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Bioacoustic Analysis for Help Identify Andestimate Distribution of Anura Due to the Effects of Ecotourism in the CA-TWA Region of Telaga Warna

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Abstract: Indonesia is a country with very high biodiversity and is known as Mega Biodiversity. In Indonesia found about 450 species of Anura representing about 11% of all species in the world, and 28 species ofwhich 28 live in West Java. Anura animals have a pattern of calling behavior that is essential for mating: males produce call-up behavior that attracts females and, in some species, represents the extent of their territory. Research on frogs and toads is considered necessary considering the absence of more detailed data on the bioacoustics of these frogs, especially in the West Java area, so that variations and patterns of anura sounds are known in the Telaga Warna Nature Reserve and Nature Park (CA-TWA) area and can make scientific contributions in information on variations and sound patterns owned by anura animals in terms of anura conservation in Indonesia. This research was conducted from month March-December 2018, located in Telaga Warna Nature Reserve and Nature Park, Bogor, West Java. Call the recording every 6:00 p.m. to 11:00 p.m. each night during the sampling period. The number of anura species in the villa and swamp areas is more abundant than the lake area, and the presence of Pearl maroon frogs (nyctixalus margaritifer) found in the villa and lake areas, while the Bufo melanotictus type that likes to live in the lake area. It can be seen that the villa and swamp areas are still maintained vegetation by looking at the medium density of the canopy. Steeper slope conditions help the flow of nutrients from the soil due to the erosion process and settle in flat to gentle areas. The density of the canopy in the area helps maintain the surface temperature of the land with a stable land surface temperature ranging from 15 – 21 ^{0}C.

Keywords: Anura; Bioacoustic; Frog; Telaga Warna

Introduction

Indonesia is one of the three countries that have the highest hayati diversity. This is what makes Indonesia known as one of the world's biodiversity hotspots and Mega Biodiversity (Prasetyo et al., 2015). Protected areas in Indonesia in 2014 reached an area of 29.6 million hectares (BPS, 2016) with a total deforestation area of 6.5 million hectares. In this area lives in it 15% of the world's amphibious animals and reptiles (LHK, 2014). But since 2011, Indonesia has been declared as the country with the third highest number of threatened species (total 772). Approximately 6600 species of amphibians in the world are threatened with extinction, 43% have decreased population, 22% in the vulnerable category and 35 species have experienced extinction in nature (Stuart et al., 2004).

The extinction crisis of these animals (Stuart et al., 2004; Whittaker et al., 2013) as a consequence of climate change, habitat fragmentation, the emergence of infectious diseases, increased likelihood of direct predation by domestic animals and interactions among these factors, 40% of the 7,125 known amphibian species are at high risk of imminent extinction (Crooks & Soule, 1999; Daszak et al., 2000; Dodd & Smith, 2013; Hof et al., 2011; Stuart et al., 2004).

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One of the several recorded extinctions of Javanese endemic frogs is Philautus jacobsoni originating from Central Java (Iskandar & Mumpuni, 2017). Similar to Barbourula, kalimantanensis is endemic, Borneo is under threat of extinction (Birkhofer et al., 2006).

Telaga Warna area is a conservation area natural agar which was established since 1981 based on the decree of the Minister of Agriculture Number 481/Kpts/Um/6.1981 and has the potential to be developed as a tourist area in terms of visitors and beauty. Government Regulation Number 28 of 2011 states that, the main function of TWA is as tourism and natural recreation. Nature tourism activities at Telaga Warna CA-TWA are carried out in utilization blocks determined based on the Decree of the Director General of PHPA N0.45/Kpts/DJ-V1/95, which is 2 hectares (Conservation and Natural Resources Agency, 2016).

One of the destinations of such ecotourirm is for local and international tourism. According to Backyard nature (2009) ecotourism is a type or form of tourism that involves traveling and exploring a destination without damaging, damaging or polluting the natural environment (Backyardnature, 2009). Basically the word ecotourism is a combination of the two words "ecology" and "tourism" that have, when used separately, different definitions. Ecology is the study of the way of life of objects and their environment interacting with each other while seeking travel from one destination to another in order to explore the destination in one way or another.

