INFORME/ENSAYO Rev. Bol. Ecol. 17: 65-76, 2005

CONSIDERATIONS ON MEASURING GIANT OTTER *(Pteronura brasiliensis)* RELATIVE ABUNDANCE FOR CONSERVATION PLANNING

ESTIMACIÓN DE LA ABUNDANCIA RELATIVA DE LA LONDRA *(Pteronura brasiliensis)* PARA LA ELABORACIÓN DE ESTRATEGIAS DE CONSERVACIÓN

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ABSTRACT

Population date is critical fbr establishing conservation strategies for mammal species. For the giant otter (*Pteronura brasiliensis),* two standard methods have been described to collecf baseline data: the Range-Wide Distribution Survey Strategy (RDSS-GO) and the Population Census Methodology Guidelines (PCMG-GO). Here we discuss the potential of an intermedíate methodology based on measuríng giant otter relative abundance. The advantages and disadvantages of relative abundance measures are discussed and preliminary recommendations for a methodological protocol are detailed. Emphasis is placed on the need to rigorously test and calibrate this proposed technique in the future.

RESUMEN

Durante la fase de diseño de estrategias de conservación de especies de mamíferos, es importante tener a su disposición datos sobre el estado de las poblaciones. Para la londra *(Pteronura brasiliensis),* dos métodos estándares han sido propuestos para la colecta de datos de línea base: la Estrategia para estudiar Patrones de Distribución (RDSS-GO) y la Metodología para realizar Censos de Poblaciones (PCMG-GO). En el presente artículo, se propone un tercer enfoque: el Método para determinar Abundancias Relativas. Se describen las ventajas y desventajas de este método. Se sugiere realizar pruebas de este método propuesto en el futuro.

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INTRODUCTION

In Bolivia, the giant otter *(Pteronura brasiliensis)* is recovering slowly and is currently found in at least three distributional strongholds of regional importance (VAN DAMME, 2002b): the Paraguay River basin (Pantanal), the Itenez River basin and western Amazonia (Heath, Madidi, and Manuripi Rivers). A similar situation of increasing giant otter populations has been described for other South American countries (CARTER and ROSAS, 1997; SCHENCK, 1999; GROENENDIJK ef a/., 2001; DUPLAIX, 2003; MARMONTEL, pers. comm.). Nevertheless in the face of increasing pressure from accidental hunting, agricultural development and associated habitat destruction and degradation in the region there is an urgent need to steer this recovery process with adequate conservation strategies.

A critical issue in designing conservation strategies for mammal species is establishing the level of minimum information necessary for making effective conservation decisions and prioritizing interventions. Usually detailed data on the distribution and/or the abundance of the species is desired; however this information is difficult to gather in the field. Researchers have recently established two standard methods for studying giant otter distribution and population abundance; the **Range-Wide Distribution Survey Strategy** (RDSS-GO; GROENENDIJK et al., 2005a) and the **Population Census Methodology Guidelines** (PCMG-GO; HAJEK ef a/., 2005). In this paper we discuss the advantages and disadvantages of the established methods and propose an intermediate approach, by standardizing evaluations of giant otter relative abundance.

The Range-Wide Distribution Survey Strategy (RDSS-GO)

It responds to the need for defining the distribution of giant otters (GROENENDIJK *et al.,* 2005a). However, because it is based on signs (scats, tracks, dens), it tells us little about the importance of a given survey area in terms of population size and relative abundance. Indeed, the validity of assessing Eurasian otter population size based on. the frequency of encountered signs has been the subject of fierce debate (see MASON and MACDONALD, 1987; KRUUK *etal,* 1986; KRUUK, 1995). With regards to giant otters, recently used dens or campsites prove that giant otters are present or absent in the area (RDSS-GO; GROENENDIJK et *al.,* 2005a). However, to date clear correlations between the density of campsites and dens and the number of giant otter groups and/or individuals have not been demonstrated (GROENENDIJK, pers. comm.; MARMONTEL, pens, comm.; STAIB, 2005). In addition, research is required on the environmental conditions that influence the number of signs produced by giant otter individuals or groups. It is therefore generally agreed that sign counts, such as the RDSS-GO (GROENENDIJK *etal.,* 2005a), should not be used as estimators of population size (REUTHER *etal.,* 2000).

