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APPENDIX I

Beasley, I.L., K. Robertson, and P. Arnold. 2005.
Description of a New Dolphin, the Australian Snubfin Dolphin,
***Orcaella heinsohni*. Marine Mammal Science 21(3): 365-400**

(Full Content in CD Only[28])

[28] To reduce the length of my thesis, a CD is attached on the back cover of my thesis, which provides the full content for all Appendix (I-IX). Appendicies providing new data not yet published are included in full in my thesis Appendix (III, VI, VIII and IX). Data already published but directly relevant to my thesis are included in the CD only with only a title page and abstract in my thesis Appendix (Appendicies I, II, IV, V, VI and VII).

MARINE MAMMAL SCIENCE, 21(3):365–400 (July 2005)

DESCRIPTION OF A NEW DOLPHIN, THE AUSTRALIAN SNUBFIN DOLPHIN *ORCAELLA HEINSOHNI* SP. N. (CETACEA, DELPHINIDAE)

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ABSTRACT

Comparisons of the Irrawaddy dolphin, *Orcaella brevirostris*, between Australian and Asian sites documented geographic differences in height of dorsal fin, presence or absence of a median dorsal groove in front of the dorsal fin, and coloration (presence or absence of a dorsal cape). Analysis of genetic data provided support for two clades within the Asian samples, the Mekong River samples from Cambodia and southern Laos, and all other marine and freshwater sites from Thailand, Indonesia, and the Philippines. The major separation, however, was between sites in Asia and those from Australia (5.9% of base pair differences, compared with 1.2% for within Australia and 1.5% for within Asia). Within a 403 base segment of the mtDNA control region, Australian specimens had 17 diagnostic sites with 16 fixed base pair differences and one insertion/deletion. Consistent, statistically significant differences in skull characters of Australian specimens have previously been demonstrated and are reviewed in this paper. There was a high concordance in character differences demonstrated between *O. brevirostris* from all Asian sites and Australian specimens, especially in the genetic and osteological characters. Based on the range and concordance of character differences, we propose that the Australian dolphins be recognized as a new species, *Orcaella heinsohni* (suggested common name: Australian snubfin dolphin).

Key words: Irrawaddy dolphin, snubfin dolphin, *Orcaella brevirostris*, *Orcaella heinsohni*, taxonomy, skull morphology, geographic variation, molecular analyses, external morphometrics.

APPENDIX II

Beasley, I.L., P. Arnold, and G. Heinsohn. 2002.

Geographical Variation of the Irrawaddy Dolphin, *Orcaella brevirostris*

The Raffles Bulletin of Zoology: Supplement 10. 15-34.

(Full Content in CD Only)

THE RAFFLES BULLETIN OF ZOOLOGY 2002 Supplement No. **10**: 15-34

GEOGRAPHICAL VARIATION IN SKULL MORPHOLOGY OF THE IRRAWADDY DOLPHIN, *ORCAELLA BREVIROSTRIS* (OWEN IN GRAY, 1866)

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ABSTRACT. **–** Analysis of skull morphology of Irrawaddy Dolphin *Orcaella brevirostris* specimens from throughout its range resulted in significant separation of specimens from Australia (including one specimen from Papua New Guinea) and those from Asian countries. Specimens from Australia were characterised by a range of nodular nasal ossicles (vs. two transversely elongate, antero-posteriorly compressed nasal bones in Asian specimens); a reduced mesethmoid plate, widely separated from the nasal ossicles by exposed frontal bones (vs. well developed mesethmoid plate, adjacent to, or contacting the nasal bones); and narrowly separated pterygoid hamuli (vs. widely separated). The Australian specimens showed a more derived cranial osteology, suggesting an origin from Asian populations – possibly during an episode of lowered sea level – with subsequent genetic isolation of the Australian populations. The results from this study indicate a taxonomic separation of Australian specimens at the subspecies or even species level, but no formal proposal is made, pending further study using both morphological and molecular characters.

KEY WORDS. **–** Irrawaddy dolphin, *Orcaella brevirostris*, cranial osteology, geographical variation, taxonomy, systematics.

INTRODUCTION

The Irrawaddy dolphin *Orcaella brevirostris* (Owen in Gray, 1866) is a small delphinid that occurs in the tropical/subtropical Indo-west Pacific, from the northwest Bay of Bengal to northeastern Australia (Stacey & Arnold, 1999). Preliminary abundance estimates for *Orcaella* suggest that populations throughout its range in Asia are small and many may be declining (Dhandapani, 1992; Stacey & Leatherwood, 1997; Kreb, 1999; Smith & Hobbs, 2002; Beasley et al., 2002). Only in northern Australia have substantial populations been documented (Freeland & Bayliss, 1989), leading Perrin et al. (1996) to advocate significant conservation efforts in that region. While such efforts are important in their own right, the concept of Australia as a single refuge rests on the assumption that *Orcaella* is represented by a single taxonomic entity throughout its range. Preliminary information from our research suggests that this may not be the case.

Anderson (in Gray, 1871) described a new species, *Orcaella fluminalis*, from the Ayeyarwady [Irrawaddy] River, Burma [Myanmar], which has also been recognised as the subspecies *O.b. fluminalis* Ellerman & Morrison-Scott, 1951. Subsequent researchers (e.g. Lloze, 1973; Pilleri & Gihr, 1973-1974) have failed to find features supporting recognition of these taxa. Presently, only the species *O. brevirostris* and the nominotypical subspecies *O. b. brevirostris* are recognised as valid (Rice, 1998).

Arnold & Heinsohn (1996) examined the cranial osteology of 18 Australian specimens and compared these with descriptions and figures of 10 Asian specimens in the literature (Owen, 1866; van Beneden & Gervais, 1868-1879; Anderson, 1879; Fraser & Purves, 1960; Pilleri & Gihr, 1973-1974). They commented on differences in the vertex, including multiple nasal bones (referred to as 'ossicles' in the present paper) in Australian specimens (vs. two, transversely elongate nasal bones in Asia), reduced mesethmoid plate (vs. well defined mesethmoid plate, abutting on or close to the nasal bones in Asia) and narrow separation of the pterygoid hamuli (vs. widely separated pterygoid hamuli in Asia).

In a phylogenetic study of delphinid cetaceans, LeDuc et al. (1999) analysed the full cytochrome B sequences of two *Orcaella* specimens, one from northeastern Australia (marine habitat) and the other from the Mekong River, Lao P.D.R.

APPENDIX III

Land-Based Observations to Investigate the Feasibility of Direct Counts and Distance Sampling Techniques

(Full Content)

LAND-BASED OBSERVATIONS TO INVESTIGATE THE FEASIBILITY OF DIRECT COUNTS AND DISTANCE SAMPLING TECHNIQUES

INTRODUCTION

Land-based observations were conducted as part of the research documented in Chapter 6. These observations aimed to investigate the proportion of dolphins potentially missed by the boat-based observer team, compare group size estimates between platforms, and investigate dolphin dives times to assess surface availability.

METHODOLOGY

Two land-based survey methodologies were used throughout the study: *dolphins missed/group size observations* and *surface and dive time observations*. For both methodologies, observers were positioned at the top of designated river banks, overlooking a deep water area (Figure III.1). The observers' heights above the river surface varied from 15-20 m, depending on the water level in the river.

Dolphins Missed/Group Size Observations

A major disadvantage of the direct count boat surveys was that, as a result of the small boat size and initial inability to conduct independent observations from 2001-2003, it was not possible to estimate the proportion of dolphins missed during the surveys through independent boat based observations until 2004 and 2005. Land-based observation surveys were designed to provide two important pieces of information relevant to direct count estimates:

1. **dolphins missed -** the proportion of dolphins that are potentially missed during up-river direct count boat surveys;
2. **group size comparisons -** a comparison of group size estimates between land and boat-based observation teams.