Many ecotourism businesses he promoted without understanding his most basic principles (Wood, 2003). The impact of ecotourism is similar to the impact of small-scale development, water and sanitation, and roads, but there are additional concerns for sensitive environments. Adverse effects include: Soil erosion and soil compaction, Determination of water resources and quality due to inappropriate design and siting of latrines, cesspools, and solid waste, Deforestation from firewood harvesting, camping, and construction, Destruction of unique flora, Changes in animal behavior due to human intervention, and Pollution from litter, oil residue, or vehicle exhaust.

At the same time, the potential benefits of ecotourism can adversely affect the environment of protected areas. Improvements in employment, infrastructure (roads, electricity, and telecommunications) technical assistance, or services (education, health) can stimulate people to migrate around protected areas. Also, improved economic conditions are often accompanied by increased solid waste production. It is also feared that this is happening in the protected forest area of Telaga Warna.

Anura animals have a pattern of calling behavior very important for mating: males produce call-up behavior that is attractive to females and, in some species, indicates the extent of their territory (Gerhardt & Huber, 2002).

Geographic variation for call-up structure has been studied in a number of uran species, and some findings are associated with factors such as differences in body size (Castellano et al., 2000; Castellano et al., 2002) or differences in the size of laryngeal structure (Bou & Ryan, 2004; Wilczynski & Ryan, 1999). Categorical variations of call behavior associated with geographic distance between populations have been reported for different anuran (Bernal et al., 2005; Castellano et al., 2000; Giacoma & Castellano, 2001; Nevo & Capranica, 1985; Pröhl et al., 2006; Wilczynski & Ryan, 1999). The sound characteristics of several species of frogs from the tribes Bufonidae (Duttaphrynus melanostictus and Ingerophrynus biporcatus), Dicroglossidae (Fejervarya limnocharis and Occydozyga sumatrana), Ranidae (Hylarana chalconota) and Rhacophoridae (Polypedates leucomystax) from Bali have been described by Marquez and Eekhout (Marquez & Eekhout, 2006).

Of the four main categories of acoustic signals, call sounds play a very important role in mate selection by female individuals and as a medium for males to carry out their reproductive activities (Xiong et al., 2015). In addition, the call sound is also considered one of the key characters responsible for reproductive isolation and speciation processes in the toad group (Cocroft & Ryan, 1995; HC Gerhardt, 1991; Howard & Young, 1998; Leary, 2001; Wei et al., 2012).

The increasing number of visitors (ecotourism) and sustainable development in the area so that Telaga Warna Nature Reserve and Nature Park (CA-TWA) will have a negative effect on the destruction of anura microhabitat. Telaga Warna Area is a nature reserve conservation area established since 1981 based on the decree of the Minister of Agriculture Number 481/Kpts/Um/6.1981 and has the potential to be developed as a tourist area in terms of visitors and beauty. Government Regulation Number 28 of 2011 states that, the main function of TWA is as tourism and natural recreation. Nature tourism activities at Telaga Warna CA-TWA are carried out in utilization blocks determined based on the Decree of the Director General of PHPA N0.45/Kpts/DJ-V1/95, which is 2 hectares (Conservation and Natural Resources Agency, 2016).

To determine the influence of this ecoturim on the anura that is hisup in it, researchers feel the need to conduct an analysis to identify and estimate the distribution of anura in the nature reserve area and Telaga Warna natural tourism area and relate it to the effects of ecotourism. One of the appropriate methods

for estimating the number of anura species is the bioacustik method. The goals of this study are: 1) Identify and estimate the distribution of anura in the area of natural areas and natural tourism parks (Ca-Twa) Telaga Warna. 2) To know the effect of ecotourism on the distribution of anura in the Telaga Warna nature reserve and nature park (Ca-Twa) area.