The Population Census Methodology Guidelines (PCMG-GO)

HAJEK *et al.* (2005) suggested that establishing the absolute size of a population is critical when evaluating the long-term viability of a population. The giant otter is one of the few Neotropical mammal species for which accurate population censuses can be conducted (HAJEK ef a/., 2005), because it is diurnal, social, iives in clearly defined family territories, and, of critical importance, individuals can be recognized on the basis of the color patterns on their throats (GROENENDIJK ef *al.,* 2005a). To date this population census methodology has been implemented in Tambopata National Reserve and Manu National Park in south-eastern Peru (SCHENK and STAIB, 1998; GROENENDIJK ef *al.,* 2005b), where long-term study allowed identification of the majority of otter individuals and permitted the analysis of population trends and population interchange (SCHENK and STAIB, 1998). Nonetheless, censuses are very time and resource consuming and require specialized training and experience, meaning they can only be conducted in a small number of selected areas.

BENEFITS OF A STANDARDIZED RELATIVE ABUNDANCE MEASURE FOR GIANT OTTERS

To effectively prioritize giant otter conservation efforts it is necessary to evaluate the relative importance of different areas for giant otter, in both space and time. Given the lack of resources to conduct population censuses across the entire giant otter range, exploring the validity of measuring giant otter populations based on the frequency of direct observations is worth some future investment. This is particularly relevant considering that multi-disciplinary research teams that visit remote areas are unable to generate standard information on giant otters other than to confirm presence, as in the RDSS-GO (GROENENDIJK *etal.,* 2005a).

Since direct observations of giant otter are relatively easy, it is worthwhile to assess the potential collection of relative abundance data during range wide surveys (GROENENDIJK *et el.,* 2003c). The main applications of measuring relative abundance are: a) the comparison of giant otter abundance between different areas, waterways, or habitats and resulting determination of potential giant otter strongholds, and conservation focal areas; b) the evaluation of (medium- and long-term) changes in giant otter abundance within a habitat or area. These are the minimum population evaluations typically required for designing regional otter conservation strategies. Indeed, for most neotropical wildlife species, complete population censuses are not practical and *only* relative abundance estimates are available, therefore relative abundance data may be all we have to establish conservation priorities.

Temporal comparisons of giant otter relative abundance

If surveys are done using standardized methods, the evaluation of temporal changes in giant otter relative abundance at key sites will be increasingly important. When incomplete counts can be assumed to be constant proportions of actual abundance, the differences over time represent changes in relative abundance as long as sampling effort is similar and conducted under the same environmental conditions. This ensures that differences in observation probability within the same habitat are minimal. Any confounding variables influencing observation probability should be assessed. In particular, water levels should be measured as this factor greatly affects observation probabilities for giant otters.

Spatial comparisons of giant otter relative abundance

Relative abundance surveys have a greater power of detection of temporal giant otter population trends at one location. They are less effective when used for the comparing between habitats because giant otters live in a variety of environmental conditions such as oxbow lakes in white water floodplains (GROENENDIJK *et a*/., 2005b), tectonic lakes (TEN *etal.,* 2001), artificial lakes or reservoirs (MATTOS ef a/., 2002), black and clear water rivers (DUPLAIX, 1980; GROENENDIJK *etal.,* 2005b; VAN DAMME *et el.,* 2002a; GONZALES JIMENES, 1997), marsh habitats, and granite plate rivers with rapids (DUPLAIX, 1980,2003). Spatial comparisons of giant otter relative abundance should only be made for similar habitats.