Figure III.1. Two observers undertake land-based observations overlooking Khasak Makak Pool. The observer on the left is searching for dolphins through binoculars, while the observer on the right is searching by naked eye. Observers were able to cover entire deep water pools, apart from Tbong Klar Pool, where two land-based stations were used to cover the area.

Study Area and Timing:

Land-based observations were conducted by a second group of observers working independently of the boat survey team, from January 2003–January 2004. Depending on the personnel available, one to three land-based teams (consisting of one to two people per team), conducted observations in a single day. One observer team was located overlooking one deep pool area. Land-based teams were positioned randomly over these deep water habitats, depending on which habitat the boat survey team was scheduled to cover on a given survey day.

Observations began once each land-based observation team arrived at the pre-determined deep water area. The time that observations began depended on the location of the area in relation to the departure point for that day (e.g. areas further away started later in the day). A land-based observer team overlooked one area during the entire day and observations normally ceased in the late afternoon (1600–1700 hours).

One observer searched for dolphins for 30 min and then rested for 30 min. On occasions when there were two observers at a location, one observer scanned intently for dolphins for 30 min of each rotation with binoculars and the other searched by naked eye. After 30 min searching for dolphins, the observer team stopped observations for a 30 min rest, while occasionally looking out for the boat survey team to enter the area. On commencement of the next 30 min observation period, binocular duty was rotated to the observer previously searching through naked eye. This rotation continued throughout the day.

It was assumed that the land-based observation team had a higher probability of observing dolphins in an area, and estimating group size more accurately than the boat-based survey team because:

1. land-based observers were at a much higher elevation over the area than the boat survey team (i.e. 15–20 m versus 1–2.5 m), facilitating observations;
2. land-based teams were stationary and able to scan the entire area over a longer period than the boat survey team;
3. land-based observers were able to observe dolphin groups over the entire area at one time, thereby facilitating estimates of group size.

Sighting Information

Area Without the Survey Boat - Once a dolphin group was sighted, the land-based team observed dolphins in the area for 15 minutes and estimated group size. Group size was determined in the same manner as that used during the boat-based surveys to obtain 'best', 'low' and 'high' estimates of the number of dolphins in the combined groups (Chapter 6). Once group size was established, the land-based team observed dolphin movements for the remaining hour, noting any unusual behaviours, or interactions. At the beginning of the next hour, if the dolphins were still within the area, a new estimate of group size was obtained after a further 15 minute observation period. This pattern continued while dolphins remained in the area. If the dolphins departed from the area, the observers recorded the time that they were last seen. Searches then resumed at the start of the next hour.

Area With the Survey Boat - Once the survey boat entered the deep water area, the land-based team searched intently for dolphins throughout the entire time the survey boat was transversing the area. All sightings were recorded, including an absence of dolphins. If dolphins were sighted, the land-based team recorded their presence and spent the remaining time establishing group size. The location of individuals in the group(s) in relation to the boat was recorded, as well as any unusual dolphin behaviour. The time that the survey boat left the area was recorded and normal observations continued at the start of the next hour. A standardised data sheet was used to record presence/absence of dolphin groups and group sizes.

Surface and Dive Time Observations

Land-based surface and dive time observations were conducted to estimate the probability that dolphins are sighted on, or near, the track-line. All surface and dive time land-based observations were undertaken independently of boat surveys, or groups missed/group size land-based observations.

Study Area and Timing

The surface and dive time observations were undertaken at Kampi Pool in April 2001, using the same standardised methodology throughout. Kampi Pool was chosen for observations as it was easily accessible to Kratie Township, where I was based. Unfortunately, time and logistical constraints prevented observations being undertaken at other areas, or for a longer time frame at Kampi Pool.

Sighting Information

Once dolphins' were sighted from the land-based site, search effort was stopped and a sighting form completed. We recorded time, visibility, sighting method (binoculars or naked eye), distance from observation point and sighting cue (e.g. splash, dolphin, bird). The preferred targets of the observations were distinct 'groups' that were not interacting with other groups at the time of observations. If smaller groups were constantly interacting, then the larger group was followed, if it was deemed possible without compromising the data.

Surface and dive times were recorded for groups and not individuals. It was generally impossible to follow an individual and thus groups were the targets of observations. As a result of the strong group stability (See Chapter 8), the group often surfaced and dove synchronously. Dive times were defined as the interval when the last individual in the group disappeared to the time that the first individual in the group re-appeared. Once the sighting form had been completed, data were recorded on group dive times. We observed the group through either binoculars, or by naked eye (depending on the group's distance from the land-based site), and dictated the dolphins' disappearance and re-surfacing into a dictaphone. Data on the behaviour of the majority of the animals, group size and presence of boats were also continuously noted. These data were later transcribed onto datasheets by playing back the recordings in real-time, using a stop-watch to determine timings.

RESULTS

Land-Based Observations for Up-River Direct Counts

A total of 16 days of land-based surveys were undertaken over 209 hours from 2003–2004. Observation effort was similar in all critical areas, although slightly higher at Koh Pidau Pool (45 hrs) and lower at Chiteal Pool (4 hrs) (Figure III.2). Chiteal Pool is the best suited of all critical areas for land-based observations, as a result of the small pool size and lack of obstructing vegetation enabling the entire pool to be viewed clearly. However, as a result of financial constraints and the large distance from Kratie Township, where the land-based observer staff were based, land-based observations were rarely possible at this site.

Proportion of Dolphins Missed by the Boat-based Observer Team

All dolphin groups sighted by land-based observers (*n*=16), were sighted by boat-based observers. Boat-based observers sighted one further group of one to two individuals that the land-based observers did not sight. This group was at the bottom of Kang Kohn Sat Pool and probably out of sight of the land-based observation team at the time of the sighting (Table III.1).

Table III.1. Number of dolphin groups sighted by land- and boat-based observer teams. Land-based observations were undertaken over two years of the study period. The boat-based observers did not miss any dolphin groups that were sighted by land-based observers in critical dolphin habitats. A total of 16 dolphin groups were sighted by land-based observers and 17 dolphins groups sighted by the boat-based observers.

Year	Month	Total Days	Time (hrs)	# Groups Sighted by Land-based Teams	# Groups Sighted by Boat-based Teams
2003	**January**	2	36	2	2
	March	4	47	5	5
	April	1	17	2	2
	May	5	70	5	6
2004	**January**	4	39	2	2
	TOTAL	16	209	16	17

Group Size Estimates

The results of group size comparisons between land and boat-based observers suggest that the boat-based observers over-estimate group size by, on average, only one dolphin. Of the 16 occasions when both land-based and boat-based observers sighted dolphins, 31% (five occasions) were exactly the same best estimates and 38% (six occasions) were within one dolphin. All larger group size differences of four to six dolphins (25%, $n = 4$), occurred at Koh Pidau Pool, where dolphins commonly occur over a larger area than in other pools (Table III.2.).

Land-based Observations to Estimate Sighting Probability

A total of 284 minutes (4 hr and 44 mins), were spent collecting surface and dive times. A total of 74% of the total dives (211 min) were 30 seconds of less in duration. Twenty-eight percent of dives (73 min) were longer than 30 seconds, with an average of 54 seconds (range 31-249 seconds).

