

# PESUT MAHAKAM CONSERVATION PROGRAM

## TECHNICAL REPORT:

Abundance and threats monitoring surveys during medium to high water levels September & October/November 2010



by

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## **Preface and Acknowledgements**

This technical report presents results of the abundance and threats monitoring surveys on the freshwater Irrawaddy dolphin population in the Mahakam River, in East Kalimantan, Indonesia. This research is part of the larger “ Pesut Mahakam Conservation Program”, which is an ongoing research and conservation program executed by Yayasan Konservasi RASI since 1999 in cooperation with the East Kalimantan Nature Conservation Agency (BKSDA Kaltim) and local Governments (West and Central Kutai Districts). Data were collected at medium water levels in September 2010 and high water levels by end of October/ early November 2010. The data within this report are still under revision and should not be cited without prior permission of the author.

Surveys were conducted by Danielle Krebs, Sanjaya (both NGO RASI), Tara Whitty (Scripps Institution of Oceanography, USA), Fahmi (Nature Conservation Agency-BKSDA). Photo-id analyses were performed by Danielle Krebs and Imelda Susanti. I would like to thank them and our boatmen Pak Acoh and Pak Udin very much for their patience, flexibility and hard work. I am also grateful for the information that fishermen, villagers along the Mahakam and colleagues shared with me.

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## Summary

Two extensive abundance monitoring surveys were conducted between 21 September and 30 September 2010 and 26 October and 4 November 2010 using photo-identification of dorsal fins for mark-recapture analysis. In addition, several interviews were conducted with fishermen daily to obtain new information on threats, mortality and distribution patterns. Data were during extensive monitoring surveys collected at medium water levels in September 2010 and high water levels by the end of October/ early November 2010 in order to monitor the population abundance, importance of earlier identified core areas and threats to the freshwater Irrawaddy dolphin population in the Mahakam River in East Kalimantan, Indonesia. Based on Petersen Mark-Recapture Analysis the population was estimated at 87 individuals (CV=12%; 95% CL = 81-106), which is similar to the numbers derived from the mark-recapture surveys conducted in 2007 (N= 87; CV=9%; 95% CL = 75-105). The major threat involved direct mortality, which was largely caused by gillnet entanglement (66% of all deaths). Mean annual mortality between 1995 and 2010 was four dead dolphins per year. Other threats are habitat degradation through noise and chemical pollution, prey depletion through unsustainable fishing techniques (electro-fishing, poison and trawl), habitat displacement from container barges and increasingly shallow lakes through sedimentation. A new threat involves the recent presence of oceanic coal-carrier ships that now move upstream through major dolphin habitat raising considerable concern about the tremendous amount of underwater noise pollution these boats produce. In time, changes in occupancy have occurred regarding previously identified core areas where the “Muara Pahu – Penyinggahan sub-districts area” represented the primary core area before 2007 in terms of densities and the second largest core area was “the Pela/ Semayang –Muara Kaman area”. Currently, the first core area has much lost of significance and can be less and less often observed by local residents and also during both surveys on 2010, no dolphins were encountered here. This is probably caused by the decreased habitat quality in the upstream areas and the subsequent decrease of fish resources in these areas due to opening of oilpalm plantation in fish spawning swamp areas that connect with this area and noise pollution from coalbarge transport in narrow tributaries. Current conservation activities focus on gaining local governmental and community support to protect these areas through multi-stakeholder workshops and preparing a management plan with task division for each organization for each area. Mitigation of unsustainable fishing techniques by introducing more sustainable fishing techniques and pollution reduction (due to chemical waste and boat noise) are vital components for the survival of this critically endangered freshwater dolphin population.

## Introduction

### *History and background*

River dolphins and porpoises are among the world's most threatened mammal species. The habitat of these animals has been highly modified and degraded by human activities, often resulting in dramatic declines in their abundance and range (Reeves *et al.* 2000). In Indonesia one representative freshwater dolphin population is known to inhabit the Mahakam River and associated lakes system in East Kalimantan that is the facultative river dolphin species *Orcaella brevirostris*, commonly and locally referred to as Irrawaddy dolphin and Pesut, respectively. The species is found in shallow, coastal waters of the tropical and subtropical Indo-Pacific and in the following major river systems: Mahakam, Ayeyarwady, Mekong, where alarming declines in their numbers and ranges and ongoing and pervasive threats occurred (Smith *et al.*, 2003). The species is protected in Indonesia and adopted as symbol of East Kalimantan and has been classified as “Critically Endangered” in 2000 based on the results of the ongoing research program (Pesut Mahakam Conservation Program) (Hilton-Taylor 2000).

The Irrawaddy dolphin population in the Mahakam River is the only obligate or true freshwater dolphin population in Indonesia. An analysis of tissues samples from 6 individuals

indicated that the population has two unique genetic haplo-types compared to the coastal Irrawaddy dolphins in Northeast Kalimantan (Malinau), Thailand and Philippines (Robertson, 2009)

Significant data on Irrawaddy dolphins in the Mahakam were collected during a two-month preliminary study in 1997 and during a 3.5 years intensive Ph.D. research effort from early 1999 until mid 2002. Prior to this work there was an almost total absence of knowledge on the status of the freshwater Irrawaddy dolphin population in the Mahakam River and of the coastal Irrawaddy dolphins in East Kalimantan, Indonesia. Follow-up monitoring surveys were repeated in 2005 and 2007 by Yayasan Konservasi RASI in cooperation with the East Kalimantan Nature Conservancy Agency (BKSDA) to estimate total abundance and investigate mortality and threats. The research focused in particular on their abundance, population dynamics, and threats and a comparison of their social structures, acoustic behaviours and the degree of separation was made between coastal and freshwater Irrawaddy dolphins (Kreb, 2004; Kreb and Budiono, 2005).

### *Objectives*

The aim of the current research project conducted in 2010 was to provide a comparative set of data to detect any trends in abundance and distribution, to update the photo-id catalogue, to assess the stability of preferences of core areas, and to obtain the latest information on threats and on mortality rates since 2007. Based on this new information, the new course will be set out for conservation action, which effectively will contribute to the population's survival. This latest information will be presented in local district workshops in Central Kutai, where no protected area are present or have been officially proposed, and will be used as basis to propose such an area after the first proposed dolphin conservation area in West Kutai (Muara Pahu sub-district).

