Freshwater Shrimp Diversity and its Correlation to Water Properties in Selected Sites of Cañas River in Cavite, Philippines

Dickson N. Dimero[1 2], *Michelle T. Bono[1 2],
Sherine M. Cruzate[1 2] and Rainiel R. Rupido[1]
[1]*Department of Biological Sciences*
College of Arts and Sciences
Cavite State University-Main Campus
[2]*College of Science and Computer Studies Graduate Studies*
De La Salle University-Dasmariñas

ABSTRACT

Shrimps can be used as indicator of water quality degradation in freshwater systems. Hence, this study was conducted to assess the diversity level of shrimps in selected sites of Cañas River of Cavite and correlate the population count of shrimps to the physico-chemical parameters of riverine water. Water samples were collected in selected sites of Cañas River- Mataas na Lupa River, Mayang Falls, Tejero River, and Wawa River. The physicochemical parameters such as temperature, velocity, depth, pH, DO, TDS, TSS and BOD were determined. Collected shrimps were identified based on morphological characteristics. Except for TDS, the physicochemical properties of the rivers conform to the standard limits set by DENR-EMB for Class C freshwater ecosystem. Six specie s of shrimps were identified, namely: *Litopenaeus vannamei*, *Penaeus merguiensis, Penaeus monodon, Penaeus semisulcatus, Macrobrachium lar* and *Palaemon concinnus.* The most abundant species was *P. concinnus* because it appears to typically inhabit fresh or slightly brackish waters. The population count of the shrimps moderately increases as the depth, width, TDS, TSS, and BOD of water increase, and moderately decreases as the velocity, pH, and DO of the riverine water increase.

Keywords: *Diversity, river, shrimps, water properties*

INTRODUCTION

Freshwater shrimps are widely distributed in all biogeographical regions, except the Antarctica (De Grave & Anker, 2008) and are important faunal component in tropical ecosystem (Crowl et al, 2001, Soomro et al., 2016). In nature, freshwater shrimps have significant role on food webs of invertebrate groupings (Tchakonté *et al.,* 2014). They serve as bottom-feeders as they consume on the plant detritus in the river substrate (Soomro, *et al.*, 2016). Moreover, they are vital source of protein for both human beings and other aquatic organisms such as fishes. Through this beneficial role, freshwater shrimps reutilize nutrients and regulate nutrient outflows from the river ecosystem by the way of converting organic detritus of plants from substrate into dissolved nutrients, which can be combined with covering waters and can be used by plants and phytoplanktons (Endangered Species International, 2015). In general, freshwater shrimps are keystone species in the river ecosystem as the freshwater shrimps have active role of maintaining the food web (Djiriéoulou, *et. al*, 2014; Dimero, 2009).

Cañas River is one of the six major rivers in the Province of Cavite. The river is 38.9-kilometer-long, by which flowing from Tagaytay City to Tanza and Rosario and drains to Manila Bay. This river is classified as Class C water (Fishery Water, Recreational Water Class II and Agricultural Water), in which it is designed for fishery and industrial water supply. This river is very vital as it serves as the source of water for agricultural irrigations and for recreational activities like boating and fishing. (DENR Region 4A-CALABARZON, 2012).

Cañas River can support aquatic lives by providing habitat for fishes and crustaceans. Seven crustacean species were identified to be present in the river. Among these identified

To this day, no study that deals with the diversity of freshwater shrimps on the said river has been conducted. Hence, this study attempted to assess the diversity of freshwater shrimps in the Cañas River. Likewise, the correlation between the diversity of shrimps and the physicochemical properties of the river water was investigated.

METHODOLOGY

Sampling Sites

The presence of shrimps was assessed in four (4) selected sites in Cañas River of Cavite, namely: Mataas na Lupa (Indang), Mayang Falls (Trece Martires City), Tejero (Gen. Trias City), and Wawa (Rosario) (Figure 1). Each site was divided into three 10 m by 10 m transects (upstream, midstream and downstream) with a 10-meter distance from each other. The three transects were placed parallel to the flow of water. Coordinates of selected sites were included.

