ISSN Print : 1656-4707
ISSN Online: 2467-5903

The Palawan Scientist

Volume 9 July 2017

A Research Journal of the Western Philippines University
Aborlan, Palawan
www.wpu.edu.ph

www.palawanscientist.org

The Palawan Scientist, a recipient of the CHED's Journal Incubation Grant for the year 2017 – 2020, is an annual international peer-reviewed multi-disciplinary journal published by the Western Philippines University, Palawan, Philippines. It accepts original research articles, notes and short communications in agriculture, fisheries and aquatic sciences, environment, education, engineering, mathematics, sociology and related disciplines.

Disclaimer

The Editorial Board of WPU is making all possible efforts to ensure the accuracy of all information, but it does not provide warranties as to the accuracy and or completeness of the information. The opinion and ideas expressed in this publication are by the authors and not necessarily of WPU. The WPU cannot accept any legal responsibility or liability arising from plagiarism and other errors.

Cover Photos

A resin collector standing in front of a towering Almaciga tree *Agathis philippinensis* in Tanabag, Puerto Princesa City, Palawan, Philippines (Photo by Edgar D. Jose). Inset photo shows the gum copal, a resin produced by the sap of the tree (Photo by Roger G. Dolorosa). Gum copal is popularly used as incense. It is also used as ingredient for varnish, adhesives, paints, waterproofing products and many others.

The Palawan Scientist, Vol. 9

EDITORIAL

The diverse topics covered by four original papers and one research notes in this 9th volume of The Palawan Scientist Journal of the Western Philippines University were contributed by researchers from WPU and other agencies and academic institutions from within and outside the country.

The first paper by Lars Vermeer and co-authors presented the effects of resin harvesting on the status of the *Agathis philippinensis* population. The study found that there is overharvesting of the resource, which threaten the population of *A. philippinensis* in the studied area.

Alejandro A. Bernardo Jr. described the importance of riparian forest in enhancing the avifaunal diversity. The study found high avifaunal species in the riparian forest strip compared to swidden farm and primary forest.

The toxicity of dispersant Mardeus-455 added to water accommodated fractions (WAF) on rabbitfish fry was investigated by Rodulf Anthony T. Balisco and Gerald F. Quinitio. The study provided evidence that fish fry mortalities were proportional to the ratio of dispersant and WAF.

The status of research instruction among secondary schools implementing Science, Technology and Engineering (STE) Program in MIMAROPA Region, school year 2015-2016 was studied by Wendell I. Formalejo and Eufrecina Jean Dr. Ramirez.

The research notes of Jean Beth S. Jontila describe the possible occurrence of the sea cucumber *Actinopyga spinea* in one of the islands within Puerto Princesa Bay.

We are so thankful to all the authors of these papers and we look forward for their continued support. It is because of our contributors and the diligent works of our external reviewers and members of the editorial board that make us achieve the CHEDs Journal Incubation Grant from 2017 - 2020.

With this current grant along with the WPU's core values such as culture of excellence, commitment, creativity and team work, it is without doubt that The Palawan Scientist would become at par with other reputable journals.

Congratulations for a job well done!

Elsa P. Manarpaac, PhD
President
Western Philippines University

Effects of resin harvesting on the status of the *Agathis philippinensis* population in the Cleopatra's Needle Critical Habitat, the Philippines

Lars Vermeer[1]*, Kellie G. Bocxe[1], Pieter Zuidema[1], Lita Sopsop[2], Kyra Hoevenaars[3] and Karina M. Reyes-Antonio[3]*
[1]Forest Ecology and Forest Management Group, Wageningen University and Research Centre, PO Box 47, 6700 AA Wageningen, The Netherlands,
[2]College of Agriculture, Forestry and Environmental Sciences, Western Philippines University, Aborlan, Palawan, Philippines
[3]Centre for Sustainability PH Inc., PENRO Road, Barangay Santa Monica, Puerto Princesa City 5300, The Philippines
*Corresponding authors. E-mail hello@centreforsustainabilityPH.org or larsvermeer15@hotmail.com

ABSTRACT

In Palawan, the Philippines, a biological hotspot was turned into a protected area, called Cleopatra's Needle Critical Habitat (CNCH). The most important goals of the CNCH are to conserve the rich endemic biodiversity and to maintain the culture of the *Batak*, a group of indigenous people who depend on forest resources for their livelihood. As resin extraction from *Agathis philippinensis* is a key component of the income of the *Batak* people, it is important to study the scope for sustainable exploitation of this species. This study focused on the effects of resin harvesting on the physical status and mortality of *A. philippinensis* trees in 15 subpopulations within the CNCH. These population characteristics were related to the intensity of resin harvest and the distance to communities. We found that the physical tree status deteriorated and the proportion of dead trees increased with harvest intensity and proximity to communities. These results indicate that overharvesting of the resource is taking place, which may lead to prolonged recruitment failure and population decline of *A. philippinensis* in the study area.

Keywords: *Agathis philippinensis*, *Batak*, bark removal, resin extraction, unsustainable harvest.

INTRODUCTION

In 2016, over 100 acres of original primary forest was designated as Cleopatra's Needle Critical Habitat (CNCH) in Palawan, Philippines. The CNCH is an evergreen forest characterized by abundant rainfall and very

The Palawan Scientist, 9:1-16

warm weather, these are the reasons why there are many different types of vegetation and animal species found. This tropical rainforest located in a mountainous region was identified, in a November 2013 study published in *Science,* as the world's fourth most "irreplaceable" area for unique and threatened wildlife. The CNCH contains 85% of Palawan's endemic and endangered plant and animal species. This unique blend of endemic species can be explained by the fact that the island was once connected to Borneo, resulting in a mix of influences from Sundaland and the Philippine Archipelago (Rainforest Trust 2013).

The CNCH also shelters the last tribe of hunter gatherers in the Philippines (FAO 2011; CS 2014). This indigenous people, called the *Batak*, live of NTFPs (Ticktin 2004; Ella 2008). The area around Cleopatra's Needle (the highest mountain in the CNCH area) is divided in seven *barangay* (smallest division in a municipality) of which four are home to a *Batak* tribal village. The other areas are used by the so-called lowlanders; people who live in the villages at the edge of the forest. The borders between these areas are not clearly defined and there is no regulation on who may enter or leave the forest.

Until the end of the nineteenth century the *Batak* were physically and culturally isolated from other human populations living in Palawan. Since then, the *Batak* and their biophysical surroundings were incorporated in the wider socio-ecological system of lowland Philippine society (Eder 1987). As a result, their community became market-entrenched due to the rampant exploitation of forest resources. Currently, most of the *Batak* income is obtained by selling NTFPs to the lowlanders. These NTFPs include honey, rattan (strong stems used to make baskets and other furniture), but mostly the resin from the *Agathis philippinensis* tree (local name: Almaciga) which accounts for 80% of their income (CS 2014). This indicates that the *Batak*, although participating in a wider socio-ecological system, are still highly dependent on the ecosystem services provided by the forest. However the health of this tropical forest ecosystem seems to be suffering, indicated by the declining number of *A. philippinensis* trees in the CNCH (Halos and Principe 1978; Ella and Domingo 2012; CS 2014). Other areas in the Philippines with *A. philippinensis* populations show similar trends, where unsustainable resin harvesting methods seem to be the main cause of this decrease (Westphal and Jansen 1989; Ella and Domingo 2012).

The extent in the decrease in population of the *A. philippinensis* population has been reduced in the CNCH and the cause(s) of this reduction is, is still unknown. Subsequently, it is unclear how the diminishing population of *A. philippinensis* is going to affect the *Batak.* To provide an

insight on these issues, this study focuses on providing an overview of the state of degradation of the *A. philippinensis* population in the CNCH.

METHODOLOGY

This study was conducted in CNCH in Palawan, Philippines (Figure 1). For the data collection all *A. philippinensis* trees along 200x50 meter transects were sampled (including dead trees; Clark et al. 2014).

The selection procedure for the starting points of the transects were based on a random sampling design placed over a map of the CNCH area.

Figure 1. Map of the study area in Palawan, the Philippines circled in light green (Rainforest Trust 2013).

Of all the living *A. philippinensis* trees the diameter at breast height (DBH), the total surface area of bark removed and the overall physical status of the *A. philippinensis* trees were collected. A method of visually determining the physical status of a tree (Prooijen 2008) was used with the following categories, which were based on observations of diseased *A. Philippinensis* trees described by Halos and Principe (1978) and personal observations (Figure 2):

1. **Healthy**: the bark of the tree has a red-greyish colour and the crown is full.
2. **Early stage**: a dark brown discoloration of the bark around the basal area.
3. **Diseased**: the branches start shedding twigs and leaves and the density of the crown decreases. The tree stem is only hollow (in a state of decay) directly behind the harvested areas.
4. **Terminal**: the trunk is colonized by white ants/termites and the heartwood of the tree is rotting. Density of the crown is low.
5. **Death**: the trees collapse before they die because of (a combination of) rotten heartwood and storms.

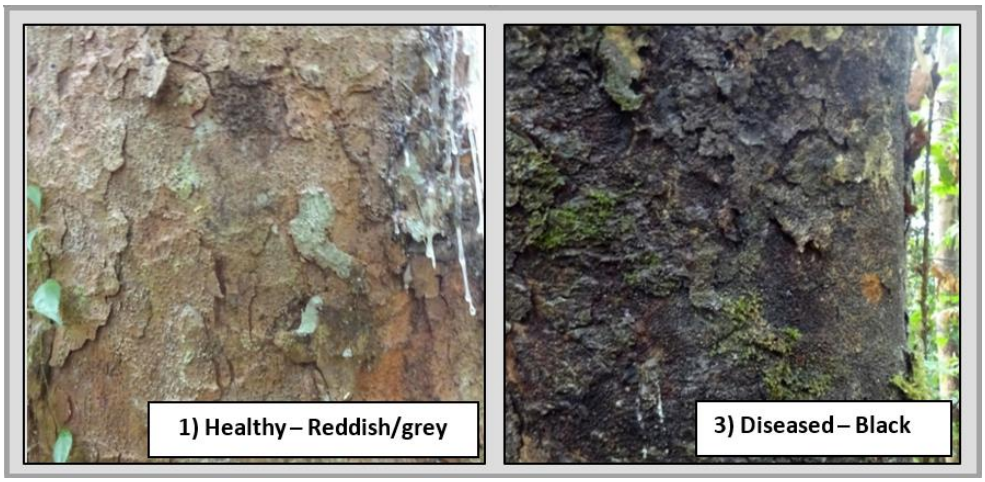

Figure 2. Example of a healthy bark (left) and the bark of a diseased tree (right).

The total surface area of bark removed for harvesting (in cm^2) was used to calculate the harvest intensity of each tree (1). The harvest intensity is the percentage of the bark below 250 cm that is harvested (Figure 3). The

threshold of 250 cm was used as this was vertically the highest tree that was harvested.

(1). *Harvest Intensity = (surface of bark removed / (circumference x 250) x 100*

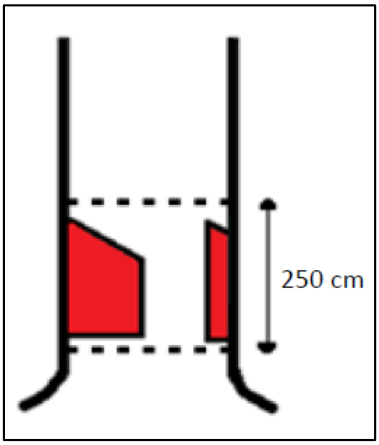

Figure 3. In red are the areas harvested for resin of the *A. philippinensis*. Harvest intensity is the percentage of the circumference *250 cm that was harvested.

The distance and the number of hours walking from each transect to the nearest village were determined. For each transect, the average DBH, physical status and harvest intensity was calculated and a dead/alive ratio of *A. philippinensis* was determined. This transect data only includes trees with a DBH higher than 40 cm, as this is the size from which resin collection of the *A. philippinensis* tree starts.

Sixteen local resin collectors from both the *Batak* villages and the "lowland" *barangays* were interviewed. Information was collected about their harvesting methods and how these changed over time. They were also asked to compare the state of degradation in the different areas compared to the past and if there were any changes in management measures. Finally, they provided an estimate of the degradation in areas where quantitative research was not conducted.

The transect data was imported into SPSS v. 20. All variables were normally distributed. Spearman Correlation tests were used to find correlations between (i) the harvest intensity and physical status, (ii) harvest intensity and ratio dead/alive and (iii) distance from nearest village and ratio

dead/alive. An additional, summarizing, variable was created to indicate the state of degradation of *A. philippinensis* subpopulations in the CNCH. This variable was based on correlations and trends in the measured variables and was used to create a map with the degradation state of *A. philippinensis* in the CNCH. This degradation state ranges from no degradation, low degradation, and moderately degraded to heavily-degraded. The transect locations and their corresponding state of degradation suggests where the degradation transition lines are in the CNCH. To interpolate the state of degradation in areas that lack measurements, observations were made, and information about logging and degraded areas were obtained from resin collectors through interiew. These observations, including any noticeable changes in the harvest intensity, physical status, DBH and ratio dead/alive, were noted while hiking and provided a very general understanding of the state of degradation in areas where quantitative research was not conducted.

RESULTS

The six expeditions completed for this study, have resulted in fifteen transects during which 206 living and 50 dead *A. philippinensis* trees were sampled. 67 of the living trees were excluded from this analysis as their DBH was below 40 cm.

Transect Data

The strongest correlation occurred between the harvest intensity and the physical status ($r=0.868$, $p=0.000$) (Figure 4). A low harvest intensity (<10%) corresponded with trees that were healthy or at an early stage of deterioration, while a high harvest intensity (>30%) corresponded with trees that were between a diseased and terminal state.

There was a moderately positive relation between the harvest intensity and the ratio dead/alive ($r=0.562$, $p=0.029$; Figure 5). With increasing harvest intensity the number of dead trees per 10 living trees increased from approximately 1 dead tree per 10 living trees for a low harvest intensity (<10%) to 8 dead trees per 10 living trees for a high harvest intensity (>30%).

The distance from the nearest village and the ratio dead/alive showed a moderately strong negative correlation ($r=-0.720$, $p=0.002$; Figure 6). 2.5 hours walking from the nearest village one can find 8 dead trees per 10 living trees, while 6.5 hours away from the nearest village one can encounter 1 dead tree per 10 living trees.

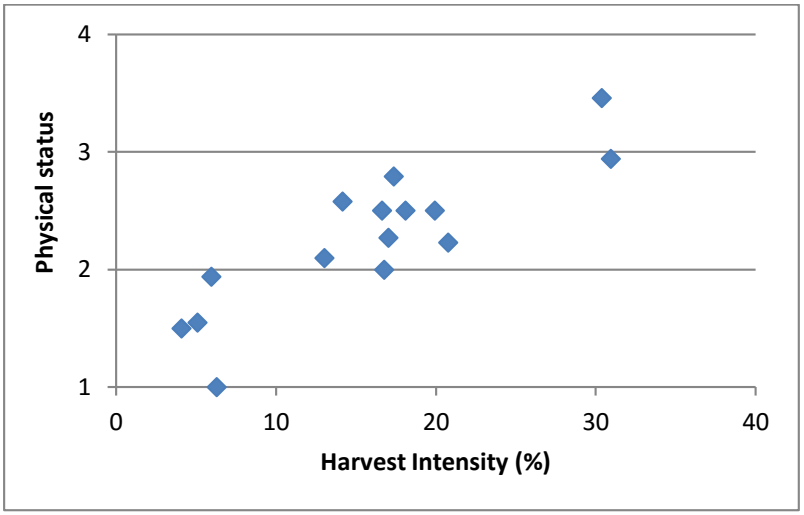

Figure 4. The relation between average harvest intensity and the average physical status of the transcects (r=0.868, p=0.000). The physical status is 1=healthy to 4=terminal.

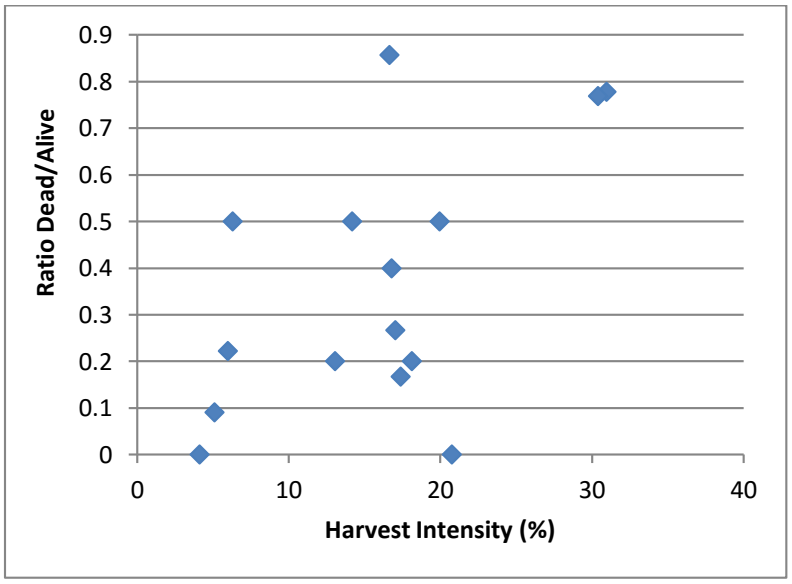

Figure 5. The relation between average harvest intensity and the ratio dead/alive of the transects (r=0.562, p=0.029).

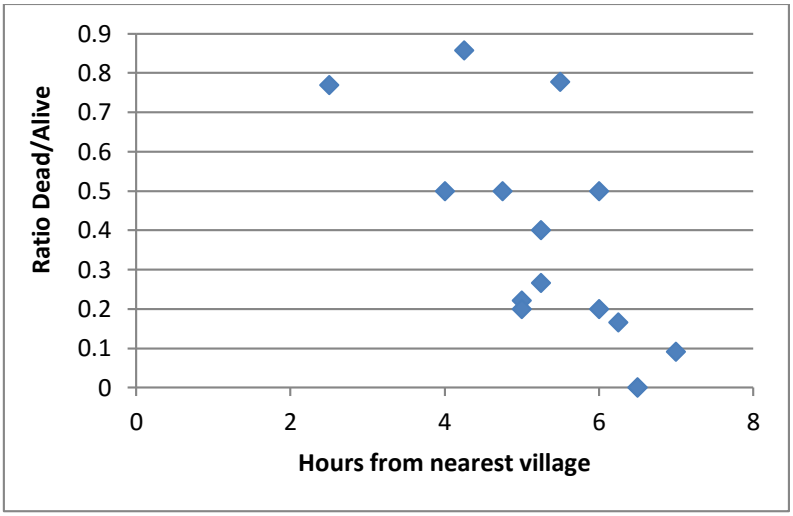

Figure 6. The relation between the distance from the nearest village and the ratio dead/alive of the transects (r=-0.720, p=0.002).

Degradation State

Relations between the four health variables (harvest intensity, DBH, physical status and ratio dead/alive) indicate a trend (Table 1 and 2). This trend shows that the *A. philippinensis* subpopulations in the CNCH are at different degradation levels (Table 1 and 2). The tables begin with subpopulations that have encountered *no degradation*. This indicates that they have a low harvest intensity (< 10%), exist out of a set of large trees (DBH > 100 cm) which are healthy (physical status < 2), and consist of less than 2.5 dead trees per 10 living trees (Table 1).

Table 1. Four states of transect degradation regarding *A. philippinensis* populations due to prolonged harvesting of resin. The states are based on variations in the average harvest intensity, average DBH, average physical status and ratio dead/alive of the fifteen transects in the CNCH.