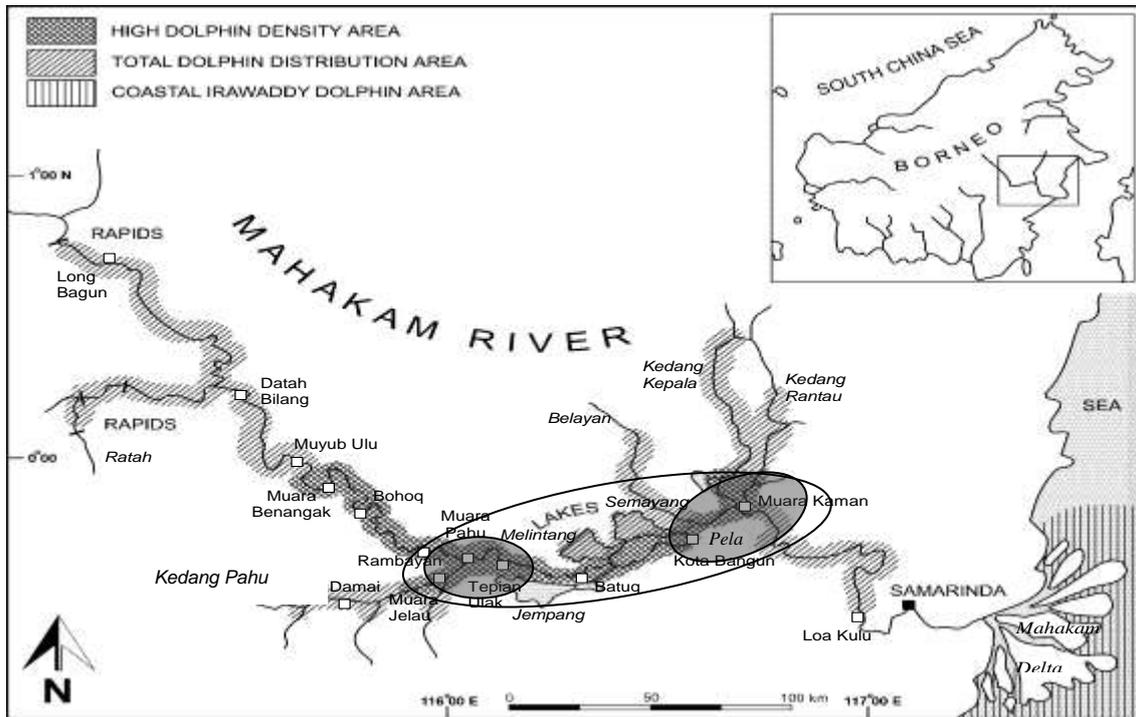
## **Methods**

### *Data collection*

We searched the Mahakam River by boat from Muara Kaman (180km from the coast) to Laham (c. 500km from the coast) including the tributaries Kedang Rantau, Kedang Kepala, Belayan, Kedang Pahu, Ratah and Semayang and Melintang Lakes based on previous sightings information (Kreb & Budiono, 2005) and interviews with residents that confirmed their absence in more upstream sections (Fig. 1). Two extensive abundance monitoring surveys were conducted between 21 September and 30 September 2010 and 26 October and 4 November 2010 using photo-identification of dorsal fins for mark-recapture analysis. In addition, several interviews were conducted with fishermen daily to obtain new information on threats, mortality and distribution patterns. The total distance searched on effort during each survey was 991 km for the first survey, and 562 km for the second survey, respectively totalling 1473 km in 127 hours. To monitor abundance and locate dolphin groups during both surveys, the river was scanned from small motorized boats (26 hp) traveling at an average speed of 11.6 km h<sup>-1</sup>. The observation team consisted of three observers: two front and one rear. The total observation time during dolphin sightings for both surveys was 11.7 h. Digital photographs were taken of dolphin dorsal fins using a digital Nikon D700 camera and 300mm/f4.0 lens and Nikon D300 and 24-120mm/f3.5-5.6 lens. Effort was made to photograph every individual within the group irrespective of whether they appeared to have distinct dorsal fin markings.

For each sighting, duration, location, group behaviour, size and composition were noted. During both monitoring surveys in September and October/November, on average, each group observation lasted a little over one hour. Having already determined the number of dead dolphins between 1995 and 2007 (Kreb, 2005a, Kreb *et al.*, 2007, Kreb *et al.*, 2010), we determined the number of dead dolphins between 2007 and 2010 from our own observations and received reports

and from semi-structured interviews with fishermen during the 2010 field surveys. Incomplete or untrustworthy accounts with missing locality, date, or traceable eyewitnesses were disregarded.



**Fig. 1.** Study area with a) total dolphin distribution area, b) areas of high dolphin density and c) coastal Irrawaddy dolphin area. The coastal dolphin area is based on observations and interviews. Existing and proposed dolphin conservation core areas are marked with two dark-gray highlighted circles.

### Analysis

In order to estimate abundance, two methods were used, i.e. mark-recapture techniques through photo-identification (described in detail in *Kreb, 2005*) and minimum counts. In order to estimate abundance Petersen's method for mark-recapture analysis was used, which assumes that in between the period of mark and capture there are no gains and losses. In between both surveys September – November, only one new calf was observed with neo-foetal folds but no dolphins have been reported dead between the survey periods. Therefore, we consider the error very small and the Petersen's method very suitable. Because of improved technology due to use of digital photography and use of burst photography options we were able to photograph calves' dorsal fins as well, so a correction factor was left out to account for unidentifiable dolphins. A straightforward formula to estimate abundance and approximate confidence limits of the Petersen method were used as described in (*Sutherland, 1996*):

$$\text{Eqn 1.1 } N = (n_1 + 1)(n_2 + 1) / (m_2 + 1) - 1$$

$$\text{Eqn 1.2 } W_1, W_2 = p \pm [1.96 \sqrt{p(1-p)(1-m_2/n_1) / ((n_2 - 1) + 1/2n_2)}]$$

$$CL_{1,2} = n_1 / W_{1,2}$$

$$\text{Eqn 1.3 } CV(N) = N^{-1} \sqrt{\frac{n_1^2(n_2 + 1)(n_2 - m_2)}{(m_2 + 1)^2(m_2 + 2)}}$$

where:  $N$  = total population size

$n1$  = number identified on the first occasion;

$n2$  = total number identified on the second occasion;

$m2$  = number of previously identified dolphins found on the second occasion;

$p = m2/n2$

$CL_{1,2}$  = lower and upper approximate confidence limits

$CV$  = coefficient of variation

The matching of photo-identified individuals in the 2010 surveys to the existing photo-id catalogue was performed by two analysts in order to obtain an objective match or new id.

In order to measure mean group size per survey, we used the definition that a group would maintain its composition and size for at least one hour. If observation time lasted several hours and other groups were observed to join, the newly formed group was only included if the formation lasted for one hour.

## **Results**

### *Distribution*

Sightings in the main Mahakam River during the 2010 surveys were confined to the area between Muara Kaman (c. 180 km from the coast) and Muara Muntai (c. 235 km from the coast) (Fig. 2). Tributary sightings in 2010 include the tributaries Kedang Rantau (which mouths at Muara Kaman), Kedang Pahu (which mouths at Muara Pahu at 300km from the coast), Pela River, which connects with Semayang Lake confluence. The Ratah River was surveyed until the first section at 25km from the mouth where in 2007 and years before a group of dolphins occurred in a 2.5 km-long section between a rapid and shallow area. However, this year no dolphins remained in this section, where they first arrived in 1998 and according to information with locals this group of 3 dolphins had moved further upstream. According to local information a group of 2 dolphins still occurred in a small pool of 40 x 50m at 100km from the mouth of Ratah River.

All sightings made of pesut during all surveys between 1997 and 2010 were confined to the area between Muara Kaman ( $\pm$  180 km from the mouth) and Tering ( $\pm$  420 km from the mouth) (Figure 3). Pesut has also been found in the tributaries in the middle Mahakam area, i.e. Kedang Rantau, Kedang Kepala, Belayan, Kedang Pahu, Pela, Semayang and Melintang Lakes; Pesut has also been found in between rapid streams at about 20 and 100 km upstream of the Ratah River, which mouths into the Mahakam at at least 500km upstream from the sea mouth. The maximum distribution area can seasonally extend beyond these areas both in downstream (until c. 90 km from the mouth) and upstream direction but is limited by the rapids upstream of Long Bagun at 600km from the mouth.

During population abundance monitoring surveys in 2007 we found that the population was more or less equally distributed in two districts Central and West Kutai, respectively 42 dan 52 individuals. Using photo-identification techniques we found that only three individuals were found in both (core) areas during previous surveys, whereas the rest of identified individuals were only found in (core) area during all previous surveys, which gives evidence that the groups of pesut generally remain in the same area. In 2007 an increase of groupsize of between 16-18 individuals was detected in the tributary Kedang Rantau near Muara Kaman, where before 2007 (1999-2002; 2005) only groups of maximum 6 individuals occurred.