Water Sample Collection

Collection of water samples for physicochemical analysis of water was done in the transects at every site corresponding to the direction of the current of the river water using a 6 L-plastic bottles and 300 ml-plastic bottles. Water samples were collected between 5:30 a.m. – 9:00 a.m. Water samples for analysis of Biochemical Oxygen Demand (BOD) were collected in 6 L plastic bottle. Meanwhile, water samples of about 300 mL were collected and used for the determination of other water parameters such as pH, DO, TDS and TSS.

Physicochemical Properties of Water in Selected Sites of Cañas River

The water temperature, depth of the river, velocity of the water, water pH, total dissolved solids (TDS) of water, dissolved oxygen (DO) in water, and total suspended solids (TSS) of water from the selected rivers were determined using laboratory thermometer, calibrated string with, stopwatch, pH meter, and Cyberscan and Chem Analyzer respectively. On the other hand, the biological oxygen demand (BOD) was determined at the Department of Science and Technology - Cavite Water and Wastewater Testing Laboratory (DOST-CWWTL), Trece Martires City, Cavite using the Azide Modification method.

Collection of Shrimps

Collection of shrimps was done between 6:30 a.m. to 9:00 a.m. They were collected using a dip frame net and shrimp traps. Both of these were submerged in river water down to the benthic part of the river (substrate). Inside the trap, shrimp baits such as fish heads/meat and toasted coconut meat were placed. All caught shrimps in the traps and nets in each survey site were handpicked and counted. Different species of shrimps were placed on a separate container with 70% – 90% of alcohol for preservation and were properly labelled. These shrimps will be subjected to characterization and identification.

Identification of Shrimps

Shrimps were identified based on the morphological features using the identification keys of Carpenter and Niem (1998) and Motoh (1980). Likewise, the identified species were verified and validated by an invertebrate curator from the Invertebrate Museum, Institute of Biology, College of Science, University of the Philippines Diliman.

Diversity Index

The number of species and the percent abundance per species of freshwater shrimp were determined. In addition, the diversity level of freshwater shrimps between the sampling sites was analyzed using the Shannon's diversity index. This was calculated using the formula:

$$H = -\mathrm{SUM}[(p_i) \times \ln(p_i)]$$

where p_i is the proportion of total samples belonging to its species.

CAVITE STATE UNIVERSITY CAVITE PHILIPPINES 1906

For the evenness, it was calculated by dividing H by H_{max} (here $H_{max} = \ln N$). The equitability of the evenness assumed a value between 0 and 1 with 1 being complete evenness.

H_{max} = ln(N) Maximum diversity possible
E_H = Evenness = H/H_{max}

Variables: **SUM** = summation
H = Shannon's diversity index
N = number of species, = species richness
p$_i$ = proportion of total sample represented by species i Divide no. of individuals of species i by total number of samples
E$_H$=equitability (evenness)

Data Analysis

The analysis of data was done using the analysis of variance (ANOVA) to express the differences among mean chemical properties and was compared using Duncan's Multiple Range Test (DMRT). Pearson correlation was used to correlate the physico-chemical parameters of water and the diversity of freshwater in the rivers.

RESULTS

Shrimps Identified in the River

Six species of freshwater shrimps were found in Cañas River, namely: *Palaemon concinnus, Penaeus semisulcatus, Macrobrachium lar, Litopenaeus vannamei, Penaeus merguiensis* and *Penaeus monodon* (Table 1 and Figure 2). This is in contrary to the result of Dimero (2009) where in only *Paneus sp*. was found in Labac River of Cavite.

