 Netting

Netting may be needed for collecting specimens to confirm the identification of adult butterflies and dragonflies observed along transects or during area-based surveys. The traditional ‘butterfly net’ is used to collect butterflies and a more rigid one is used for dragonflies.

9 Freshwater Fish Survey

Fish sampling should be carried out at a time of year when the stream is not flooding and the weather is not too cold that the fishes become inactive. Sampling of freshwater fish could be conducted actively by pursuing fish, or in passive ways, which rely on fish swimming into a net or a trap. The habitat to be surveyed would determine the most suitable surveying technique. Other factors to be considered include water depth and clarity, presence of aquatic or emergent vegetation or speed of the current. Freshwater fish in reservoir or fishponds have seldom been the focus of ecological impact assessment and sampling methods in such habitats are therefore not covered in this guidance note.

9.1 Bankside Counts

Direct counting along stream bank is a simple method to survey fish in shallow, slow-moving streams with clear water and minimal vegetation. Suitable observation points are chosen within the study area. Counting of fish should be started a few minutes after arrival at each observation point to minimize the effects of disturbance. Direct counting of fish with a pair of binoculars should be made for a fixed period of time (e.g. 10 minutes). The fish is identified as far as possible and the number recorded. However, this method is not applicable to surveying fish in deeper water, turbulent areas, turbid water or stream with dense riparian and aquatic vegetation.

9.2 Trapping

Pot traps of about 3-mm mesh size with baits such as pieces of meat for predatory species and bread for omnivorous/ herbivorous species could be used for fish trapping. Pots traps will be placed at representative spots at the sampling site for a fixed period of time (e.g. 20 minutes). During this period, disturbance to the sampling water body should be avoided. The species and number of trapped is recorded. In some occasions, appropriate trap will be set overnight for trapping nocturnal fish species.

9.3 Netting

D-framed hand net of about 3-mm mesh size could be used to search for fish in microhabitats such as deep/turbid waters or vegetation.

9.4 Cast netting

Cast net is a net circle in shape with weight around the perimeter. It can be used to sample fish in river month with shallow water. Casting of net is usually done from the bank or a boat. It requires a lot of practices and skill to control the distance to cast and to maximize the size of the net in the air before it touches the water surface. One type of cast net is equipped with a purse line around the perimeter, which is used to close the net after casting to improve catching efficiency. However, cast net does not work well in stream with rocky substratum and high flow.

9.5 Electro-fishing

Electro-fishing involves the use of electric current to stun fish with the electrodes for easy capture. The stunned fish are then collected with hand net and transferred to containers of water for the fish to recover and be identified. However, this technique requires a lot of safety precautions and a high level of training is essential. More importantly, this technique could be highly intrusive particularly in small sample areas. It may injure or kill the fish sampled or other non-target species and eggs and small fry may even be more vulnerable. If not handled properly, the surveyor and other people in the vicinity may subject to certain risk of electric shock. Its operation in Hong Kong could only be undertaken with the permission from the Agriculture, Fisheries and Conservation Department. This method has seldom been applied in the ecological impact assessment studies in Hong Kong.

10. Stream Invertebrates Survey

Selection of surveying methods for stream invertebrates depends largely on the characteristics of the stream habitats, especially the texture of stream substrates (hard or soft) and the flow of the

stream. In Hong Kong, most streams are made up of boulders and gravels with accumulated sediment, but are rarely with bedrock or pure sand substrates. Various direct searching and collecting techniques for these types of stream habitats are available to provide valuable baseline information on stream invertebrates. The stream invertebrates collected should be identified as far as possible (generally to Family level and supplemented by morphospecies where needed). A comprehensive key for identification purpose is available in Dudgeon (1999).

10.1 Kick Sampling

Kick sampling is a relatively quick method to survey benthic invertebrates in shallow fast-flowing streams. A D-frame net of 0.5 mm mesh size is placed in water with the net mouth facing the water current, invertebrates in the stream bed are dislodged by kicking and disturbing the substrate for a fixed time period (e.g. 3 minutes) and are subsequently caught in the net.

10.2 Individual Stone Sampling

Individual stones could be searched for invertebrates by rolling and brushing them in front of a net in order to obtain brief information of stream invertebrates in qualitative term..