Significant changes in dolphin distribution have occurred in time. Between 1999-2002 two cores have been identified where dolphins occurred in highest densities, i.e. the first core area of "Muara Pahu – Penyinggahan" in West Kutai, and the second core area of "Pela/Semayang – Muara Kaman" in Central Kutai. In 2005, 78% of the pesut population could be found in the first core area in West Kutai, but in the 2007 survey this percentage had been decreased until 57% and in two extensive monitoring surveys conducted in 2010 not one individual was found in West Kutai district area and the entire population was found in Central Kutai district.

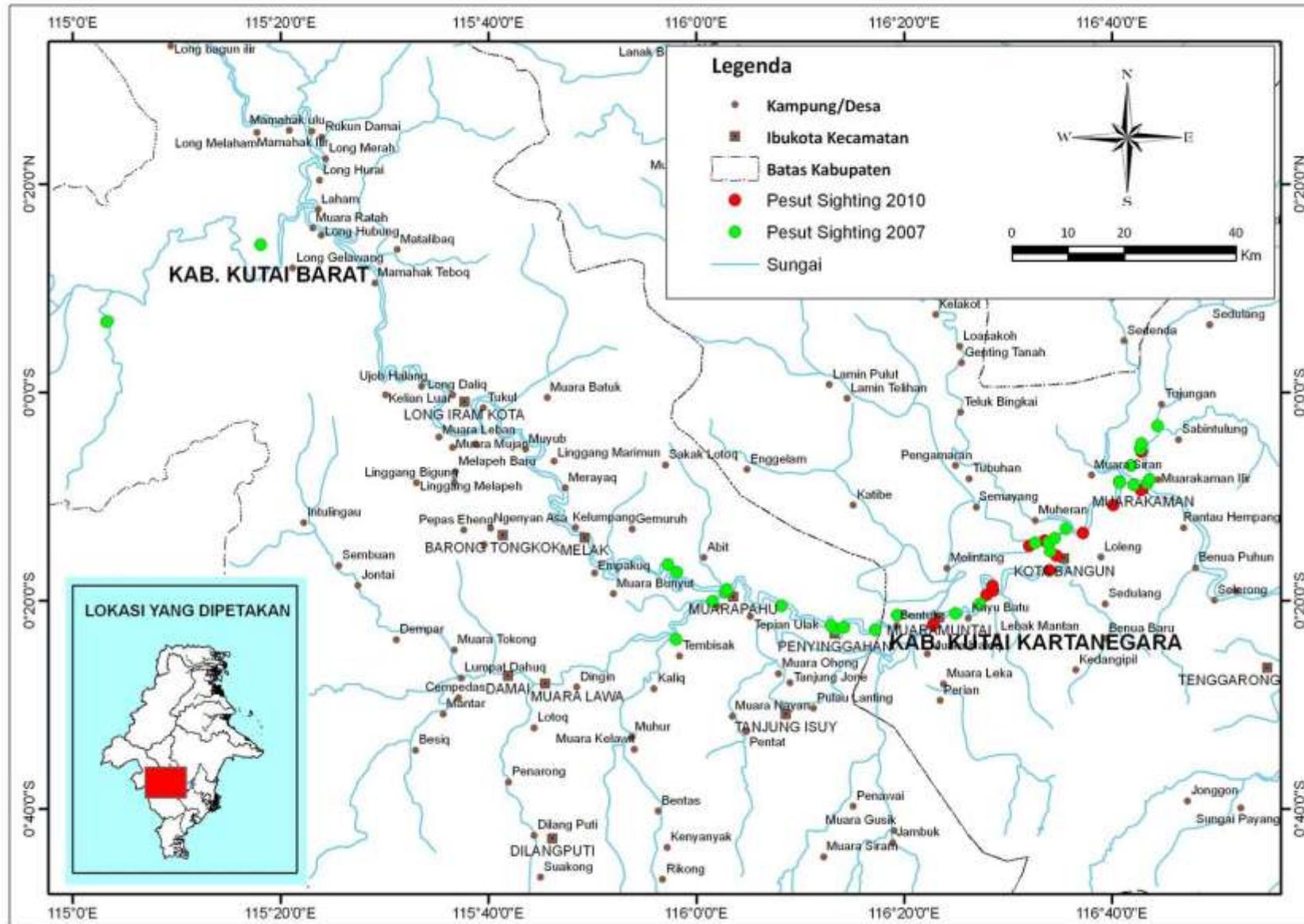


Figure 2. Sightings of Pesut during 2007 (green dots) and 2010 (red dots) surveys.

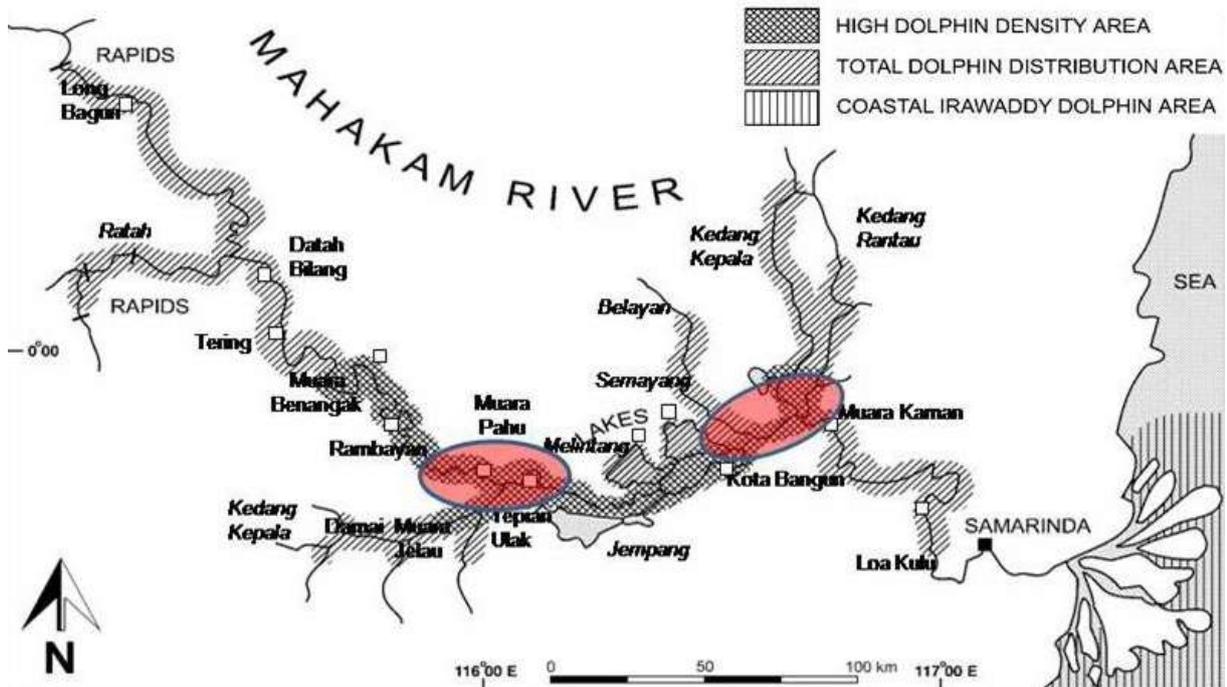


Figure 3. Distribution area of pesut. Dolphin core areas are indicated with red circles

Although pesut may migrate during certain water conditions, this still does not provide a satisfactory explanation as before pesut could be found in West Kutai during any water condition, whether high, medium or low. Although based on reports dolphins still occur in West Kutai and Muara Pahu in particular, they can be less and less often observed by local residents and fishermen, whereas the dolphins since as long as they can remember have been very abundant in this core area. This is probably caused by the decreased habitat quality in the upstream areas and the decrease of fish resources in these areas.