The *Palaemon concinnus* (54.17%) was the most abundant species of freshwater shrimps that occurred in Cañas River, followed by *Litopenaeus vannamei* (16.67%) and Penaeus *merguiensis* (12.50%). Wawa River had the highest number of shrimps collected with 16 counts with four species - *Palaemon concinnus, Macrobrachium lar, Litopenaeus vannamei and Penaeus monodon*. Tejero River had eight counts with three shrimp species -. *Palaemon concinnus*, Both two rivers had high occurrence of freshwater shrimp in downstream part. However, there were no shrimps collected in Mataas na Lupa River and Mayang falls.

The absence of shrimps in Mataas na Lupa River and Mayang falls could be influenced by very high level of DO in water. The tolerance DO levels for shrimp culture range from 3-10 mg/L and the standard optimum DO level ranges from 4-7 mg/L (Kasnir, et al., 2014). Hence, the DO levels of Mataas na Lupa River (11.20 mg/L) and Mayang Falls (12.60 mg/L) were exceeding the range of tolerance DO levels for shrimps (3-10 mg/L), which could be the reason of the absence of shrimps in these rivers. However, shrimps were present in Tejero River and Wawa River possibly because of the DO levels in water (7.55 mg/L and 5.15 mg/L DO, respectively) met the tolerance and standard optimum DO levels for shrimp.

Diversity Indices

Shannon-Wiener Index. In Shannon-Wiener Index (H), high value of H would be representative of more diverse. The H-value of Wawa River (1.10343) was higher than the H-value of Tejero River (0.97432) (Table 2), which means that the freshwater shrimps in Wawa River are more diverse than the Tejero River. Therefore, Wawa River had the higher species richness and more diverse shrimp species.

Simpson's Index. In Simpson's Index (D), the D-value ranges between 0 and 1, in which 0 indicates no diversity and 1 indicates infinite diversity. That is, the higher the value of D, the lower the diversity. The D-value of freshwater shrimps in Tejero River (0.90625) was higher than Wawa River (0.765625) (Table 2). Hence, the diversity of freshwater shrimps in Tejero River was found lower than the Wawa River. This could be due to the fact that shrimps in Tejero River are dominat-

Palaemon concinnus and *Panaeus merguiensis.*

Evenness. The values of evenness calculated from Shannon-Wiener Index (EH) and Simpson's Index (ED) indicate the proportion of species present on the site. The values of evenness ranged between 1 and 0, in which one indicates complete evenness and 0 indicates no evenness. Hence, the community will possibly have the highest evenness value if all the species within sample area has the same abundance while it will have the lowest evenness value if most of the individual belong to one species. The EH value of freshwater shrimps in Tejero River was higher (0.88686) than the EH value of shrimps in Wawa River (0.79596) (Table 2). It means that although the Tejero River had the fewer number of species present, the shrimp individuals in the community were more evenly distributed between these species. Both ED values of Tejero River (0.302083) and Wawa River (0.191406) could describe the evenness of individuals' distribution of freshwater shrimps on two sites as relatively low, as the ED values were closer to 0 that indicates no evenness.

Physical Properties of Cañas River

The physical properties of the selected sites of Cañas river (water temperature, depth, velocity) were determined (Table 3).

Temperature

The mean temperature of Cañas River ranged from 23.67 ℃ to 25℃ (Table 3). The water temperature of Mayang Falls and Mataas na Lupa River were recorded to be low with 23.67℃ and 24℃, respectively. The shades of the thick vegetation surrounding the banks of Mataas na Lupa River and Mayang Falls could trap the sunlight from penetrating into the river water making the water temperature of the water on these rivers very cold. Vegetation-covered water will not absorb as much heat as the water exposed to sunlight (Wetzel, 2001). As the river water passes Tejero and Wawa Rivers, the water temperature became cold with both water temperatures of 25 ℃. Higher water temperature of these rivers could be attributed to the exposure to sunlight. Water temperature can be affected by several conditions on environment including sunlight and heat transfer from the atmosphere (Fondriest Environmental, Inc., 2014).

Velocity

The water flow in the selected sites of Cañas River was quite slow at 3.77 cm/s to 12.53 cm/s.