Method

The research was conducted from March to December 2018. The research location was in the Telaga Warna Nature Reserve and Nature Park, Bogor, West Java. The materials and tools used are headlamps, Anura samples from the study site, notebooks, sweeping net (if necessary), stationery, Audio Technica AT875R microphones, Fostex FR2LE recorders, head lamps, flashlights, boots, raincoats, gloves, thermometers, hygrometer, Anura identification guide, observation sheet, raven pro software, laptop and camera. The research procedure is as follows:

Anura Call Recording

The recording of the anura was conducted between 18:00 and 23:00 each night during the sampling period per sampling point (figure 2). The recording period is carried out for 20 to 25 minutes using the Audio Technica AT875R microphone which has a frequency sensitivity range between 90 Hertz (Hz) to 23 Kilohertz (KHz), then the sound is recorded with a Fostex FR2LE recording device in WAV sound format (Kurniati & Hamidy, 2016). Air temperature is measured using a thermometer, and humidity using a hygrometer immediately after acoustic recording.

Frog examinations are recordings of audiospectrograms, oscillograms, and power spectra generated to measure the temporal and spectral features of each species (Marquez et al., 1993). Audio spectrograms are used to measure the frequency of calls over time. Oscillators (waveforms) represent the pressure of sound waves over time that describe the elements of the call. Then the data is written in the table below which has been modified from the visual search method (VES) and an example of guessing the abundance of frogs.

Bioacoustic analysis is performed using Raven Pro's Raven software program is software used to visualize, and measure sound. Call duration: the duration from the beginning of a call to the end is measured in seconds (Roy & Elepfandt, 1993).

Making Maps of Ground Surface Temperature, Vegetation Density, and Slope Slope: Download landsat 8 satellite images from earth explorer ultrasound to create maps of vegetation density and surface temperature, then analyzed and mapped using the arcgis 10.3 program. Download ASTER GLOBAL DEM satellite imagery from gdex.cr.usgs.gov and then analyze and map using the arcgis 10.3 program.

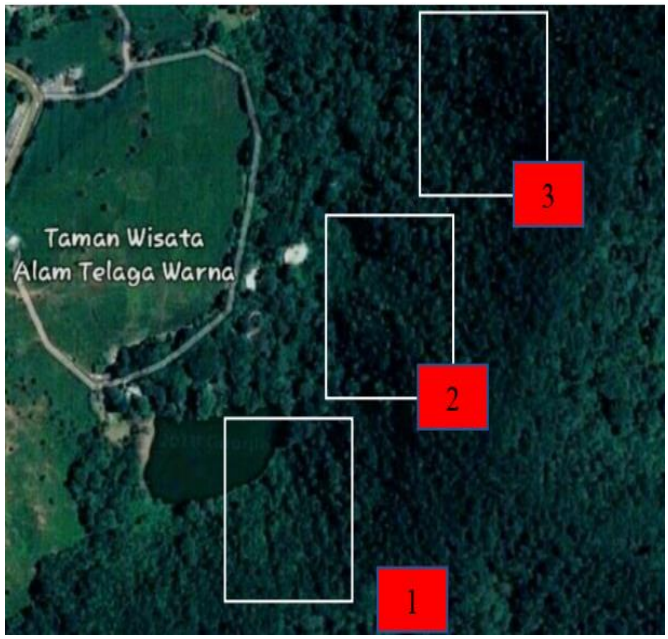

Figure 1. Observation location at CA-TWA Telaga Warna. Information: 1= Frog sampling point (Lake), 2 = Frog sampling point (Villa), 3 = Frog sampling point. (Source: Google Earth)

Result and Discussion

Result

The recorded sound was then separated for each species assisted by Nyctix. Indonesian community which is a non-profit community and engaged in observing amphibians. Separation is done using sound analysis software making it easy to identify anura species through sound patterns through wavelength patterns and spectrograms.

The acoustic data displayed in the spectrogram are helpful for identifying the species of anura being studied. Call sounds play a very important role in mate selection by female individuals and as a medium for males in carrying out their reproductive activities (Xiong et al., 2015); In addition, the call sound is also considered one of the key characters responsible for reproductive isolation and speciation processes in the toad group (Cocroft & Ryan, 1995; HC Gerhardt, 1991; Howard & Young, 1998; Leary, 2001; Wei et al., 2012). Pulse and frequency variations can be seen from Appendix (1).

The sound result data found for each area can be seen in table 1.