State of population degradation	Harvest intensity	DBH (cm)	Physical status	Ratio dead/alive
No	< 10%	> 100	< 2	< 0.25
Low	10% - 25%	> 100	> 2	< 0.25
Moderate	> 25%	> 100	> 2	> 0.5
Heavy	10% - 25%	< 100	> 2	> 0.5

An *A. philippinensis* subpopulation with a *low degradation* was inflicted with a moderate harvest intensity (10% - 25%). This set of trees also contains large trees (DBH > 100 cm), but they are diseased or even terminal (physical status > 2). However, less than 2.5 dead trees can be found per 10 living trees. With a *moderate degradation* state, the harvest intensity is high (> 25%), most trees are large (DBH > 100 cm) and either diseased or terminal (physical status > 2). In addition, more than 5 dead trees per 10 living trees can be found.

If the state of a stand becomes heavily degraded the ratio dead/alive remains constant (Table 2). However, the harvest intensity, DBH and physical status have decreased. This last state of degradation contains subpopulations with a moderate harvest intensity (10% - 25%), a relatively small set of trees (DBH < 100 cm), that are diseased or terminal (physical status > 2) and comprise out of more than 5 dead trees per 10 living trees. No *A. philippinensis* subpopulations were encountered where no harvesting had occurred.

Table 2. State of degradation for all fifteen transects and the corresponding trends in the average harvest intensity, average DBH, average physical status and ratio dead/alive for *A. philippinensis* in CNCH.

Transect	Average harvest intensity (%)	Average DBH (cm)	Average Physical status	Ratio dead/alive	State of degradation
9	4.1	115	1.5	0.00	No
14	5.1	162	1.6	0.09	No
15	6.0	132	1.9	0.22	No
7	17.0	132	2.3	0.27	Low
8	17.4	148	2.8	0.17	Low
11	20.8	114	2.2	0.00	Low
12	18.1	105	2.5	0.20	Low
10	31.0	112	2.9	0.78	Moderate
13	30.4	120	3.5	0.77	Moderate
1	14.2	90	2.6	0.50	Heavy
2	16.6	71	2.5	0.86	Heavy
3	6.3	57	1.0	0.50	Heavy
4	13.0	54	2.1	0.20	Heavy
5	20.0	68	2.5	0.50	Heavy
6	16.8	66	2.0	0.40	Heavy

Based on the quantitative research, the interviews with the resin collectors and the significant correlation between the distance from the nearest village and the ratio dead/alive all areas of the CNCH could be assigned with one of the four states of degradation (Figure 7). The degradation is most intensive in the southern regions of the CNCH. Most of the areas are heavily degraded and some even logged. *A. philippinensis* becomes less degraded when the distance from the nearest village exceeds approximately 10 km. Moving further north after this transition line the state of degradation quickly decreases to a state of low degradation, because the areas that are moderately degraded comprise a relatively small surface area. Closer to Cleopatra's Needle and especially north of this peak there is no degradation of *A. philippinensis* trees according to the resin collectors. It is probable that large parts of Langogan are still undisturbed. Closer to Marufinas there is some low to moderate degradation.

DISCUSSION

This study strongly suggests that the degradation of *A. philippinensis* in the CNCH has an anthropogenic cause. At all study sites, *A. philippinensis* subpopulations subjected to tapping (high harvesting intensities) had a worse physical status than subpopulations that were exempt from tapping (Figure 4). In addition, the number of dead trees per 10 living trees significantly decreases with proximity from the nearest villages (Figure 6). As all dead trees had collapsed due to tapping, these results demonstrate that the prolonged harvesting of a NTFP, in this case resin, can gradually affect the state of tree populations in a primary forest.

The effect of bark removal on the health of a tree is also evident in other studies. In these studies, however, the researcher often used growth as a derivative for the physical status. For example, in south-east Asia Dijkman (1951) found that the extraction of latex from *Hevea* trees resulted in a reduction of 50% in diameter increment. Kärkkäinen (1981) found that when resin yield was doubled in Scots pine the diameter increment dropped by 35%. Research done on the effect of debarking on *K. senegalensis* by Gaoue & Ticktin (2010) also resulted in reduced growth of individuals of all size classes. It is thought that the process of dying due to debarking is caused by dysfunction of the phloem (the innermost layer of the bark). Depending on the intensity of harvesting, the transfer of assimilates from the leaves to the roots decreases. This affects the health of the roots and, as a consequence, the overall health status of the tree (Guedje et al, 2007).

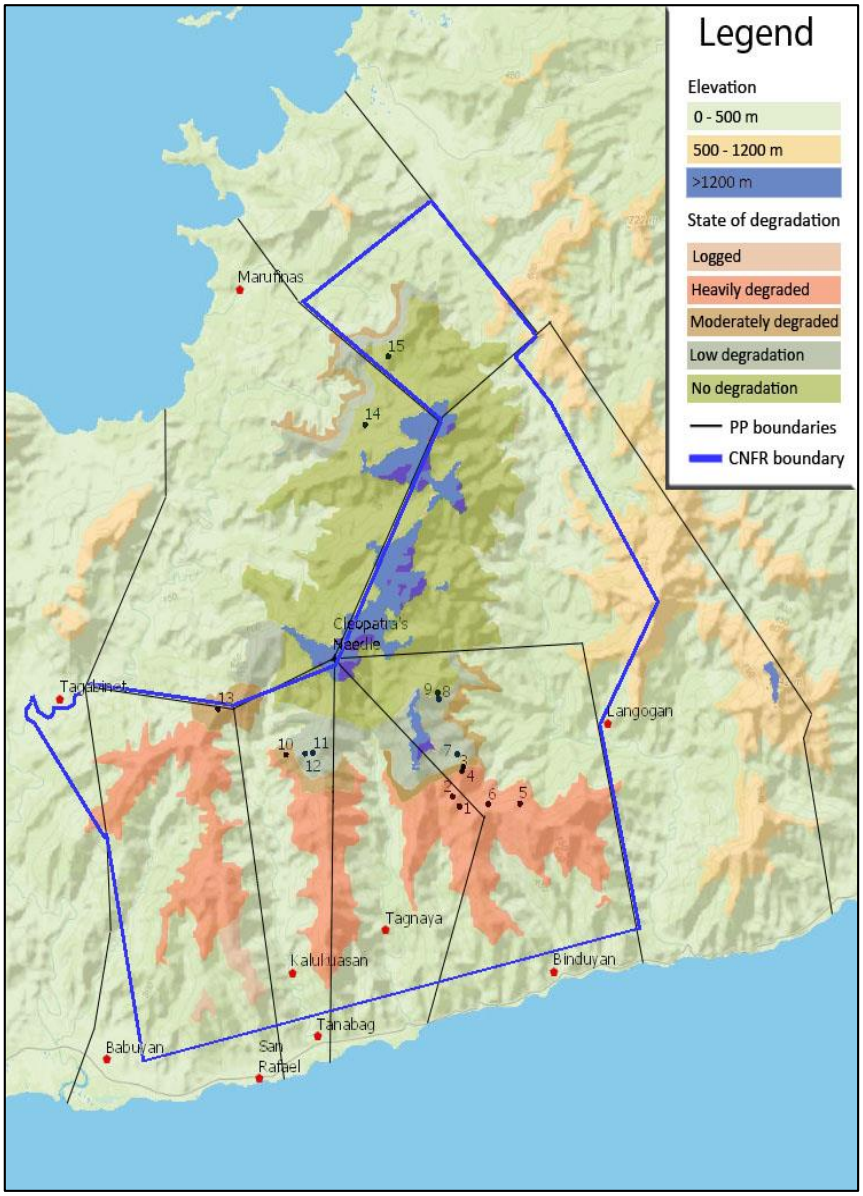

Figure 7. The occurrence and state of degradation of *A. philippinensis* in the CNCH. *A. philippinensis* trees occur between 500-1200 meter indicated by yellow. Inside the CNCH these areas are coloured indicating the state of degradation. The states of degradation are: (i) logged (light red), (ii) heavily degraded (red), (iii) moderately degraded (brown), (iv) low degradation (light blue) and (v) no degradation (green). The villages of resin collectors in the CNCH are indicated by red dots.

In addition to removing too much bark (overtapping), all tapped *A. philippinensis* trees in the CNCH had signs of cuts that extend past the bark to the sapwood portion of the tree, thereby penetrating the vascular cambium. This is called deep tapping and occurs widely in the CNCH due to the use of the machete. The machete reduces the precision and control of removing the bark so that the cambium is penetrated during harvesting. All of the interviewed resin collectors bring a machete as their main harvesting tool during the collecting trips. Based on the interview with the Chieftain of Kalukuasan the resin collectors previously used tapping knives for inflicting the cuts. These knives were more sustainable as they provide more precision and control. However, the *Batak* shifted to using the machete as the tapping knives became and continue to be too expensive for them to buy (400 peso or $9).

The use of the machete, however, is not the only reason why the tapped *A. philippinensis* trees had signs of deep tapping. The other cause is re-chipping where the accumulated resin that spreads out over the wound is removed and a new cut (about 3 cm of bark) is added above the first wound. With each consecutive re-chipping, however, the depth of the wound increases since not only the resin is removed but also an additional layer of bark. Subsequently, it becomes increasingly likely over time that the vascular cambium of a tree gets damaged if the first cut had not already reached this layer. The interviewed resin collectors believe that due to re-chipping a tapped tree is going to decline, as the process of wound closure is prohibited.

The effect of the depth of the wound on the physical status of *A. philippinensis* could not be determined during this study. This is because all samples that were tapped had signs of a damaged vascular cambium. Nevertheless, knowledge on the effect of the depth of a wound on *A. philippinensis* would be valuable when establishing a sustainable harvesting method. Literature on the depth of tapping wounds indicates that the impact of the depth of a wound is species-specific, and depends on the rate of wound closure (Ngubeni 2015). Based on the rate of wound closure a tree can be considered for bark harvesting. Some trees like *Prunus africana* and *Ocotea bullata* (Vermeulen 2009) show good wound regrowth, while in contrast *Burkea africana* and *Detarium microcarpum* showed poor or no bark regrowth (Delvaux 2009). Delvaux (2009) indicates that the ability to recover from tapping wounds in a relatively short time prevents large-scale insect attacks. The same study showed that leaving a thin layer of bark and the vascular cambium resulted in a wound recovery rate of 50% to 80%, whereas complete removal of the bark and cambium resulted in no or poor recovery (Delvaux 2009). According to Delvaux (2009), recovery from a

wound therefore depends on the ability to preserve at least the vascular cambium after tapping.

Results coincide with that of Delvaux (2009) in that complete removal of the bark and cambium enables termites and potentially fungi and bacteria to infect the tree and thus the structure of the tree is weakened. In combination with strong winds, the trees snap where the stem is rotten. All of the sampled dead *A. philippinensis* trees died this way. Due to re-chipping of the bark the *A. philippinensis* trees do not get the chance to recover. More research is needed to determine whether *A. philippinensis* can recover when the vascular cambium is preserved during tapping.

The results suggest that the harvesting methods used by the resin collectors in the CNCH are not sustainable (Figure 7). About half of the areas where *A. philippinensis* trees thrive were either logged or heavily degraded. The worst conditions were observed in the southern regions of the CNCH. Here, the proximity of *A. philippinensis* subpopulations to the most populated villages in the area is the smallest, which results in the greatest pressure. The extent of the degradation in these regions is large enough to threaten *A. philippinensis* subpopulations with local extinction. This is because tapping decreases the chance for *A. philippinensis* trees to become reproductively viable. Bocxe et al. (2015) indicate that it is likely that an average *A. philippinensis* tree in the CNCH starts to produce cones from a DBH larger than 110 cm. Trees in the southern regions of the CNCH are, with an average of 68 cm, too small to assure the next generation of offspring. In addition, large *A. philippinensis* trees are becoming increasingly rare in the southern regions of the CNCH. As a result, resin collectors are already starting to target trees from a DBH smaller than 40 cm for resin collection thereby jeopardizing the long term survival of *A. philippinensis* in this area.

North of the heavily degraded areas a transition line separates the degraded from the undisturbed areas. The transition line ranges from 11 to 13 km to the nearest village. This range corresponds with the distance resin collectors can cover during a three day hiking trip. Resin collectors are reluctant to cross this transition line because that would require more resources and would induce higher risks. In addition, enough *A. philippinensis* trees that still provide resin, can be found within a one-day hike from their village. For now, these factors maintain the undisturbed state of *A. philippinensis* trees in the regions around and north of Cleopatra's Needle.

Subpopulations of *A. philippinensis* in between areas that are heavily degraded and undisturbed contain trees that have an average DBH close to

or larger than 110 cm. This suggests that these *A. philippinensis* subpopulations comprise of trees that at least produce cones. However, studies have indicated that resin tapping can also affect cone fertility for resin producing trees like *Boswellia papyrifera* (Rijkers et al. 2006; Eshete et al. 2012) and *Khaya senegalensis* (Gaoue and Ticktin 2008). To understand the state of *A. philippinensis* in areas that are either low or moderately degraded, more research is needed on the effects of resin tapping on the cone production and fertility of *A. philippinensis*. The success of the nurseries that have been set up in the CNCH in 2015 suggest that fertility of the cones is not or barely affected by tapping.

Although the causes of utilizing unsustainable harvesting methods could not be proven during this study, the consequences of such methods can undoubtedly jeopardize the future of the local people. With the current decline of *A. philippinensis* trees, the resin collectors have to cover an increasingly large area to obtain enough resin in order to make it worthwhile. Not only does this increase the duration of the trips and the amount of supplies they need, but it also increases the chance of serious injuries. As a result, 35.7% of the surveyed resin collectors think that within 5 to 10 years it will not be feasible to collect resin from *A. philippinensis* trees in their region. Another 35.7% believe this will take up to 20 years. The remaining collectors think it will take more than 20 years to deplete the resin from *A. Philippinensis* trees in their region. All resin collectors agree, however, that it is only a matter of time. As a result, 80% of their current income and a specific way of living might disappear.

CONCLUSION

What the CNCH area needs, is what the CNCH stands for, that is: a protected natural area which stimulates the sustainable relationship of the *Batak* with their natural surroundings. Currently, however, this relationship is not sustainable. This is apparent by the decline of *A. philippinensis* trees in the area, on which the *Batak* depend for their income, by commercializing harvested resin. This unsustainable resource use is caused by removing too much bark in terms of surface area (overtapping) and depth (deep tapping). Using the wrong tapping tools is influential for the sustainability of resin harvesting. As a result, the population of *A. philippinensis* cannot reproduce, which creates an imminent local extinction, especially in the southern regions of the CNCH. The majority of the resin collectors in these regions indicate that resin extraction will lose its profitability within 20 years. As a consequence, it is likely that the main source of income for the *Batak* will disappear should the use of unsustainable harvesting methods endure.

ACKNOWLEDGEMENTS

This study was funded by Flora and Fauna International (UK) and Philippine Tropical Forest Conservation Foundation. We are thankful for the comments and suggestions of two anonymous external reviewers.

REFERENCES

Bocxe KG, Vermeer L, Zuidema P, Sopsop L and Hoevenaars K. 2015. Effect of resin harvest on reproduction and physical status of *Agathis philippinensis*. Proceedings of the 2nd Palawan Research Symposium. 25 – 33.

Clark DB, Hurtado J and Saatchi SS. 2014. Tropical Rain Forest Structure, Tree Growth and Dynamics along a 2700-m Elevational Transect in Costa Rica, PloS one, 10(4). e0122905

CS (Centre for Sustainability). 2014. Saving the Almaciga Tree, Palawan, Philippines.

Delvaux C. 2009. Responses to bark harvesting of medicinal tree species from Forêt Classée des Monts Kouffé, Benin. Doctoral dissertation, Université de Ghent, Belgique.

Dijkman MJ. 1951. Hevea: thirty years of research in the Far East. The chronica botanica co, Waltham, mass: USA. 348p.

Eder JF. 1987. On the road to tribal extinction: depopulation, deculturation, and adaptive well-being among the *Batak* of the Philippines. University of California Press.

Ella AB. 2008. Almaciga resin gathering by indigenous people of Palawan province in the Philippines. IUFRO World Series, 21, 46p.

Ella AB, and Domingo EP. 2012. Almaciga (*Agathis philippinensis* Warb.): Valuable but Diminishing Tree Species in the Philippines. IUFRO World Series Vol. 30, 75p.

Eshete A, Teketay D, Lemenih M and Bongers F. 2012. Effects of resin tapping and tree size on the purity, germination and storage behavior of *Boswellia papyrifera* (Del.) Hochst. seeds from Metema District, northwestern Ethiopia. Forest Ecology and Management, 269: 31-36.

FAO. 2011. Forest Cover, Forest types, Breakdown of forest types, Change in Forest Cover, Primary forests, Forest designation, Disturbances affecting forest land, Value of forests, Production, trade and consumption of forest products, p217-327. The Food and Agriculture Organization of the United Nations' Global Forest Resources Assessment (2005 and 2010).

Gaoue OG and Ticktin T. 2008. Impacts of bark and foliage harvest on *Khaya senegalensis* (Meliaceae) reproductive performance in Benin. Journal of Applied Ecology, 45(1): 34-40.

Gaoue OG and Ticktin T. 2010. Effects of harvest of nontimber forest products and ecological differences between sites on the demography of African mahogany. Conservation Biology, 24(2): 605-614.

Guedje NM, Zuidema PA, During H, Foahom B and Lejoly J. 2007. Tree bark as a non-timber forest product: The effect of bark collection on population structure and dynamics of *Garcinia lucida* Vesque. Forest Ecology and Management, 240(1): 1-12.

Halos SC and Principe EB. 1978. The vanishing almaciga (*Agathis philippinensis*) of Samar, Philippines [gymnosperms]. Forest Genetic Resources Information (FAO).

Kärkkäinen M. 1981. Increasing resin content in pine and spruce stemwood for higher by-product yield. Communicationes Instituti Fore-stalis Fenniae, 96: 1–81

Ngubeni N. 2015. Bark re-growth and wood decay in response to bark stripping for medicinal use. MS Thesis, University of Stellenbosch. 112p.

Prooijen G. 2008. Stadsbomen Vademecum, boomcontrole en onderzoek. 3.6 Groeiringanalyse. IPC Groene Ruimte Arnhem.

Rainforest trust. 2013. Saving Palawan's Endemic Wildlife, Philippines. Online available: https://www.rainforesttrust.org/projects/complete-projects/palawan-island-philippines/. Accessed on 22 April 2015.

Rijkers T, Ogbazghi W, Wessel M and Bongers F. 2006. The effect of tapping for frankincense on sexual reproduction in *Boswellia papyrifera*. Journal of Applied Ecology, 43(6): 1188-1195.

Ticktin T. (2004). The ecological implications of harvesting non-timber forest products. Journal of Applied Ecology, 41(1): 11-21.

Vermeulen WJ. 2009. The sustainable harvesting of non-timber forest products from natural forests in the southern Cape, South Africa: Development of harvest systems and management prescriptions. Doctoral dissertation, Department of Conservation Ecology and Entomology, Stellenbosch University, Stellenbosch. 210p.

Westphal E and Jansen PCM. 1989. Plant resources of South-East Asia: a selection. Pudoc. 322p.