Further land-based discussion and conclusions can be found in Chapter 6

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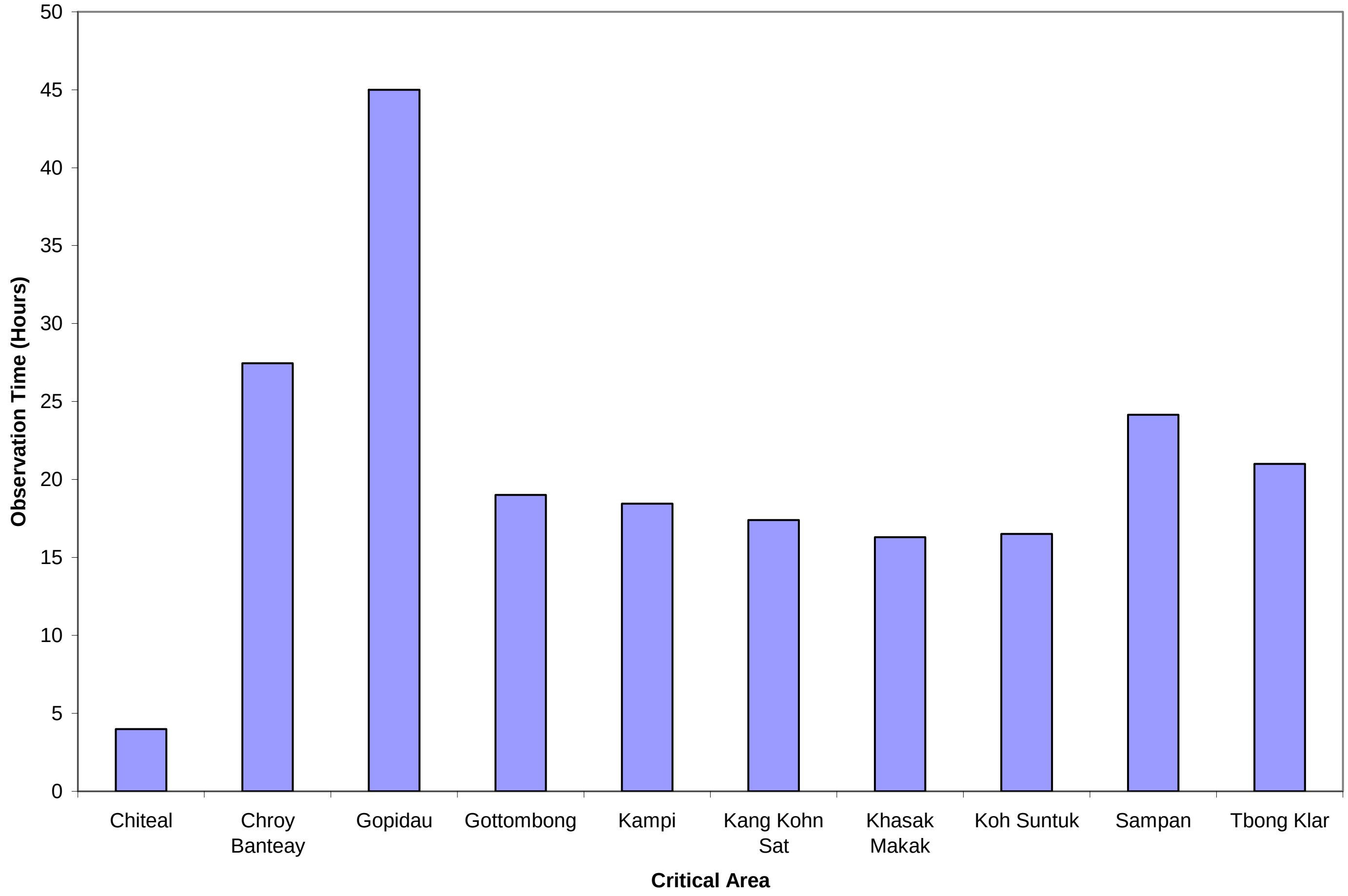

Figure III.2. Total time spent undertaking land-based observations at each deep pool critical area. Total time was similar between all areas, except for more effort conducted at Koh Pidau Pool and less effort at Chiteal Pool.

Table III.2. Summary of land-based observations and group size estimates. Surveys at each critical area provided group size estimates by the land-based and boat-based survey teams. These group size estimates could then be compared, to establish the potential accuracy of the boat-based survey team estimates.

Date	Total Observations (Hours)	Area	Land-based Sighted	Best	Low	High	Boat-based Sighted	Best	Low	High	Best Estimate Group Size Difference
4-Jan-03	9:00	CHROY BANTI	YES	3	2	4	YES	4	3	6	1
4-Jan-03	9:15	KAMPI	YES	8	6	10	YES	8	4	10	0
8-Jan-03	8:15	KOH PIDAU	NO				NO				-
8-Jan-03	9:30	KHASAK MAKAK	NO				NO				-
12-Mar-03	0:30	CHROY BANTEY	NO				NO				-
12-Mar-03	0:30	KAMPI	YES	10	8	12	YES	10	7	13	0
14-Mar-03	9:00	KOH PIDAU	YES	6	6	7	YES	11	9	14	5
14-Mar-03	7:00	KHASAK MAKAK	YES	2	2	2	YES	2	2	3	0
15-Mar-03	7:00	TBONG KLAR	NO				NO				-
15-Mar-03	6:00	GOTTOMBONG	NO				NO				-
16-Mar-03	8:00	KOH SUNTUK	YES	4	3	5	YES	5	5	7	1
16-Mar-03	9:00	KANG KOHN SAT	YES	3	2	4	YES	4	3	6	1
5-Apr-03	9:00	KOH PIDAU	YES	10	9	10	YES	16	14	19	6
5-Apr-03	8:00	SAMPAN	YES	8	7	8	YES	7	6	10	-1
3-May-03	9:00	KAMPI	YES	7	5	8	YES	7	14	11	0
3-May-03	9:15	CHROY BANTEY	YES	3	2	3	YES	4	4	6	1
5-May-03	8:15	SAMPAN	NO				NO				-
5-May-03	9:30	KOH PIDAU	YES	6	5	7	YES	10	9	13	4
6-May-03	6:00	GOTTOMBONG	NO				NO				-
6-May-03	6:30	TBONG KLAR	NO				NO				-
7-May-03	8:40	KANG KOHN SAT	NO				YES	1	2	1	1
7-May-03	8:50	KOH SUNTUK	YES	15	12	17	YES	17	14	20	2
8-May-03	4:00	CHUUTEAL POOL	YES	6	5	7	YES	6	5	8	0
15-Jan-04	9:00	CHROY BANTEY	NO				NO				-
16-Jan-04	9:20	KOH PIDAU	YES	4	3	6	YES	9	8	11	5
16-Jan-04	8:00	SAMPAN	NO				NO				-
17-Jan-04	5:00	GOTTOMBONG	NO				NO				-
17-Jan-04	4:20	TBONG KLAR	NO				NO				-
18-Jan-04	2:00	TBONG KLAR	YES	9	8	11	YES	8	7	11	-1
18-Jan-04	1:25	KOH CHERUM	NO				NO				-
		TOTAL GROUPS SIGHTED	**16**				**17**				**1**

The shaded boxes indicate a higher group size estimate by the boat-based observer team, compared to the land-based team.

APPENDIX IV

Mekong Dolphin Conservation Project. 2005.
***Mekong Dolphin Conservation Strategy*. Unpublished Report Submitted to the Cambodian Department of Fisheries. 82 pp.**

(Full Content in CD Only)

MEKONG RIVER IRRAWADDY DOLPHIN CONSERVATION AND MANAGEMENT PLAN 2004-2008

Prepared by the Mekong Dolphin Conservation Project and Cambodian Department of Fisheries
July 2004

DRAFT FOR DOF INTERNAL REVIEW

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British Embassy
Phnom Penh

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Please note, this document is a preliminary document and remains in draft form until formally accepted by the Cambodian Department of Fisheries. The document will also be distributed for national and international review to further refine conservation activities.

APPENDIX V

Department of Fisheries. 2005.

Cambodian Mekong Dolphin Conservation Strategy. Ministry of Agriculture, Forestry and Fisheries, Phnom Penh, Cambodia. 29 pp.

(Full Content in CD Only)

KINGDOM OF CAMBODIA
NATION RELIGION KING

MINISTRY OF AGRICULTURE FORESTRY AND FISHERIES
DEPARTMENT OF FISHERIES

CAMBODIAN MEKONG DOLPHIN Conservation Strategy

APPENDIX VI

Orcaella Life-history Information Obtained Through the Carcass Recovery Program

(Full Content)

LIFE HISTORY INFORMATION OBTAINED THROUGH THE CARCASS RECOVERY PROGRAM

INTRODUCTION

I initiated a carcass recovery program in 2001 to collect information on mortality rates and causes (Chapter 9) and life-history parameters of *Orcaella*. There is minimal information available regarding Irrawaddy dolphin life-history parameters (Chapter 2) and most is assumed based on characteristics of other small cetaceans.