Table 1. Variety of Anura Species in the Puncak Color Lake Region

Species	Area			Pulse	Frequency (Hz)	
	Lake	Villa	Swamp		Low	Tall
Fejervarya limnocharis	√		√	5	0	11076.9
Limnonectes cuhlii		√		4	0	5639.3
Limnonecte smicrodiscus	√	√		2	363.6	2484.8
Microhylaa chatina	√	√	√	4	524.6	6950.8
Megophrys montana			√	9	262.3	3147.5
Rana chalconota	√	√	√	5	727.3	6909.1
Nyctixalus margaritifer		√	√	10	363.6	4727.3
Philautus auriafasciatus	√	√	√	2	242.4	3393.9
Rhacophorus margoritifis		√	√	5	131.1	4590.2
Rhacophorus reinwardtii	√	√	√	4	181.8	3454.5
Bufo melanostictus	√			1	402.2	3486.0
Philautus Vittiger			√	1	1837.5	3842.0
Polypedates leucomostac		√		5	131.1	4590.2
Rana nicobariensis			√	1	848.5	7636.4
Total	7	9	10			

Discussion

In this case, it can be seen that the species Microhyla achatina, Rana chalconota, Philautus auriafasciatus, Rhacophorus reinwardtii are evenly distributed in the three observation areas. Several distribution patterns are also in accordance with the opinion of Ode (2017) which states that an even distribution pattern occurs because there is intense competition between individuals, so that there is a positive antagonist that encourages the division of the same space (Ode, 2017). Furthermore, the species Limnonectes microdiscus, Nyctixalus margaritifer and Rhacophorus margaritifer were found in villas and swamps. Looking at the distribution pattern of this species in the Telaga Warna area, it can be seen that some anura have wider home ranges or some frogs only occupy narrower home ranges. In accordance with the opinion of Yudha et al. (2014) which stated that Anura animals are rarely found in open areas with short grass vegetation (Yudha et al., 2014). Areas with large or broad leafy vegetation are particularly suitable for egg laying in some tree frogs (Lips, 2001).

While the rest of the other species can be found only one per observation area. While the total variation of species found is in the villa and swamp areas. As in the species Bufo melanostictus which is found only in the Lake Lake region. This species is a type of amphibian that prefers open habitats and often occurs in higher densities in disturbed habitats around human settlements than in undisturbed forests, this type is often found in ponds and farms (Kusrini, 2013). Also added that this type of frog has a strong association with disturbed habitat types. According to Iskandar (1998) this type of habitat is always near human habitation or disturbed areas. This type is never found in tropical rain forests. So that it can be said that the area of the lake that is crowded with visitors is already in the category of experiencing microhabitat damage (Iskandar, 1998).

Figure 2. Bufo melanostictus

In the Vila and Swamp area was found the species Nyctixalus margaritifer. This species is included in the vulnerable category by the IUCN redlist and is an endemic frog of Java.

Figure 3. Nyctixalus margaritifer

The encounter of Limnonectes kuhlii frogs is only found in the villa area, the presence of this frog can be used as an indicator of water quality by seeing which is an aquatic species and likes to hide and is never caught far from water bodies (Kusrini, 2013). The frog Limnonectes microdiscus is found in two regions, this is

because the nature of the frog is more hidden behind bushes and only its sound is heard (Kusrini, 2013). The frog species Polypedates leucomystax is often found among plants or around swamps and former secondary forest logging (Iskandar, 1998).

The distribution pattern produced by each frog species, especially those that are only found in one observation area or found in two observation areas, this can be said that these species have a random or clustered distribution. According to Indriyanto (2008) group distribution in a population is a common distribution in nature, both for plants and for animals, due to the need for the same environmental factors (Indriyanto, 2008). Due to the heterogeneous distribution of resources, territorial animals tend to congregate around resources (Birkhofer et al., 2006; Lancaster et al., 2003).

Based on the results of mapping data, it can be seen that species variation in 3 research sites, this can be caused by several factor. Such as the influence of vegetation density. It can be seen that the study area has a vulnerability to sparse to dense vegetation density (Figure 4). The condition of the stand at each site (place of growth) is usually described by the diameter of the trunk at chest level (DBH) and the height of the tree which is a description of the appearance of the individual trees. Elevation is an indicator of the quality of the growing place, the number of trees and the area of the base plane is a description of the diameter that reflects the density of the stand, the volume of the stand reflects the mass of wood, and the header area which is the description of the diameter of the header can describe the fruit production and seedlings of a stand (Sumarna, 2008). According to Buba (2012) states that there is a positive correlation between tree height, header diameter and header height with tree diameter (Buba, 2012).