Depth

The average depth of different sites of Cañas River ranged from 0.67 meter to1.76 meters. The deepest among the five rivers is the Wawa River with an average depth of 1.76 meters and the shallowest is the Mataas na Lupa River with 0.67 meters. Heavy rainfall and high tide were observed; hence, it contributed in depth levels of the Wawa River.

Chemical Properties

The chemical properties of water (pH, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Total Suspended Solids (TSS) and Total Dissolved Solids (TDS)) from the 4 selected sites of Cañas River were determined and recorded (Table 4). It provides necessary information to evaluate the condition of the rivers as well as the shrimps.

Ph

The mean pH of Cañas River ranged from 6.03 to 7.43 (Table 4). The pH of water in Cañas River was generally acidic (5-6.99). The water of Mataas na Lupa River and Mayang Falls were observed to be neutral with the pH levels of 7.43 and 7.56, respectively. However, the water became slightly acidic as it passes the rivers of Tejero and Wawa with the pH levels of 6.05 and 6.03, respectively. This could be caused by the garbage and other pollutants present on the water that decreased the pH of the water. Acidity of water can be caused by the water carried by the river flow, acid rain and pollution (Kazmeyer, 2017).

Dissolved Oxygen (DO)

The DO of the four rivers satisfied the standard set by the DENR-EMD for class C freshwater which was 5 mg/L. The highest DO value was recorded on Mayang falls with a value of 12.60 mg/L followed by Mataas na Lupa River with 11.20 mg/L. Wawa River registered the lowest DO of 5.55. An adequate supply of DO is essential for the survival of aquatic organisms (Dimero et al., 2021). Oxygen is produced by rooted aquatic plants and algae as a product of photosynthesis (Reyes, 2015). Generally, the DO of Cañas River is 6.69 mg/L.

Total Dissolved Solids (TDS)

The highest TDS was noted on Wawa River with a value of 11,496.67 mg/L followed by Tejero River with 7,486.67 mg/L. These values were above the standard limit set by DENR-EMB. High TDS levels in water of these rivers could be caused by the wastes coming from sewage of establishments such as houses and commercial and some industrial buildings nearby these river sites. Leaching or contamination of soil coming from industrial and domestic sewage is the source of high concentration of dissolved solids (Dimero, 2009; EMB, 2006). Good TDS levels in water were observed in Mataas na Lupa River and Mayang Falls with 153.10 mg/L and 145.23 mg/L, respectively. This could be caused by minimal wastes going on these rivers.

Total Suspended Solids (TSS)

The mean TSS level in water of Cañas River ranged from 193.67 mg/L to 768.04 mg/L (Table 3). The TSS in water of Cañas River was generally high with 512.39 mg/L TSS. All the TSS levels in water of all sites were recorded to be high (>50 mg/L). The higher levels of TDS in water were recorded in Tejero River and Wawa River with 709.59 mg/L and 768.04 mg/L, respectively. The water on these rivers was observed to blend with minute organic particles, wastewater effluent, sewage, algae, silt and mire; therefore, this could be the result of higher TSS in water. TSS consist everything flowing in water such as sediment, silt, sand, plankton and algae (Fondriest Environmental, Inc., 2014). On the other hand, lower TSS levels in water were observed in Mataas na Lupa River and Mayang Falls with 378.26 mg/L and 193.67 mg/L of water TSS levels.