METHODS

Detailed methodology for collection of carcasses and samples is presented in Chapter 9.

Gestation Period and Fetal Growth Rate

Gestation period is one of the least variable reproductive parameters in delphinids and in mammals in general (Kiltie 1982). Fetal growth in cetaceans is reported to be characterised by two phases: a short curvilinear phase, generally lasting 7–15% of the total gestation period; followed by an extended linear phase (Hugget & Widdas 1951; Laws 1959). The small sample size of fetuses collected in my stranding program prevented estimation of the gestation period and fetal growth rate for the Irrawaddy dolphin population inhabiting the Mekong River. The general trend in mammals, including odontocetes, is that gestation period increases with species size (Eisenberg 1981, Perrin and Reilly 1984), therefore, data on the gestation periods of other odondocetes of a similar size to the Irrawaddy dolphin were obtained from the literature.

Length and Weight at Birth

I calculated the mean length at birth from a sample of newborn calves, as described in Perrin and Reilly (1984). This method assumes that newborns calves are easily distinguishable from slightly older individuals. As described by Whitehead and Mann (2000b), deep creases, called fetal folds indicate that a calf is one to two days old (Figure VI.1). The umbilicus is also unhealed on a newborn. The healing of the umbilicus and lack of foetal folds were used to categorise slightly older calves. The small sample size restricted the use of the preferred 50% interpolation method to estimate length at birth, as described by Perrin and Reilly (1984).

Figure VI.1. A newborn dolphin discovered in September 2002 near Kampi Pool (OBRE02-08/09). The carcass was weighed using 100 kg scales. This specimen was classified as a newborn (as opposed to a calf), as it had obvious foetal folds and the umbilicus was unhealed.

Length to Weight Ratios

Length to weight relationships were determined using postnatal males and non-pregnant, postnatal females by using linear regressions of weight on length, as described in Brownell (1984).

Length at Sexual Maturity

For female cetaceans, the most accepted definition of sexual maturity is that the animal has ovulated at least once, as evidenced by the presence of at least one corpus luteum or corpus albicans in the ovaries (Perrin and Reilly 1984). For males, several criteria have been used that include the presence of spermatozoa in the centre of the testis (Kasuya et al. 1974), rapid change in diameter of the seminferous tubules, and presence of spermatozoa in the epididymis (Perrin et al. 1976). Because most specimens were decomposed, reproductive data were not available from most carcasses.

RESULTS

Gestation Period and Fetal Growth Rate

Only one 73 cm near-term fetus (5.3 kg) was recovered over the study period (OBRE03-02/08B). The mother died on 02 August 2003. Total length of the mother was 220 cm (180 kg: including fetus) and the cause of her death was unknown. There is one further record of Irrawaddy dolphin fetus size in the literature, where Andersen (1879) described a 210 cm female with a large 86 cm fetus weighing 10.5 kg in June, from the Bay of Bengal Region of the estuaries of the Ganges River.

No further analyses could be conducted regarding gestation period, or fetal growth rate, as a result of small sample size.

Length and Weight at Birth

The smallest neonate carcass recovered in the Mekong River during 2001–2005 was 91 cm (10.8 kg) (OBRE04-22/03). Eighteen other neonate specimens with distinct foetal folds and unhealed umbilicus were recovered, ranging in length from 91 to 114 cm (Figure VI.2). Taking the mean of these data, it is assumed that length at birth is an average of 101 cm ± s.d. 0.04 (range 91 – 114 cm) and average weight at birth is 12.5 kg ± s.d. 2.77 (range 7.3 – 15.8 kg).

Length to Weight Ratios

The relationship between length and weight was available for 29 out of the 45 carcasses (64%) recovered from 2001–2005. Sex was confirmed for all but three individuals. Maximum female length was 2.28 m (two individuals, although one was classified as a probable female) (97 kg and 130 kg respectively) and maximum male length was 2.26 m (130 kg).

One adult female (OBRE03-02/08A) was removed from further length to weight ratio analyses because she was an obvious outlier and carrying a near term fetus at the time of death. The fetus (OBRE03-02/08B) was also excluded from the length to weight ratio analyses, as a result of being a further outlier, as no other fetuses were obtained for comparison. The resulting length and weight curve for all carcasses with associated data is shown in Figure VI.3.

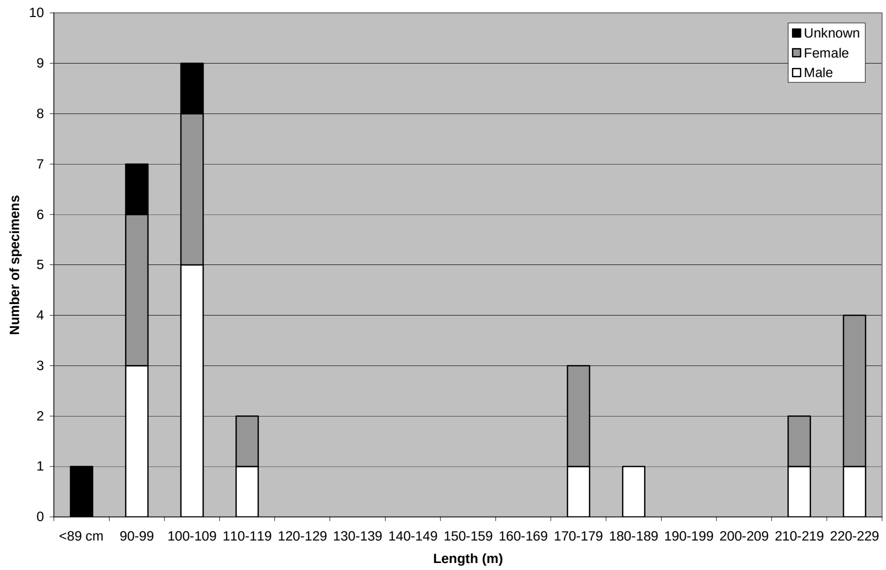

Figure VI.2. Bar chat showing lengths of Irrawaddy dolphin carcasses recovered from the Mekong River based on sex (where known). The carcass less <89 cm was a fetus from a 220 cm female. Most carcasses are newborns (91 - 114). Very few juvenile dolphins were recovered.

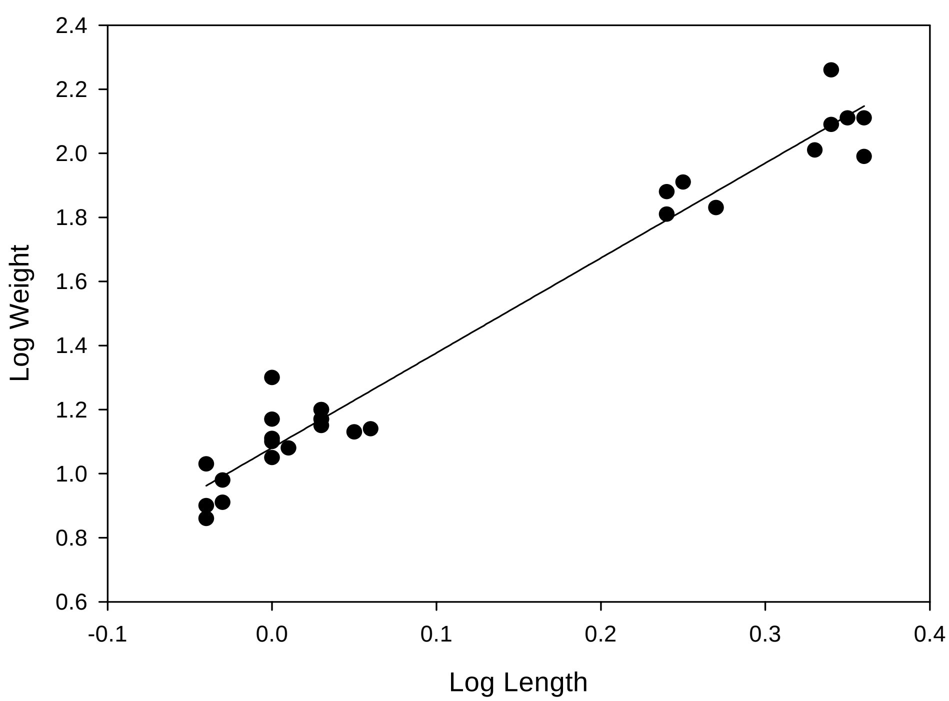

Figure VI.3. Length and weight relationships of Irrawaddy dolphins in the Mekong River based on data available from the carcass recovery program.