ARTICLE INFO

Received: 27 Oct. 2016
Revised: 6 June 2017
Accepted: 30 June 2017

Importance of riparian forest in enhancing the avifaunal diversity of upland agricultural landscape

Alejandro A. Bernardo Jr.
College of Arts and Sciences
Western Philippines University
San Juan, Aborlan, Palawan
Corresponding author: tagwati@gmail.com

ABSTRACT

To understand the importance of riparian forest in enhancing the avifaunal diversity in upland agricultural landscape, this study compared the avifaunal community of riparian forest strip to avifaunal community of a swidden farm and a nearby primary forest in Aborlan, Palawan, Philippines from August to November 2010. Results revealed that the riparian forest strip has the highest species richness, diversity index and abundance compared to swidden farm and primary forest. Moreover, the bird assemblage found in it has high index of community similarity when compared to swidden farm and primary forest. This indicates that the bird community in the riparian forest is comprised of an assortment of species that thrive in the primary forest and in the swidden farm. Meanwhile, the low abundance, species richness and diversity index together with the concurrent decline of endemic and conservation priority birds in swidden farm uncovered the vulnerability of these birds to habitat degradation. On the contrary, the high abundance, species richness, and diversity index alongside with the presence of high number of endemic and conservation priority species in the riparian forest strip unfolded its significance in enhancing the avifaunal diversity in upland agricultural landscape. Moreover, the presence of endemic and high conservation priority bird species that are restricted only to primary forest highlights the need to conserve the remaining tracts of primary forest in the area. Preserving the networks of riparian forests in upland agricultural vegetation matrix is also recommended to improve the avifaunal ecosystem functions in the area.

Keywords: avifauna, diversity, riparian forest, upland agriculture

The Palawan Scientist, 9: 17-36

INTRODUCTION

The upland agricultural landscape is a complex vegetation matrix which consists of agroforests, fallow forests, grasslands, shrub lands, residual forest fragments and swidden farms which are planted with a variety of crops. Swidden or "slash and burn farming" is a traditional form of agriculture practiced by upland dwelling communities in the tropical region. In the Philippines, it is practiced by various indigenous groups such as the Hanunuo (Conklin 1957), Tagbanua (Warner 1981; Dressler 2005; Eder 2006), Ikalahan-Kalanguya (Banaticla et al. 2008), T'boli (Hyndman et al. 1994) and Batak (Eder 1987). This farming system is developed through centuries of experience by the ancestors of these mountain-dwelling indigenous people and is practiced in accordance with a handful of customs and traditions.

This traditional method of farming begins by cutting and burning of forest vegetation, followed by short period of cropping cycles and ends in a long fallowing phase. This typical pattern of cultivation and fallowing was confirmed to be practiced by Hanunuo tribe of Mindoro (Suarez and Sajise 2010), Ikalahans of Mount Pulog (Rice 1981) and Tagbanua of Palawan (Dressler 2005).

This practice was considered sustainable because long fallowing period allows sufficient time for the restoration of soil fertility (Brady 1999). The regenerating fallow forests are also essential in performing vital ecosystem functions which improves the overall resilience of the swidden agricultural landscape.

One of the consequences of having long fallow duration is the need to have considerably large expanse of swidden space to accommodate the adequate number of fallows. Thus, this farming system is only considered sustainable in places where large areas of free access land are still available and only a few people are doing it (Suarez and Sajise 2010). However, the growing population and the increasing economic opportunities significantly increase the swidden activities in almost all developed provinces in the Philippines. Cadiz and Buot (2009) confirmed this by describing that swidden farming intensified forest destruction in Cebu Island.

In Palawan, swidden farms are common along the foothills of the mountain ranges extending from north to south end of the central island. This form of agriculture is practiced not only by indigenous communities but also by settled migrants as well (Lacuna-Richman 2006; Sopsop and Buot

2011). The congestion brought by the expansion of upland farms resulted to opening of more frontier areas in the primary forest and utilization of fallow forest before it has fully regenerated. The loss of primary forest and matured fallow forest in swidden landscape has detrimental effect to the bird community. Shankar Raman et al. (1998) described that the natural regeneration of fallow forests are important in bird diversity because the species richness, abundance and diversity of birds increase as the vegetation in the fallows recover. Considering the diverse ecosystem functions performed by birds, conserving the extant primary forest and maintaining matured fallows in an otherwise degraded upland agricultural matrix is vital in enhancing the resilience of this ecosystem.

One of the remaining matured forest fragments in the upland agricultural landscape is the network of riparian forests growing along the tributary streams. Located in steep slopes with shallow and rocky soil, these forested areas are not suitable for swidden agriculture use. Being spared from cultivation, these forest fragments are left intact with large trees and thick understory vegetations which may support wide array of birds including habitat specific forest dwellers and endemic species that are already gone in disturbed swidden areas. The riparian forest is connected to the primary forests at higher elevation and follows the meandering path of the tributary streams that cuts across the swidden farms and other disturbed habitats in the foothills, the birds thriving in it might improve the overall avifaunal diversity in the upland agricultural landscape. However, the avifaunal community thriving in the riparian forest strips in Palawan is not yet documented and thereby not fully understood. Hence, the study was conducted to understand the attributes of the avifaunal community found in the riparian forest and compare it with the bird communities in pristine primary forest and in a much disturbed swidden agricultural area.

METHODOLOGY

Time and Place of the Study

This study was conducted in the eastern slopes of the Victoria-Anipahan mountain range, specifically in the swidden landscape of Sagpangan, Aborlan, Palawan, Philippines from August to November 2010.

Description of the Study Sites

The three study sites are located in the swidden landscape of Sagpangan, Aborlan, Palawan. Site 1 is narrow riparian forest that is approximately 40 meters across in its narrowest segment while about 70 meters across in its widest section. It consists of relatively intact forest vegetation thriving along the steep and rocky banks of the cascading tributary stream that meanders through various habitats which includes swidden farms, grasslands, brush lands, secondary forests and residual forest. Although some economically important species of trees are already eliminated, this site is still dominantly covered by large trees. Site 2 is a swidden farm which is generally covered by various crops such as “gabi”, string beans, “kadios”, ginger, banana, jackfruit, “ube”, papaya, cashew and coconuts. Some pioneering species of trees were also found sparsely growing in the area. Site 3 is an old stand of primary forest with massive trees and tall emergent layer. The flourishing vegetation belongs to the climax species of trees. Anthropogenic activities taking place in this part of the forest are gathering of rattan, wild fruits, honey and other non timber forest products.

Data Collection

Data gathering was conducted from August to November 2010. Point count method of bird survey was used in this study because one of the sites (primary forest) has dense vegetation with a lot of cryptic, shy, and skulking species (Gibbons and Gregory 2006). Although the study aimed to obtain only the relative abundances, point count method was chosen because other much easier methods such as the Mackinnon list or timed species count generate relative abundances based only on how many times the species occur on the lists but the actual number of individuals in each species is not taken into account (Cavarzere et al. 2012).

Four point count stations were established in a transect line laid in each site. The transect line in site 2 (swidden farm) was purposely laid at the center of this farm to cover all the representative vegetations and at the same time to reduce the possibility of the edge effects. On the other hand, the transect line in site 1 (riparian forest strip) was laid following the meandering bank of the stream. Meanwhile, in the nearest primary forest, an area as wide as site 2 was delineated and considered as the site 3 (primary forest). A transect line was also laid at the center of the site 3.

The four point count stations were positioned at 100 meters interval to maximize the distance between point count stations and to lessen the chance of double counting the same bird at different stations (Harvey et al. 2006).

Each point count station used for counting birds was a circular plot with a radius of 25 meters (Gibbons and Gregory 2006; Sutherland 2000). The perimeter of the point count stations was marked with ribbons to help the researcher to identify the boundaries easily. The counting of birds was done twice each day, one during early in the morning (6:00-10:00) and another during late in the afternoon (3:00-5:00) because birds were most active during these periods of the day (Bibby et al. 1998).

A 10-minute settling time was allowed to pass before starting each bird count; this is to allow the return of bird activities that was interrupted by the arrival of the researcher. All birds detected using visual and auditory cues within 10 minutes inside the circular plot were recorded (Bibby et al. 1998). Any individual bird was recorded only once during the 10 minute counting period. Counting of birds was repeated four times in all stations, reaching a total bird count of 160 minutes per study area. The number of sampling repetitions for this study was based on the results of the species discovery curve.

Classification, Endemism and Conservation Status

Taxonomy of birds was based from the International Ornithological Committee World Bird List version 7.2 (Gill and Donsker 2017) while the level of endemism and conservation status of birds were based from International Union for Conservation of Nature (IUCN) Red List of Threatened Species version 2016-3 (IUCN 2017).

Data Analysis

The avifaunal communities between sites were compared using standard measures of biodiversity such as species richness, abundance, Shannon's diversity index and evenness. Changes in any of these parameters are important indicators of habitat degradation (Chapman and Reich 2007; Carete et al. 2009; Barzan et al. 2015). The degree of similarity of bird communities across the different sites were compared using the Horn's Information Theoretic Index of Similarity. The presence of endemic and high conservation priority species in different sites were also compared using species richness of target species.

RESULTS AND DISCUSSION

Species Diversity and Abundance

The avifaunal survey discovered 82 species of birds from 40 families across the three sites compared (Table 1). Fifteen species were found to be endemic to Palawan, four species were endemic to Philippines, nine were resident species with endemic race, nine were migratory species and the remaining 45 were resident species.

Table 1. Distribution, level of endemism, conservation status, and names of birds recorded in the entire study area. (**Level of Endemism:** R - Resident species; RPER - Resident species with Palawan endemic race; PES - Palawan endemic species; PHES – Philippine endemic species; M – Migrant; **Distribution in the study area**: P – Primary forest; R – Riparian; S – Swidden farm; (+) – Present)

Family	Scientific Name	English Name	Conservation Status (IUCN)	Level of Endemism	Distribution in the Study Area		
					P	R	S
Accipitridae	*Spilornis cheela palawanensis*	Crested Serpent-Eagle	Least concern	RPER	+		+
Accipitridae	*Nisaetus cirrhatus*	Changeable Hawk-Eagle	Least concern	R	+	+	+
Aegithinidae	*Aegithina tiphia*	Common Iora	Least concern	R	+	+	+
Alcidinidae	*Alcedo atthis bengalensis*	Common Kingfisher	Least concern	M		+	
Alcidinidae	*Alcedo meninting meninting*	Blue-Eared Kingfisher	Least concern	R		+	
Alcidinidae	*Ceryx erithaca*	Oriental Dwarf Kingfisher	Least concern	R		+	
Alcidinidae	*Todiramphus chloris collaris*	Collared Kingfisher	Least concern	R		+	+
Apodidae	*Collocalia esculenta*	Glossy Swiftlet	Least concern	R	+	+	+
Apodidae	*Collocalia troglodytes*	Pygmy Swiftlet	Least concern	PHES		+	
Apodidae	*Hirundapus giganteus*	Brown-Backed Needletail	Least concern	R	+	+	+
Ardeidae	*Egretta garzetta*	Little Egret	Least concern	M		+	+
Ardeidae	*Butorides striata*	Striated Heron	Least concern	M		+	
Ardeidae	*Bubulcus coromandus*	Eastern Cattle Egret	Least concern	M		+	+

Family	Scientific Name	English Name	Conservation Status (IUCN)	Level of Endemism	Distribution in the Study Area		
					P	R	S
Ardeidae	*Egretta intermedia*	Intermediate Egret	Least concern	M		+	+
Artamidae	*Artamus leucorynchus*	White-Breasted Wood-Swallow	Least concern	R			+
Bucerotidae	*Anthracoceros marchei*	Palawan Hornbill	Vulnerable	PES	+	+	
Campephagidae	*Coracina striata difficilis*	Bar-Bellied Cuckoo-Shrike	Least concern	RPER	+		
Campephagidae	*Lalage nigra*	Pied Triller	Least concern	R		+	+
Campephagidae	*Pericrocotus igneus*	Fiery Minivet	Near threatened	R	+	+	
Chloropseidae	*Chloropsis palawanensis*	Yellow-Throated Leafbird	Least concern	PES	+	+	
Columbidae	*Treron curvirostra*	Thick-Billed Green-Pigeon	Least concern	R	+	+	+
Columbidae	*Treron vernans*	Pink-Necked Green-Pigeon	Least concern	R	+	+	+
Columbidae	*Ptilinopus leclancheri*	Black-Chinned Fruit Dove	Least concern	R	+	+	
Columbidae	*Ducula aenea*	Green Imperial Pigeon	Least concern	R	+	+	
Columbidae	*Macropygia tenuirostris*	Reddish Cuckoo-Dove	Least concern	R	+	+	
Columbidae	*Spilopelia chinensis*	Spotted Dove	Least concern	R		+	+
Columbidae	*Geopelia striata*	Zebra Dove	Least concern	R		+	+
Columbidae	*Chalcophaps indica*	Common Emerald-Dove	Least concern	R	+	+	
Coraciidae	*Eurystomus orientalis*	Oriental Dollar Bird	Least concern	R	+	+	+
Corvidae	*Corvus enca*	Slender-Billed Crow	Least concern	R		+	+
Cuculidae	*Cacomantis merulinus*	Plaintive Cuckoo	Least concern	R	+	+	
Cuculidae	*Eudynamys scolopaceus*	Asian Koel	Least concern	R	+	+	
Cuculidae	*Phaenicophaeus curvirostris*	Chestnut-Breasted Malkoha	Least concern	R	+	+	
Cuculidae	*Centropus sinensis*	Greater Coucal	Least concern	R			+

Family	Scientific Name	English Name	Conservation Status (IUCN)	Level of Endemism	Distribution in the Study Area		
					P	R	S
Cuculidae	*Centropus bengalensis*	Lesser Coucal	Least concern	R			+
Dicaeidae	*Prionochilus plateni*	Palawan Flowerpecker	Least concern	PES	+	+	+
Dicaeidae	*Dicaeum pygmaeum palawanorum*	Pygmy Flowerpecker	Least concern	RPER	+	+	+
Dicruridae	*Dicrurus leucophaeus leocophaeus*	Ashy Drongo	Least concern	R	+	+	+
Dicruridae	*Dicrurus hottentottus palawanensis*	Hair-Crested Drongo	Least concern	RPER	+	+	
Estrildidae	*Lonchura leucogastra*	White-Bellied Munia	Least concern	R	+	+	+
Estrildidae	*Lonchura atricapilla*	Chestnut Munia	Least concern	R		+	+
Estrildidae	*Lonchura punctulata*	Scaly Breasted Munia	Least concern	R		+	+
Hirundinidae	*Hirundo rustica*	Barn Swallow	Least concern	M	+	+	+
Irenidae	*Irena puella tweeddalii*	Asian Fairy-Bluebird	Least concern	RPER	+	+	
Laniidae	*Lanius cristatus lucionensis*	Brown Shrike	Least concern	M		+	+
Monarchidae	*Terpsiphone cyanescens*	Blue-Paradise Flycatcher	Near threatened	PES	+	+	+
Monarchidae	*Hypothymis azurea*	Black-Naped Monarch	Least concern	R	+	+	+
Motacillidae	*Motacilla cinerea*	Grey Wagtail	Least concern	M		+	+
Muscicapidae	*Cyornis lemprieri*	Palawan Blue Flycatcher	Near threatened	PES	+		
Muscicapidae	*Muscicapa griseisticta*	Grey-Streaked Flycatcher	Least concern	M	+	+	+
Muscicapidae	*Copsychus niger*	White-Vented Shama	Least concern	PES	+	+	+
Nectariniidae	*Arachnothera dilutior*	Pale Spiderhunter	Least concern	PES	+	+	+
Nectariniidae	*Cinnyris jugularis*	Olive-Backed Sunbird	Least concern	R	+	+	+
Nectariniidae	*Anthreptes malacensis paraguae*	Brown-Throated Sunbird	Least concern	RPER	+	+	+
Nectariniidae	*Aethopyga shelleyi shelleyi*	Lovely Sunbird	Least concern	PHES	+	+	

Family	Scientific Name	English Name	Conservation Status (IUCN)	Level of Endemism	Distribution in the Study Area		
					P	R	S
Oriolidae	*Oriolus xanthonotus*	Dark-Throated Oriole	Near threatened	R	+		
Oriolidae	*Oriolus chinensis*	Black-Naped Oriole	Least concern	R	+	+	
Paridae	*Periparus amabilis*	Palawan Tit	Near threatened	PES	+	+	
Passeridae	*Passer montanus*	Eurasian Tree Sparrow	Least concern	R			+
Phasianidae	*Gallus gallus*	Red Jungle Fowl	Least concern	R	+	+	
Phasianidae	*Polyplectron napoleonis*	Palawan Peacock-Pheasant	Vulnerable	PES	+		
Phasianidae	*Excalfactoria chinensis*	Blue-Breasted Quail	Least concern	R			+
Picidae	*Mullerripicus pulverulentus*	Great Slaty Woodpecker	Vulnerable	R	+	+	
Picidae	*Chrysocolaptes erythrocephalus*	Red-Headed Flameback	Endangered	PES	+	+	
Picidae	*Dinopium everetti*	Spot-Throated Flameback	Near threatened	PES	+	+	
Pittidae	*Erythropitta erythrogaster*	Red-Bellied Pitta	Least concern	PHES	+		
Pittidae	*Pitta sordida*	Hooded Pitta	Least concern	R	+	+	
Psittaculidae	*Tanygnathus lucionensis*	Blue-Naped Parrot	Near threatened	R (Near Endemic)	+	+	
Psittaculidae	*Prioniturus platenae*	Blue-Headed Racquet-Tail	Vulnerable	PES	+	+	
Pycnonotidae	*Pycnonotus atriceps*	Black-Headed Bulbul	Least concern	R	+	+	+
Pycnonotidae	*Pycnonotus cinereifrons*	Ashy-Fronted Bulbul	Least concern	PES	+	+	+
Pycnonotidae	*Alophoixus frater*	Palawan Bulbul	Least concern	PES	+	+	+
Rallidae	*Amaurornis phoenicurus*	White Breasted Water Hen	Least concern	R		+	+
Rhipiduridae	*Rhipidura nigritorquis*	Philippine Pied Fantail	Least concern	PHES		+	+
Sittidae	*Sitta frontalis palawana*	Velvet-Fronted Nuthatch	Least concern	RPER		+	
Sturnidae	*Gracula religiosa*	Common Hill Myna	Least concern	R	+	+	
Sturnidae	*Aplonis panayensis*	Asian Glossy Starling	Least concern	R		+	+
Cisticolidae	*Orthotomus sericeus*	Rufous-Tailed Tailorbird	Least concern	R	+	+	+

Family	Scientific Name	English Name	Conservation Status (IUCN)	Level of Endemism	Distribution in the Study Area		
					P	R	S
Locustellidae	*Megalurus palustris*	Striated Grassbird	Least concern	R			+
Pellorneidae	*Malacocincla cinereiceps*	Ashy-Headed Babbler	Least concern	PES	+	+	+
Timaliidae	*Macronous gularis woodi*	Pin-Striped Tit-Babbler	Least concern	RPER	+	+	
Turnicidae	*Turnix suscitator haynaldi*	Barred Buttonquail	Least concern	RPER		+	+

Based on the results, the riparian forest strip has the highest avifaunal species richness (70), followed by primary forest (54) and swidden farm (46) (Table 2). Similarly, bird abundance follows the same trend with the following abundance values of 267, 255 and 176 respectively. As abundance and species richness influenced the diversity index, the computed Shannon's diversity index also follows the same trend. Riparian forest strip has the highest Shannon's diversity index value of (1.73), followed by primary forest (1.64) and swidden farm (1.58) (Table 2). Evenness values across the sites compared were almost the same.

Table 2. Diversity and evenness values of bird communities in swidden farm, riparian forest and primary forest.