Biological Oxygen Demand (BOD)

The BOD level in water of Cañas River was generally good with 3.5 mg/L BOD. Wawa River was recorded to have the highest BOD level in water of 5 mg/L, still under the limit (7 mg/L) for Class C water body classification of DENR. Biochemical oxygen demand is a measure of how much dissolved oxygen is being consumed as microbes break down organic matter. A high demand, therefore, can indicate that levels of dissolved oxygen are falling, with potentially dangerous implications for the river's biodiversity (EEA, 2015). Floating dead plants and animals, human and animal manure, wastewater effluent and failing sewage systems were observed in the river which could be the sources of high BOD level in water. Organic matters such as leaves and woody debris, dead organisms, animal manure, wastewater treatment plants, feedlots, and food-processing plants, failing septic systems, and storm water runoff are the sources of BOD in water (APHA, 1992) The BOD levels in the water of Mataas na Lupa River, Mayang Falls and Tejero River were 3 mg/L, 2 mg/L and 4 mg/L, respectively. BOD level ranging from 2 to 4 mg/L does not present pollution (Anyanwu & Solomon, 2015).

Correlation of Shrimps to Physicochemical Properties of River Water

The depth, width, TDS, TSS and BOD had moderate positive correlation to population count of freshwater shrimps (Table 5). With this, as the depth, width, TDS, TSS, and BOD increase, the population count of freshwater shrimps moderately increases. The same result was observed by De Luna (2020) and Dimero (2009) where in shrimp population count in Labac River of Cavite is positively correlated to depth, width, TDS, TSS and BOD of river water. All the shrimp species were observed present only on the rivers with high value of depth. Results adhere with the study of Camara, et al. (2009) on Macrobrachium dux in Banco River Basin.

However, the velocity of water flow, pH, and DO had moderate negative correlation to population count of freshwater shrimps, which means that as the velocity of water, pH, and DO increases, the population count moderately decreases and vice versa. Rivers with low water current velocity were observed to have the high density of all the shrimp species. This observation was in agreement with the study of Camara, et al. (2009) for Macrobrachium thysi in Banco River Basin. All the shrimp species seemed to be abundant in water with high levels of TDS, TSS, and BOD; and lower levels of DO and pH.

Water temperature showed a weak positive correlation to freshwater shrimp count. Weak correlation indicates that there is lower likelihood of relationship between the two variables. This means that the water temperature has no significant correlation with the population count of freshwater shrimps (>0.01 significant level).

CONCLUSIONS

Six freshwater shrimps were identified in selected sites of Cañas river- *Litopenaeus vannamei, Penaeus merguiensis, Penaeus monodon, Penaeus semisulcatus, Macrobrachium lar* and *Palaemon concinnus*.Shrimps in Wawa River were more diverse than Tejero River. Evenness of shrimps in Tejero River was found higher than in Wawa River. The physicochemical properties of water of the river sites were within the standard limits set by the DENR-EMB except for the total dissolved solids. Shrimp population count moderately increases as depth, width, TDS, TSS and BOD increase. However, shrimp population count moderately decreases as the velocity of water flow, pH and DO increase.

LITERATURE CITED

Camara, I.A., Konan, K., Diamandé, D., Edia, E., and Gourène, G. (2009). Ecology and diversity of freshwater shrimps in Banco National Park, Côte d' Ivoire (Banco River Basin). *Knowledge and Management in Aquatic Ecosystem*, *393*. Retrieved from http://dx.doi.org/10.1051/kmae/2009020.

Carpenter, K.E. and Niem, V.H. (1998). The living marine resources of the Western Central Pacific. FAO species identification guide for fishery purposes. Cephalopods, crustaceans, holothurians and sharks. *FAO*, *2*, 687-1396.

Crowl, T.A., McDowell, W.H., Covich, A.P. and Johnson, S.L., 2001. Freshwater shrimp effect on dtrital processing and nutrients in tropical headwater streams. Ecology, 82: 775-783.

De Luna, J.(2020). Diversity of Freshwater Shrimps in Relation to the Physicochemical Properties of Water in Selected Sites of Labac River. College of Arts and Sciences, Cavite State University.

De Grave, S., Cai Y. and Anker, A. (2008). Global diversity of shrimps (Crustacea: Decapoda: Caridea) in freshwater. *Hydrobiologia*, *595*, 287–293. doi: 10.1007/s10750-007-9024-2.