The resulting regression equation using standardised data obtained from the carcass recovery program to estimate weight is

$$Y \text{ (weight)} = 1.082 + 2.896 \text{ (total length)}.$$

Length and weight measurements were highly correlated (Pearsons Correlation, $R^2 = 0.984$, $P = 0.000$).

DISCUSSION

Gestation Period and Fetal Growth Rate

The gestation period of an Irrawaddy dolphin in captivity was estimated to be 14 months, based on the time between last observed mating of a male and female in one tank and parturition (Marsh et al. 1989; Tas'an et al. 1980; Tas'an & Leatherwood 1984). However, this proposed gestation period is much higher than reported for most other small delphinids and phocoenids, which range from 10–12 months and 8–11.4 months respectively (Perrin & Reilly 1984). A long gestation period of 14 months is reportedly more likely for larger cetaceans such as the killer whale (*Orcinus orca*) (12-16 months), long-finned pilot whale (*Globicephala melaena*) (15.2 months) and false killer whale (*Psuedorca crassidens*) (15.5. months) (Perrin & Reilly 1984).

There is little data available on gestation of other river dolphin species, however Anderson (1879) reported that his informants regarded the gestation period to be eight to nine months (Brownell 1984). The small sample size of fetuses in this study prevented any reliable assessment of fetal growth rate and gestation period.

It has been reported that most of the odontocetes lie close to a curve of increasing gestation period with size and have gestation periods of ten to twelve months, fitting with an annual seasonal cycle (Whitehead & Mann 2000b). Based on other small delphinids and phocenids with comparable lengths at birth, e.g. Indo-Pacific hump-back dolphin (*Sousa chinensis*): 100 cm at birth, gestation period 11 months (Jefferson 2000); striped dolphin (*Stenella coeruleoalba*): 99.8–100.0 cm at birth, gestation period 12 months (Kasuya 1972); dalls porpoise: 100 cm at birth, gestation period 11 months (Gaskin et al. 1984), I would expect that the gestation period of 11 months described for other small cetaceans would be similar for the Irrawaddy dolphin.

Length and Weight at Birth

Based on newborn carcasses recovered in the Mekong River, length at birth is an average of 101 cm ± s.d. 0.04 (range 91–114 cm). Average weight at birth is 12.5 kg ± s.d. 2.77 (range 7.3–15.8 kg). There are few other reliable estimates of Irrawaddy dolphin length and weight at birth in the literature. A 211 cm female Irrawaddy dolphin live-captured from the Mahakam River (Semayang–74GSA16mOb1) gave birth to a female 96 cm neonate (79GSA105mOb17), that weighed 12.3 kg (the adult females total length was obtained seven months after the calf was born). This live birth provides empirical evidence in support of the proposed average length of birth, as described in this study.

Relationships Between Length and Weight

The female Irrawaddy dolphin born in captivity in Jakarta increased in length by 57 cm (153 cm, 59%) and 32.7 kg in weight (45 kg, 266%) after seven months (Tas'an *et al*., unpublished report 1980, Marsh *et al.* 1980). The growth rates of Irrawaddy dolphins appear similar to that of striped dolphins (and probably other delphinids of similar proportions), based on preliminary data, where striped dolphins' attain body lengths of 166 cm, at the age of one year (Miyazaki 1977).

Peak Calving Period

Based on the carcass recovery data, there appear to be two main calving peaks: the primary period being the start of the dry season (January to March); and the secondary period being the end of the wet season (September to November). It is likely that the seasonal floods and subsequent fish migrations are a major factor determining calving periods, as discussed below.

Seasonal reproduction is least obvious in the offshore tropical odontocetes (Whitehead & Mann 2000a) when compared with other riverine and inshore cetaceans. It could be expected that seasonal reproduction would be more pronounced in river dolphin populations, because of the definite seasonal changes in water levels and associated fish movements. There are various critical stages during pre- and post conception which may influence calving periods, these being the female's body condition required to ovulate, the availability of food and habitat during the mother's lactation period, the time that the calves begin to eat fish, and the weaning period.

I hypothesise that the primary calving peak shown by the Mekong dolphin population at the start of the dry season is likely to be related to food and habitat requirements of lactating females. It has previously been hypothesised that if food availability is seasonal, then females may have reproductive schedules arranged so that peak periods of food availability coincide with time of greatest energy demand (Oftedal 1984). Most fish species congregate in deep pools in the Kratie to Khone Falls River stretch during the dry season. Dolphins also inhabit these pools during the dry season and it would be assumed that this peak period of food availability would be most suitable for a lactating female.

At the start of the wet season when water levels start to rise, many migratory fish move downstream into Tonle Sap Great Lake (a distance of more than 400 km from Kratie Township). The lake then covers five to eight percent of Cambodia's land area. Such an expanse of water and increased difficulty in catching fish would probably reduce food availability. In other regions of the river, fish move up tributaries or are scattered throughout the river column. The high water velocity during the wet season, in addition to limited food supply, would probably not be conducive to a lactating female with associated calf.

It has also been proposed that availability of easily caught prey at time of weaning may be important for the offspring (Kasuya 1995). However, it is likely that the time of weaning is highly variable for each individual calf depending on individual fitness, experience of mother and food availability. Of the two calves born in Chiteal Pool in January 2004, both were seen trying to catch fish in July 2004, at seven months old (own personal observations). The period until full weaning is not yet known for Irrawaddy dolphins, however, it could be assumed that calving periods were timed to ensure that calves were being weaned when fish availability was at its highest.

A further proposition is that newborn animals may have increased survival, and/or lower energy expenditure in warmer, calmer or less predator infested waters (Brodie 1975; Lockyer 1987). There are no known natural predators of dolphins in the Mekong River, unlike some dolphin species which are predated on by sharks, such as the Indian Ocean bottlenose dolphins, *Tursiops* sp. in Shark Bay, Australia (Mann & Watson-Capps 2005). In the upper Cambodian Mekong River, water temperature is slightly cooler at the start of the dry season (January–February) (temperatures of 24.8^{o}C) and much warmer at the height of the dry season (April–May) (32.9^{o}C) (Chapter 7). It is unlikely that the cooler water temperatures would cause concern for newborns, however certainly the warmer temperatures may present problems both in terms of overheating and the potential for disease.

Water velocity is also an important consideration. At the start of the dry season waters are cooler but with some downstream movement. However, at the height of the dry season there is virtually no water movement within deep pool areas, which causes the water in, and around, the deep pool areas to heat up significantly, particular during mid-day. At the start of the wet-season (June–July), water velocity increases dramatically, until its height in September when in can reach speeds of up to 9 km/hr (Chapter 7). I envisage that it would be extremely difficult for a newborn to remain close to its mother during periods of high water velocity, expending significant amounts of energy swimming in the river, when deep water pool refuges are no longer evident.