Location	Number of Bird Species	Number of Individual Birds	Shannon's Diversity Index	Evenness
Swidden Farm	46	176	1.58	0.95
Riparian Forest	70	267	1.73	0.94
Primary Forest	54	255	1.64	0.95

The high species richness and abundance of birds in the riparian forest strip were due to the combined presence of both forest dwelling and open dwelling species in the area. The similarity of vegetation characteristics between riparian forest strip and adjacent primary forest possibly attracted the forest dwelling species. Posa and Sodhi (2006) disclosed that bird species richness is positively correlated with vegetation characteristics such as the canopy size, tree density and ground cover. Similarly, Sallabanks et al. (2006) reported that the canopy cover was the best predictor of variation in abundance of numerous bird species. Moreover, the presence of native forest vegetation along the riparian forest strip could be another factor that possibly attracted the forest dwelling bird species. Rotenberg (2007) divulged that native vegetation played significant role in enhancing bird species richness in the plantation habitat. Meanwhile, the close proximity of

riparian forest strip to open habitat such as grasslands and swidden farms could have attracted open dwelling generalist bird species which resulted to further increase in the species richness and abundance of birds at this site.

Avifaunal Community Similarity

The similarity index of the avifaunal community between swidden farm and the primary forest had the lowest value (Ro=0.48) (Figure 1). This suggests that the assemblage of birds in the primary forest was less similar to those found in the swidden farm. This disparity could have been attributed to the loss and decline of forest dwelling species and the increased presence of open dwelling generalist species in the swidden farm. Thiollay et al. (2005) subscribe to this idea by declaring that the rapid decrease in the number of forest species in plantations was offset by an increase in the number of open habitat species.

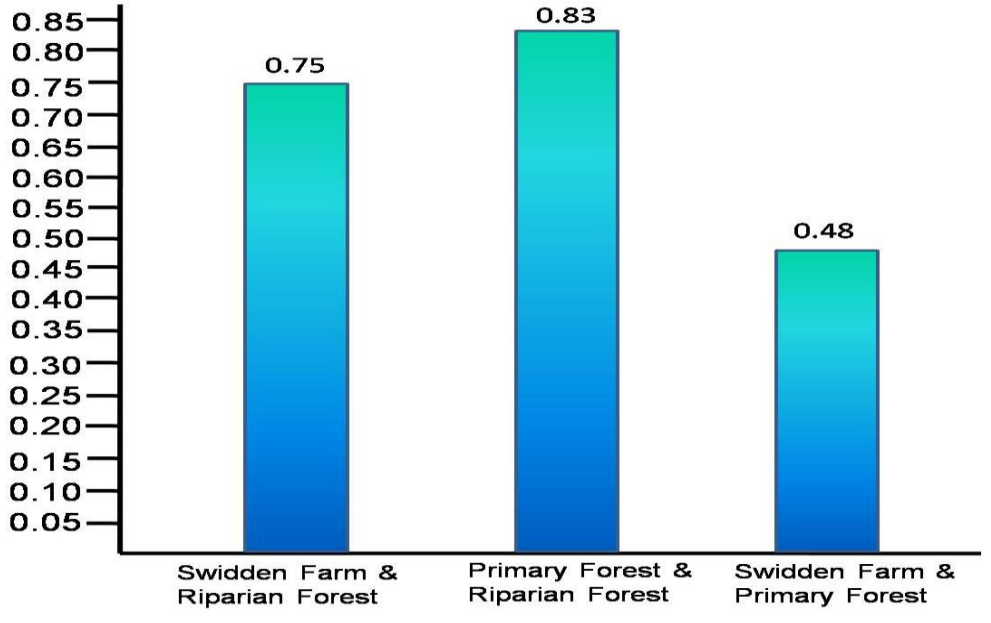

Figure 1. Degree of similarity (Horn's Information Theoretic Index) of avifaunal communities in swidden farm, riparian forest and primary forest.

In contrast, the similarity index between the bird communities of primary forest and riparian forest (Ro=0.83) was the highest among all compared sites. Similarly, the similarity index between bird communities of riparian forest strip and swidden farm was also comparably high (Ro=0.75). This suggests that the bird community in the riparian forest was similar to those found in the primary forest and to those found in the swidden farm. Chan et al. (2008) confirmed the importance of riparian forest ecosystem in forest birds when they observed distribution patterns of birds and insect prey in a tropical riparian forest. They disclosed that more birds (both number of individuals and species) were recorded in the riparian zone than in upland forest during wet season due to the availability of adult aquatic insects. The presence of strict forest dwellers in the riparian forest strip magnifies its importance in enhancing the localized movements of forest dwelling species between forest fragments. According to the study conducted by Mosley et al. (2006), the riparian forest strip functions as movement corridors during breeding and fall migration periods of birds in boreal mixed wood forest in Northeastern Ontario, Canada. Another factor that could have attracted the forest dwelling birds in the riparian forest strip was the presence of the remnant native vegetation. In some studies it was observed that native vegetation enhances the presence of avifaunal species in a given area (Rotenberg 2007; Haslem & Bennett 2008; Manhood et al. 2012). Aside from the forest dwelling bird species, diverse open dwelling birds found in the swidden farm also visit the riparian forest strip as indicated by the high similarity index value between these two sites. Some open dwelling species could have been attracted by the availability of more food in the riparian forest strip. Open dwelling generalist species that can tolerate forest edges and other species that visits the streams were common visitors recorded in the riparian forest. It was also observed that some members of the family Columbidae that prefers open habitat such as the Spotted Dove (*Spilopelia chinensis*) and Zebra Dove (*Geopelia striata*) and some members of family Estrildidae such as the White-Bellied Munia (*Lonchura leucogastra*) and Chestnut Munia (*Lonchura atricapilla*) used trees along the edges of riparian forest as nesting places.

Level of Endemism of Birds

All the Palawan endemic bird species (15) recorded in the study area were also found in the primary forest. Among these, 13 species were also found in the riparian forest while only seven species were also recorded in the swidden farm (Figure 2). Equally high number of resident species (7 species) with Palawan endemic race was recorded in both the primary forest and riparian forest strip. On the other hand, only four species of birds with

Palawan endemic race was found in the swidden farm. Finally, out of the four Philippine endemic bird species recorded across the habitat surveyed, two were found in the primary forest, three were found in the riparian forest and only one was found in the swidden farm.

The results indicate that the riparian forest strip has the capacity to support both endemic bird species and races. Conserving this forest strip within the swidden vegetation matrix will improve the overall abundance and richness of endemic bird species and races at a landscape level. However, the data also exposed that the primary forest supports some Palawan endemic birds that were not recorded in the riparian forest such as the Palawan Peacock-Pheasant (*Polyplectron napoleonis*) and Palawan Blue Flycatcher (*Cyornis lemprieri*). Mallari et al. (2011) corroborates with this observation by declaring that old growth forest has the highest conservation value for Palawan's endemic birds. Similarly, Riley (2003) come up with a similar finding by asserting that endemic and threatened birds in Karakelang, Talaud Islands, Indonesia were encountered more frequently or occurred at higher densities in the primary forest. This strongly suggests that maintaining the stands of primary forest fragments within the upland agricultural vegetation matrix is important for the conservation of endemic birds.

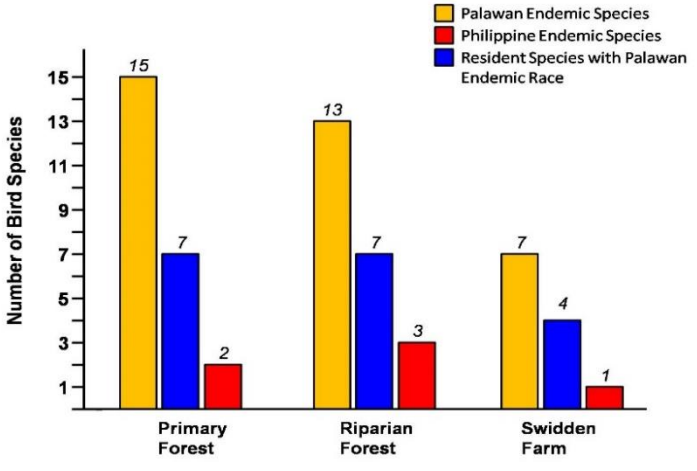

Figure 2. Number of endemic species and races found in swidden farm, riparian forest and primary forest sites.

On the other hand, the swidden farm has little value in conserving both the endemic bird species and endemic bird races. Expanding the area used for upland agriculture will not only compromise the overall species richness and abundance of birds, but will also have undesirable

consequences to the population of endemic birds. The sensitivity of forest dwelling endemic birds to habitat modifications highlights their vulnerability to habitat degradation (Wijesinghe and Brooke 2005).

Presence of Conservation Priority Bird Species

Out of the total number of bird species recorded, 12 species were included in the 2016 Red List of Globally Threatened Species set by the International Union for the Conservation of Nature (IUCN 2017). Among the red listed birds, seven species were classified in the category near-threatened, four species were classified in the category vulnerable and one was listed in the category endangered. More importantly, four out of the seven near-threatened, three out of the four vulnerable and the only endangered bird species were also endemic to Palawan. These bird species have narrow geographical distribution and most of them are forest specific which are vulnerable to forest degradation (Posa and Sodhi 2006).

Primary forest has the highest number of conservation priority species followed by the riparian forest strip and swidden farm (Figure 3). All the near-threatened (7), vulnerable (4) and endangered (1) birds recorded in all the sites were also found in the primary forest while only five near-threatened, three vulnerable and one endangered species were recorded on riparian forest strip. Meanwhile, only one near- threatened species and no vulnerable and endangered species were recorded in the swidden farm. The results unveiled that although primary forest harbors the highest number of conservation priority bird species, the riparian forest also supports many conservation priority bird species. In contrast, the swidden farm provides less support to conservation priority bird species. This finding explicitly exposed that most of the conservation priority bird species in the study area are forest dependent and are sensitive to habitat degradation. In a much wider scale, it was confirmed that 75% of the threatened birds globally are dependent to forest (Simberloff 2001).

Among the seven species of near-threatened birds found in the primary forest, four were Palawan endemic species. These are the Palawan Tit (*Periparus amabilis*), Palawan Blue Flycatcher (*Cyornis lemprieri*), Blue Paradise-Flycatcher (*Terpsiphone cyanescens*) and Spot-Throated Flameback (*Dinopium everetti*). Likewise, three out of the four vulnerable birds recorded in the primary forest were also Palawan endemic species. These are the Palawan Hornbill (*Anthracoceros marchei*), Palawan Peacock-Pheasant (*Polyplectron napoleonis*) and Blue-Headed Racquet-Tail (*Prioniturus platenae*). Finally, the only endangered endemic bird species recorded in the study area, the Red-Headed Flameback (*Chrysocolaptes*

erythrocephalus) was also recorded in the primary forest. These data highlight the importance of primary forest habitat in the conservation of threatened endemic birds.

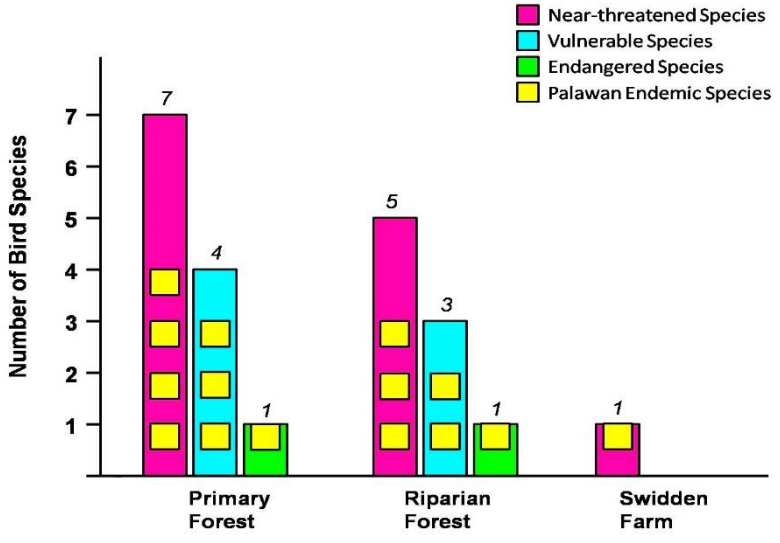

Figure 3. Number of species and endemism of conservation priority birds found in swidden farm, riparian forest and primary forest based on the IUCN Red List of Globally Threatened Species (2016).

Most of the conservation priority endemic bird species found in the primary forest were also recorded in the riparian forest. Three out of the four near-threatened, two out of the three vulnerable and the only endangered endemic bird species recorded in the primary forest also thrive in riparian forest strip. This result clearly indicates that the riparian forest strip is also important in supporting the conservation priority endemic bird species. On the contrary, only one near-threatened bird species was found in the swidden farm. This suggests that the disturbance in the swidden farm causes significant changes in its bio-physical features that end up losing its ability to support the conservation priority endemic species.

CONCLUSIONS AND RECOMMENDATIONS

The riparian forest strip that grows along the steep slopping banks of the meandering tributary streams in the upland agricultural landscape is an

important habitat and feeding ground for a wide array of bird species as shown by high species richness, abundance and diversity index values. The high community similarity index between bird communities of riparian forest strip and primary forest suggests that most birds found in the primary forest are also found in the riparian forest strip. Likewise, the high community similarity index between bird communities of riparian forest strip and swidden farm also suggests that most birds found in the swidden farm are also visiting the riparian forest strip. Despite the dissimilarity of bird assemblage that thrive in the primary forest and swidden farm as reflected by the low community similarity index, these birds congregate in riparian forest strip. One of the possible reasons for the attraction of forest birds in the riparian forest strip is the presence of indigenous large trees and thick understory vegetation which is much similar to the ambient environment of the primary forest. On the other hand, open dwelling species thriving in the upland agricultural areas are possibly attracted by the food supply and nesting sites in the riparian forest strip. Furthermore, riparian forest fragment is also an important habitat for endemic and threatened birds in highly degraded vegetation matrix.

As the conversion of forest to swidden farms and other upland development considerably decreased the avifaunal species richness, abundance, diversity, number of endemic and high conservation priority species, having a well preserved network of riparian forest strip connected to the primary forest stands closed to it will generally enhance the existing bird community at the landscape level.

An information and education campaign must be conducted to educate the local people about the significance of riparian forest fragments in the conservation of endemic and high conservation priority bird species. It must effectively disseminate the importance of riparian forest strips in enhancing the depauperate avifaunal diversity in the upland agricultural vegetation matrix and at the same time convey information on the invaluable ecosystem functions and services done by different birds.

The local government unit must come up with a management plan which aims to limit further expansion of swidden agriculture in the remaining primary forest and at the same time address the welfare of the people living in the area by providing low impact sustainable livelihood options. Additionally, it is suggested that a well monitored and guided co-management scheme between upland swidden farmers and responsible government units leading to the protection and conservation of riparian forest strips be implemented.

ACKNOWLEDGEMENTS

The author would like to acknowledge the Tagbanua community in Sagpangan, Aborlan, Palawan for sharing their experiences and stories on birds and for serving as guides during the assessment. The comments and suggestions of two anonymous external reviewers helped improved this paper.

REFERENCES

Banaticla MN, Palijon AM and Takeuchi K. 2008. Assessing local variation in shifting cultivation and fallow management among households in the Kalahan forest reserve, Northern Luzon, Philippines. Journal of Nature Studies, 7(2): 129-143.

Barzan FR, Baigorria JME and Bo RF. 2015. Bird community diversity in three habitat types in an ecological corridor in the Atlantic Forest of Misiones Province, Argentina. Tropical Conservation Science, 8(4):955-974.

Bibby C, Jones M and Marsden S. 1998. Expedition Field Techniques: Bird Surveys. Expedition Advisory Centre. Royal Geographic Society. London. 137p.

Brady NC. 1999. The Nature and Properties of Soil. Prentice-Hall Incorporated. United States of America.

Cadiz G and Buot Jr. IE. 2009. An enumeration of woody plants of Catipla forest fragments Cebu Island, Philippines. Philippine Journal of Systematic Biology, 3:1-7.

Carete M, Tella JL, Blanco G and Bertellotti M. 2009. Effects of habitat degradation on the abundance, richness and diversity of raptors across Neotropical Biomes. Biological Conservation, 142:2002-2011.

Cavarzere V, Da Costa TVV and Silveira LF. 2012. On the use of 10-minute point counts and 10-species lists for surveying birds in lowland Atlantic forests in Southern Brazil. Papéis Avulsos de Zoologica. Museu de Zoologica da Universidad de Sáo Paulo, 52(28):333-340.

Chan EKW, Yu Y, Zhang Y and Dudgeon D. 2008. Distribution patterns of birds and insect prey in a tropical riparian forest. Biotropica, 40(5):623-629.

Chapman KA and Reich PB. 2007. Land use and habitat gradients determine bird community diversity and abundance in suburban, rural and reserve landscapes in Minnesota, USA. Biological Conservation, 135:527-541.

Conklin HC. 1957. Hanunuo agriculture: a report of an integral swidden system of shifting cultivation in the Philippines. FAO Forestry Development Paper No. 12. Volume II of the FAO Series on Shifting Cultivation. Food and Agriculture Organization of the United Nations. Rome. 209p.

Dressler W. 2005. Disentangling Tagbanua lifeways, swidden and conservation on Palawan Island. Human Ecology Review, 12(1):21-29.

Eder JF. 1987. On the Road to Tribal Extinction: Depopulation, Deculturation and Adaptive Well-Being Among the Batak of the Philippines. Berkeley: University of California Press. USA. 277p.

Eder JF. 2006. Land use and economic change in the post frontier upland Philippines. Land Degradation and Development 17:149-158.

Gibbons DW and Gregory RD. 2006. Birds. In: Sutherland W (ed). Ecological Census Techniques: A Handbook. 2nd edition. Cambridge University Press, United Kingdom. 432p.

Gill F and Donsker D. Eds. 2017. IOC World Bird List (v 7.2). http:// www.worldbirdnames.org. doi.org/10.14344/IOC.ML.7.2. Accessed on 27 April 2017.

Harvey C, Medina A, Sanchez D, Vilchez S, Hernandez B, Saenz J, Maes J, Casanoves F and Sinclair F. 2006. Patterns of animal diversity in different forms of tree cover in agricultural landscape. Ecological Applications, 16(5):1986-1999.

Haslem A and Bennett AF. 2008. Birds in agricultural mosaics: the influence of landscape pattern and countryside heterogeneity. Ecological Applications, 18(1)185-196.

Hyndman D, Duhaylungsod L, Thomas B. 1994. To the last grain of rice: T'boli subsistence production. Dialectical Anthropology, 19: 45-79.

IUCN (2016). The IUCN Red List of Threatened Species. Version 2016-3. http://www.iucnredlist.org. Accessed on 12 May 2017.

Lacuna-Richman C. 2006. The use of non-wood forest products by migrants in a new settlement: experiences of a Visayan community in Palawan, Philippines. Journal of Ethnobiology and Ethnomedicine, 2:36.

Mallari NAD, Collar NJ, Lee DC, McGowan PJK, Wilkinson R and Marsden SJ. 2011. Population densities of under storey birds across a habitat gradient in Palawan, Philippines: implications for conservation. Oryx, 45(2): 234-242.

Manhood SP, Lees AC and Peres CA. 2012. Amazonian countryside habitats provide limited avian conservation value. Biodiversity Conservation, 21(2):385-405.

Mosley E, Holmes SB and Nol E. 2006. Songbird diversity and movement in upland and riparian habitats in boreal mixedwood forest of Northeastern Ontario. Canadian Journal of Forest Research, 36(5):1149-1164.