A PROPOSED STANDARDIZATION OF RELATIVE ABUNDANCE SURVEYS

Habitat Categories and conservation potential

Relative abundance measures obtained in lakes and rivers may not be directly comparable, but within each broad habitat type comparison is possible. To compare giant otter populated areas we propose to recognize two basic habitat categories: rivers, or other flowing waters, and lakes. In the Amazon, the former are often black or clear waters, and the latter are often oxbow lakes in white water floodplains. Temporal marsh habitats can also be considered river habitats during the dry season, when giant otters retreat to the river channel, as happens in certain areas of the Pantanal (Jo Franckx, pers. comm.).

It should be emphasized that to determine the relative importance of areas for conservation decision making, detailed quantitative comparisons of giant otter population sizes between habitats would be best but are often not required. It may actually be more useful to assign different rivers to categories according to the size of their giant otter populations. For example, the conservation potential of river sites could be categorized as follows:

VERY LOW : < 2 otters per 100 km of river
LOW: between 2 and 10 otters per 100 km of river
MEDIUM: between 11 and 20 otters per 100 km of river
HIGH: more than 20 otters per 100 km of river

The threshold values suggested above are only preliminary and should be refined in the future. Threshold values, based on sound field data, may also be established for lake habitats. Similar indices might be developed to indicate the potential of specific aquatic habitats for the conservation efforts and/or recolonization of giant otters. Below we propose a method for obtaining measures of giant otter relative abundance based on direct observations.

General survey guidelines

The proposed standardized method for measuring giant otter relative abundance in river habitats is based on the guidelines suggested by GROENENDIJK et al. (2005a), combined with the authors' experience surveying these animals in the field. By following these guidelines giant otter surveyors will produce more comparable data:

1) Relative abundance should be measured at sufficiently large scales, thereby reducing sampling variability. It is recommended that all giant otters be counted along arbitrary river stretches of a minimum of 50 km (GPS-measured distance). Any individuals spotted along the both sides of the river, in the open water or on the river bank, should be counted. If the river is very wide, observers should travel along one river bank, indicating this fact in the data collection report, but still register all the giant otters seen.
2) If a river is to be surveyed only once a year, or less frequently, then it is important to do so during the dry season, when water levels are at their lowest.
3) To avoid double-counting of individuals surveys should be carried out in the shortest possible time period.
4) To maximize giant otter observation opportunities, surveys should be conducted paddling downstream at a constant speed, i.e. without using an outboard motor. In larger rivers, an outboard motor may be used; however average traveling speed should consistently be below 10 km/hour. The outboard motor should be switched off when fresh giant otter signs are found, after which the surveyor can continue by paddling. The latter method facilitates covering greater distances.
5) The surveyor should navigate from the early morning till the late afternoon, and during any breaks, the water body should be observed from the bank to count any passing giant otters. These records should be mentioned separately in the survey report.
6) All variables that may influence observation probability should be recorded, for example, weather conditions, time of the day, etc.
7) When giant otter groups are encountered, to avoid double counting, only the minimum number of otters should be registered; that is, one should note the maximum number of giant otters seen at any one moment in time. Giant otter surveyors can further reduce the riks of double counting by filming and photographing the individuals to iden tify them by their throat patterns. However, this activity should not be allowed to significantly affect average traveling speed. Cubs should be registered separately with the same minimum count criteria as adults.
8) Tributaries that flow into the surveyed river channel are not entered; however, surveys should include old river meanders in permanent connection with the main river channel.
9) Relative abundance should be expressed as the number of individuals encountered in a 100 km stretch of river or lake banks, and should include also include the number of giant otter groups encountered for those 100 kms (see appendices for forms).

We propose the same relative abundance survey methods for lake habitats, except that total traveling distance would be the sum of the distances along the different lake banks. We propose that a minimum of 50 km (GPS-measured distance) of combined lake banks and/or all lakes present within a defined area be surveyed. If the latter is not possible due to time constraints, lakes should be selected at random.