The peak calving periods shown here for the Irrawaddy dolphins inhabiting the Mekong River do not directly correspond with reported peaks for South American river dolphins in relation to the flood cycle. There are varying accounts of the calving period for the Amazon River dolphin, or boto (*Inia geoffrensis*). One boto population in the Brazilian Amazon was reported to calve mainly in May, June and July, as water levels reach their peak and began to decline (Reeves et al. 2002) (which would correspond to the September to November secondary calving peak in the Mekong River). It was proposed that lactating females are better able to meet their energy needs at this time, as fish are forced by the receding waters to leave the flooded forests and concentrate in the rivers, thereby potentially making the fish easier to catch (Reeves et al. 2002). However, in an Orinoco tributary, boto calves were born only near the end of the low-water period and were never seen during periods of falling water levels (whereas the primary calving peak of January to March in the Mekong River is at the start of the low-water period). It is possible that another confounding factor between river systems in that the Amazon River experiences lateral flooding, rather than vertical flooding shown in the Mekong River. Flooding into forested areas may provide an easier source of fish than during the dry season.

Length at Sexual Maturity

A 211 cm female Irrawaddy dolphin live-captured from the Mahakam River (Semayang – 74GSA16mOb1) gave birth to a female 96 cm neonate and a 220 cm female from the Mekong River was carrying a 73 cm fetus (5.3 kg). These data are all that are available to estimate length at sexual maturity. I assume that female sexual maturity occurs at a total length of at least 211 cm. No data is available on the length or age of sexual maturity for male Irrawaddy dolphins.

Female cetaceans start to reproduce at three to fifteen years of age, when at about 85-95% of their mean adult body length (Whitehouse and Mann 2000). It is hypothesized that reproduction when the mother is smaller that about 90% of mean adult body size is sufficiently inefficient that the potential benefits of offspring produced, (the survival of which may be very low), are outweighed by the demands on the mother's growth and the effects on her future offspring (Reiter & Le Boeuf 1991; Reznick et al. 1990; Whitehead & Mann 2000a). This hypothesis is supported by the low survival rate of first offspring (Whitehouse and Mann 2000).

Studies in Japan found that striped dolphins, attain sexual maturity at nine years, at length of 212 cm in females and 220 cm in males. Physical maturity is attained at 14 to 15 years at the length of 222 cm in females and 236 cm in males (Kasuya 1972). The franciscana dolphin (*Pontoporia blainvillei*) (a much smaller species of river dolphin than the Irrawaddy dolphin: maximum length 174 cm) attains physical maturity (based on fusion of vertebral epiphyses to the centrum), soon after the onset of sexual maturity. Franciscana neonates are born 70–88 cm long after a gestation period of 10.5 months. This species is sexually mature at 2.7 years of age and reaches a maximum age 16 years (Brownell 1984; Kasuya & Brownell 1979)). Any evidence of physical maturity (*i.e*., skull fusion), would indicate that sexual maturity has already occurred and perhaps up to five to six years previously.

CONCLUSION

This study has contributed significantly towards further understanding the life history of Irrawaddy dolphins in the Mekong River. Based on newborn carcasses recovered in the Mekong River, Irrawaddy dolphin length at birth is an average of 101 cm ± s.d. 0.04 (range 91 – 114 cm). The average weight at birth is 12.5 kg ± 2.77 (range 7.3 – 15.8 kg). No data were available on gestation period or fetal growth rates, although based on data of females with fetuses, adult females apparently reach sexual maturity by at least 211 cm. No data are available on rates of male sexual maturity. The published literature on other small cetaceans suggests a gestation period of about eleven months.

Although calves are born year round, the primary calving periods are January to March (start of dry season) and September to November (end of wet season). The maximum length of an adult male was 226 cm, maximum female length was 228 cm.

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APPENDIX VII

Gilbert, M. and I.L. Beasley *et al*. 2005.
***Mekong River Irrawaddy Dolphin Stranding and Mortality Summary: 2001-2005*. Wildlife Conservation Society, Cambodia. 48 pp.**

(Full Content in CD Only)

JCU
JAMES COOK UNIVERSITY

WWF

MEKONG RIVER IRRAWADDY DOLPHIN STRANDING AND MORTALITY SUMMARY

JANUARY 2001 – DECEMBER 2005

WILDLIFE CONSERVATION SOCIETY

APPENDIX VIII

Biological and Social Research Recommendations

(Full Content)

TableVIII.1. The following table outlines the priority biological knowledge (BK) required that relates directly to conservation of the Irrawaddy dolphin population in the Mekong River. The priorities are based on the results of my study and the most immediate needs for conservation (this table is adapted from Wang *et al*. 2004). The headings in bold are those activities that I consider high priority.

Information On:	Overall current importance (High, Medium, Low)	Methods	Current level of information (Excellent, Good, Poor, None)	Overall current priority (High, Medium, Low)	Most urgently required with a limited budget
BK1. Mortality and Pathology	**High**	**-- Necropsy examination on all carcasses** **-- Laboratory investigation on fresh carcasses** **-- Parasite loads** **-- Contaminant patterns**	**Good** **None** **Good** **Poor**	**High** **High** **High** **High**	√ √ √ √
BK2. Health Status (body condition, scars, bio-markers, skin conditions)	**High**	**-- Analysis of injuries and scars (photo-id)** **-- Analyses of body condition** **-- Analyses of prevalence of skin problems (photo-id)**	**Good** **Poor** **Good**	**High** **High** **High**	√ √ √
BK3. Population Genetics (level of inbreeding)	**High**	**-- Carcass recovery**	**None**	**High**	√
BK4. Demography / Life History	**High**	-- Age/sex structure of schools **-- Carcass analyses**	Poor **Good**	Low **High**	 √
BK5. Population Monitoring	**High**	-- Historical research -- Repeated boat-based surveys **-- Repeated photographic surveys** **-- -Population modeling**	Excellent Excellent **Excellent** **None**	Low Low **High** **High**	 √ √
BK6. Abundance	Medium	-- Boat based surveys	Excellent	Medium	

		-- Land-based surveys -- Photo-ID (mark-recapture) -- Aerial surveys -- Genetic recapture	Good Excellent None None	Low High Low Low	 √
BK7. Behaviour	**High**	**-- Behaviour when exposed to tourism boat traffic**	**None**	**High**	√
BK8. Habitat Requirements	Medium	-- Collection of environmental data -- Multivariate habitat preference analyses -- Prey density and distribution	Good Poor None	Medium Medium Medium	
BK9. Population Discreetness	Medium	-- Morphology -- Genetics -- Movement (photo-id) -- Distribution	Excellent Good Excellent Excellent	Low Medium Low Low	
BK10. Distribution	Low	-- Boat-based surveys -- Reports of sightings (interviews) -- Reports of sightings (public) -- Aerial surveys -- Satellite/radio tagging	Excellent Excellent Good None None	Medium Low Low Low Medium	
BK11. Individual Movements	Low	**-- Photo-id** -- Telemetry	**Excellent** None	**High** Low	√
BK12. Feeding Ecology	Low	-- Stomach contents -- Direct observations of feeding -- Prey density	None Poor None	Low Low Low	
BK13. Behavioral Ecology	Low	-- Ethological studies -- Acoustic studies -- Behavioural sampling --Telemetry	None Poor None None	Low Medium Low Low	

TableVIII.2. The following table outlines the priority social knowledge (SK) required that relates directly to conservation of the Irrawaddy dolphin population in the Mekong River. The priorities are based on the results of my study and the most immediate needs for conservation. The headings in bold are those activities that I consider high priority.