The following developments have very likely contributed to the habitat degradation in the last recent years; i.e. the fast rate of conversion of swamps areas, that represent important fish spawning areas by oilpalm plantations, the coal-cleaning waste that enters into the Kedang Pahu River through small outlets and the underwater noise pollution caused by coal-carrying tugboats in the same narrow tributary, illegal use of electro-fishing and poison.

The most drastic changes have occurred in the core area of Muara Pahu where between 2002-2005 on average daily minimal 12 pesut (5-21 pesut) composed of 3 groups (2-6 dolphins/group) occurred for 42% of daylight hours (20%-65%) between 7:00-18:00 at any water level condition. At least 31 different individuals could be identified during 5 days consecutive land-based observations during every survey. With the increase of coal-carrying tugboat entering and passing through the Kedang Pahu River, pesut more often appears by the end of the afternoon or in the evening and in 2010 since fish spawning areas have been converted in oilpalm plantations, pesut are increasingly difficult to observe and also passing through the core area without spending much time in it.

### *Abundance*

The population of Irawaddy dolphins in the Mahakam in 2010 was estimated at 87 individuals (CV=12%; 95% CL = 81-106), based on Petersen's mark re-capture analysis, which is similar to the numbers derived from the mark-recapture surveys conducted in 2007 (N= 87; CV=9%; 95% CL = 75-105) (Kreb, *et al.*, 2007). Total number of directly identified individuals in 2007 was 91, whereas the total number of dolphins directly identified in 2010 was 71 dolphins. This number is lower because of the fact that there were more surveys conducted in 2007 than in 2010.

The mean number of detected dead dolphins per year between 1995 and 2010 is 4 individuals (=4% of total population), whereas total number of recorded deaths is 68 dolphin in 16 years. Regression analysis showed that a significant decrease has occurred to the minimum detected annual mortality throughout the last years ( $b = -0.27$ ,  $df = 14$ ,  $t = -2.3$ ,  $p < 0.05$ ). If the period is divided into two periods, i.e. 1995-2002 and 2003-2010 the mean number of deaths decreases from 5 individuals (5% of population) to 3 deaths per year (3% of population).

Birth rates detected in 2000-2002 are 5-6 calves per year (5-6% of population), whereas the number of calves identified during one of the 2010 surveys also totalled 5 dolphins. During a Ph.D study conducted between 1999-2004 (Kreb, 2004), it was found that 50% of the population were adults of which 25% represented reproductive females. With a population of 87 individuals, it would theoretically mean that 21 adult females would give birth to one calf every 2-3 years based on their 14-month pregnancy cycle. Based on these data, in theory every years 5 calves should be born, which fits well with our field observations. In conclusion between 2005 and 2010 there have been no significant changes in population abundance but there have been significant changes in the core distribution areas of the dolphins (as described next).

*Group sizes & composition*

Mean group sizes encountered during 7 and 5 on-effort sightings for the September and October/November surveys were 10 and 12 dolphins, respectively with a median of ten dolphins (range: 5-20 dolphins) for both surveys, whereas during 2007 the median of group sizes encountered was four dolphins (range: 2-17 dolphins). During the first survey, at least 5 different calves were sighted with estimated ages between 1 month to up to more or less one year of age. In October/November, at least 4 different calves with up to year were detected including one newborn calf with neofoetal folds.

*Threats*

**Direct mortality**

The major threat to Mahakam Irrawaddy dolphins is direct mortality from gillnet entanglement (66% of deaths with known causes (N=68) documented through interviews and direct observations between 1995 and 2010 (Figures 4 & 5). The majority of dead dolphins were adults (76%), 14% were juveniles and 10% were newborn calves. Most dolphins died as a result of entanglement in gillnets with mesh sizes of 10 –17.5 cm. The close association of fishermen and dolphins increases the potential for entanglement. Dolphins are often observed feeding in close proximity to nets and many fishermen use the dolphins’ feeding patterns as indicators of the location and time to set gillnets. Dolphins are reported to aid fishermen by guiding fish into their nets. In turn, fishermen reported that on several occasions they had successfully released dolphins from gillnets. But at least five dolphins accidentally killed in gillnets were eaten and the skin of two of them were used as skin allergy medicine.

Vessel strikes, all, except for one adult, involving juvenile dolphins, accounted for 10% of mortalities. Deliberate kills each accounted for 9% of the documented deaths, the latter occurring mostly in isolated areas where the dolphins were rarely found. Neonatal mortality involved 5% , whereas three percent of deaths occurred after being trapped in shallow water, and electro-fishing. Long-line fishing (*rawai*) and poison accounted each for 2% of deaths.

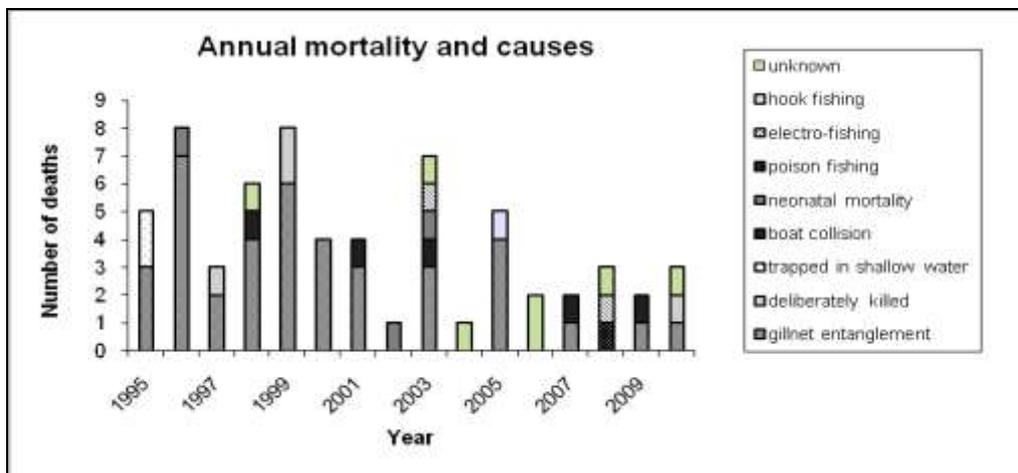


Figure 4. Minimum mortalities recorded through own observations and through reports and fishermen interviews

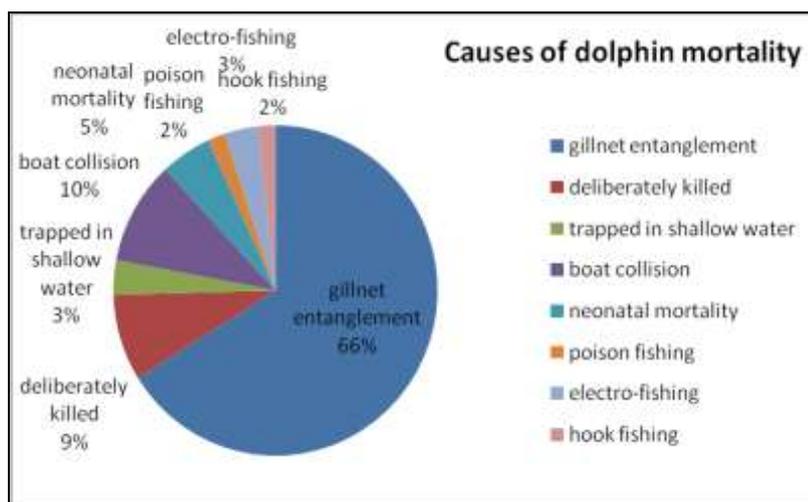


Figure 5. Causes of dolphin mortality

Factors that degrade dolphin habitat and thereby present an indirect threat to the animals include 1) sedimentation that is reducing the depth of lakes and reducing fish resources, 2) high frequency noise pollution generated by boat propellers and high decibel noise from tugboats and barges used for coal transport, 3) chemical pollution, mainly from coal and gold-cleaning waste, and 4) prey depletion from illegal and unsustainable fishing methods (electro-fishing, poison and trawl) and over-fishing to support unsustainable aqua-culture practices (breeding of fish that feed on other fish). These are detailed below:

### Sedimentation

A recent range decline involves the disappearance of the dolphin from Jempang Lake since the mid-1990's, probably due to a reduction in the depth of the lake from sedimentation caused by deforestation of the watershed. High densities of gillnets and sedimentation have also restricted the possibility of movements into the other two lakes, Melintang and Semayang. Except during high water levels dolphins are now confined to a narrow boat channel between the lakes where there is a high risk of vessel collision and noise pollution impacts. Besides, sedimentation is decreasing the fish resources (see *prey depletion*)

### Noise pollution

The main source of noise pollution is high-speed vessels (40-200 hp) (mean = 4.6 boats/ h in dolphin habitat). Dolphins dive for significantly longer periods when the boats are within 300 m of them (Kreb & Rahadi, 2004). In addition, frequent passing of fast moving motorized canoes with long propeller sticks (max 26 hp) also caused dolphins in the Pela River to dive longer. Container barges pass daily (mean = 8.4 boats per day) through primary dolphin habitat on the Kedang Pahu River, a narrow tributary of the Mahakam. These vessels take up over two-thirds of the width of the river and over half the depth of the tributary during the dry season. Dolphins always changed their direction (if swimming upstream) when they encountered loaded container barges. During low water periods they actively avoided the tributary, whereas before the presence of container barges dolphins entered the tributary while moving upstream to the Bolowan confluence (c. 10 km from the Kedang Pahu mouth) at all water levels according to information from local fishermen. A new type of self-propelled oceanic carrier ship is now also being used to carry coal directly from the mining company at Muara Bunyut (near Melak). This raises considerable concern about the tremendous amount of underwater noise pollution produced by these ships in such a restricted water body, as well as the effect of these ships in increasing the channelization of the river bed impacting in fish spawning that is also taking place on the curved slopes of the river banks.

### Chemical pollution

Mercury and cyanide are introduced into the river from leaks in dams that retain wastes from large-scale gold mining operations and from small-scale illegal operations operating along the river. Accidental dumping of coal dust occurs frequently and this may have caused changes in the skin pigment of dolphins in this area observed in 2002 and 2007. In other areas such pigmentation changes have never been observed. In addition, coal cleaning waste enters the larger tributaries and

lakes through the connecting narrow streams at high water periods. Pesticides (non-organic fertilizers and herbicides) from oilpalm plantations that enter the river system through company made channels also form an unmonitored threat.

### **Prey depletion**

Intensive fishing with gillnets, electricity, trawls (especially in the lakes), poison (Dupon/Lamet, Deses, Gadong's root) and aqua-culture of fish that are being fed with small fishes, which are directly caught from the lakes or river, has probably contributed to the significant decline of natural fish resources (Fisheries Department, 2007). This prey depletion may also be affecting the time and energy the dolphins have to spend finding prey. Logging of riparian forest also reduces fish resources. It increases water temperature and sedimentation and reduces the amount of detritus, which is food for fish. Decreased fish densities may increase dolphin presence at gillnets. Conversion of swamp forests to oil palm concessions, a widespread practice in the region, also severely reduces fish spawning areas. Particularly, the dams built by the company to prevent flooding is preventing spawning fish to get in these swamp areas or juvenile fish to get out.

### *Potential future threats*

Future threats include direct mortality and ongoing habitat degradation (logging, noise-and chemical pollution), which latter may cause stress that decreases reproductive success whereas pollution may result in unhealthy or non-viable offspring. Other threats include prey depletion from unsustainable fishing techniques (especially electro-fishing, intensive gillnetting for unsustainable aqua-culture practices, which use predator fish and trawling) and possibly inbreeding depression, such as reduction in the survival of offspring during the first year of life, reduced adult survival, fecundity, and/or success in competition for mates. However, population viability analysis indicated that the extent to which the population has been inbred at this stage is still low. Most likely, the Mahakam population has flourished from a small founder population, which is able to maintain its genetic diversity, considering the low pod sizes and scattered occurrence of coastal populations of *Orcaella brevirostris*. Also, it is supposed that before effects of inbreeding depression take place the population will already be at such an unviable size due to demographic stochasticity and a deterministic decline.

## **Conservation**

### *Current and past conservation activities*

Conservation work started as soon as research data on estimated and preferred dolphin areas became available. In 1999, a first effort, in cooperation with the East Kalimantan Nature Conservation Agency (Forestry department), involved raising public awareness of the protected status of the dolphins over the entire length of the river through information by disseminating information to all the heads of villages. In 2000, a local NGO, Yayasan Konservasi RASI (Conservation Foundation for Rare Aquatic Species of Indonesia) was established with the initial aim of protecting the dolphins and their habitat. RASI activities to date include, 1) dolphin population monitoring; 2) delineation of important dolphin sites; 3) environmental awareness programs for the general public and target groups, i.e., elementary and high-school children, fishermen, government officials, and companies; 4) developing environmental education school packages for junior and senior high schools and elementary schools in regular or extra-curricular courses; 5) socio-economic surveys and assessment of attitudes towards dolphin conservation in fishing communities; 6) workshops to train fishermen in safe techniques to release dolphins from fishing nets and in sustainable fishing techniques; 7) familiarizing fishermen with sustainable aqua-culture and establishing sustainable fishermen cooperatives which are financially supported to engage in sustainable aqua-culture; 8) establishment of a Mahakam Information Center in the major dolphin core area of Muara Pahu to inform residents and tourists about the importance of this dolphin site and to build local (governmental) interest; and 9) multi-stakeholder workshops to discuss and endorse the establishment of two protected areas for dolphins and important fish spawning areas in West and Central Kutai and to develop regulations.

In addition, the Environmental Departments (BLH) in both West and Central Kutai districts conducted workshops to build the awareness of communities in the proposed dolphin protected areas of the dolphins and with new conservation measures.

### *Current and future research plans*

Current and future research includes bi-annual monitoring surveys to: (1) Monitoring threats, mortality and birth rates and population size (using direct counts and mark-recapture analysis methods) to detect long-term trends; (2) Updating the photo-identification catalogue to identify site fidelity and social ecology with specific reference to breeding; (3) Assessing the long-term fidelity to previously identified core habitat areas; 4) Collecting tissues from recovered carcasses to assess the genetic variation and demographic connectivity between the coastal and riverine populations.

### *Locations, size and management of planned or existing protected areas*

The first officially protected area for the Mahakam dolphins is the 'Kawasan Pelestarian Alam Habitat Pesut Mahakam, Muara Pahu, Kutai Barat' or the 'Natural Reserve Habitat Pesut Mahakam, Muara Pahu, West Kutai District' (Figure 6). A formal decision on the establishment and protected status was taken by the regent of West Kutai: SK: 522.5.51/ K. 471/2009. The Government Department assigned to coordinate management and work with the communities is the Environmental Department (Badan Lingkungan Hidup) of West Kutai District and Yayasan Konservasi RASI is the collaborating NGO. Detailed district regulations and management plan for the PA still need to be approved through a formal decree (Appendix 1). This protected area encompasses core dolphin habitat in a 36-km section of the main river between Tepian Ulak and Rambayan and c. 22 km of the Kedang Pahu River between Muara Pahu and Muara Jelau. The area also includes 23 km of protected tributary systems (Baroh and Beloa) and freshwater and peat swamp forest habitat (with between 150-500m wide protected riparian forest strips), that is not frequented by dolphins but represents important fish spawning habitat and directly supports the fish stock for the dolphin area. The total size of the PA is 4,100 ha. A 27 km buffer zone downstream of Tepian Ulak until Penyinggahan was proposed by the local government and supported by the local community but this is not yet officially designated.