Posa MC and Sodhi NS. 2006. Effects of anthropogenic land use on forest birds and butterflies in Subic Bay, Philippines. Biological Conservation, 129:256-270.

Rice D. 1981. Upland Agricultural Development in the Philippines: an Analysis and a Report on the Ikalahan Programs, p79-90. In: Olafson H. (ed). Adaptive Strategies and Change in Philippine Swidden-Based Societies. Forest Research Institute. PDM Press Incorporated. Laguna, Philippines.

Riley J. 2003. Population sizes and the conservation status of endemic and restricted-range bird species on Karakelang, Talaud Islands, Indonesia. Bird Conservation International, 13(1):59-74.

Rotenberg JA. 2007. Ecological role of a tree (Gmelina arborea) plantation in Guatemala: An assessment of an alternative land use for tropical avian conservation. The Auk, 124(1): 316-330

Sallabanks R, Haufler J and Mehl C. 2006. Influence of forest vegetation structure on avifaunal community composition in West-Central Idaho. Wildlife Society Bulletin, 34(4):1079-1093.

Shankar Raman T, Rawat G and Johnsingh J. 1998. Recovery of tropical rainforest avifauna in relation to vegetation succession following shifting cultivation in Mizoram, North-East India. Journal of Applied Ecology, 35(2):214-231.

Simberloff D. 2001. Threatened birds of the world. The Auk, 118(4):1112-1113.

Sopsop LB and Buot Jr IE. 2011. Human forest interaction in Aborlan Guba system, Palawan Island, Philippines: implications for conservation and management. Asia Life Sciences: The Asian International Journal of Life Sciences, 20(1):155-173.

Suarez RK and Sajise PE. 2010. Deforestation, swidden agriculture and Philippine biodiversity. Philippine Science Letters, 3(1):91-99.

Sutherland W. 2000. The Conservation Handbook: Research, Management and Policy. Blackwell Publishing, Australia. 278p.

Thiollay JM, Castelletta M and Sodhi N. 2005. The effects of extreme forest fragmentation on the bird community of Singapore Island. Biological Conservation, 121(1):135-155.

Warner K. 1981. Swidden strategies for stability in a fluctuating environment: The Tagbanua of Palawan, p13-28. In: Olafson H. (ed). Adaptive strategies and change in the Philippine swidden-based societies. Forest Research Institute. PDM Press Incorporated. Laguna, Philippines.

Wijesinghe M and Brooke M. 2005. Impact of habitat disturbance on the distribution of endemic species of small mammals and birds in a

tropical rain forest in Sri Lanka. Journal of Tropical Ecology, 21(6):661-668.

ARTICLE INFO

Submitted: 14 March 2017
Revised: 21 May 2017
Accepted: 7 July 2017

Toxicity of dispersed oil on Gold–saddle rabbitfish *Siganus guttatus* fry

Rodulf Anthony T. Balisco[1,2] and Gerald F. Quinitio[2]
[1]College of Fisheries and Aquatic Sciences
Western Philippines University – Puerto Princesa Campus
Sta. Monica, Puerto Princesa City, Palawan
[2]Institute of Marine Fisheries and Oceanology
College of Fisheries and Ocean Sciences
University of the Philippines Visayas, Miagao, Iloilo, Philippines
Corresponding author: ratbalisco@gmail.com

ABSTRACT

The acute toxicity of dispersant Mardeus-455 added to water accommodated fractions (WAF) were evaluated in Gold-saddle rabbitfish *Siganus guttatus* fry after 72 h exposure under laboratory conditions. Mortalities of fry exposed to different concentrations of dispersed oil were recorded every hour for the first 6 h, every 3 h for the next 12 h, and every 6 h thereafter. Results showed that the higher the ratio of dispersant and WAF, the higher the mortality of the rabbitfish fry which may be due to the enhanced availability of polyaromatic hydrocarbons (PAH). The LC_{50} was computed at 3.692% of the oil volume. The application of dispersant in cleaning oil spills must be limited to reduce its harmful effect in the marine environment. Assessing toxicity of dispersed oil in fish fry may help understand the extent of environmental damage after cleaning oil spill using dispersant.

Keywords: acute toxicity, dispersed oil, *Siganus guttatus,* water accommodated fraction, mortality

INTRODUCTION

Oil spill is a common sea mishap occurring worldwide that affects the marine environment and its organisms. Several concerned agencies are on full alert to mitigate the impacts of the oil spill the soonest possible time. One of the famous oil spill incidents that occurred in world history was the Exxon Valdez in 1989 that spilled 41 million liters of oil into the marine environment (Lin and Mendelssohn 2004). In the Philippines, the oil spill incident off Guimaras coasts in 2006 by MT Solar I tanker spilled an estimated 7.6 million liters of oil which brought much attention not only from the national government, research and academic institutions, but also from the private

The Palawan Scientist, 9: 37-48

sectors because of the impact it brought in one of the richest fishing grounds in the country (Uno et al. 2010).

To minimize the destruction caused by oil spills, different clean-up methods are being used to mitigate the effect of spilled oil in the marine environment before it reaches the shorelines and its organisms (McIntosh et al. 2010). Of these methods, dispersants are widely used. The chemical dispersants are applied to breakdown oil and move it from the top of the water, making the oil easily dissipated in the atmosphere (Fiocco and Lewis 1999). This method helps in cleaning and restoring the status of affected areas, but dispersant combined with oil slick in the water becomes more toxic to marine organisms since dispersed oil is incorporated in the water column (Page et al. 2000). Some reports indicated that the use of dispersant alone posed lower toxicity than dispersed oil when tested in marine organisms (Fingas 2008). However, the viability of dispersant as a mean to control and minimize the overall environmental damage has been proven and is cost effective.

The aftermath effects of oil spill are much anticipated in the coastal areas since after the spill, water are mixed with oil due to current and wave action. This creates the water accommodated fraction (WAF) mixed with water column (McIntosh et al. 2010). Beach, mangrove flats and seagrass beds are the first affected by oil spill since these areas serve as the nursery and feeding ground of juveniles of marine organisms. Observations during various oil spill accident, where dispersants have been used, have shown a considerable mortalities among marine animals in the intertidal zones (Rice et al. 1977). Once these areas are affected by oil spill and dispersants are applied in nearshore environment, the aquatic organisms are at risk and high mortality is observed when improperly used (Rice et al. 1977, Milinkovitch et al. 2011). The toxicity of the oil spill and dispersant will affect future food supply since recruitment will be hindered.

Despite the number of publications on the toxicity of crude oil and dispersed oil in marine organisms, most of these studies deal on long term toxicity (i.e. >10 days) (Lockhart et al. 1996, Cohen and Nugegoda 2000, Scarlett et al. 2006). The rabbitfish (family Siganidae) being a tropical fish have fry that normally inhabit seagrass beds and can easily be affected during oil spill events. It is important to determine the toxicity of dispersed oil to rabbitfish fry since they usually inhabit the upper water column at this stage and can be found in the estuaries and coastal areas where the spilled oil are usually carried over time. A study on the toxicity of crude oil and oil-dispersant mixtures to juvenile rabbitfish *Siganus rivulatus* was conducted (Eisler and Kissil 1975). Quinitio and Siladan (2013) also studied the

reproductive performance of *Siganus guttatus* exposed to dispersed bunker oil but uses mature individuals from areas affected during the 2006 Guimaras oil spill incident. No similar study was conducted for *S. guttatus* fry. To address such gap, this study aimed to determine the mortality of Gold-saddle rabbitfish *Siganus guttatus* fry exposed to dispersed oil for 72 h. Moreover, the LC_{50} of the dispersed oil was also determined.

MATERIALS AND METHODS

Experimental Animal

The Gold-saddle rabbitfish (*S. guttatus*) fry with 1.8-2.5 cm total length were obtained from the Marine Fish Hatchery of Aquaculture Department of the Southeast Asian Fisheries Development Center (SEAFDEC/AQD). The fry were stocked in basins and provided with aeration for three days acclimation prior to the experiment. These were fed to satiation with artificial feeds twice a day until they were acclimatized. The fry were not fed 24 h prior to and during exposure to the experiments.

Experimental Treatments

Water accommodated fraction preparation. The water accommodated fraction (WAF) was prepared in a closed, low-energy system using filtered (0.40 µm) seawater (35 ppt). The filtered seawater (3600 ml) was placed in amber, round glass flask, and 400 ml of crude oil (Petron Bunker C oil) was added by drops on the water surface while stirring using a magnetic stirrer with speed set at 360 rpm. The stirring was carefully controlled to avoid a large vortex and formation of oil droplets or emulsions. After 18 h of stirring, the WAF was siphoned out and placed in glass jars leaving 500 ml only. The WAF (500 ml) was then diluted in 10 L water to have a final ratio of 1:300 (oil and water). This prepared WAF is effective for 2–3 days (El Samra et al. 1986).

Preparation of treatments. The dispersant Mardeus–455 used was obtained from the Marine and Environmental Protection Command of the Philippine Coast Guard (PCG–MEPCOM). This was applied in an aquarium filled with 10 L WAF per treatment. The rabbitfish fry were exposed to different levels of toxicity 30 min after the application of dispersant to the WAF.

The different treatments with the amount of WAF and dispersants used are shown in Table 1. The treatment used was based on the study of

Barron (2003) where they used dispersant: oil ratio of 1:10 to 1:50. Each treatment had four replicates. The fry were exposed to the different treatments and 72-h LC_{50} (lethal concentration wherein 50% of the population died) were determined.

Each aquarium was aerated and stocked with 10 fry. The number of surviving fry was checked every hour for the first 6 h, every 3 h for the next 18 h, and every 6 h from 24 h to 72 h. The fry were considered dead if no opercular movement were observed, and/or seen floating in the water surface.

Table 1. The volume of water accommodated fraction and dispersant and the corresponding oil: water ratio used in different treatments.

Treatment	Number of test fry per replicate	Volume of dispersant (ml)	Dispersant: oil ratio (%)
*Control	10	0	WAF only
1	10	0.44	1:80 (1.25)
2	10	0.88	1:40 (2.50)
3	10	1.16	1:30 (3.33)
4	10	1.75	1:20 (5.00)
5	10	3.50	1:10 (10.00)

Water parameters. Water temperature and salinity were measured every time the mortality was checked which started from the start of the experiment. The salinity and water temperature range were 34 – 35 ppt and 25 – 28.5°C, respectively.

Statistical Analyses

The LC_{50} of the dispersant was determined using Probit Analysis of the Statistical Package for Social Sciences (SPSS ver. 15). Mortality was first log transformed and fitted with the probit values before it was analyzed. The LC_{50} was computed using the formula:

$y = a + bx$

Where:

y = probit value at LC_{50} (value is 5)
a = intercept
b = slope
x = unknown variable

In determining the significant differences between and among treatments, analysis of variance (ANOVA) was used in each period at α = 0.05.

RESULTS

The mean cumulative mortality of rabbitfish fry are shown in Figure 1. When the fish were exposed to the different treatments, it was noted that they were lurking around the aquarium and seemed to gasp for air. During the first hour of exposure (1h), the highest oil: dispersant ratio (Treatment 5) showed the highest mean mortality (100%), followed by Treatment 4 (92.5%), Treatment 3 (25.0%), Treatment 2 (7.5%), and Treatment 1 (2.5%).No mortality was observed in the Control treatment. The mean cumulative mortality in the Control and Treatments 1 and 2 were significantly different from that of Treatments 3, 4 and 5. On the other hand, the mean cumulative mortality in Treatment 3 were significantly different ($p<0.05$) with Treatments 4 and 5, while no significant differences were observed between Treatments 4 and 5 ($p>0.05$).

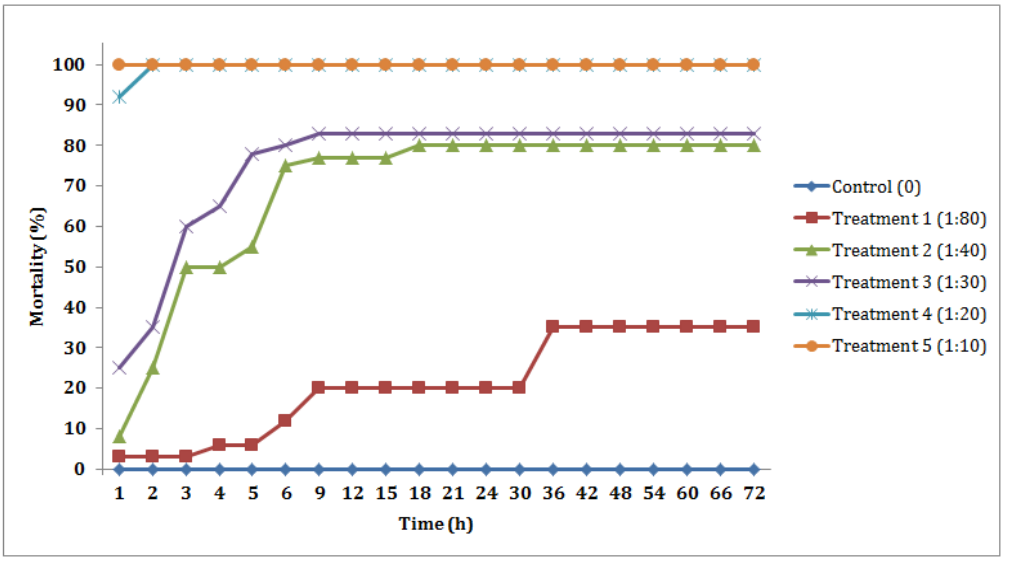

Figure 1. Mean cumulative mortality of Gold-saddle rabbitfish *Siganus guttatus* fry exposed to different concentrations of dispersed oil in different time scales.

After 2 h, all fry were dead in Treatment 4, and 25% and 35% of fry died in Treatments 2 and 3, respectively. An increase in mortality was observed in Treatment 3 with a mean of 60.0% after 3 h. Treatment 2 had 50.0% mean mortality and it was 2.5% in Treatment 1. During 3 h of exposure, mean mortality in the Control and Treatment 1 already showed significant difference ($p<0.05$) with Treatments 2 and 3. Treatments 2 and 3 showed significant difference ($p<0.05$) with Treatments 4 and 5.

In the fourth hour of exposure, 65.0% of the fry were dead in Treatment 3, 50% in Treatment 2, 7.5% in Treatment 1, and still no mortality in the Control. After 5 h, 77.5% mean cumulative mortality was observed in Treatment 3, 57.5% in Treatment 2, no increase in mortality in Treatment 1 (7.5%), and Control (0%). On the other hand, a mean of 80% had died in Treatment 3, 75.0% in Treatment 2, 12.5% in Treatment 1, and no mortality in the Control at the 6 h of exposure. During these exposure periods, the Control and Treatment 1 showed significant difference ($p<0.05$) with Treatments 2, 3, 4 and 5. On the other hand, Treatments 2 and 3 showed significant difference ($p<0.05$) with Treatments 4 and 5. The difference in the mean cumulative mortality among treatments changed after 6 h of exposure, wherein the Control and Treatment 1 were already significantly different ($p<0.05$) with Treatments 2, 3, 4 ,and 5 but no significant difference ($p>0.05$) were observed among the latter four treatments.

The trend of mean cumulative mortality seemed to have changed at the 9 h of exposure, wherein 80.0% occurred in Treatment 3, 77.5% in Treatment 2, 20.0% in Treatment 1, and still no mortality in the Control. The Control had significant difference ($p<0.05$) with Treatments 1, 2, 3, 4 and 5, while Treatments 1, 2 and 3 also had significant difference ($p<0.05$) with that of Treatments 4 and 5. This trend continued until the 12 h of exposure, but Treatment 3 had changed at 12 h with 82.5%, showing no significant difference ($p>0.05$) with Treatments 4 and 5. At 15 h, an increased mean cumulative mortality of 80.0% was observed in Treatment 2 and was already not significantly different ($p>0.05$) with Treatments 3, 4 and 5. From then on until 72 h, no increase in mortality had been recorded, showing a plateau in the mortality rate curve. Treatments 4 and 5 showed highest mean cumulative mortality (100.0%) at the end of the 72 h exposure period, followed by Treatment 3 (82.5%), and Treatment 2 (80.0%). Only 20% of the fry died in Treatment 1, and no mortality was observed in the Control.

The LC_{50} of all treatments was calculated to be 3.692%. This means that 3.692% of the oil volume may give a 50% mortality to rabbitfish fry.

DISCUSSION

This study showed the toxicity of different dispersant concentrations applied to WAF using rabbitfish (*S. guttatus*) fry as test animal in a 72-h exposure period. The mortality in each treatment increased with time, except in the Control. In the 1 h after exposure, mortality in the Control and Treatments 1 and 2 (low dispersant concentrations) were lower compared to that of Treatments 3, 4 and 5 (high dispersant concentrations). The two highest concentrations (Treatments 4 and 5) showed abrupt mortalities during the first hour of exposure. It is possible that in the high dispersant concentrations, the PAHs of the oil were already available in the water, which may be the main cause of fry mortality (Singer et al. 1998) in the 1st, 2nd and 3rd hour of exposure. These results showed that when higher concentrations of dispersant were added in the WAF, higher mortalities occurred among the rabbitfish fry. The same result was observed by Cohen et al. (2005) in the 96-h toxicity test of Australian bass (*Macquaria novemaculeata*) using dispersed crude oil, where they noted that almost 90% of the test animals already died in the 6 mg/L dispersant: oil ratio. Moreover, Edwards et al. (2003) had similar results using inland silverside *Menidia beryllina* and estuarine invertebrate *Mysidopsis bahia* as test animals, wherein 80% mortality was observed in a 72-h exposure period. The recommended use of a dispersant-to-oil percentage of 20% (1:5) in the red sea bream (*Pagrus major*) yielded higher oil concentrations in the water, and resulted in a higher mortality rate than the use of lower percentages of dispersant to oil (Koyama and Kakuno 2004).

Generally, the effects of the different concentrations of the dispersant vary with brands. The effectiveness of dispersant generally increases with increasing dispersant application (Fingas 2002). In the study of DeCola (1999, as cited by Barron 2003) under laboratory conditions of the dispersant Corexit 9500 on the Alaska North Slope crude oil, the dispersant effectiveness was directly proportional to the dispersant: oil ratio, ranging from 1:10 to 1:50. Polyaromatic hydrocarbons (PAH) were accounted for much of the toxicity based on several studies (Barron et al. 2003, Gonzales et al. 2006). Dispersed droplets are also important route of exposure that causes mortality of some organisms in the marine environment either through droplet/gill interactions or through ingestion (Fuller et al. 2004). Studies showed that some organisms accumulated PAHs differently via particulate or dissolve routes. Marine organisms may also be exposed to oil by contamination of their food. Many oil constituents, such as the monoaromatics (MAHs) and PAHs are narcotic substances which cause a state of arrested activity of protoplasmic structures (Barron et al. 2003). Many studies have found that the PAH concentration is much higher in

chemically-dispersed oil than for physically-dispersed oil (Barron 2003). Moreover, several researchers have recently noted higher toxicities of chemically-dispersed oil and that the PAH bioaccumulation kinetics are increased in chemical dispersions (Committee 2006). This study proved that chemically dispersed oil is more toxic in marine organisms than crude oil alone. The result of this study also concurs to Almeda et al. (2014) where chemically dispersed oil caused greater mortality in microzooplankton than crude oil alone.

