

Ecological risks from zinc contamination to preys of the Irrawaddy dolphin (*Orcaella brevirostris*) in Banten Bay

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Abstract. Banten Bay is an estuarine ecosystem which serves as important habitat for Irrawaddy dolphin (*Orcaella brevirostris*), also functions as a fishing ground for artisanal fishers, maritime port, shipyard, and surrounded by industrial zones. One major impact from land-based industrial development is the load of heavy metal pollution (Zinc –Zn), which cause a potential threat to Irrawaddy dolphin population as a predator in the ecosystem through bioaccumulation process from its prey. This research aimed to measure ecological risks in Irrawaddy dolphin due to Zn contamination in its potential prey, i.e., sardines (*Sardinella fimbriata*) and squids (*Loligo* sp.). Survey on dolphin population was conducted in Banten Bay from Jan 2013 to Feb 2014 with participatory mapping and visual observation, while Zn concentration in dolphin's preys was measured using Atomic Absorption Spectrophotometer (AAS) and analyzed by Risk Quotient (RQ) with base assumption that Maximum Allowable Concentration (MAC) of Zn is 6.7 mg/kg wet weight. Results showed that concentration of Zn in squids (7.67 ± 1.02 mg/kg WW) was higher than that of sardines (3.46 ± 0.29 mg/kg WW). Thus, squids have a moderate risk, while sardines have low risk to bioaccumulation of Zn in Irrawaddy dolphin.

1. Introduction

Irrawaddy dolphin (*Orcaella brevirostris*) is one of protected species where found in Banten Bay [1]. Local name of Irrawaddy dolphin in Indonesia is Pesut Mahakam. Mahakam is one of the rivers in Kalimantan Island where was Irrawaddy dolphin's habitat [2]. Irrawaddy dolphin also found in other coastal waters, river, and lake in Indonesia [3], [4], [5]. This member of Delphinidae has "Vulnerable" status, and some sub-population has "Critically endangered" category in International Union for Conservation of Nature (IUCN) [6].

Banten Bay is a shallow estuarine ecosystem, with a maximum depth is 30 meters. Banten Bay has rapid economic development, like fisheries activity, shipyard, and surrounded by industrial area [7]. Cilegon and Bojonegara was an industrial area in the west of the bay and produced the highest volume pollution to Banten Bay [8]. There are 16 metal industries [9], which could generate heavy metals contamination to environment. Previous Research [10] indicates high zinc contamination existed in Banten Bay.

Heavy metals pollution in Banten Bay will threaten Irrawaddy dolphin's life. Ecological impact from pollution like habitat destruction and bioaccumulation in Irrawaddy dolphin's body. Heavy metals contamination in cetacean could lead organs and function damage until causing death [11]. This research aims to evaluate ecological risk from zinc contamination to prey of the Irrawaddy dolphin (*Orcaella brevirostris*) in Banten Bay.



2. Method

This research is part of Irrawaddy dolphin research in Banten Bay at 2013-2014. Irrawaddy dolphin main prey is small pelagic fish, cephalopods, and some species of macrozoobenthos [12]. This research sample is Sardines (*Sardinella fimbriata*) and Squid (*Loligo* sp.). Local fishing port reported during the year, sardines and squid are existed in Banten Bay. Prey's sample analyzed in Environmental Analysis Laboratory, Faculty of Agricultural Technology, Bogor Agricultural University. Samples analyzed by Atomic Absorption Spectrophotometer (AAS) with five replication.

Before ecological risk from metals, contamination analyzed, Maximum Allowable Concentration (MAC) metals information is required. MAC value (mg/ kg WW) was estimate refer to [13]:

$$MAC = \frac{RfD \times BW \times AT}{IR \times FI \times EF \times ED} \quad (1)$$

where: *RfD* = References Dose Zn (mg/ kg ww per day); *BW* = Body Weight (kg); *AT* = Average Time (days); *IR* = Ingestion Rate (kg per day); *FI* = Fraction Ingested; *EF* = Exposure Frequency (days/ year); *ED* = Exposure Duration (year).

Some of the variables for calculated MAC was not available for Irrawaddy dolphin. Therefore, some variable information applied from other species with the same ecological niche. This paper refers to Finless porpoises (*Neophocaena phocaenoides*) [14], shown in Table 1.

Table 1. Variable for estimate MAC.

Variables	Values
References Dose Zn	0.3 mg/ kg WW
Body Weight	60 kg
Average Time	10.220 days
Ingestion Rate	3 kg/ day
Fraction Ingested	0.9
Exposure Duration	28 years
Exposure Frequency	365 days/ year

Ecological risk evaluates with Risk Quotient (RQ) value from metals concentration in prey compared with MAC value [13]:

$$RQ = \frac{Zn\ Concentration}{MAC} \quad (2)$$

Risk classification: $RQ < 1$: Low Risk, $1 \leq RQ < 10$: Moderate Risk, $RQ \geq 10$: High Risk.