Controlling observation probability

The comparison of giant otter relative abundance measures obtained for different habitats or at different time periods within the same habitat only makes sense when observation probability during the survey process is more or less constant. Observation probability (ft) is the probability, nearly always less than 1, that an individual animal from the population will be seen by the observer. With an estimate for observation probability, a count can be translated into an estimate of abundance. Ideally observation probabilities need to be constant across surveys, and knowledge of the factors that can influence giant otter observation probability is of utmost importance (NICHOLS and CONROY, 1996). A plethora of factors can affect observation probability of giant otters such as:

1) Gross morphology of the habitat may affect observation probability significantly; for example, the probabilities of spotting giant otters in an oxbow lake derived from a white water floodplains, or in rivers of a clear or black water floodplain, or in marshes, are all different.

2) Habitat complexity probably influences observation probability: in a complex habitat with many escape possibilities the probability of encountering giant otters might be lower than in a linear river habitat. The degree of river meandering influences observation probability greatly because otters can escape easily before being seen using land cross-overs, boulders, islands, or smaller creeks.
3) Local hydrologicai conditions can affect the probability of encountering giant otter; for example, in extensively inundated areas observation probabilities are considerably less than when water levels are lower, because the animals disperse.
4) The behaviour of giant otters can be significantly influenced by anthropogenic disturbance and this may vary temporally and spatially thus possibly producing local differences in observation probabilities.
5) Weather conditions, such as rainfall, wind, and air temperature, may also influence observability.
6) Surveyor experience may be a factor influencing observation probabilities, because experienced surveyors have a better idea where and how to look for the animals.
7) Choice of transport during a survey may also influence observation probability. For example, a noisy outboard motor may cause them to flee or hide.
8) Group size influences observation probabilities because under the same environmental conditions, it is easier to spot groups than individuals.

The surveyor may not always be able to detect all the variables that influence local observation probability. Table 1 suggests ways to reduce the influence of the most common factors detailed above. Whenever possible, the otter researcher should measure these variables, and use them as covariates in the analysis.

Table 1: Recommendations of approaches to account for variables that influence observation probabilities for giant otters

Influencing variables	**Correction Difficulty**	**Recommendations**
Gross morphology (lake versus river habitats)	Difficult	Compare values between similar habitats; for cross habitat comparisons calculate observation probabilities for each habitat (conduct a population census in a sub-area)
Habitat complexity	Difficult	Compare values between similar habitats; for cross habitat comparisons calculate observation probabilities for each habitat (conduct a population census in a sub-area)
Hydrology (water level)	Relatively easy	Conduct surveys only during the dry season
Human disturbances	Difficult	Collect data on escape behaviour of giant otters in the respective habitats
Weather conditions	Relatively easy	Measure these variables and use them as covariates in the analysis. Concentrate surveys in season with stable weather conditions
Experience of the surveyor	Relatively easy	Train surveyors, standardized forms
Transport Choice	Easy	Standardize transport choice; small boat without motor or with small outboard
Giant otter group size	Difficult	The % of transients (solitary individuals) in a population may be expected to be constant (note: assumption may not be true) across all giant otter areas. A population census conducted in sub-areas may provide a datum on observation probability of transients

Reducing double-counting in giant otter relative abundance surveys

Observation probability *(b)* can be larger than 1 when double-counting of individual giant otters occurs. Generally, all the factors mentioned above (Table 1) will tend to decrease *b,* whereas double-counting will increase *b.* Double counting cannot be excluded entirely during a relative abundance survey, especially when the river is meandering. The probability of double-counting can be reduced if individual giant otters (or groups) can be recognized on the basis of their throat patterns. This may be possible for populations whose members were 100% identified during previous visits, however, VAN DAMME *et al.* (unpublished data) found that less than 15% of observed individuals in the Paragua River in the northeast of Bolivia could be filmed satisfactorily during a giant otter relative abundance survey. We can reduce the probability of double-counting by:

1) Undertaking the count in the shortest time possible while maintaining a constant boat speed. The reliability of this approach depends not only on the skills of the surveyor but also on river morphology.
2) Surveying larger distances. When two family groups are observed on the same day, but at a distance of 80 km apart, it is unlikely that they are the same group, as the daily travelling distan-ce of an otter group is probably lower than 20 km (DUPLAIX, 1980). During the dry season, when giant otters have cubs, they generally use less area (VAN DAMME, unpublished data).