10.3 Netting

Netting is used to collect stream invertebrates in deeper slow-flowing streams, riparian habitats or within stream substrate. The method can also be applied to survey aquatic invertebrates in standing water or freshwater wetland. However, the samples collected by the following netting methods should not be combined with those of kick sampling as they yield different components of the stream fauna. Dip netting involves using a simple dip net to disturb the stream substrate and search among debris, aquatic and emergent vegetation to retrieve invertebrates from the habitats. Sweep netting which includes trailing vegetation and trailing roots along the stream bank could also be applied. The net contents should then be brought back to the laboratory for sorting, identification and counting.

11. Other Survey Methodologies

In the sections above, some survey methodologies for the major taxa groups normally covered by ecological impact assessment studies in Hong Kong have been discussed and provided for reference. The taxa groups covered and the methods listed are, however, by no means mandatory or exhaustive. Ecological surveyors should take into consideration the background of each project, the specific conditions of the study area and the requirements of the study brief *etc*., and to choose the most suitable methods to gather accurate and representative baseline information for ecological impact assessment. If necessary, the readers may consult further references such as those listed in "Further Reading" for more information.

Agriculture, Fisheries and Conservation Department
In conjunction with Environmental Protection Department

Date of issue: July 2004

Further Reading

Bibby, C.J., N.D. Burgess and D.A. Hill. 1992. *Birds Census Techniques*. British Trust for Ornithology and the Royal Society for the Protection of Birds. Academic Press, London.

Dudgeon, D. (1999). *Tropical Asian Streams: Zoobenthos, Ecology and Conservation.* Hong Kong University Press, Hong Kong.

Foster, J. and T. Gent. 1996. *Reptiles Survey Methods: Proceedings of a seminar held on 7 November 1995 at the Zoological Society of London's Meeting Rooms, Regent's Park, London: English Nature Science Series no. 27*. English Nature Science, London.

Gilbert, G., D.W. Gibbons and J. Evans. 1998. *Bird Monitoring Methods. A Method of Techniques for Key UK Species*. The Royal Society for the Protection of Birds.

Hayek, L.C. and A.B. Martin. 1997. *Surveying Natural Populations*. Columbia University Press, New York.

Heyer, W.R., M.A. Donnelly, R.W. McDiarmid, L.C. Hayek and M.S. Foster. 1994. *Measuring and Monitoring Biological Diversity: Standard Methods for Amphibians.* Smithsonian Institution Press, Washington.

HMSO. 1996. *Biodiversity Assessment. A Guide to Good Practice.* HMSO, London

Institute of Environmental Assessment, 1995. *Guidelines for Baseline Ecological Assessment.* E & FN SPON, London.

JNCC. 1993. *Handbook for Phase 1 Habitat Survey – A Technique for Environmental Audit*. Joint Nature Conservation Committee.

Kent, M. and P. Coker. 1992. *Vegetation Description and Analysis: A Practical Approach.* John Wiley & Sons, Chichester.

New, T.R. 1998. *Invertebrates Surveys for Conservation*. Oxford University Press, Oxford.

Pollard, E. and Yates, T.J. 1993. *Monitoring Butterflies for Ecology and Conservation. The British Butterfly Monitoring Scheme.* Chapman & Hall, London.

Sayre R., E. Roca, G. Sedaghatkish, B. Young, S. Keel, R. Roca and S. Sheppard. 2000. *Nature in Focus. Rapid Ecological Assessment*. Island Press, Washington.

Southwood, T.R.E. 1978. *Ecological Methods with Particular Reference to the Study of Insect Populations.* Chapman & Hall, London.

Sutherland, W.J. 1996. *Ecological Census Techniques: A Handbook*. Cambridge University Press, Cambridge.

Upton, M.S. 1991. *Methods for Collecting, Preserving, and Studying Insects and Allied Forms.* The Australian Entomological Society, Brisbane.

Wilson, D.E., F.R. Cole, J.D. Nichols, R. Rudran and M.S. Foster. 1996. *Measuring and Monitoring Biological Diversity: Standard Methods for Mammals.* Smithsonian Institution Press, Washington.