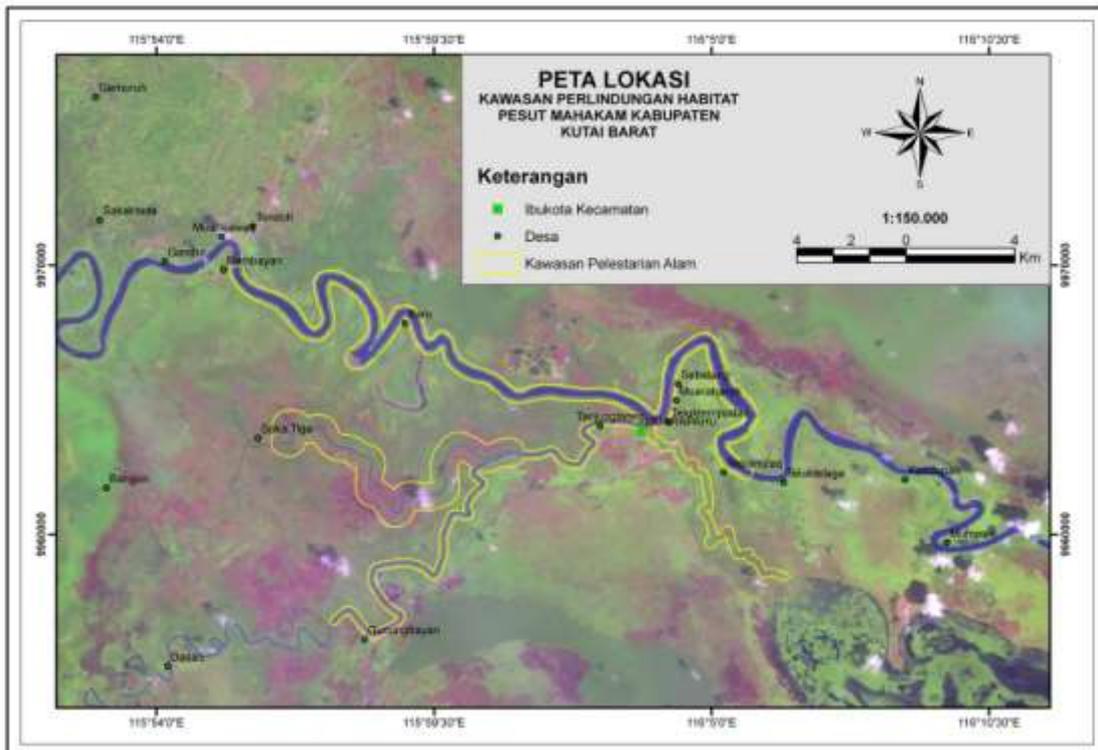


Figure 6. Map with location of the protected dolphin area in West Kutai.

The second proposed protected area is the 'Natural Reserve Habitat Pesut Mahakam in Central Kutai District', with a total size of 2.900 ha, which comprises the following: a 27-km section of the main river between Pela and Muara Kaman, a section 17 km upstream of the Kedang Rantau River to Sebintulung, a section of 7 km upstream of the Kedang Kepala River to Muara Siran, the 4-km long Pela tributary and its connecting confluence with Semayang Lake (2 km radius), and the 10km long, deep-water channel (200 m width) in southern Semayang lake, that leads to Melintang Lake (Figure 7).

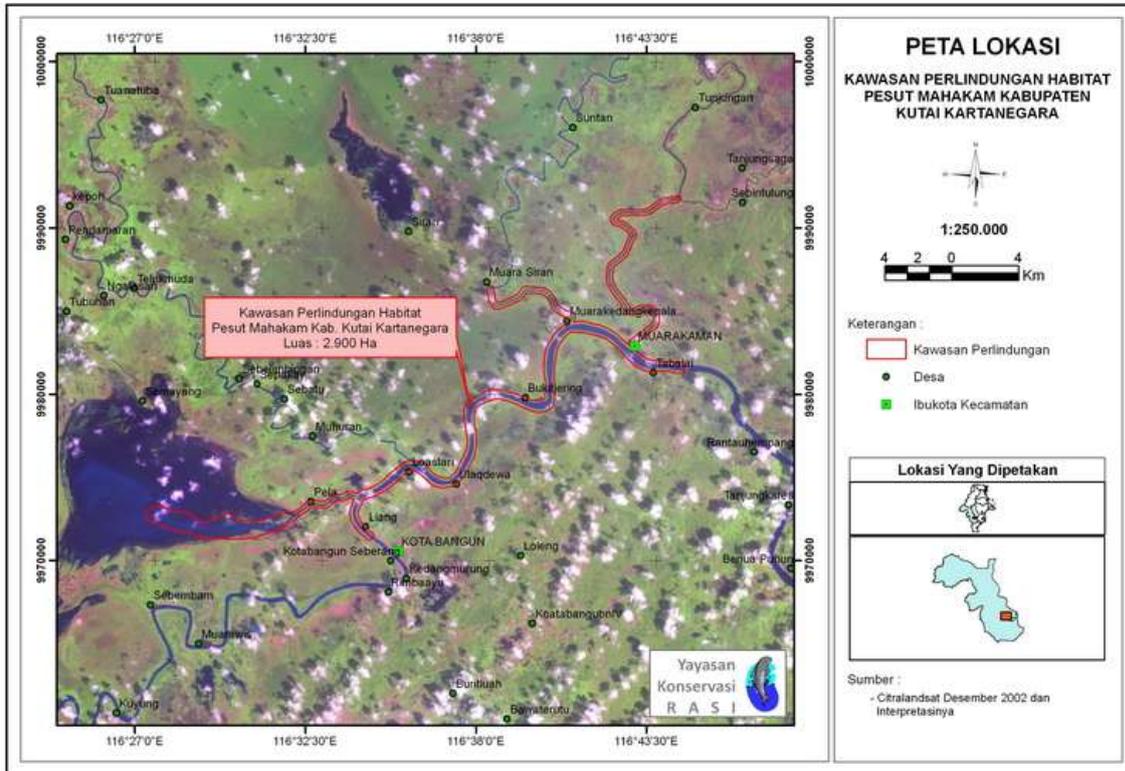


Figure 7. Proposed PA for Central Kutai district.

For both PAs, the general objectives are the following:

1. Establishment of community-supported protected areas for the freshwater dolphin Pesut Mahakam, *Orcaella brevirostris* to provide efficient habitat protection by implementing habitat quality improving measures by reducing chemical and noise pollution and reducing mortality risks caused by gillnet entanglement and vessel strikes.
2. Protection of fish resources through sustainable fishing methods and law enforcement of illegal fishing practices with the aim to protect prey resources of the Pesut Mahakam and sustain economic livelihoods of local fishing communities.
3. Riparian forest protection and rehabilitation within the protected area with the aim to reduce erosion and sedimentation, to protect fish spawning areas, fishery sources (tree seeds and fruits providing food for fishes), other protected species, and ecotourism potential.
4. Raising environmental awareness of local communities, government and other stakeholders for sustainable use of its natural environment and its resources and commitment for freshwater dolphin conservation.