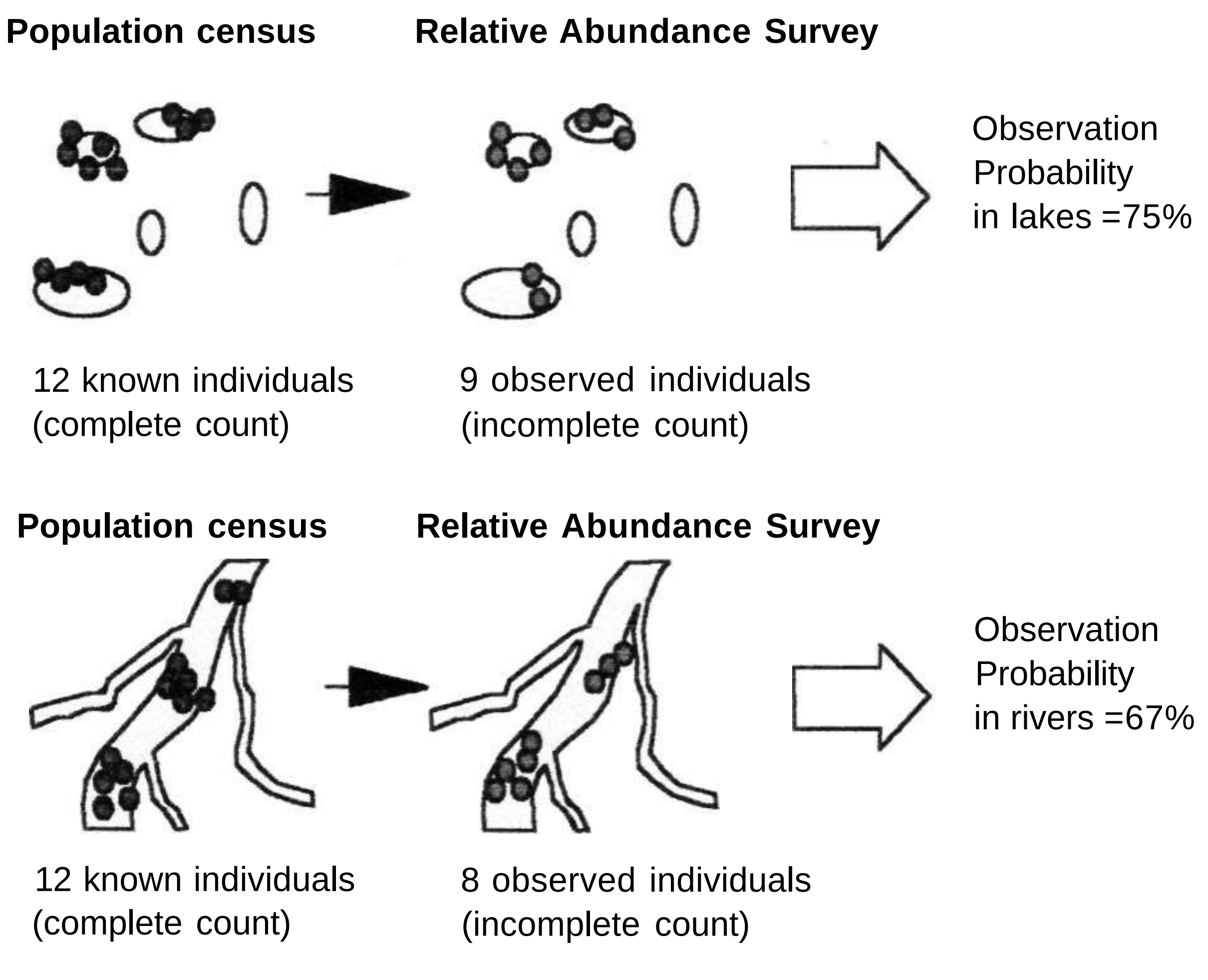

Fig. 1: Determination of the observation probability of giant otters in lakes and rivers