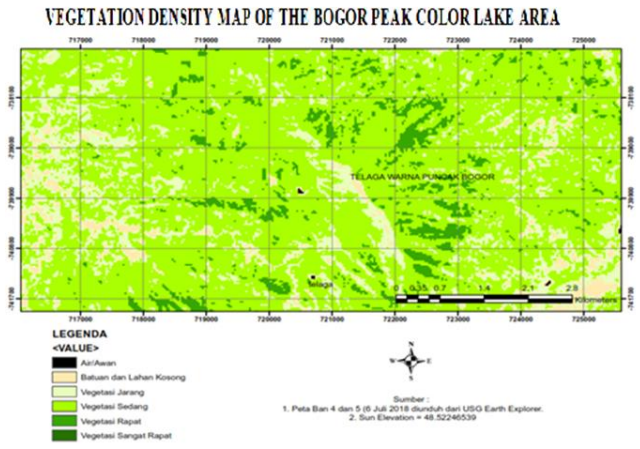

Figure 4. Vegetation density conditions of the Peak Color Lake Are

Forest vegetation is a dynamic system, always developing according to the conditions of its habitat (Marsono, 1999). The mechanism of shared life has close interaction, both between fellow individuals who make up the vegetation itself and with other organisms, so that it is a living and growing system and dynamic (Gem, 1996).

Forest ecosystems, will form stratification of the arrangement of tree canopy according to the vertical direction and occur due to the presence of trees that occupy the dominant tree class, codominant trees, middle trees, depressed trees, and lower/dead trees (Indriyanto, 2006). These open places are usually overgrown with weeds that interfere with the growth of the main tree species or staple crops (Indriyanto, 2008). The growth of weeds can be seen from the data collection site in the lake area. This shows the type of sound dominated by frogs Hylarana chalconota and Bufo sp.

In forest ecosystems, stratification will form from the arrangement of the tree crowns in a vertical direction and occurs because there are trees that occupy dominant tree classes, codominant trees, middle trees, stressed trees, and dead/down trees (Indriyanto, 2006). These open places are usually overgrown with weeds which interfere with the growth of the main tree species or staple crops (Indriyanto, 2008). The weed growth can be seen from the data collection point in the lake area. This shows the type of sound that is dominated by Hylarana chalconota frogs and Bufo sp.

In the following research factors that can affect the statement above by looking at the surface temperature conditions of the color lake. Based on the results of the map below, the surface temperature conditions of the observation area range from 15-21^{o}C. Soil temperature affects various processes in the soil, namely; Microorganism activity, organic matter remodeling, chemical reactions in soil, rock weathering & pedogenesis, nutrient solubility in soil, leaching/leaching nutrients from soil, other pedological processes, humification and mineralization, structuring, latosolization, podsilization and changes in soil moisture (Bernal et al., 2005). Meanwhile, changes in soil temperature can be restrained by the presence of: soil soil, soil control like mulch & vegetation, cloud, snow, aslope, soil slope (Crooks & Soule, 1999).

Temperature variations in the peak lake area can be caused by changes in land cover. The more and denser the vegetation in a field, the lower the surface temperature of the land, and vice versa if a land has little and sparse vegetation, the surface temperature of the land will be higher. The more vegetation cover, the colder the surface temperature of the land/land and vice versa (Jatmiko, 2015).

Land surface conditions that tend to be stable are ideal places for anura to live. Some amphibians reduce

their evaporative water loss (EWL) through adaptations, such as mucus production (Lilywhite et al., 1997). Dehydration affects physiological performance (Ladyman & Bradshaw, 2003; Moore & Gatten, 1989) such as increasing blood osmolality (Moore & Gatten, 1989) and can decrease the performance of activities such as locomotion, predator avoidance and foraging (Kohler et al., 2011; Moore & Gatten, 1989).