Department of Environment and Natural Resources (DENR) Environment Management Bureau. (2022). Region IV-A, List of Water Bodies. Retrived from: https://water.emb.gov.ph/?page_id=761

Department of Environment and Natural Resources (DENR). (2016). Administrative Order No. 08 Series of 2016 (2016). *Water quality guidelines and general effluent standards of 2016*. Retrived from: https://pab.emb.gov.ph/wp

-content/uploads/2017/07/DAO-2016-08-WQS-and-GES.pdf

Dimero, D. N. (2009). *Crustaceans as bioindicator of water in Labac River of Cavite* (Master's thesis). Graduate School, Cavite State University, Cavite, Philippines.

Dimero, D.N., Cruzate, S.M., Bono, M.T. and Creus, J.K. (2021) Diversity of Diatoms in Selected Rivers of Indang, Cavite, Philippines and their Correlation to Water Properties.The Thailand Natural History Museum Journal. 14 (2), 39-50. ISSN 1686-770X. http:doi.org.10.14456/thnhmj.2021.4

Djiriéoulou, C.K., Konan, M.K., Koné T., Bamba, M., Bi, G.G and Koné, I. (2019). Shrimp Assemblages in Relation to Environmental Characteristics of Four Shallow Rivers in South East Côte d'Ivoire. Turkish Journal of Fisheries and Aquatic Sciences 14: 651-658. ISSN 1303-2712

Environmental Management Bureau (EMB) (2006). *National water quality status report CY 2001 to 2005*. Retrieved from: https://emb.gov.ph/wp-content/uploads/2019/08/NWQSR-2001-to-2005.pdf

Erce, A. and Quiñones, A.M. (2017). *Identification of fish and crustacean species and water quality assessment of Cañas River watershed, Cavite, Philippines* (Bachelor's thesis). DFES, CAFENR, Cavite State University, Philippines.

European Environment Agency. (2015) Biochemical Oxygen Demand in Rivers. Retrived from: https://www.eea.europa.eu/data-and-maps/daviz/rivers-biochemical-oxygen-demand-1#tab-chart_1_filters=%7B%22rowFilters%22%3A%7B%7D%3B%22columnFilters%22%3A%7B%22pre_config_country%22%3A%5B%22Europe%22%5D%7D%7D

Fondriest Environmental, Inc. (2014). Water temperature: Fundamentals of Environmental Measurements. Retrieved from: https://www.fondriest.com/environmental-measurements/parameters/water-quality/water-temperature.

Kasnir, M and Harlina, R. (2014). Water quality parameter analysis for the feasibility of shrimp culture in Takalar Regency, Indonesia. J. Aquac. Res. Development, 5, 273. doi: 10.4172/2155-9546.1000273

Kazmeyer, M. (2017). *Water pH and pollution*. In Sciencing. Retrieved from: https://sciencing.com/water-ph-amp-pollution-5850000.html.

Motoh, H. & Kuronuma, K. (1980). *Field guide for the edible Crustacea of the Philippines*. Retrieved from: https://repository.seafdec.org.ph/bitstream/handle//10862/152/ediblecrustacea.pdf

Reyes, I.A. (2015). Macroinvertebrates Associated with the Physicochemical Properties of Water in Selected Rivers of Indang, Cavite. College of Arts and Sciences, Cavite State University. 63 pp.

Soomro, A.N., Waryani B., Hiroshi S., Ali Baloch W., Masashi S., Qureshi, S. T., and Saddozai, S. (2016). Diversity of freshwater shrimps (Atyidae and Palaemonidae) along the Continnum of Urabaru Stream, Kikaijima Island, Japan. *Pakistan J. Zool.*, *48*(2), 569-573.

Tchakonté, S, Gideon, A, Diomande, D, Camara, I, Konan, K, and Pierre, N. (2014). Impact of anthropogenic activities on water quality and Freshwater Shrimps diversity and distribution in five rivers in Douala, Cameroon. *Journal of Biodiversity and Environmental Sciences (JBES)*, *4*(2), 183-194.