Testing and calibrating the proposed method

Given the above concerns, we strongly recommend testing the proposed relative abundance survey methods and categories with repetitions at test sites of known population size. Critical analysis of variations in relative abundance estimates across survey repetitions will guide in the interpretation of single survey estimates. Survey repetitions should be conducted during the same general sampling period and under the same general conditions. Established long-term giant otter study sites may offer the best opportunity for calibrating the proposed methods, although the number of repetitions per site may be limited by time and labour constraints.

We recommend that observation probabilities (fi) for giant otter be determined in areas where the actual abundance was established beforehand through a complete count (population census) (Fig. 1). For example, assuming that an hypothetical area (for example a lake habitat) has a population of 75 individuals determined by the Population Census Methodology Guidelines (PCMG-GO), observation probability may be calculated after carrying out a standard relative abundance survey in the same area. If during relative abundance surveys we record 48 individuals, in this case the observation probability for this population would be 48/75 (64%). To obtain reliable estimates of observation probability, the time between the population census and the relative abundance survey should be as short as possible, to avoid additions (births and immigrants) and losses (deaths and emigrants) between application of the two methods (SOUTHWELL, 1996). We recommend that b be calculated separately for giant otter populations in lakes and in rivers, because observation probability may be very different in these habitats.

CONCLUSIONS

When comparing the advantages and disadvantages of proposed field methods for surveying giant otters (see Table 2), relative abundance surveys may be a realistic compromise among the available options: it is a relatively cheap alternative, and potentially allows for comparisons on both spatial and temporal scales. Critically, it is a method that could be applied during multi-disciplinary biodiversity surveys, thereby providing an opportunity to collect a standardized form of data on giant otter from many more sites than is currently possible using existing established methodologies (GROENENDIJK *et al.,* 2005a; HAJEK *et al.,* 2005).

To date, methods for estimating relative abundances have been rarely used for giant otter, and when they were the results were not comparable due to the lack of standardization (GROENENDIJK et al., 2005a). We would like to stress that the methods proposed herein still need to be tested at known population sites before their potential at regional, national, and range-wide scales can be truly evaluated. In the future the applicability of standard line transect methods for river and lake habitats should be explored (GROENENDIJK er a/., 2005c). This method is successfully used in evaluating wildlife populations in Neotropical and other forest habitats, but has also been used to estimate population sizes and densities for marine mammals (BUCKLAND *et al.,* 2001). Line transect methods are being used for giant otters in the Peruvian Amazon (BODMER, pers. comm,).

ACKNOWLEDGEMENTS

We would like to thank the members of the UICN/SSC Otter Specialist Group for the stimulating discussions that preceded the writing of the present discussion paper. We also would like to acknowledge the thought-provoking comments on a previous version of the manuscript by Claus Reuthert, Nicole Dupleix, Christof Schenk, Jessica Groenendijk, Wendy Townsend and Frank Hajek. Jo Franckx and Fernando Carvajal are acknowledged for their sustained support of giant otter research in Bolivia. The ideas expressed in the present paper were born during field trips conducted in the Noel Kempff Mercado National Park (Bolivia), financed by BP, Bird Life International, Fauna & Flora international, Conservation International (CI) and Wildlife Conservation Society (WCS), and logistically supported by the Fundacion Amigos de Naturaleza (FAN) and the staff of the Noel Kempff Mercado National Park (SERNAP). The present research was carried out in the framework of the program LONDRA-WATCH.