The LC_{50} of a substance is the "lethal concentration of which 50% of the test population died". A LC_{50} of 3.692 was determined in this study which indicates that a 3.692% of the dispersant: oil ratio gave a 50% mortality in rabbitfish fry samples. This low LC_{50} might be attributed to the dispersant's low surfactant components when it was manufactured. The study by Greco et al. (2006) calculated a 6.6% LC_{50} of Corexit 9500 when it was used in dispersing spilled oil in Alaskan waters. It is possible that different brands of dispersant would give different LC_{50}.

This study revealed that no mortality was observed in crude oil (WAF) alone and the lowest dispersant application (0.44 ml) had lower mortality compared with the other treatments. This suggests that the application of 5% or higher dispersant (1:20 dispersant: oil ratio) on WAF would give significant mortality to rabbitfish fry. Rhoton et al. (2001) found out that application of Corexit 9527 alone is less toxic compared when it was applied in crude oil in *Menidia berylina* juvenile. This is because oil treated with dispersants enhances the droplet formation of oil, increasing both its accommodation into the water column and its solute-solvent interfacial contact area (Singer et al. 1998). Bobra et al. (1989) showed that toxicity of dispersed oil on eggs and juvenile of marine fish have different sensitivity compared to mature fish. This is also in accordance to some studies were early life stages of marine fish seems to be more sensitive to PAH exposure than adult fish (McIntosh et al. 2010). Mature life stages of animals are more tolerant to exposures in different oil-dispersant mixtures compared to eggs and juvenile fish (Fingas 2002). It was also suggested that variations in PAH resistance of different life stages of marine fish may reveal the differences in the bioaccumulation of hydrocarbons by eggs and larvae (Carls and Rice 1988).

Based on the results of this study, WAF alone and WAF applied with the lowest concentrations of dispersant (1.25% dispersant to oil volume) incurred the lowest mortality while the dispersed oil concentration of 5% and 10% incurred the highest mortalities on rabbitfish *S. guttatus* fry in a 72-h exposure. The higher the dispersant: oil ratio, the higher the mortality which was attributed to increased concentration of dispersant that caused the

polyaromatic hydrocarbons (PAHs) in the WAF to become more available in the water which are known to be toxic. Even at the lowest dispersant: oil ratio, mortality occurs and may affect mortality of siganid fry.

While the purpose of dispersant is to reduce the effect of oil spill in aquatic ecosystems, it turns out that application of dispersant to mitigate the negative impact of oil spill complicates the problem. The application of dispersant in cleaning oil spills must be limited to reduce its harmful effect in the marine environment and its organisms. A similar study using adult rabbitfish must also be considered. Since there are no documented studies on the effect of dispersant Mardeus-455, it is recommended to compare its toxicity with other brands of dispersant in rabbitfish and in other marine organisms to provide more adequate information on the negative effects of dispersants in aquatic environment if not used properly.

ACKNOWLEDGMENTS

We would like to thank the Marine Finfish Hatchery of SEAFDEC/AQD Tigbauan Main Station for providing the rabbitfish fry, and to PCG–MEPCOM - Western Visayas for providing the dispersant. The help of Manong Condring in the preparation of WAF and various aquaria is also appreciated. The senior author was a recipient of the DOST-PCAMRD scholarship for the MS Fisheries (Fisheries Biology) degree. We are also thankful to the comments and suggestions of two anonymous reviewers.

REFERENCES

Almeda R, Hyatt C and Buskey EJ. 2014. Toxicity of dispersant Corexit 9500A and crude oil to marine microzooplankton. Ecotoxicology and Environmental Safety, 106:76-85.

Barron MG. 2003. Critical evaluation of CROSERF test methods for oil dispersant toxicity testing under subarctic conditions. Prince Williams Sound Regional Citizen's Advisory Council, Anchorage, Alaska. 13 p.

Barron MG, Caris MG, Short JW and Rice SD. 2003. Photoenhanced toxicity of aqueous phase and chemically dispersed weathered. Alaska North Slope Crude Oil to Pacific Herring eggs and larvae. Environmental Toxicology and Chemistry, 22: 650-660.

Bobra AM, Shiu WY, Mackay D and Goodman RH. 1989. Acute toxicity of dispersed fresh and weathered crude oil and dispersants to *Daphnia magna.* Chemosphere, 19:1199-1222.

Carls MG and Rice SD. 1988. Sensitivity differences between eggs and larvae of walleye pollock, *Theragra chalcogramma*, to hydrocarbons. Marine Environmental Research, 26: 285-297.

Cohen AM and Nugegoda D. 2000. Toxicity of three oil spill remediation techniques to the Australian bass *Macquaria novemaculeata.* Ecotoxicology and Environmental Safety, 47 (2):178-185. (https://doi.org/10.1006/eesa.2000.1946)

Cohen AM, Gagnon MM and Nugegoda D. 2005. Alterations of metabolic enzymes in Australian bass *Macquaria novermaculeata* after exposure to petroleum hydrocarbons. Environmental Toxicology and Chemistry, 49:200-205.

Committee on Understanding Oil Spill Dispersants: Efficacy and effects (Committee) 2006. Toxicological effects of dispersants and dispersed oil. Chapter 5. In: Oil spill dispersants: efficacy and effects. The National Academies Press, Washington, D.C. 193-275.

Edwards KR, Lepo GE and Lewis MA. 2003. Toxicity comparison of biosurfactants and synthetic surfactants used in oil spill remediation to two estuarine species. Marine Pollution Bulletin, 46:1309-1316.

Eisler R and Kissil GW. 1975. Toxicities of crude oils and oil-dispersant mixtures to juvenile rabbitfish, *Siganus rivulatus.* Transactions of the American Fisheries Society, 104 (3):571-578. http://dx.doi.org/10.1577/15488659(1975)104<571:TOCOAO>2.0.CO;2)

El Samara MI, Ibrahim MA, Ahmed IF and Awartani SM. 1986. Dispersants to mullet fry (*Liza macrolepis*) of the Arabian Gulf. Qatar University Science Bulletin, 6:363-369.

Fingas M. 2002. A white paper on oil dispersant effectiveness testing large in tanks. Prince Williams Sound Regional Citizen's Advisory Council. Anchorage, Alaska. 26 p.

Fingas M. 2008. A review of literature related to oil spill dispersants especially relevant to Alaska. Prince William Sound Regional Citizen's Advisory Council. Achorage, Alaska. 146 p.

Fiocco RJ and Lewis A. 1999. Oil spill dispersants. Pure Applied Chemistry, 71 (1):27-42.

Fuller C, Bonner J, Page C, Ernest A, McDonald T and McDonald S. 2004. Comparative toxicity of oil, dispersant and oil plus dispersant to several marine species. Environmental Toxicology and Chemistry, 23:2941-2949.

Gonzales JJ, Viñas L, Franco MA, Fumega J, Soriano JA, Grueiro G, Muniategui S, Lopez-Mahia P, Prada D, Bayona JM, Alzaga R and Albaiges J. 2006. Spatial and temporal distribution of dissolved/dispersed aromatic hydrocarbons in seawater in the area

affected by the Prestige Oil Spill. Marine Pollution Bulletin, 53:250-259.

Greco G, Corra C, Garaventa F, Chelossi E and Faimali M. 2006. Standardization of laboratory bioassays with *Balanus amphitrite* larvae for preliminary oil dispersants toxicological characterization. Chemical Ecology, 22:163-172.

Koyama J and Kakuno A. 2004. Toxicity of heavy fuel oil, dispersant and oil-dispersant mixtures to a marine fish *Pagrus major.* Fisheries Science, 70:587-594.

Lin Q and Mendelssohn IA. 2004. Dispersant effects on salt marsh vegetation: Toxicity evaluation and oil remediation. Louisiana Applied and Educational Oil Spill Research and Development Program, OSRADP Technical Report Series 169-30-4151. 22 p.

Lockhart WL, Duncan DA, Billeck BN, Danell RA and Ryan MJ. 1996. Chronic toxicity of the water-soluble fraction of Norman wells crude oil to juvenile fish. Spill Science and Technology Bulletin, 3 (4):259-262.

McIntosh S, King T, Wu D and Hodson PV. 2010. Toxicity of dispersed weathered crude oil to early life stages of Atlantic herring (*Clupea harengus*). Environmental Toxicology and Chemistry, 29(5): 1160-1167. (https://doi.org/10.1016/S1353-2561(97)00024-8)

Milinkovitch T, Godefroy J, Theron M and Thomas-Guyon H. 2011. Toxicity of dispersant application: biomarkers responses in gills of juvenile golden grey mullet (*Liza aurata*). Environmental Pollution, 159 (10): 2921-2928.

Page CA, Bonner JS, Summer PL, McMonald TK, Autenrieth RL and Fuller CB. 2000. Behavior of chemically-dispersed oil and a whole oil on a near-shore environment. Water Research, 34(9): 2507-2516. (https://doi.org/10.1016/j.envpol.2011.04.035)

Quinitio GF and Siladan MG. 2013. Reproductive performance of *Siganus guttatus* (Bloch) exposed to dispersed bunker oil. Mem. Fac. Fish. Kagoshima Univ., Special Issue: 45-50.

Rhoton SL, Perkins RA, Braddock JF and Behr-Andres C. 2001. A cold-weather species response to chemically dispersed fresh and weathered Alaska North Slope crude oil. In: Proceedings, 2001 International Oil Spill Conference, American Petroleum Institute, Washington, D.C. 1231-1236.

Rice SD, Short JW and Karinen JF. 1977. Comparative oil toxicity and comparative animal sensitivity. In: Wold DA. (ed). Fate and effects of petroleum hydrocarbons in marine ecosystems and organisms. Pergamon Press, New York, NY. pp. 78-94.

Scarlett A, Rowland SJ, Canty M, Smith EL and Galloway TS. 2006. Method for assessing the chronic toxicity of marine and estuarine sediment-

associated contaminants using the amphipod *Corophium volutator.* Marine Environmental Research, 63 (5):457-470. (https://doi.org/10.1016/j.marenvres.2006.12.006)

Singer MM, George S, Lee I, Jacobson S, Weetman LL, Blondina G, Tjeerdema RS, Aurand D and Sowby MI. 1998. Effects of dispersant treatment on the acute aquatic toxicity of petroleum hydrocarbons. Environmental Toxicology and Chemistry, 34: 177-187.

Uno S, Koyama J, Kokushi E, Monteclaro H, Santander S, Cheikyula JO, Miki S, Añasco N, Padila IG, Tarberna HS and Matsuoka T. 2010. Monitoring of PAHs and alkylated PAHs in aquatic organisms after 1 month from the Solar I oil spill off the coast of Guimaras Island, Philippines. Environment Monitoring Assessment, 165(1): 501-515. doi:10.1007/s10661-009-0962-1

ARTICLE INFO

Submitted: 10 March 2017
Revised: 5 May 2017
Accepted: 15 July 2017

Research instruction among secondary schools implementing Science, Technology and Engineering (STE) Program in MIMAROPA Region

Wendell I. Formalejo[1] and Eufrecina Jean DR. Ramirez[2]
[1]Curriculum and Learning Management Division, DepEd MIMAROPA Region, Pasig, Philippines,
[2]Graduate School, Centro Escolar University, Manila, Philippines,
Corresponding author: wendell.formalejo@deped.gov.ph

ABSTRACT

Research plays a critical role of expanding the frontier of knowledge and boosting national economic development, but research as a field is undervalued in the Philippines. This study assessed the status of research instruction in terms of course content, teaching strategies, and research collaboration among secondary schools implementing Science, Technology and Engineering (STE) Program in MIMAROPA Region, school year 2015-2016. Mixed method approach utilizing the survey questionnaire, classroom observation and focus group discussion was used in this study. The respondents were composed of the Grade 10 students and the research teachers of the STE high schools. Majority of the teacher-respondents are in middle-age, female, had earned academic requirements for master's program, had moderate experience in teaching, had attended research trainings, and had on-going researches. Overall, both respondents showed somewhat positive attitude ($\bar{x}$ =5.21) towards research activities, however, they manifested negative attitude, specifically, that of research anxiety ($\bar{x}$ =3.45). On the status of research instruction, significant findings were noted in course content, teaching strategies and research collaboration. In terms of content, most of the topics were rated "very well discussed" and "well discussed" except for "Introduction to Statistics" and "Preparation of Proposals"; hence, improvement must be done on these topics. Surprisingly, research teachers had moderately utilized the proposed strategies along these topics. On the other hand, it is noteworthy that the respondents had undergone the right direction in research collaboration by networking with various experts, institutions and organizations.

Keywords: Research Instruction, Science, Technology and Engineering (STE) Program

INTRODUCTION

"Publish or Perish" this quote has always been a motivation for educators and scientists to continuously conduct research to learn and generate new knowledge. Today, living in a publish-or-perish paradigm is a

The Palawan Scientist, 9: 49-62

great challenge to be able to sustain one's career in the academe (Carpenter 2015). Nevertheless, we cannot discredit the fact that research is very important, and that we don't have a choice but to participate and embrace this kind of academic undertaking. Truly, in the academic community, research and publications are considered as a person's contribution to Science as bases for promotion.

Biyo (2003), a multi- awarded teacher, scientist and researcher, said that research is very exciting; it means sleepless nights, disappointments and physical and mental exhaustion. But the joy of discovering something new in nature makes it all worthwhile. However, Sen. Bam Aquino said that research as a field is undervalued in the Philippines during the discussion on the proposed Magna Carta for Scientists (Anonymous 2017). This is the big picture of research in the Philippines. Nevertheless, the importance of research cannot be discredited, thus, participating and embracing this kind of academic undertaking is necessary.

With this in mind, research even in the junior high school was initiated and has been pursued to schools offering special curricular program in science. Seeing the need to provide opportunities for the development of scientific attitude, technological skills and higher order thinking skills among the students in the Basic Education, the Philippine government encouraged school institutions to adopt Science and Mathematics curriculum through Republic Act 7678, which gave the idea of the use of a special Science curriculum.

To pursue this, the Department of Education (DepEd), through its Bureau of Secondary Education (BSE), identified the 112 high schools nationwide with its corresponding identified Special Science Classes (SSC) to implement the enriched curriculum in Science and Technology, and Mathematics. Formerly, the program was called ESEP (Engineering and Science Education Program) now, it is STE (Science, Technology and Engineering) Program.

In the interview of the researcher with some of the research teachers, most of them admitted their professional inadequacy and they felt that some aspects in research instruction need to be strengthened. Similarly, it was a consensus among the members of the Regional Screening and Review Committee (SRC) that some of the research outputs of the students that were submitted as research entries in the conduct of the Regional Science and Technology Fair reflected a kind of research instruction still wanting in excellence and still needing improvements, causing them not to qualify in the higher level of competitions.

Studies that assessed teachers' preparedness in terms of teaching strategies, and instructional practices results revealed that instructional strategy is a key variable in the teaching learning process, Slavin et al. (2012), Pascuala (2006) and Fulp (2002). Slavin et al. (2012) further justified the importance of using appropriate teaching methods, strategies and introduced mastery of learning to enhance instruction and have sufficient potential to improve students' learning.

Students' attitudes towards research are not generally positive. In addition, majority of the students perceived that research was a difficult endeavor (Sabzwari et al. 2009). Students thought that research is a tough and a dry subject (Adam and Holcomb 2006). Meanwhile, students who find research difficult and stressful develop greater research anxiety, thus sacrificing their grades in the course (Paga 2013). Moreover, as cited by Papanastasiou (2005), a positive attitude towards research undertaking is a key to success and progress in the knowledge based societies.

It is in this light the researcher assessed the extent to which research instruction is implemented in secondary schools with STE Program in MIMAROPA Region, during school year 2015-2016. Specifically, this sought to answer the following research questions: (1). What is the profile of research teachers among secondary schools implementing STE Program in MIMAROPA Region in terms of the following; age; gender; highest educational attainment; years of research teaching experience and research-related trainings attended; (2). What is the attitude of students and teachers towards research? (3). What is the status of research instruction in terms of; course content; teaching strategies; and research collaboration?

METHODOLOGY

This study made use of mixed method approach utilizing the survey questionnaire as the primary instrument, supported by classroom observations, and focus group discussion. The quantitative part used two sets of questionnaires: one for the student and one for the research teachers. To describe the attitude of the research teacher towards research, the Revised Attitude towards Research (R-ATR) scale devised by Papanastasiou (2014) was used.

The qualitative aspect of this study was done through classroom observation and focused group discussion (FGD). Classroom Observation served as a supplemental data gathering instrument to validate the responses of the respondents in the questionnaire. FGD further validated the data provided in the questionnaire. The data which were not captured by the administration of the questionnaire and the conduct of the observation were

collected through FGD. The data gathered through the survey questionnaire, classroom observations and FGD were triangulated to establish a relationship among the variables being studied, and to have a clearer picture of the status of research instruction.

The respondents of this study were the teachers handling research in the seven (7) secondary schools who were chosen using complete enumeration. Meanwhile, the student respondents were those belonging to the upper and lower quartiles of the senior population of the seven (7) secondary school implementing STE Program in MIMAROPA Region. Respondent schools include Oriental Mindoro National High School of Calapan City, Domingo Yu Chu Memorial National High School of Oriental Mindoro, Sablayan National Comprehensive High School of Occidental Mindoro, Landy National High School of Marinduque, Looc National High School of Romblon, Palawan National School of Puerto Princesa City and Narra National High School of Palawan.

Descriptive Statistics such as Frequency Count, Rank and Percentage Technique were used to determine the profile of the teachers. On the other hand, Weighted Mean and Standard Deviation were utilized to examine the attitude of the students and research teachers towards research and the status of research instruction such as course content, teaching strategies and research collaboration.

RESULTS AND DISCUSSION

Profile of Research Teachers among Secondary Schools Implementing STEP in MIMAROPA Region

Majority of the teacher respondents are in middle-age, female, had completed academic requirements for master's program, moderate experience in teaching and had attended research trainings.

Attitudes of Students and Teachers towards Research

Attitudes towards research means a detailed study of thinking, feelings and the person's behavior towards research (Papanastasiou 2011). Table 1 presents the attitudes of students and teachers towards research. This measured research usefulness, research anxiety, and positive research predisposition of the respondents.

Table 1. Attitudes of students and teachers toward research.