Wetzel, R.G. (2001). *Limnology: Lake and river ecosystem* (3rd Ed). San Diego, CA: Academic Press.

Table 1. Diversity indices of freshwater shrimps in four selected sites of Cañas River

FRESHWATER SHRIMP	INDIVIDUALS COUNTED				TOTAL	PERCENT ABUNDANCE (%)
	ML*	MF*	T*	W*		
Palaemon concinnus	0	0	4	9	13	54.17
Penaeus semisulcatus	0	0	1	0	1	4.17
Macrobrachium lar	0	0	0	2	2	8.33
Litopenaeus vannamei	0	0	0	4	4	16.67
Penaeus merguiensis	0	0	3	0	3	12.50
Penaeus monodon	0	0	0	1	1	4.17
Total	0	0	8	16	24	
Percent Abundance (%)	0	0	33.33	66.67		100

*ML: Mataas na Lupa River; MF: Mayang Falls; T: Tejero River; W: Wawa River

Table 2. Diversity indices of freshwater shrimps in four selected sites of Cañas River

SITE	SHANNON-WIENER INDEX (H)	EVENNESS (E_H)**	SIMPSON'S INDEX (D)*	EVENNESS (E_D)**
Tejero	0.97432	0.88686	0.90625	0.302083
Wawa	1.10343	0.79596	0.765625	0.191406

*0 = no diversity; 1 = infinite diversity
**0 = no evenness; 1 = complete evenness

Table 3. Physical properties of water in selected sites of Cañas River

RIVER	TEMPERATURE (℃)*	VELOCITY (cm/s)**	DEPTH* (m)
Mataas na Lupa	24	3.77	0.67
Mayang Falls	23.67	12.53	1.03
Tejero	25	1.53	1.28
Wawa	25	1.93	1.76
Mean	24.42	4.94	1.19

Table 4. Chemical properties of water in selected sites of Cañas River

RIVER	pH	DO mg/L	TDS mg/L	TSS mg/L	BOD mg/L
Standard	6.5-8.5	5.00	1,000	80	7
Mataas na Lupa	7.43a	11.20a	153.10a	378.26b	3a
Mayang Falls	7.26a	12.60a	145.23a	193.67a	2a
Tejero	6.05b	7.55b	7,486.67b	709.59bc	4ab
Wawa	6.03b	5.55b	11,496.67c	768.04c	5b
Mean	6.69	9.23	4,820.4	512.39	3.5

*Source: standard criteria for the physicochemical properties of water cited by Maglangit *et al*., 2014 and Anyawu and Solomon, 2015.
*Means followed by the same letters with in a column are not significantly different at 0.02 level of difference (DMRT)

Table 5. Correlation of shrimp count and physicochemical properties of water in selected sites of Cañas River

PHYSICOCHEMICAL PROPERTY	PEARSON'S R	SIGNIFICANCE	INTERPRETATION
Depth	0.411**	0.000	Moderate Positive Correlation
Width	0.531**	0.000	Moderate Positive Correlation
Temperature	0.133	0.170	Weak Positive Correlation
Velocity	-0.354**	0.000	Moderate Negative Correlation
pH	-0.409**	0.000	Moderate Negative Correlation
DO	-0.442**	0.000	Moderate Negative Correlation
TDS	0.553**	0.000	Moderate Positive Correlation
TSS	0.450**	0.000	Moderate Positive Correlation
BOD	0.602**	0.000	Moderate Positive Correlation