Table 2: Advantages and disadvantages of techniques to measure giant otter distribution and abundance

	Population census	**Relative abundance survey**	**Distribution survey**
Advantages	*Complete counts can be obtained *Population densities can be calculated *Basis for studies on population ecology, behavior, dispersion, impacts of human activities etc.	*Intermediate time and labor intensive *Allows for comparison of giant otter abundance between habitats *Allows for evaluation of long-term changes (trends) in abundance of giant otter *Identification of "strongholds" for the species	*Less time and labor needed *Can be applied relatively easily on a range-wide scaie *Can be easily standardized *Can be used to monitor long-term changes in distribution of giant otters
Disadvantages	*Time and labour intensive *High cost	*High sampling variability *Difficulties to compare abundance between habitats with very different characteristics	*Over-representation of giant otter distribution when large grids are used *No information on giant otter abundance is obtained
Applicability for different otter species	*Giant otter (in selected areas)	*Giant Otter	*Eurasian otter *Neotropical river otter *Giant Otter
Applications	*Basis for the development of local/regional conservation strategies	*Basis for the development of regional, national and range-wide conservation strategies	*Identification of corridors *Basis for the development of national and range-wide conservation strategies

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ANNEX 1. Model for Measuring Giant Otter Relative Abundance/Finding Report

A. BASIC DATA

Name of surveyor..

Name of survey..

Date of survey: Start..........................End.............................

B. DESCRIPTION OF SURVEY SITE AND SURVEY METHOD

Country............................**Region**.....................**Geodetic datum**......

Height above sea level (altitude)................m Watershed.................

Description of survey site habitat

Weather conditions at start of the survey...
Weather conditions at end of the survey...
Water level............................1= High/flooding; 2= Intermediate; 3= Low

FOR A RIVER SURVEY:

GPS coordinates (site starting point) - Decimal degrees:
Latitude (hddd.ddddd)................Longitude (hddd.ddddd)....................

GPS coordinates (site end point) - Decimal degrees:

Latitude (hddd.ddddd)................Longitude (hddd.ddddd)....................

Search direction: O Upstream O Downstream

FOR A LAKE SURVEY:

GPS coordinates lake 1 - Decimal degrees:
Latitude (hddd.ddddd)................Longitude (hddd.ddddd)....................
Lake name:
GPS coordinates lake 2 - Decimal degrees:
Latitude (hddd.ddddd)................Longitude (hddd.ddddd)....................
Lake name:

GPS coordinates (site starting point) - Decimal degrees:
Latitude (hddd.ddddd)................Longitude (hddd.ddddd)....................
Lake name:

C. RESULTS/FINDINGS

FOR RIVER SURVEYS

DAY NR.	DATE	STAR-TING TIME	STAR-TING POINT (GPS)	END TIME	END POINT (GPS)	KM NAVIGATED	NR GROUPS	TOTAL NR. !ND.	TOTAL NR. CUBS	ADDITIONAL COMMENTS
1	09/08/2004	9:00	0512829 8611109	12.00	0515900 8614219	24.5	1	6	2	2 individuals were filmed
1	0.9/08/2004	14:00	0515900 8614219	17:00	0513000 8611200	13.2	2	6	0	
2	10/08/2004	9:00	0513000 8611200	12:00	0512829 8611109	120	2	7	1	

FOR LAKE SURVEYS

LAKE NR.	DATE	STAR-TING TIME	STAR-TING POINT (GPS)	END TIME	END POINT (GPS)	KM NAVIGATED	NR FAM.	TOTAL NR, IND.	TOTAL NR. CUBS	ADDITIONAL COMMENTS
1	09/08/2004	9:00	0512829 8611109	12:00	0515900 8614219	2.0	0	0	0	2 individuate were filmed
1	09/08/2004	14:00	0515900 8614219	17:00	0513000 8611200	11.4	2	6	0	
2	10/08/2004	9:00	0513000 8611200	12:00	0512829 8611109	23.2	3	5	1	

Note: These tables may contain also lines for additional details regarding each gtant observations; number of observed, number of identified otters, location, habital, behaviour, etc.