Information On:	Overall current importance (High, Medium, Low)	Methods	Current level of information (Excellent, Good, Poor, None)	Overall current priority (High, Medium, Low)	Most urgently required with limited budget
SK1. Evaluation of Dolphins for Development Project	**High**	**-- Household based surveys** **-- Field observations**	**None**	**High**	√
SK2. Resource Use Patterns	**High**	**-- Household based interviews**	**None**	**High**	√
SK3. Stakeholder Characteristics	High	-- Household based interviews -- Basic demographics	Poor	Medium	
SK4. Stakeholder Perceptions	High	- Dolphin conservation - Fisheries conservation	Good	Medium	
SK5. Organisation and Resource Governance	**High**	**-- Identify all relevant stakeholders involved in dolphin/fisheries/riverine conservation and management.** **-- Interview relevant people from each organisation to determine their role in management within the river.** **-- Prepare a short report detailing the results of these interviews, relevant contact people and their contact details.**	**Poor** **Poor** **None**	**High** **High** **High**	

SK5. Traditional Knowledge	**High**	**-- Household based interviews**	**Poor**	**High**	
SK6. Non-market and Non-use Values	Medium	-- Household based interviews	Poor	Medium	
SK7. Market Attributes for Extractive and Non-Extractive Use	High	-- Household based interviews	Poor	Medium	
SK8. Gender Issues	Medium	-- Household based interviews	Poor	Medium	

Table VIII.3. The following table outlines the current and potential threats to Irrawaddy dolphins in the Mekong River and the socio-economic information (SEIi) required to assess these threats (this table was adapted from Wang *et al.* (2004)). The headings in bold are those activities that I consider high priority.

Threats	Current Threat Impact (High, Medium, Low)	Known, Likely, Potential, Unlikely	Socio-economic Information Needed to Assess Threat	Overall current priority (High, Medium, Low)	Most urgently required with limited budget
SEI1. Accidental Entanglement in Gillnets	**High**	**Known**	**-- Fisheries practices and locations.**	**High**	√
SEI2. Direct Catch in Seine Nets	**High**	**Known**	**-- Occurrence of direct catch.** **-- Level of direct catch.** **-- Locations of direct catch.** **-- Villagers involved in direct catch.**	**High** **High** **High** **High**	√ √ √ √
SEI3. Direct Deaths Through Illegal Fishing	**Low**	**Potential**	**-- Use of illegal fishing gear.** **-- Locations of illegal fishing gear use.** **-- Locations of direct deaths.**	**High** **High** **High**	√ √ √
SEI4. Contaminants	**High**	**Known**	**-- Contaminant types and sources.** **-- Disposal techniques for contaminants**	**High** **High**	√ √
SEI5. Traditional Use of Dolphin Parts for Medicine	Low-High	Known	-- Source of dolphins used. -- Occurrence of use. -- Use type. -- Level of use.	Medium Medium Medium Medium	
SEI6. Depletion of Prey (over-fishing, loss of prey habitat)	Low-High	Known	-- Fishing gear type. -- Biomass of fish caught. -- Species of fish caught.	Medium Medium Medium	

SEI7. Habitat loss (village construction, land development, sedimentation)	Medium-High	Likely	-- Local development patterns. -- Immigration and emigration rates.	Medium	
SEI8. Boat Collision and Harassment	Medium	Likely	-- Boat types used. -- Areas of boat use. -- Occurrence of collision. -- Local involvement in dolphin-watching tourism.	Low Low Medium Medium	
SEI9. Reduction in Freshwater Flow (dam or waterway construction)	Low-High	Potential	-- Existing local water use. -- Planned local water use.	Low Low	

APPENDIX IX

Management Recommendations

(Full Content)

Table IX.1 The following table summarises the current major threats (CMT) to Irrawaddy dolphins in the Mekong River and suggested management options to mitigate these threats (this table is adapted from Wang *et al*. 2004). The headings in bold are those activities that I consider high priority.

Threats	Current Threat Impact (High, Medium, Low)	Mitigation/Management Option	Mitigation/Management Option Potential Impact To Local Communities	Overall current priority (High, Medium, Low)	Most urgently required with limited budget
CURRENT MAJOR THREATS					
CMT1. Accidental Entanglement In Gillnets (reduce anthropogenic mortality to zero)	High	**-- Provide alternative sources of protein**	High - Positive *(benefit to communities)*	**High**	√
		-- Diversify livelihoods	High - Positive *(benefit to communities)*	**High**	√
		-- Education and awareness	Medium - Positive *(benefit to communities)*	Medium	
		-- Community-based dolphin and fisheries conservation zones. **-- Prohibit the use of gillnets**	High - Negative *(initial loss of fisheries, however, potential benefits in the future with increased fish stocks)*	**High**	√
		-- Fisheries management options: (1) gear modification, (2) the use of pingers, (3) modify fishing practices (e.g. tending nets constantly), (4) compensate fishers for losses (e.g. buy out program/net compensation to cut dolphins out of nets)	High - Negative	**High**	√

CMT2. Direct Catch In Seine Nets (reduce anthropogenic mortality to zero)	High	**-- Increased national legislation**	High – Negative (violators) *(fisheries restrictions)* High – Positive (general community)	**High**	√
		-- Extension to all Department of Fisheries offices	Low *(virtually no impact on communities initially, however potentially increased enforcement in the future)*	Medium	
		-- Education and awareness	Medium - Positive *(benefit to communities)*	Medium	
CMT3. Direct Deaths Through Illegal Fishing (reduce anthropogenic mortality to zero)	Low	**-- Provide alternative sources of protein**	High - Positive *(benefit to communities)*	**High**	√
		-- Diversify livelihoods	High - Positive *(benefit to communities)*	**High**	√
		-- Education and awareness	Medium - Positive *(benefit to communities)*	Medium	
		-- Increased national legislation and enforcement	High – Negative (violators) Low/High - Positive (general community) *(*there would be little direct impact to the general community, the majority of whom do not engage in illegal fishing activities. However, a high positive impact to those villagers that would like to conserve fish stocks and dolphins).*	**High**	√

		-- Construction of dolphin/fisheries monitoring posts	Low	Low	
		-- Prohibit large scale commercial fish purchasing in the upper Cambodian Mekong River	Medium - Negative	Medium	
CMT4. Boat Collision And Harassment (reduce un-necessary boat harassment which could lead to decreased fitness and/or direct death)	Medium	**-- Speed restrictions in critical dolphin areas**	Low	**High**	√
		-- No engine policy for tourism boats	Low	**High**	√
		-- Strict dolphin-watching guidelines	Low	**High**	√
		-- Education and awareness	High - Positive	Medium	
CMT5. Contaminants (reduce anthropogenic mortality to zero)	High	**-- Establish clearly the source of contaminants**	High - Positive	**High**	√
		-- Provide accurate information to government agencies/NGOs regarding the effects of the contaminants on the dolphin population	High - Positive	Medium	
		-- Increase awareness of local communities to the threat of contaminants and their effects	High - Positive	Low	
		-- Regulate chemical use, handling, disposal and transport of PBT compounds (e.g. PCBs, dioxin)	High - Positive	**High**	√
CMT6. Dam Or Waterway Construction	High	-- Obtain and provide relevant scientific information regarding the potential	High - Positive	Low	

(retain the integrity of the lower Mekong River system)		effects of dam and waterway construction to relevant authorities/NGOs and communities			
		-- Add dolphins to EIA for constructions	High - Positive	**High**	√
POTENTIAL THREATS					
CMT7. Traditional Use Of Dolphin Parts As Medicine (reduce anthropogenic mortality to zero)	Low-High	-- Increase national legislation that prohibits the possession of dolphin parts	Low - Negative	Low	
		-- Conduct education and awareness programs to emphasise the use of modern medicines for human/livestock use	Medium - Positive	Medium	
CMT8. Habitat Loss (retain the integrity of the lower Mekong River system)	Medium	**-- Include dolphins in EIA for any river development project**	High - Positive	**High**	√
		-- Establish protected area in areas near critical dolphin habitats where no settlement or construction is allowed	Medium - Negative	**High**	√
		-- Restore habitat near dolphin critical areas already degraded (e.g. deforestation)	High - Positive	Medium	
CMT9. Village, Agricultural, Industrial Discharge (retain the integrity of the lower	Medium	-- Encourage recycling and burning of rubbish	High - Positive	Low	

Mekong River system)					
		-- Introduce buffer zones, integrated pest management and other practices to prevent or reduce runoff of pesticides	Medium - Positive	Low	

Table IX.2. The following table outlines the priority activities for mitigation of threats and mortality rates (MTM). The priorities are based on current data available based on the results of my study and the most immediate needs for conservation (adapted from Wang et al. 2004). The headings in bold are those activities that I consider high priority.