**Correlation is significant at the 0.01 level

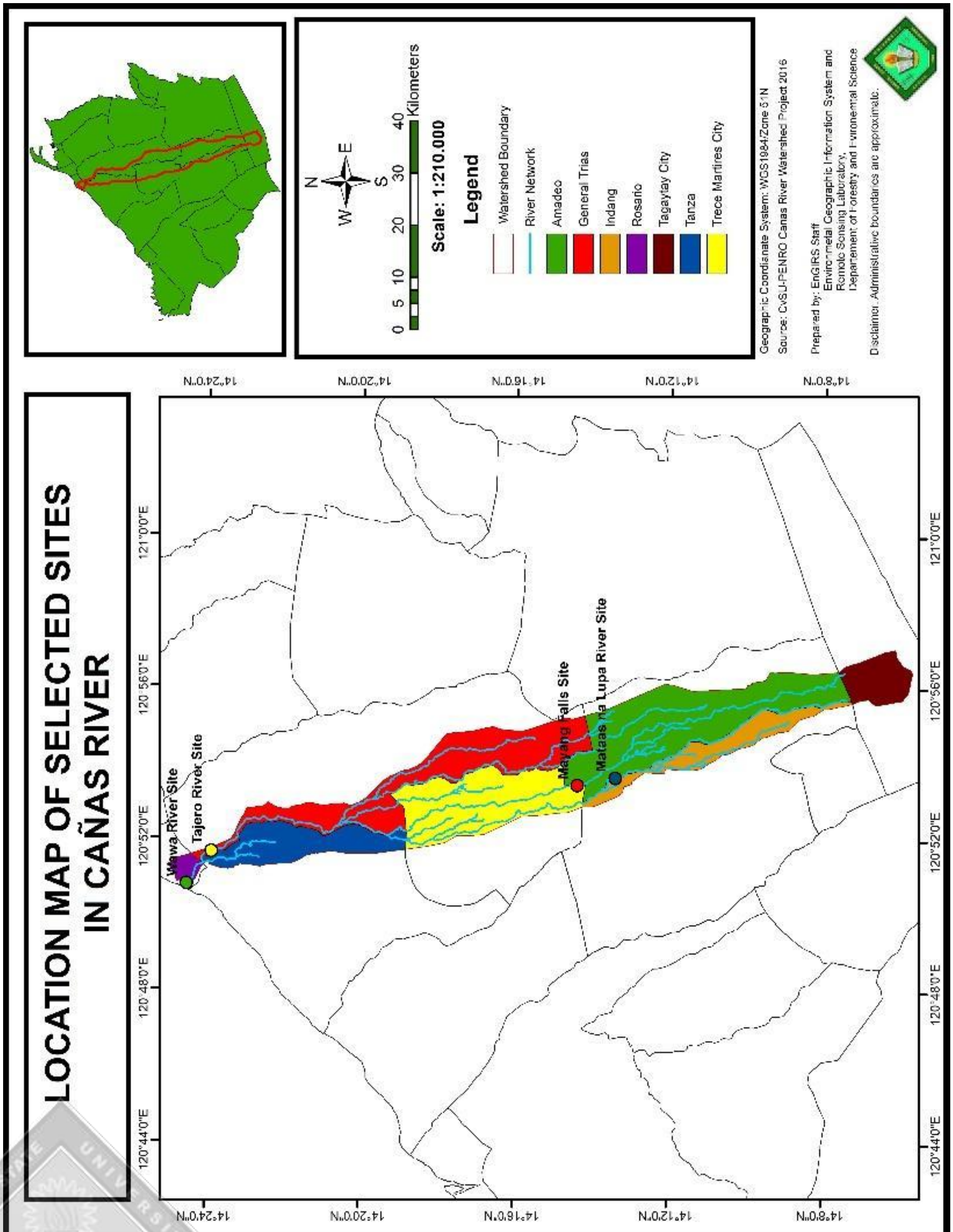

Figure 1. Location map showing the four sampling sites in Cañas River of Cavite

Figure 2. Shrimps found in different sites of Cañas River: (A) *Palaemon concinnus*; (B) *Penaeus semi-sulcatus*; (C) *Macrobrachium lar*; (D) *Litopenaeus vannamei*; (E) *Penaeus merguiensis;* and (F) *Penaeus monodon*