Attitudes	Students			Teachers			Overall		
	$\bar{x}$	s.d.	Verbal Interpretation	$\bar{x}$	s.d	Verbal Interpretation	$\bar{x}$	s.d	Verbal Interpretation
RESEARCH USEFULNESS									
Research is useful for my career.	7.00	0.00	Very positive attitude	6.18	1.11	Fairly positive attitude	6.59	0.56	Very positive attitude
Research is connected to my field of study.	6.86	0.38	Very positive attitude	5.57	1.48	Fairly positive attitude	6.22	0.93	Fairly positive attitude
The skills I have acquired in research will be helpful to me in the future.	6.57	0.79	Very positive attitude	6.26	1.13	Fairly positive attitude	6.42	0.96	Fairly positive attitude
Research should be indispensable in my professional training.	6.71	0.49	Very positive attitude	4.28	1.49	Undecided	5.50	0.99	Fairly positive attitude
	6.79	**0.42**	**Very positive attitude**	**5.57**	**1.30**	**Fairly positive attitude**	**6.18**	**0.86**	**Fairly positive attitude**
RESEARCH ANXIETY									
Research excites me. *	3.29	2.06	Somewhat negative attitude	3.53	1.34	Undecided	3.41	1.40	Somewhat negative attitude
Research makes me feel at ease. *	3.46	1.85	Somewhat negative attitude	4.33	1.78	Undecided	3.90	1.82	Somewhat positive attitude
Research does not stress me at all. *	3.57	2.15	Undecided	2.85	1.61	Somewhat negative attitude	3.21	1.88	Somewhat negative attitude
Research makes me feel relaxed. *	3.33	2.58	Somewhat negative attitude	3.24	1.65	Somewhat negative attitude	3.28	2.12	Somewhat negative attitude
Research is easy*	3.71	1.98	Undecided	3.19	1.74	Somewhat negative attitude	3.45	1.86	Somewhat negative attitude
	3.47	**2.12**	**Somewhat negative attitude**	**3.43**	**1.62**	**Somewhat negative attitude**	**3.45**	**1.82**	**Somewhat negative attitude**
POSITIVE RESEARCH PREDISPOSITION									
I enjoy research.	6.57	0.53	Very positive attitude	5.62	1.00	Fairly positive attitude	6.10	0.77	Fairly positive attitude
I love research.	6.43	0.53	Fairly positive attitude	5.29	1.22	Somewhat positive attitude	5.86	0.88	Fairly positive attitude
I am interested in research.	7.00	0.00	Very positive attitude	5.72	1.11	Fairly positive attitude	6.36	0.56	Fairly positive attitude
Research is pleasant.	6.00	1.41	Fairly positive attitude	5.40	1.06	Somewhat positive attitude	5.70	1.24	Fairly positive attitude
	6.50	**0.62**	**Fairly positive attitude**	**5.51**	**1.10**	**Fairly positive attitude**	**6.01**	**0.86**	**Fairly positive attitude**
GRAND WEIGHTED MEAN	**5.89**	**1.05**	**Fairly positive attitude**	**4.84**	**1.34**	**Somewhat positive attitude**	**5.21**	**1.08**	**Somewhat positive attitude**

NOTE: * *These statements are reversed form of the Original Statements*

Results reveal that the respondents exhibit a fairly positive attitude towards research usefulness ($\bar{x}$=6.18), for they strongly agreed that research is very useful to their own chosen career ($\bar{x}$ =6.59). Likewise, the respondents developed fairly positive attitude towards the following indicators such as the skills they have acquired in research will be helpful in their future ($\bar{x}$=6.42); research is connected to their field of study ($\bar{x}$=6.22) and research is indispensable in their professional training ($\bar{x}$=5.50). This affirms the study of (Siemens et al. 2010), where results revealed that majority of the students felt that research would be beneficial in their career realizing the need of spending more time on research activities.

Similarly, the respondents have fairly positive attitude towards positive research predisposition ($\bar{x}$ =6.01), as they manifest interest in research ($\bar{x}$=6.36); they enjoy research ($\bar{x}$=6.10); they love research ($\bar{x}$=5.86) and they find research pleasant ($\bar{x}$ =5.70). The results imply that the respondents generally have optimistic perception about research.

However, the interesting result of the study is that the two groups of respondents have somewhat negative attitude such as research anxiety as they slightly disagree that research makes them feel at ease ($\bar{x}$ =3.90); research is easy ($\bar{x}$=3.45); research excites them ($\bar{x}$=3.41); research makes them feel relaxed ($\bar{x}$=3.27) and research does not stress them at all ($\bar{x}$=3.21).

This result conforms to the findings of Adams and Holcomb (2006) that the attitudes towards research were generally negative. This result is validated by the responses of the respondents in the FGD conducted where majority of them stated that they didn't like research along the mentioned aspects. Overall, the respondents have somewhat positive attitude towards research undertakings ($\bar{x}$=5.21).

However, the findings of the study imply that both the students and teachers need help in transforming their negative attitudes toward research to positive especially along the following aspects: (1) minimizing fear and anxiety, and (2) coping with stressful conditions and the feeling of being nervous in conducting research. This conforms to the findings of (Sabzwari et al. 2009) that majority of the students perceived that research was a difficult endeavor despite their positive attitude towards research. The difficulties may be attributed to what Adams and Holcomb (2006) stated that students do not understand the concepts of research and its importance in their professional life.

Status of Research Instruction

Course content. Course content specifies what is to be learned as specified in the instructional objectives such as concepts, values, skills and attitudes which need to be learned by research students. Table 2 shows content along planning, implementation and presentation.

Findings of the study reveal that the two groups of raters unanimously agreed that the following course contents are discussed to a very large extent or they are very well discussed: Problem Identification ($\bar{x}$=4.64), The Research Process ($\bar{x}$=4.56), Introduction to Research ($\bar{x}$=4.54), and Variables in Research $\bar{x}$=4.51) while Ethics in Research ($\bar{x}$=4.48), Actual Conduct of the Study ($\bar{x}$=4.30), Research Design ($\bar{x}$=4.27), Research Objectives ($\bar{x}$=4.24), Data Collection ($\bar{x}$=4.21), Research Tools ($\bar{x}$=4.10), Data Processing ($\bar{x}$=4.06), Data Analysis and Interpretation ($\bar{x}$=4.04), Preparation of the Final Research Paper ($\bar{x}$=4.04) are discussed to a large extent or well discussed.

It is interesting to note that the respondents rated the Introduction to Statistics in Research ($\bar{x}$=2.99), and Preparation of Research Proposal ($\bar{x}$=2.94) as discussed to some extent or moderately discussed only.

As revealed, it was noted that the concepts under statistical tools and preparation of research proposal were moderately discussed. As supported during the FGD, the same topics were identified to be the least discussed and preferred topics of the student respondents'.

The result denotes that moderate discussion of these topics will negatively affect the optimum learning opportunity and knowledge preparation of students in research in the classroom as these topics are believed to be very crucial in the preparation of research proposals and the completion of the scientific investigation. It will also affect the success of the research process.

In the effort to improve and maximize research instruction especially along research planning which serves as the waterloo of most students as revealed in the data and during the FGD, concerned teachers must allocate sufficient time for every difficult lesson especially along the topics under prior to preparation of Chapters I, II, and III which are very vital in the preparation of Research Proposal. Proper time management in teaching difficult concepts can facilitate the attainment of the objective of research instruction.

To facilitate the teaching of statistical tools, it is noteworthy to encourage teachers to incorporate the use of technology in teaching statistical concepts. Literature reveals that the use of Pearson Higher Education Statistics (PHStat) software in teaching Statistics is found to be effective. Likewise, sufficient trainings in the use of the program will be more beneficial for both research students and teachers.

Table 2. Summary table for the status of research instruction in terms of course content.

Indicators	Overall			Ranking
	$\bar{x}$	s.d	Verbal Description	
A. RESEARCH PLANNING				
1. Introduction to Research	4.54	0.67	Very well discussed	3rd
2. The Research Process	4.56	0.59	Very well discussed	2nd
3. Problem Identification	4.64	0.57	Very well discussed	1st
4. Research Objectives	4.24	0.92	Well discussed	8th
5. Variables in Research	4.51	0.72	Very well discussed	4th
6. Research Design	4.27	0.85	Well discussed	7th
7. Research Tools	4.10	0.95	Well discussed	10th
8. Introduction to Statistics in Research	2.99	0.92	Moderately discussed	14th
9. Preparation of Research Proposal	2.94	0.74	Moderately discussed	15th
OVERALL	4.08	0.77	Well discussed	Third
B. RESEARCH IMPLEMENTATION				
10. Data Collection	4.21	0.85	Well discussed	9th
11. Actual Conduct of the Study	4.30	0.65	Well discussed	6th
12. Data Processing	4.06	1.01	Well discussed	11th
13. Data Analysis and Interpretation	4.04	0.96	Well discussed	12.5th
OVERALL	4.10	0.87	Well discussed	Second
C. RESEARCH PRESENTATION				
14. Preparation of the Final Research Paper	4.04	1.04	Well discussed	12.5th
15. Ethics in Research	4.48	0.75	Well discussed	5th
OVERALL	4.26	0.90	Well discussed	First
GRAND TOTAL	4.15	0.85	Well discussed	

Teaching strategies. Teaching strategies are methods and approaches which consist of purposeful, planned activities and tasks that are undertaken in the classroom to bring about the expected outcomes. Table 2 displays the summary table for the status of research instruction in terms of utilization of teaching strategies per major topic.

It could be discerned from Table 3 that the two groups of raters perceive that the research teachers highly utilized teaching strategies, except for the Introduction to Statistics in Research (Statistical Tool) ($\bar{x}$=2.86), and 2) Preparation of Research Proposal ($\bar{x}$=2.98).

The computed grand overall weighted mean of ($\bar{x}$=4.07; Table 3) implies that the two groups of raters unanimously agreed that along research instruction the teachers used variety of teaching strategies, such as lecture-discussion, group assignment, consultancy sessions, chalk-talk, board work, home exercises, group project, workshop, exposure trips and interviews.

In support to the above findings, it was also noted during the classroom observation that as part of the teaching learning process, the teachers conduct review and give overview of day's course content, employ non-lecture learning activities which motivate and provoke critical thinking creating an atmosphere conducive to learning, utilize other tools/instructional aids (i.e. technology, computer, video, overheads).

In addition, teachers deliver well-planned instruction and present the lesson in an orderly manner using the most appropriate teaching method/strategy. It was also observed that teachers are adept in the art of questioning, the technique of handling student's responses and cites up-to-date information about the subject.

However, it is alarming that the teacher-respondents moderately utilized the aforementioned strategies to the most complicated research topics such as the Introduction to Statistics in Research (Statistical Tools) and Preparation of Research Proposal.

As claimed by many educators, there is a dire need for teachers to maximize the use of effective teaching strategies, and the topics must be fully discussed. Slavin et al. (2012) justified the importance of using appropriate teaching methods and strategies, for it can enhance instruction and significantly improve students' learning. Slavin et al. (2012), Pascuala (2006) and Fulp (2002) in their studies assessed teachers' preparedness in terms of teaching strategies and instructional practices; they considered instructional strategy as a key variable in the teaching learning process.

Table 3. Summary table for the status of research instruction in terms of utilization of teaching strategies per major topic.

Indicators	Students			Teachers			Overall			Rank
	$\bar{x}$	s.d.	Verbal Description	$\bar{x}$	s.d.	Verbal Description	$\bar{x}$	s.d.	Verbal Description	
I. RESEARCH PLANNING										
1. Introduction to Research	4.26	0.88	Highly utilized	4.14	0.72	Highly utilized	4.20	0.80	Highly utilized	3rd
2. The Research Process	4.01	1.16	Highly utilized	4.09	0.81	Highly utilized	4.05	0.99	Highly utilized	
3. Problem Identification	4.25	0.88	Highly utilized	4.34	0.67	Highly utilized	4.30	0.78	Highly utilized	
4. Research Objectives	4.27	0.89	Highly utilized	4.49	0.65	Highly utilized	4.38	0.77	Highly utilized	
5. Variables in Research	4.23	0.90	Highly utilized	4.44	0.53	Highly utilized	4.34	0.72	Highly utilized	
6. Research Design	4.18	0.88	Highly utilized	4.42	0.53	Highly utilized	4.30	0.71	Highly utilized	
7. Research Tools	4.20	0.90	Highly utilized	4.27	0.83	Highly utilized	4.24	0.87	Highly utilized	
8. Introduction to Statistics in Research (Statistical Tool)	2.89	1.06	Moderately utilized	2.82	0.82	Moderately utilized	2.86	0.94	Moderately utilized	
9. Preparation of Research Proposal	2.96	0.92	Moderately utilized	3.00	0.69	Moderately utilized	2.98	0.81	Moderately utilized	
OVERALL	3.92	0.94	Highly utilized	4.00	0.62	Highly utilized	3.96	0.78	Highly utilized	
II. RESEARCH IMPLEMENTATION										
10. Data Collection	3.93	1.01	Highly utilized	4.17	0.81	Highly utilized	4.05	0.91	Highly utilized	1st
11. Actual Conduct of the Study	3.97	1.04	Highly utilized	4.20	0.65	Highly utilized	4.08	0.85	Highly utilized	
12. Data Processing	4.11	0.96	Highly utilized	4.36	0.61	Highly utilized	4.24	0.79	Highly utilized	
13. Data Analysis and Interpretation	3.45	0.80	Highly utilized	4.28	0.76	Highly utilized	4.12	0.78	Highly utilized	
OVERALL	3.99	0.95	Highly utilized	4.25	0.71	Highly utilized	4.12	0.83	Highly utilized	
III. RESEARCH PRESENTATION										
14. Preparation of Final Research Paper	4.17	0.97	Highly utilized	4.25	0.74	Highly utilized	4.21	0.86	Highly utilized	2nd
15. Ethics in Research	4.14	0.98	Highly utilized	4.00	1.12	Highly utilized	4.07	1.05	Highly utilized	
OVERALL	4.16	0.98	Highly utilized	4.12	0.93	Highly utilized	4.14	0.96	Highly utilized	
GRAND OVERALL	4.02	0.96	Highly utilized	4.12	0.75	Highly utilized	4.07	0.86	Highly utilized	

Research collaboration. Research collaboration refers to manifested initiatives in working with others for partnership to realize the objectives of an investigation. Table 4 shows the status of research instruction in terms of research collaboration.

Table 4. Summary table for the status of research instruction in terms of Collaboration.

Classification of Profession Institution/Organization/Entity	Specific Name of Profession Institution/Organization/Entity
Experts	1. Electrical Engineer 2. Mechanical Engineer 3. Agricultural Technologist 4. Licensed Technician
Government Agencies	1. Department of Agriculture 2. Department of Agrarian Reform 3. Department of Science and Technology 4. Industrial Technology Development Institute 5. Department of Public Works and Highways 6. Department of Trade and Industry 7. Department of Health (District Hospitals and Provincial Hospitals 8. Department of Environment and Natural Resources 9. National Food Authority 10. National Irrigation Administration
Non-Government Organizations	1. SAMVECO – Sablayan Market Vendors Multi – Purpose Cooperative 2. Puerto Princesa City Water District
Academic Institutions	1. Western Philippine University 2. Holy Trinity University 3. University of the Philippines – National Sciences Research Institute
Laboratories	Clinical Laboratory 1. Suretech Diagnostic Laboratory, Narra, Palawan. 2. Intertek Testing Services Philippines, Inc. intertek provides clients across the world with quality control, research, testing, measurement, and certification activities for industry, commerce, markets, institutions, and governments

It was revealed from the survey and the focus group discussion that research teachers and students had functional research collaboration. They were able to collaborate with experts, government agencies, Non-Government organizations, and Higher Educational Institutions (HEI's). The respondent schools through the Research teachers and the students attempted to link and collaborate with clinical laboratories through testing, measurement, and certification activities.

The foregoing results imply that the schools through the efforts made by the research teachers had undergone the right directions, priorities and thrust by networking with various experts, institutions, organization and entities. They manifested and promoted partnership/collaboration with other research institutions, local and national as well as with industry and private laboratories, for the conduct of research and application of research outputs.

This manifestation of participation and networking conforms with the basic policies and principles advocated by NHERA (2009), stipulating the intent that all research endeavors should involve the participation of as many stakeholders as possible and should be organized preferably as network instead of stand-alone undertaking of schools or individual researcher.

CONCLUSION AND RECOMMENDATION

The teacher respondents belong to the middle-age level, mostly female, had earned certain academic requirements for master's program, have moderate experiences in teaching and had attended research-related trainings. Overall, both respondents have somewhat positive attitude towards research activities, however, negative attitude, specifically that of research anxiety, was noted. On the status of research instruction in terms of course content, topics were well discussed, but improvement on instruction on the topics regarding "Introduction to Statistics in Research" and "preparation of research proposals" is wanting. Along teaching strategies, majority of these are highly utilized. However, it's also alarming to note that research teachers moderately utilize the strategies along topics identified to be moderately discussed, thereby instruction in these aspects ought to be strengthened. On the other hand, it is noteworthy that the respondents had undergone the right direction in research collaboration by networking with various experts, institutions and organizations.

All research teachers must continue their professional growth by pursuing graduate degrees. Attainment of both master's and doctorate degrees is indispensable and required to all research teachers. Research teachers may consider looking for scholarship grants offered by HEIs', Department of Education (DepEd) and other agencies here and abroad. It is

highly recommended that there is a need to develop positive attitudes towards research for both students and teachers.

Teachers' commitment and dedication are indispensable in quality teaching. There is a need for teachers to maximize the use of effective teaching strategies and the topics must be discussed to a very large extent. Thus, teachers must allocate sufficient time for discussion of every difficult lesson especially along the concepts covered by Chapters I, II and III, for they are vital components in the preparation of research proposal. In addition, the teaching of statistical tools is encouraged to incorporate technology in teaching various statistical concepts.

ACKNOWLEDGMENTS

The researchers would like to express gratefulness to the Department of Education MIMAROPA Region and Centro Escolar University for the support and contribution to the successful development of this study. The comments of two anonymous reviewers helped improve the manuscript.

REFERENCES

Adams NA and Holcomb WR. 2006. Analysis of the relationship between anxiety about mathematics and performance. Psychological Reports, 59: 943-948.

Anonymous. 2017. Sen. Bam aims to promote welfare of Filipino scientists, researchers. http://www.bamaquino.com/sen-bam-aims-promote-welfare-filipino-scientists-researchers/

Biyo J. 2003. The Power of the Human Spirit. A speech delivered during the San Miguel Corporation's Best Practices Forum on 24 October 2003 at Edsa Shangri-La Hotel, Pasig, Metro Manila. http://sntpost.stii.dost.gov.ph/frames/OcttoDec03/pg4to7.htm. Accessed on 06 October 2015.

Carpenter B. 2015. In the face of a New Paradigm. A message given during the 43rd Commencement Exercises of College of the Atlantic, Bar Harbor, Maine. https://www.coa.edu/live/news/369-in-the-face-of-a-new-paradigm---laurel-ceremony. Accessed on 06 October 2015.

Fulp L. 2015. Status of Elementary School Science Teaching. http://serc.carleton.edu/resources/45727.html. Accessed on 07 July 2015

Paga GF. 2013. Master in Education student attitudes towards research. South Asian Studies a Research Journal of South Asian Studies, 28 (1): 97-105.

Papanastasiou EC. 2005. Factor structure of the attitudes towards research = scale. Statistics Education Research Journal, 4(1):16-26.

Papanastasiou EC. 2006. Anxiety in Undergraduate Research Methods Courses: It's Nature and Implications. A paper presented to the annual meeting of the American Educational Research Association, San Francisco, CA.

Papanastasiou EC. 2014. Revised-Attitudes towards Research Scale (R-ATR); A First Look at its Psychometric Properties. Journal of Research in Education, 24(2):146-159.

Pascuala NT. 2014. Impact of Mathematics and Science Instructional Practices, Curriculum and Academic Achievement to the Career Choice of Laboratory School Graduates of University of Rizal System-Morong. International Journal of Sciences: Basic and Applied Research, 15(1): 397-415.

Sabzwari S, Kauser S and Khuwaja AK. 2009. Experiences, attitudes and barriers towards research amongst junior faculty of Pakistani medical universities. BMC medical education, 9(1): 68.

Siemens D, Punnen S, Wong and Kanji N. 2010. A Survey on the Attitudes towards Research in Medical School. BMC Medical Education 10, 4. http://dx.doi.org/10.1186/1472-6920-10-4. Accessed on 19 July 2015

Slavin RE, Lake C, Hanley P and Thurston A. 2012. Effective programs for elementary science: A best-evidence synthesis. Baltimore, MD: Johns Hopkins University School of Education's Center for Data-Driven Reform in Education.