Information On:	Overall current importance (High, Medium, Low)	Methods	Previous level of activities (Completed, Significant, Some, Once, None)	Overall current priority (High, Medium, Low)	Urgently required with limited budget
MITIGATION OF THREATS AND MORTALITY					
MTM1. Adapted Formalised Conservation and Management Plan	HIGH	-- Develop a draft conservation and management plan for circulation nationally within Cambodia (relevant NGOs, government departments etc).	Completed	--	
		-- Endorse the action plan at a national workshop led by Department of Fisheries, also discussing implementation strategies for the recommendations.	Completed	--	
		-- Submit the document for international review, to further refine the management objectives and suggested activities.	None	**High**	√
		-- Develop a formalised action plan with comments from international NGOs, regional government agencies and input from international experts.	None	**High**	√
MTM2. Community Development And Diversification Of Livelihoods	HIGH	**-- Initiation of sustainable development solutions in villages near critical dolphin habitats.**	Significant	**High**	√
		-- Encourage diversification of livelihoods through village development activities and dolphin-watching eco-tourism.	Significant	**High**	√
		-- Development of land-based fish culture.	Significant	**High**	√
MTM3. Improved	HIGH	**-- Development of national legislation.**	Some	**High**	√

Legislation And Enforcement		**-- Enforcement of regulations**. -- Extension to all Cambodian DOF offices and relevant agencies in Laos and Vietnam.	Some None	**High** Medium	√
MTM4. Direct Conservation Intervention	HIGH	**-- Development of dolphin/fisheries conservation zones.** -- Construction of dolphin/fisheries monitoring posts. **-- Establishment/facilitation of effective community dolphin/fisheries committees**. **-- Demarcation of dolphin/fisheries conservation zones**.	None None None None	**High** Medium **High** **High**	√ √ √
MTM5. Sustainable Dolphin-Watching Eco-Tourism	HIGH	**-- Develop appropriate management and regulations regarding dolphin-watching ecotourism (Cambodia and Laos)** -- Develop and distribute effective educational and awareness information to tourists (Foreign and Khmer)	Some Significant	**High** Medium	√

Table IX.3. The following table outlines the priority activities for education and awareness (EA). The priorities are based on current data available based on the results of my study and the most immediate needs for conservation (adapted from Wang et al. 2004). The headings in bold are those activities that I consider high priority.

Information On:	Overall current importance (High, Medium, Low)	Methods	Previous level of activities (Significant, Some, Once, None)	Overall current priority (High, Medium, Low)	Urgently required with limited budget
EDUCATION AND AWARENESS PRIORITIES					
EA1. Village Workshops	High	**-- Conduct village-based workshops to: (1) outline project results, (2) emphasise the importance of dolphin/fisheries conservation, (3) emphasise the importance of reporting any dolphin carcasses found, (4) discuss villagers concerns and perceptions regarding dolphin/fisheries conservation and potential solutions to threats**. -- Distribute awareness and educational material.	Some Some	**High** Medium	√
EA2. School Visits	High	-- Undertake school visits to present information about dolphins, fisheries and the Mekong River habitat. -- Distribute awareness and educational materials. -- Conduct colouring competitions.	Some Some None	Medium Medium Medium	
EA3. Awareness Raising With Seine Net Fishers and Authorities South of Kratie to Phnom Penh	High	**-- Visit households, fishers (particularly seine net fishers) and chief of villages/communes/districts to emphasis the importance of releasing dolphins if caught in fishing gear and raise awareness on national legislation to protect dolphins.** **-- Distribute posters in public areas and village/commune and district chief houses regarding releasing dolphins if**	None None	**High** **High**	√ √

		caught alive in fishing gear. **-- Emphasise to all stakeholders the importance of reporting sightings of dolphins south of Kratie and reporting any dolphin carcasses encountered.**	Some	**High**	√
EA4. Integration Of Monks Into Environmental Education And Awareness Activities	High	**-- Initiate discussions with head monks in Kratie and Stung Treng Provinces to determine the level of co-operation and extension local monks may be able to provide and encourage initial collaboration.** -- Co-operate to develop additional extension and awareness materials monks are able to use to disseminate information. -- Conduct meetings/workshops with monks in the Kratie to Lao/Cambodian border river section.	None None None	**High** Medium Medium	√
EA7. Regional Co-Operation With Educational Activities	Medium	**-- Establish contact with all relevant agencies in respective countries regarding the status of dolphins and potential for collaboration**. -- Distribute MDCP project documents (including monthly and project reports) to all interest parties and relevant government agencies. -- Distribute regionally all MDCP educational and awareness materials. Consideration should be given to duplicating materials (if appropriate) in either Lao or Vietnamese language.	None None None	**High** Medium Medium	√
EA5. General Community Awareness Raising	Medium	**-- Production of a poster emphasising the importance of conserving dolphins in the Mekong River and restricting the use of illegal fishing gears.** **-- Reprinting of the Mekong dolphin folklore poster** **-- Reprinting of the San San the Mekong Dolphin Colouring Book (with minor changes)** **-- Production of a writing notebook for children and villagers, emphasizing the importance of dolphin**	Once Once Once None	**High** **High** Medium Medium	√ √

		conservation. **-- Reprinting of the Mekong Dolphin Conservation Project T-shirt for distribution to local community members that assist with the project.** -- Submission of popular articles on dolphins and their conservation status to Khmer magazines. -- Regular national radio advertisements, to emphsise the importance of dolphin/fisheries conservation in the Mekong River and releasing any dolphins caught in fishing gear. -- News broadcast about the dolphins in the Mekong River and threats to their survival (Khmer and English). -- One hour television program in association with the Cambodian produced "Smart Game", emphasizing dolphin conservation.	Once None None None None	**High** Medium Medium Medium Low	√
EA6. Provincial Workshops	Low	-- Conduct one workshop in each province (Kratie and Stung Treng) to present the results of MDCP research to provincial authorities and line-departments. -- Discuss dolphin/fisheries conservation and potential solutions to problems facing dolphins and the riverine ecosystem -- Distribute educational and awareness materials/reports to all provincial authorities and line-departments.	None None None	Low Low Low	

Table IX.4. The following table outlines the priority activities for clarification of national roles and responsibilities. The priorities are based on current data available based on the results of my study and the most immediate needs for conservation (adapted from Wang et al. 2004). The headings in bold are those activities that I consider high priority.

Information On:	Overall current importance (High, Medium, Low)	Methods	Previous level of activities (Significant, Some, Once, None)	Overall current priority (High, Medium, Low)	Urgently required with limited budget
CLARIFICATION OF NATIONAL AND REGIONAL MANAGEMENT					
NRM1. National Coordination	HIGH	**-- Continue the Mekong Dolphin Conservation Project.** **-- Identification of responsible national agencies** -- Conduct a national workshop on Irrawaddy dolphin conservation priorities in the Mekong River.	Significant Some Once	**High** **High** Medium	√ √
NRM2. Regional Coordination	HIGH	-- **Stung Treng (Cambodia) and Champasak (Lao) Provincal meeting to discuss conservation priorities for Chiteal.** **-- Identification of responsible regional agencies Stung Treng (Cambodia) and Champasak (Lao) provincial meeting to discuss conservation priorities for Chiteal Pool**. -- Regional working group meeting (southern Laos, Cambodia and Vietnam). -- Establishment of a trans-boundary Irrawaddy dolphin management committee (Lao, Cambodia and Vietnam).	Once Some None None	**High** **High** Medium High	√ √ √