The proposed regulations and policies for both areas focus on sustainable fisheries (no electro-fishing or poison-fishing, facilitating sustainable aqua-culture forms and establishing gillnet regulations to reduce the risk of dolphin entanglement (nets must be set parallel to shore in locations near and visible to residents, not set at night and regular net checks required, net mesh size >4cm <10 cm, and, and reimbursement for net damage when dolphins are safely removed after gillnet entanglement). The regulations and policies address the mitigation of noise and chemical pollution by restricting coal barge transport in narrow tributaries, requiring reduced speed in confluence areas (max. 15 km/hr), promoting monitoring of water quality and safe disposal of company waste products. There is provision under the regulations for riparian forest protection and rehabilitation, protection of

fish spawning areas, active law-enforcement, and monitoring of the dolphin population and the threats to it.

With regards to law enforcement and monitoring, RASI envisions that weekly night patrols will be carried out by local task force teams as part of the *perangkat desa*, a kind of civil task force appointed by village heads who have the authority to detain people engaged in illegal activities and bring them to the local police. These teams may consist of 3-4 people who police illegal fishing activities and will be the coordination point for local fishermen to report unusual events and potentially dangerous situations for the dolphins (i.e., dangerously placed gillnets). They could provide updates of dolphin occurrence throughout the range, including in flooded swamp lakes where animals have been trapped in the past when lakes have dried out.

### *National Conservation Strategy Plan for Pesut Mahakam 2010-2020*

The National Conservation Strategy Plan for Pesut Mahakam, an initiative from the Conservation Department under the Ministry of Forestry has been developed since the end of 2010 and is currently being finalized and awaiting formal approval from the Ministry.

#### **Goal**

The National Conservation Strategy Plan for Pesut Mahakam was developed in an effort to set priorities and guidelines for conservation activities to be implemented by all stakeholders involved in habitat management to increase the population size and guarantee their long-term survival with particular reference to the development of conservation areas, production forests, coalmining and large-scale agriculture.

The conservation goal to be achieved by 2020 is a population increase until 120 individuals (40%), which may be achieved if mortality rates, which until now are 3 individuals per year can be minimized until 1 or 0 dead individuals per year. In this way, the population can grow yearly with 4%.

#### **Mission**

To obtain this goal, the following missions are set out:

1. Increase the protection for Pesut Mahakam through protection of its habitat and establishment of protected core zones.
2. Monitoring the trends of the population (change in abundance, threats, mortality and birth rates).
3. Increase the control for illegal and legal activities, which negatively impact on the population, fishery resources, and riparian forest and increase the awareness of local community for sustainable use of natural resources.
4. Have yearly funds available to protect the population and its habitat.

### **Discussion**

The apparent increase of dolphins in Central Kutai district and decreasing presence in West Kutai district is largely due to the opening of oilpalm plantations in wetland areas and coalmining activities that connect with the previous dolphin core area in Muara Pahu (see results section). Therefore there is an urgent need for habitat restoration in the affected areas and to: 1) control the pollutive factors and take preventive measures, 2) prevent further conversion of swamp areas; 3) rehabilitate riparian forest using indigenous species mixed with fruit trees, rattan and other species that may create a willingness for local communities to protect and sustainable use this forest strip.

Identified threats remained similar with previous research periods (1999-2002; 2005; 2007) and the main cause of mortality was still caused by gillnet entanglement. Regression analysis showed that a significant decrease has occurred to the minimum detected annual mortality throughout the last years ( $b = -0,27$ ,  $df = 14$ ,  $t = -2.3$ ,  $p < 0.05$ ). If the period is divided into two periods, i.e. 1995-2002 and 2003-2010 the mean number of deaths decreases from 5 individuals (5% of population) to 3 deaths per year (3% of population). This seemingly reduced number of annual deaths may in fact represent a real reduction because it is unlikely due to a decrease of death detection: Because dead dolphins are usually not buried, a dead dolphin is easily detected by villagers along the river. In addition, information about dolphins that have died in one area, especially due to human activities

such as gillnetting rarely will remain undetected by other villagers as the information spreads fast from mouth to mouth and should be picked up during the informal interviews held in most villages along the study area. However, calves may possibly be less conspicuous and may explain the stable low number of detected calf mortality in all years since 1995. Two new causes of death has recently added the list of causes, i.e. electro-shock and hook-fishing. Although still sporadic, awareness will be raised to alleviate this problem.

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**Pictures**



The Mahakam main river between 180km-500km from the mouth was surveyed including several major tributaries



Typical surfacing pattern



Less usual surfacing pattern usually associated with play and fast swim





Enough time was spent with each dolphin group to obtain enough dorsal fin pictures



The front observer scanned the river during 30 minutes continuously using hand-held binoculars. In addition there was one additional front observer scanning with the unaided eye while recording data, and one rear observer was positioned, which was necessary to detect dolphins that could possibly remain undetected after sharp bends.



Semayang Lake still forms an important habitat for the dolphins and they make daily migrations between the main river and the lake through the Pela River, where a sustainable aqua-culture project has started.

## **Appendix 1. Draft Management Plan and Task Division for the Protected Nature Reserve of Muara Pahu (KPA) – Kawasan Pelestarian Alam (KPA) Muara Pahu**

- *Management of the Protected Nature Reserve of Muara Pahu (PA) – Kawasan Pelestarian Alam (KPA) Muara Pahu*
  - 1) Develop and legalize regulations and binding policies regarding habitat protection within the PA in Muara Pahu sub-district, West Kutai.  
**West Kutai Government (Fisheries, Environment, Mining, Transport, Forestry, Public Works, Tourism), East Kalimantan Nature Conservation Agency (BKSDA), Coal-mining Company, Community representatives and YK-RASI**
  - 2) Establish a management body of collaborative stakeholders (incl. community, government, NGOs, companies) that meet on a regular basis to discuss problems and provide updated information and for coordinated action. Within this body establish an executive field unit for routine tasks.  
**West Kutai Government, BKSDA, Coal-mining Company, Community Representatives and YK-RASI**
  - 3) Having base funding yearly made available by the government for implementation of policies and regulations. Also, part of Corporate Social Responsibility Funds from the private sector should be allocated for environmental improving measures.  
**All relevant departments apply for National Funds to be able to conduct their tasks**
  - 4) Socializing with the communities and companies within the PA about the protected area status, its regulations and policies through small meetings.  
**West Kutai Government, Community representatives, Coal-mining Company and YK-RASI**
  - 5) Mapping and demarcation of PA boundaries in Tepian Ulak, Rambayan, Muara Pahu, Muara Jelau  
**Department of Environment and District Planning and Developing Body in West Kutai, YK-RASI**
  - 6) Installing information boards about the PA and its regulations in the areas of Tepian Ulak, Rambayan, Muara Pahu, Kedang Pahu (at Jelau confluence) and Bolowan Rivers.  
**BKSDA, Muara Pahu Municipality, Public Transport Department West Kutai and YK-RASI**
- *Public Transport*
  - 1) Providing and enforcing regulations for coal-transport (a ban of coal-barge transport in tributaries (Kedang Pahu within PA) and a ban on oceanic coal-tanker ships in the Mahakam)  
**Department of Environment and Mining, Public Transport Department West Kutai.**
  - 2) Installing information boards indicating a speed limit for boats (max.15 km/hr), 500m before entering the confluence area of Muara Pahu both up and downstream and in the Kedang Pahu KPA entrances at Muara Pahu and Jelau River.  
**Muara Pahu Municipality, Public Transport Department West Kutai and YK-RASI**
- *Fisheries*
  - 1) Regular patrol for illegal fishing tools (batteries, trawl and poison) in a random but frequent manner and application of law enforcement together with socialization of regulations  
**West Kutai Fisheries Department and Muara Pahu Police Department**
  - 2) Establishment of Fish Reserves within the KPA.  
**West Kutai Fisheries Department**
  - 3) Placing clear signboards with fisheries regulations or to indicate fish reserves.  
**West Kutai Fisheries Department**
  - 4) Conducting education awareness campaigns targeting at fishermen for a sustainable use of fish resources.  
**West Kutai Fisheries Department**