ARTICLE INFO

Submitted: 16 March 2017
Revised: 24 May 2017
Accepted: 28 July 2017

Research Notes

Possible occurrence of the sea cucumber *Actinopyga spinea* (Cherbonnier 1980) in Arreceffi Island, Honda Bay, Puerto Princesa City, Palawan, Philippines

Jean Beth S. Jontila
College of Fisheries and Aquatic Sciences
Western Philippines University- Puerto Princesa Campus
Sta. Monica, Puerto Princesa City, Philippines
Corresponding author: jbjontila@gmail.com

Sea cucumbers under the genus *Actinopyga* are among the commonly exploited species in the Philippines. At present, there are five species belonging to this genus in the country namely, *A. echinites, A. lecanora, A. mauritiana, A. miliaris* and *A. obesa* (Schoppe 2000, Akamine 2005, Kerr et al. 2006, Olavides et al. 2010, Purcell et al. 2012, Jontila et al. 2014). Recent surveys in different sites in Palawan did not show the occurrence of other *Actinopyga* species (Dolorosa and Jontila 2012, Collantes 2013, Pitong 2013, Sabay 2013, Saclet 2013, Dolorosa 2015).

During the monthly monitoring of sea cucumbers in Arreceffi Island Resort and Spa on June 5, 2015, one individual of *Actinopyga*, suspected to be *A. spinea* was documented. The Island is located in Honda Bay (9°54'47.66"N, 118°52'35.64"E) about 16 km away from Sta. Lourdes Wharf, Puerto Princesa City (part of the mainland Palawan). It has approximately 20 ha land area, 30 ha mangrove forest and 170 ha intertidal and shallow subtidal areas, serving as safe habitats for diverse wildlife. Since its establishment in 1991, the island resort implemented no fishing or hunting activities that enabled the once overharvested species to recover.

The substrate where the specimen was collected is mainly composed of sand and rubble, but patches of seagrasses (*Cymodocea rotundata, Enhalus acoroides* and *Thalassia hemprechii*) and stands of *Rhizophora stylosa* were also present in the area. The site is around 80 m away from the drop off and is exposed to moderate to strong wave action during high tide. The specimen was encountered during low tide in waters between 0.1 to 0.2 m deep.

The Palawan Scientist, 9: 63-67

Figure 1. A Map of Arreceffi Island showing the location where the specimen was seen (Source: Google earth, accessed on June 28, 2016).

The specimen was first identified as *A. miliaris* due to its resemblance in external appearance and similarity in habitat with *A. spinea* (Figure 2). However, further examination of its external features based on the photos revealed that it is more likely to be *A. spinea*. Both species have brown to dark brown or blackish brown coloration, but *A. miliaris* has a lighter ventral part whereas *A. spinea* is entirely uniform in color. Similarly, the papillae of both species are long and slender but such are numerous on the dorsal of *A. miliaris* while it is only moderate in *A. spinea* (Figure 2) (Purcell et al. 2012). In addition, *A. miliaris'* anal teeth are generally simple and conical in shape. In contrast, the specimen's anal teeth are triangular with distinct nodules (Figure 3) that is a key feature of *A. spinea* (Conand 1998, Purcell et al. 2012).

Figure 2. *In situ* photo of the specimen in sand and rubble substrate.

Figure 3. Close up photos of the specimen showing the triangular orange anal teeth with nodules.

Actinopyga spinea is also similar in color with *A. palauensis* but the latter has textured dorsal surface with bumpy appearance, and the mouth is often projected as trunk-like (Purcell et al. 2012). Also, the papillae of *A. palauensis* on the dorsal are small and conical while they are long and slender in *A. spinea*. Furthermore, the anus of *A. palauensis* is more terminal while that of *A. spinea* is sub terminal. However, this feature of *A. spinea* was not noted when the specimen was collected. Further visual examination of the mouth position was also done on the specimen, which was collected and frozen for future studies, but such was difficult to determine for the sample has already collapsed after ejecting its internal organs during transport in 2015. Further search was made then in the area to look for other individuals of *A. spinea* but none was encountered.

The specimen measured only 9 cm. This is far below the mean length of *A. spinea* that is 25 cm (Purcell et al. 2012). Thus, the individual could be in its juvenile or sub adult stage. However, this is difficult to

ascertain due to lack of information on its growth and maturity (Purcell et al. 2012). Information on its distribution and population trend is also limited (Conand 1998). In fact, *A. spinea* is classified as a least concern species (Conand et al. 2013, IUCN 2016).

Despite of the resemblance of *A. spinea* to *A. miliaris* and *A. palauensis,* the nodular anal teeth, the uniformly colored body, and the sparse conical papillae on the dorsal strongly suggest that the specimen is *A. spinea.* These characteristics were assumed to be sufficient for reasonable certitude but to complete the identification, ossicles examination is being undertaken for further examination of experts. If needed, DNA testing could also be done for the sample is kept viable for such procedure.

ACKNOWLEDGMENTS

Dr. Steven W. Purcell of Southern Cross University, Lismore, Queensland, Australia is greatly acknowledged for sharing his opinion about the specimen, though he did not confirm its identification. The comments of the two anonymous reviewers are also greatly acknowledged. Special thanks also to Ms. Glesselle T. Batin of Arreceffi Island/Dos Palmas Island Resort and Spa for facilitating the conduct of this survey in Arreceffi Island. This is an off-shot of the author's dissertation funded by the Department of Science and Technology-Science Education Institute (DOST-SEI).

REFERENCES

Akamine J. 2005. Role of the trepang traders in the depleting resource management: a Philippine case. Senri Ethnological Studies, 67:259-278.

Collantes SD. 2013. Species identification and spicules examination of sea cucumbers in selected barangays of Quezon, Palawan. Undergraduate Thesis, Western Philippines University – Puerto Pricesa Campus, Puerto Princesa City. 25p

Conand C. 1998. Holothurians (Sea cucucmbers, Class Holothuroidea). P 1158-1190. In: Carpenter KE and Niem VH (eds). FAO species identification guide for fishery purposes. The living marine resources of the Western Cetral Pacific. Volume 2. Cephalopods, crustaceans, holothurians and sharks. Rome, FAO, p. 687-1396.

Conand C, Purcell S and Gamboa R. 2013. *Actinopyga spinea*. The IUCN Red List of Threatened Species 2013. http://dx.doi.org/10.2305/IUCN.UK.2013-1.RLTS.T180265A1607822.en. Downloaded on 30 June 2016.

Dolorosa RG. 2015. The Sea cucumbers (Echinodermata: Holothruroidea) of

Tubbataha Reefs Natural Park, Philippines. SPC Beche-de-mer Information Bulletin, 35:10-18.

Dolorosa RG and Jontila JB. 2012. Notes on common macrobenthic reef invertebrates of Tubbataha Reefs Natural Park, Philippines. Science Diliman, 24:1-11.

IUCN. 2016. The IUCN Red List of Threatened Species. Version 2016. <www.iucnredlist.org>. Downloaded on 01 July 2016.

Jontila JBS, Balisco RAT and Matillano JA. 2014. The Sea cucumbers (Holothuroidea) of Palawan, Philippines. AACL Bioflux, 7 (3):194-206.

Kerr AM, Netchy K, Gawel AM. 2006. Survey of the shallow-waters sea cucumbers of the Central Philippines. University of Guam Laboratory, Technical Report No. 119. 51p.

Olavides RDD, Edullantes CMA, Junio-Menez MA. 2010. Assessment of the sea cucumber resource and fishery in Bolinao-Anda reef system. Science Diliman, 22(2):1-12.

Pitong A. 2013. Species composition, density, size structure and distribution of sea cucumbers (Holothuroidea) in Brooke's Pt., Palawan. Undergraduate Thesis, Western Philippines University – Puerto Pricesa Campus, Puerto Princesa City. 34p.

Purcell SW, Samyn Y and Conand C. 2012. Commercially important sea cucumbers of the world. FAO Species catalogue for fishery purposes No. 6. Rome, FAO. 223p.

Sabay D. 2013. Species composition, density and distribution of sea cucumbers (Holothuroidea) in three barangays of Puerto Princesa City, Palawan. Undergraduate Thesis, Western Philippines University – Puerto Princesa Campus, Puerto Princesa City. 43p.

Saclet J. 2013. Exploitation and trade of sea cucumbers (Holothuroidea) in selected sites of Roxas, Palawan. Undergraduate Thesis, Western Philippines University – Puerto Pricesa Campus, Puerto Princesa City. 32p.

Schoppe S. 2000. Sea cucumber fishery in the Philippines. SPC Beche-de-mer Information Bulletin, 13:10-12.

ARTICLE INFO

Received: 22 June 2016
Revised: 14 February 2017
Accepted: 30 May 2017

Guide to Authors

Manuscript Submission

1. Authors must submit an e-copy of manuscript in Microsoft Word. Although English is the official language of *The Palawan Scientist*, researches written in Filipino and other indigenous Filipino dialects (with English translation) are most welcome.

2. Manuscript intended for publication in *The Palawan Scientist* should be sent by e-mail to the Editor-in-Chief (palawanscientist@gmail.com) with office in WPU-Puerto Princesa Campus. Alternatively, the articles can be e-mailed to the University Research and Development Director, WPU, Aborlan, Palawan (wpu_reserch@yahoo.com). Received articles will be properly acknowledged and will be immediately sent off for review if it satisfies the preliminary review made by the members of the Editorial Board. If it does not satisfy the preliminary review, it will be sent back to the corresponding author for revision. No paper will be sent for review unless it strictly follows the format in this Guide to Authors.

3. The corresponding author should submit by email the following files:

- Cover letter duly signed by the author
- Certification that the submitted article has not been published before except in a form of abstract in conference proceedings; that the same article is not under consideration for publication in any language elsewhere; that all co-authors if there are has approved its submission in this journal; that all authors will transfer the copyright to publisher upon the acceptance and publication of the article; that the article will not be published in any form or language without the consent of the copyright.
- Complete article in MS Word with tables, figures and references
- Tables in MS Word or MS Excel
- Graphs or photos in PDF or JPEG files (high resolution, at least 300 dpi)

Manuscript Preparation

1. The manuscript should be no more than 6,000 words; typewritten using Arial, font 12; double-spaced, justified on A4 (8.3"x11.7") size paper, with 2.54 cm margins on all sides. All pages should be numbered consecutively at the center of the bottom of the page. Line numbers should be continuous (do not restart at each page).
2. Page 1 should contain the following: title of the article, running title, author(s), affiliation(s), name and complete contact details (mailing address, telephone number, fax number, and e-mail address) of the person to whom correspondence should be sent. A superscript in Arabic numbers should be placed after the author's name as reference to their affiliations. The title of the paper should be centered, **bold** and written in a sentence form. Capitalize only the first word of the title and proper nouns if there are. Scientific name(s) when included in the title should be italicized and not enclosed in parenthesis. Provide name and contact details of at least two

potential external Reviewers. The Editors reserve the right with regard to the selection of external reviewers.

3. Page 2 should contain a short abstract of not more than 250 words. The abstract should contain facts and conclusions, rather than citation of the areas and subjects that have been treated or discussed. It should start with the hypothesis or a statement of the problem to be solved, followed by a description of the method or technique utilized to solve the problem. It should end with a summary of the results and their implications. The abstract is to be followed by a maximum of six **Keywords**.
4. The paper should be organized with the following main headings: **ABSTRACT, INTRODUCTION, METHODOLOGIES, RESULTS, DISCUSSION, ACKNOWLEDGEMENTS, REFERENCES**. Subheadings should be in **bold** with each main word capitalized (example: **Study Site**). Paper written in other formats will not be accepted or sent for review, instead it will be returned to the author for revision.

Figures and Tables

1. Figures and tables should be numbered (Arabic numerals) chronologically. Captions for figures and tables should be double spaced and have justified margins; First line not indented.
2. References to the tables and figures in the text should be cited as: Table 1; Figure 1; Tables 1 and 2; Figures 1 and 2. Photos, maps and drawings should be treated as Figures.
3. The Table or Figure if possible should appear in the same page where it is firstly mentioned in the text.
4. Figures must be in black and white if possible with a background free from major grid lines (of y-axis); the x and y axes are labeled and legend is provided.
5. Illustration should be original line drawings of good quality and should not exceed A4 size paper. Inscriptions should be readable even if the drawing is reduced by 75%. Drawings should be scanned and saved in TIF or PDF format before embedding on the manuscript. Separate file of the photos/illustrations maybe requested upon the acceptance of the manuscript.
6. Photographs – if possible, all photos used in the paper must have been taken by the author(s). Photos taken by other researchers/individuals/organizations must be duly acknowledged in the paper. The use of photos downloaded from the web/internet is strictly forbidden unless a written permission from the copyright holder (of that photo) is presented.

Scientific, English and Local Names

1. All organisms must be identified by their English, scientific names and local names if possible.
2. Scientific names must be cited for all organisms at first mention. Subsequently, only the initial of the genus should be written except when starting a sentence with a scientific name. All scientific names should be

italicized. Example: *Tectus niloticus*; *Anadara* sp. *Musa* spp. Do not italicize the higher levels of taxonomic classification (example: family Echinometridae).

3. Local names should be in double quotes (example: locally called “saging” not ‘saging’; “palay” not ‘palay’).
4. Research articles dealing on species list should provide the authorities for each species (example: *Conus magus* Linnaeus, 1758; *Phos vandenberghi* Fraussen & Poppe, 2005).

Punctuations

1. Unfamiliar terms, abbreviations, and symbols must be defined/spelled out at first mention.
2. Mathematical equations should be clearly presented so that they can be interpreted properly. Equation must be numbered sequentially in Arabic numerals in parentheses on the right-hand side of the equations.
3. Numbers lesser than 10 should be spelled out (for example: eight trees, 10 fish) except when followed by a unit of measure (for example: 9 cm, not nine cm). Numbers should be spelled-out when starting in a sentence (example: Nine fishermen were…).
4. No apostrophes in years (example: 2014s not 2014’s)
5. No periods in acronyms (example: UNESCO not U.N.E.S.C.O.; CITES not C.I.T.E.S.)
6. Write dates in this manner: day-month-year (example: 20 October 2012 or 20 Oct 2012).
7. Use the International System of Units of measurements. Separate the value and the unit of measure (example: 5 mm, 25 g, 30 m^3, 100 µm, 9 ind ha^{-1}, 10 sacks ha^{-1}, 2 kg h^{-1} day^{-1}). To fix a single space between the value and its unit of measure, use the MS word command “CTR+SHIFT+SPACE BAR” to provide a space between the value and its unit of measure.
8. Do not separate a percent sign with the number (example: 5%, 30%).
9. Use 24-h system for time (example: 13:00 instead of 1:00 pm). To express a measured length of time, abbreviations for hour (h), minutes (min) and seconds (sec) will be used (example: 2 h and 30 min; or 2.5 h).
10. Use a single capital letter when writing latitude and longitude (example: 9°44’27.80”N and 118°41’2.01”E).
11. Compass points (north, south, east, west) and their derivations (northern, southern, eastern, western) are lowercased (example: north of Palawan) except when they form part of the place name (example: South Cotabato; Eastern Samar).

References

References to the literature citations in the text should be by author and year; where there are two authors, both should be mentioned; with three or more authors, only the first author’s family name plus “et al.” need be given. References in the text should be cited as:

- Single author: (Frietag 2005) or Frietag (2005)

- Two authors: (De Guzman and Creencia 2014) or De Guzman and Creencia (2014)
- More than two authors: (Sebido et al. 2004) or Sebido et al. (2004).

1. Use a semi-colon followed by a single space when citing more than two authors. Arrange by date of publication with the latest being the last in the list (example: Sebido et al. 2004; Frietag 2005; De Guzman and Creencia 2014).

2. Use a comma followed by a single space to separate citation of different references authored by the same author (example: Jontila 2005, 2010). If the same author and year are cited, use a "letter" to distinguish one paper over the other (example: Creencia 2010a,b).

3. Alphabetize authors with the same year of publications (example: Balisco and Babaran 2014; Gonzales 2014; Smith 2014).

4. Write journal's name in full (examples: The Palawan Scientist, not Pal. Sci; Reviews in Fisheries Science, not Rev. Fish. Sci.).

5. The list of citation at the end of the paper should include only the works mentioned in the text and should be arranged alphabetically.

6. Citing journal articles– name(s) and initial(s) of author(s), year, full title of research article (in sentence form), name of the journal (not abbreviated), volume number, issue number (if given), range of page numbers, DOI number (if available) and/or web link:
   Dolorosa RG, Grant A and Gill JA. 2013. Translocation of wild *Trochus niloticus*: prospects for enhancing depleted Philippine reefs. Reviews in Fisheries Science, 21(3-4): 403-413. DOI: 10. 1080/ 10641262. 2013. 800773.
   Jontila JBS, Balisco RAT and Matillano JA. 2014. The sea cucumbers (Holothuroidea) of Palawan, Philippines. AACL Bioflux, 7(3): 194-206. http://www.bioflux.com.ro/docs/2014.194-206.pdf

7. Citing of books – name(s) of author(s), year of publication, full title of the Book (capitalize each main word), publisher, place of publication and total number of pages.
   Gonzales, BJ. 2013. Field Guide to Coastal Fishes of Palawan. Coral Triangle Initiative on Corals, Fisheries and Food Security, Quezon City, Philippines. 208p.

8. Citing a chapter in a book – name(s) of author(s), year, full title of the chapter in a book (capitalize each main word), last name of editor and title of book, edition, publisher, place of publication and page range of that chapter:
   Poutiers JM. 1998. Gastropods. In: Carpenter KE and Niem VH (eds). FAO Species Identification Guide for Fishery Purposes. The Living Marine Resources of the Western Central Pacific Seaweeds, Corals,

Bivalves and Gastropods. Food and Agriculture Organization, Rome. p364-686.

9. Citing a Webpage – names of the author (s), year, Title of the article, webpage address and date accessed.
   Morrison H and Pfuetzner S. 2011. Australia Shells. http://www.seashells.net.au/Lists/ TEREBRIDAE. html. Accessed on 4 Sept 2011.
   CITES (Convention on International Trade of Endangered Species. 2014. The CITES Appendices. Convention on International Trade in Endangered Species of Wild Flora and Fauna. www.cites.org. Accessed on 5 Jan 2014.

10. Citing a thesis or dissertation – author's family name, initial names of the author, year, title of the thesis, degree, name of institution, address of the institution, total number of pages (p).

    Guion SL. 2006. Captive breeding performance of *Crocodylus porosus* (Schneider 1901) breeders at the Palawan Wildlife Rescue and Conservation Center. BS in Fisheries. Western Philippines University-Puerto Princesa Campus, Palawan, Philippines. 28p.
    Lerom RR. 2008. Biosystematics study of Palawan landraces of rice (*Oryza sativa* L.). Doctor of Philosophy, Institute of Biological Sciences, University of the Philippines-Los Baños College, Laguna, Philippines. 197p.

11. Citing a Report
    Picardal RM and Dolorosa RG. 2014. Gastropods and bivalves of Tubbataha Reefs Natural Park, Cagayancillo, Palawan, Philippines. Tubbataha Management Office and Western Philippines University. 25p.

12. In Press articles when cited must include the name of the journal that has accepted the paper.
    Alcantara LB and Noro T. In press. Growth of the abalone *Haliotis diversicolor* (Reeve) fed with macroalgae in floating net cage and plastic tank. Aquaculture Research.

13. Citing an article from an online newspaper.
    Cuyos JM (2011) Endangered deep-sea shells seized from Mandaue firm. Inquirer Global Nation, Cebu. http://globalnation.inquirer.net/cebudailynews/news/view/20110325-327558/Endangered-deep-sea-shells-seized-from-Mandaue-firm. Accessed on 31 May 2012.

The Palawan Scientist

www.palawanscientist.org

Volume 9, 2017

Western Philippines University
San Juan, 5302 Aborlan, Palawan
www.wpu.edu.ph