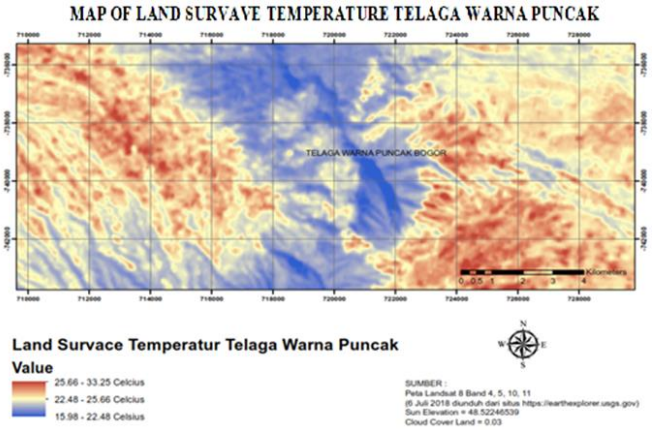

Figure 5. Land surface temperature of Telaga Area Peak Color

The influence of the variety of anura in the villa area, this can be due to subsequent factors such as the distribution of nutrient-rich substrates for the continued development of tadpoles. Based on the picture below, the color lake has a slope from gentle to steep.

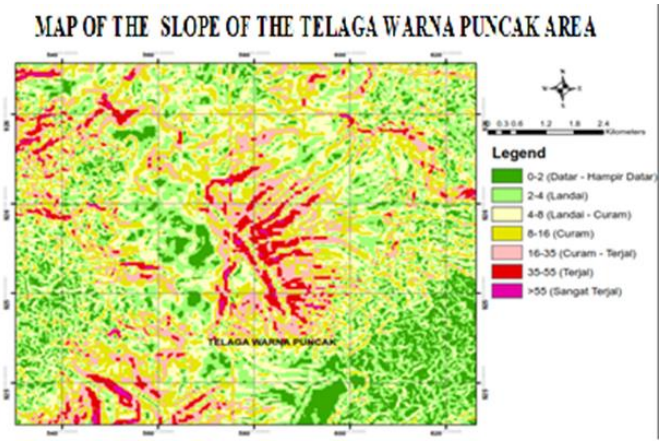

Figure 6. Map of the slope of the Telaga Warna Puncak area

The slope of the land will affect erosion due to rainwater or wind. Erosion causes the loss of fertile soil layer and good for plant growth as well as reduced ability of the soil to absorb and retain water (Arsyad, 2010). The lower the header and the tighter the header, the lower the erosion of the rain grains (Utomo, 1994). Schulte et al (2014) identified that soils perform various synchronizations of ecosystem services or 'soil functions' in relation to the provision of food, fiber and fuel production, water purification, carbon sequestration, nutrient cycling and habitat provision for organism diversity, provision and maintaining water quality (Schulte et al., 2014).

The meeting of the same type of species at each point of observation can be caused by its adaptability to changes in its environment. This is in accordance with the statement of Snyder et al. (1993) that the canyon tree frog (Hyla arenicolor) has a high resistance to evaporation of water from the skin (EWL) and has a large bladder which is used to reabsorb water. In addition, behavior patterns to avoid dehydration are found in juvenile frogs which display digging behavior to avoid water loss (Lannoo, 2005).

This resistance needs to be developed by each individual, because frogs that are dehydrated in a wet thermal gradient show a more active posture compared to a dry gradient and experience an average increase of 4 - 16% body mass due to dehydration (Mitchell & Bergmann, 2015). Water loss over time and frog mortality were significantly dependent on soil moisture, and survival rates of frogs in plantations on xeric soils were <50 percent after 72 hours (Haggerty, 2016).

Conclusion

Based on the sound results at the Ca-Twa Telaga Warna research site, 14 species of anura were identified. Moreover, the results of mapping data, it can be seen that species variations in the 3 research sites are caused by the influence of different vegetation density, temperature, light, land surface, and soil slope. The number of anura species in the villa and swamp areas is more abundant than the lake area, and the presence of Pearl maroon frogs (nyctixalus margaritifer) found in the villa and lake areas, while the Bufo melanotictus type that likes to live in the lake area. It is an indication that the lake area has suffered microhabitat damage. This type of anura has a strong association with disturbed habitat types.

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Conflicts of Interest

As for the author's interest in publishing this article, namely for the needs of lecturer performance load and lecturer performance reporting for universities in the field of research. No conflicts of Interests.

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