- 5) Enable local fishing communities to engage in sustainable fisheries (such as aqua-culture using non-piscivorous fish, which is not derived from the river and which can be fed on a combination of pellets and vegetables such as Jelawat, Mas or Nila Fish) to reduce pressure on natural fish resources. Furthermore while aid for aqua-culture is being provided the following policy should be followed:
    - a) Since initial investment may be too costly for fishermen, it is recommended that the Fisheries Department and Department of Community Development will support requests for low interest loans to overcome initial pre-harvest expenses and that need to be paid back after a period of at least one to two years to allow for income generation after several successful harvesting.
    - b) Only non-piscivorous fish is being provided
    - c) Careful selection of fishermen that are most in need of support,
    - d) While providing aid, technical assistance also needs to be provided and regular monitoring  
**Fisheries Department, Department of Community Development, YK-RASI**
  - 6) Training local fishermen to set up healthy breeding strains to reduce the costs of buying strains from other areas, in particular Jelawat and Mas Fish,  
**West Kutai Fisheries Department, YK-RASI**
  - 7) Training local women to produce nutritious, high-quality fish pellets, to guarantee quality and reduce costs of purchase and increase women involvement in production sector,  
**West Kutai Fisheries Department, UNMUL**
  - 8) Providing assistance and promoting fish chips production and marketing from sustainably bred fish as an innovative and sustainable product from the Mahakam River,  
**West Kutai Fisheries Department**
  - 9) Developing presto (high-pressure steamed and vacuum packed) fish products from Mas Fish to increase local incomes from sustainable fish breeding. Currently, this kind of product, for which there is a great demand, only uses Bandeng Fish, which is being produced in fish ponds in converted mangrove areas and sold in larger cities. But some initial experiments indicated that riverine Mas Fish is even more tastier and has a high potential for the market  
**West Kutai Fisheries Department, UNMUL**
- *Forestry*
    - 1) Preventing illegal logging activities through regular patrols and (re-) evaluation of permits for sawmill and moulding enterprises within KPA.  
**BKSDA, Forestry Department, Muara Pahu Municipality**
    - 2) Habitat rehabilitation including riparian reforestation in the PA while community landowners may be aided with tree seedlings for tree species, which fruits or other products (rattan, gaharu) can be harvested.  
**Forestry Department**
    - 3) Allocation of Corporate Social Responsibility should be allocated to environmental improving measures such as agro-forestry in order to create bufferzones and aid communities in sustainable resources use.  
**Forestry Department, Muara Pahu Municipality, Private sectors (coalmining and oilpalm companies)**
    - 4) Restoration of the ecological function of swamp areas as fish spawning areas that have been converted for oilpalm plantations  
**Forestry Department, Agriculture Department, Muara Pahu Municipality, Private sector (oilpalm companies)**
  - *Agriculture*

Socializing oilpalm companies to use more environmental friendly practices and/or apply the Roundtable on Sustainable Palm Oil Certification procedure  
**Agriculture Department, WWF**
  - *Ecotourism*
    - 1) Promoting the KPA Muara Pahu as an (inter)national eco-tourism destination.  
**Tourism Department, YK-RASI**

- 2) Building eco-tourism infra-structure  
**Tourism Department, Public Works**
- *Education*
  - 1) Providing environmental education courses at elementary and junior high schools, which are scheduled and are part of the local curriculum.  
**Education Department, YK-RASI, WWF**
- *Monitoring*
  - 1) Establishing a monitoring system for chemical waste products disposal by companies and monthly monitoring of water quality in the PA in West Kutai.  
**Department of Environment, Local Community, University of Mulawarman (UNMUL)**
  - 2) Monitoring of Pesut Mahakam population. Bi-annual abundance monitoring of entire Mahakam population and weekly monitoring of dolphin occurrence by using trained, local patrol teams.  
**YK-RASI, Local Community and BKSDA**
  - 3) Investigation of levels of erosion and sedimentation of forest strips and the Mahakam River system in West Kutai.  
**West Kutai District Government, UNMUL and YK-RASI**
  - 4) Study assessment of social-economic development of fishermen in the KPA Muara Pahu.  
**YK-RASI and UNMUL**
  - 5) Study to optimize the reserve function for different fish species.  
**Fisheries Department**

***Draft regulations and policies that apply within KPA Muara Pahu:***

- *Management of the Protected Nature Reserve of Muara Pahu (PA) – Kawasan Pelestarian Alam (KPA) Muara Pahu*
  - 1) Establishing and legalizing a multiple stakeholder management body
  - 2) Sosialization of PA boundaries, regulation and prevailing policies in the Muara Pahu PA to all layers of local society and private sector
- *Forestry*
  - 1) Demarcation of KPA Muara Pahu in Tepian Ulak, Rambayan, Muara Pahu, Kedang Pahu (at Jelau confluence) and Bolowan Rivers.
  - 2) Riparian forest protection with minimal 150m strip width from each bank within the KPA. For area that are already in use for agriculture by individual owners in collaboration and mutual agreement these people may be aided with tree seedlings for tree species, which fruits or other products (rattan, gaharu) can be harvested.
  - 3) No new permits for sawmills or mouldings along the river banks within the KPA.
  - 4) Especially for Bolowan River no logging activities within a 500m forest strip in the area between Bolowan River bank and Mahakam River bank to protect the proboscis monkey population, fish resources and ecotourism potential.
  - 5) Especially for Jintan/ Abit, no logging activities of (peat) swamp forest for protection of fish resources and ecotourism potential. Preservation of the peat swamp forest north of Jintan and the lakes, which has a high biodiversity potential as well as for scientific studies and ecotourism.
- *Fisheries*
  - 1) No use of electro-fishing, trawl and poison for fishing in the PA Mahakam River and Kedang Pahu section
  - 2) Strict application of a minimal mesh size (5 cm) regulations for gillnets to prevent capture of juvenile fish
  - 3) Recommending a maximum mesh size (< 10 cm) to prevent capture of adult spawning fish and dolphin entanglement (through entanglement of parts of fluke or fins).

- 4) Recommending gillnets to be set parallel to riverbanks and near to the riverbank.
  - 5) No night time setting of gillnets in the river sections of the PA.
  - 6) Recommending gillnets to be set near the village in sight of people or owner and if set further away nets should be attended by the owner applying to river sections of the PA.
  - 7) If a fisherman is willing to cut its gillnet and release a dolphin alive, he may receive a financial compensation if he reports to the local fisheries department and has prove of the cut net.
  - 8) Helping fishermen to engage in sustainable fishing techniques
- *Agriculture*
    - 1) Ban for oilpalm industries to converse fish spawning areas in swamps
    - 2) Ban for oilpalm industries to set up dams in swamps for flood prevention that will prevent fish from entering these spawns to spawn and in case they do enter during high flood, they are unable to leave the area again
  - *Public Transport*
    - 1) Coal-carrying container ships are not allowed to pass through the Kedang Pahu River.
    - 2) Installing information boards with a maximum speed limit of 15 km/ hr, at 500m entrances before the Muara Pahu confluences up- and downstream, and Mahakam and Jelau confluences of the Kedang Pahu River.
  - *All sectors including NGOs and education/ research institutes*
    - 1) Establishing a management authority for the Protected Area of Muara Pahu including establishment of patrolling teams
    - 2) Socialization with local communities and companies about the protected area, its regulations and policies
    - 3) Water quality control system and develop regulations for storage of coal cleaning waste product and fertilizers/ pesticides use by oilpalm industries.