3. Result and discussion

Last research reported about heavy metals pollution in Banten Bay's water and sediment, the highest concentration was Zinc [10]. These case predicted because of some metal industry near Banten Bay used Zinc for material in the industrial process [9]. Zinc is one of essential element for organism, with particular function for metabolism. However, an excess of zinc can cause organism health disorders. Zinc concentration from sardines and squid samples are shown in figure 1

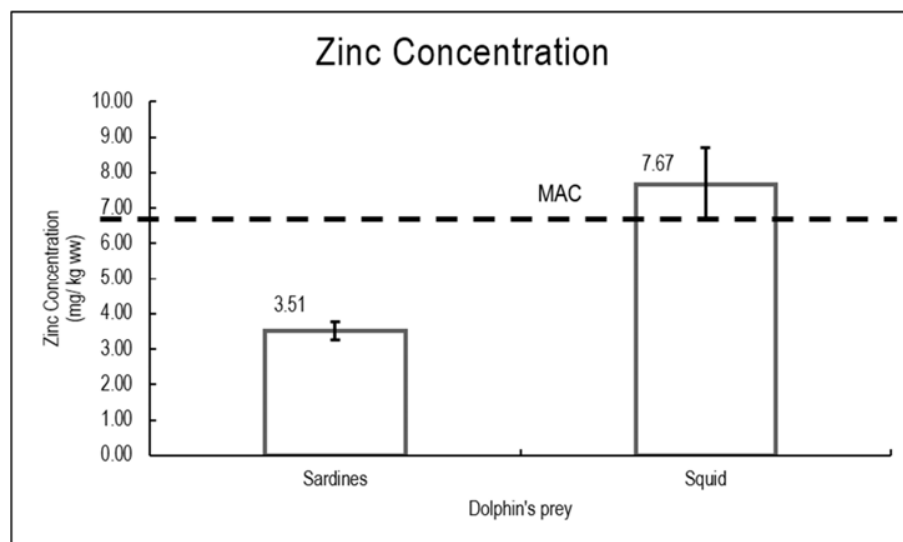


Figure 1. Zinc concentration at Irrawaddy dolphin's prey.

Figure 1 shown Zn concentration in sardines is 3.51 ± 0.52 mg/ kg WW and while in squid is 7.67 ± 1.03 mg/ kg WW. Zinc concentration in squid higher than in sardines due to the squid has bioaccumulation capacity greater than small pelagic fish [15]. Bioaccumulation capacity related to the ecological trophic food chain, squid was on the higher trophic level than sardines.

The result of zinc MAC value calculation is 6.7 mg/kg WW. Less information about Irrawaddy dolphin became an entire constrain for this research. Therefore, Irrawaddy dolphin research enhancement was required for making conservation effort. MAC value higher than zinc concentration in sardines, inversely in squid. Comparison of MAC value and Zinc concentration define as RQ value. RQ value for sardines and squid shown in figure 2.

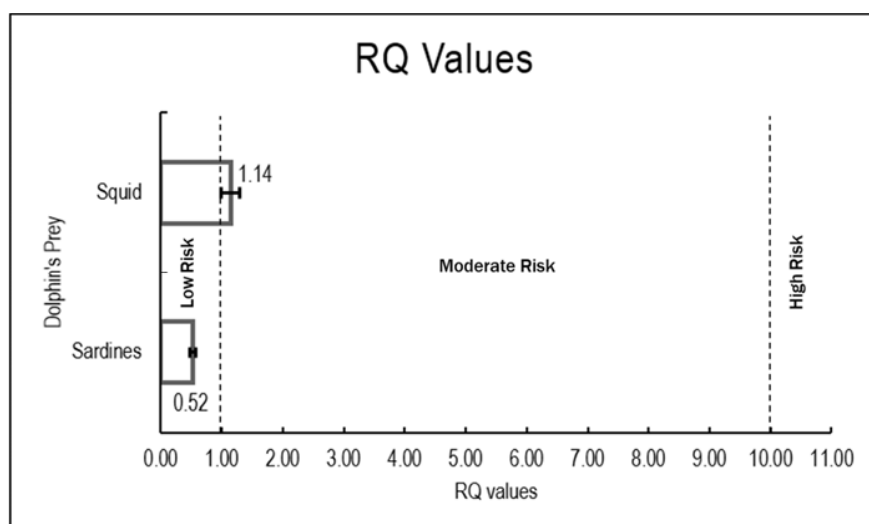


Figure 2. RQ values of squid and sardines Zn concentration.

Based on RQ value in figure 2, zinc contamination to Irrawaddy dolphin from sardines has low risk. Meanwhile, zinc concentration from squid has moderate risk contaminated to Irrawaddy dolphin. Zinc contamination could cause trouble for Irrawaddy dolphin's health.

High concentration of mercury and zinc founded in harbor porpoise died from infectious disease than physical trauma [16], [17]. Those indicate that excess mercury and zinc in the cetacean body are decreasing bodies resistance capacity from infectious disease (from bacteria, fungus, virus, parasite-like pneumonia disease).

Potential risk from zinc contamination to Irrawaddy dolphin is the devastation of the nervous system, degrade immunity, may even cause death. Previous research reported necropsy from several Irrawaddy dolphin accumulated low concentration of heavy metal in liver and kidney but was not mortality factors [18], [19]. In Mekong river, a low concentration of zinc in liver and kidney of Irrawaddy dolphin were found [20].

Irrawaddy dolphin's habitat is often overlapping with an anthropogenic activity that produces pollutant. This case requires deep research for resulting detail information about the effect of metal pollution to Irrawaddy dolphin, contaminant accumulation in Irrawaddy dolphin and many more. That information will be principle information for holistic conservation effort.

4. Conclusion

Banten Bay is already contaminated by zinc. Ecological risk of zinc contamination to Irrawaddy dolphins from sardines is low, while squid has moderates risk contaminated to Irrawaddy dolphins in Banten Bay.

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