DAVAO RESEARCH JOURNAL

https://davaoresearchjournal.ph P-ISSN 2244-4432 E-ISSN 2984-7125

Trade Dynamics of the Leopard Coral Grouper (*Plectropomus leopardus*, Lacepède, 1802) in Palawan: A Philippine Perspective on the Impacts of the COVID-19 Pandemic and Coping Strategies

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Submitted: 23 May 2025
Revised: 05 Jun 2025
Accepted: 18 July 2025
Published: 27 Jun 2025

OPEN ACCESS

ABSTRACT

The live reef fish food trade (LRFFT) is one of the fisheries activities in the Philippines, making vital contributions to the economy. The Leopard coral grouper (*Plectropomus leopardus*, Lacepède, 1802) is the most highly valued commercial fish species utilized for LRFFT. Aside from overexploitation, the trade of *P. leopardus* has been unprecedentedly challenged by the COVID-19 pandemic. This research examines these challenges through assessments of their impacts on the trade dynamics of *P. leopardus*, from 2018 to 2021, as well as qualitative analysis of the government's responses during the COVID-19 outbreak. Trade parameters examined include export volume, market value, transhipment ports, and shipment status. The results showed that Puerto Princesa City and Quezon are the top exporters of the commodity from southern Palawan, while Coron generated the highest production from northern Palawan. Live *P. leopardus* was the most preferred commodity, and the majority were transported to the National Capital Region (Metro Manila). The control measures against the pandemic, which imposed lengthy community quarantines, restrictions on the movement of people and commodities, fear of recurring outbreaks, and unstable food security, have substantially caused trade disruptions. To meet these challenges, the government's coping strategies, such as stabilizing the supply chain, food security monitoring, price-stabilization scheme, and conditional cash assistance program, were employed to offset the negative impacts in both short- and long-term scenarios. This study concludes with emerging opportunities to improve domestic policies, regulations, and collaborative partnerships among the different stakeholders for greater resilience.

Keywords: Food Security, Global Pandemic, Live Reef Fish Food Trade, Resiliency, Small Scale Fisheries

How to cite: Cayetano, C. B., Asis, E. H., Dicar, Z. A., Sajorne, R. E., Madarcos, K. G., Alcantara, L., Cayetano, A. Z., Palla, H. P., and Creencia, L. A. (2025). Trade Dynamics of the Leopard Coral Grouper (*Plectropomus leopardus*, Lacepède, 1802) in Palawan: A Philippine Perspective on the Impacts of the COVID-19 Pandemic and Coping Strategies. *Davao Research Journal*, 16(2), 156-175. https://doi.org/10.59120/drj.v16i2.411

INTRODUCTION

Aquaculture and capture fisheries are crucial for the food security of a significant fraction of the global population (Food and Agriculture Organizations, 2020). Under these food production systems, the live reef fish food trade (LRFFT) ranks among the most highly valued fishery activities that provide income for coastal communities in the Asia-Pacific region (Fabinyi and Dalabajan, 2011). The Leopard coral grouper (*Plectropomus leopardus*, Lacepède, 1802) is the most important commercial fish species utilized for LRFFT, which accounts for 55 % of the Philippines' total export (Pomeroy et al., 2008). Based on the 2019 and 2020 Philippine Fishery Profiles, the export volume of the groupers, including *P. leopardus*, reached 6,431 metric tons (MT) and 5,205 MT with equivalent market prices of US$ 19,001,000 and US$ 11,320,000, respectively (Bureau of Fisheries and Aquatic Resources, 2020, 2021). These make the species the most dominant trade commodity harvested and exported live to mainland China, Hong Kong, and Taiwan (Sadovy et al., 2003). Small quantities of live reef fish food (LRFF) are also exported to Malaysia and Singapore (Padilla et al. 2003).

Plectropomus leopardus provides vital livelihood opportunities for impoverished coastal communities of at least 1.6 million people (Southeast Asian Fisheries Development Center, 2017). Local fishers earn up to US$ 22 or approximately 40% to 300% higher than the price of a fresh species (Mapstone et al., 2001; Salao et al., 2013). However, owing to its significant economic importance, *P. leopardus* is vulnerable to high fishing pressure (Samoilys, 1997; Gonzales et al., 2020) and destructive fishing methods (Burke et al., 2002). These practices not only damage the reef but also exploit species from juveniles to adults (Padilla et al., 2003). Although several factors contribute to the supply chain of *P. leopardus* in the country (Barber and Pratt, 1997a, 1997b), this study specifically investigates the effects of the Coronavirus disease (COVID-19) as a novel and emerging factor affecting the species' supply chain.

The emergence of COVID-19 triggered a health and economic crisis, intensifying poverty and food insecurity in both agricultural and fishery sectors (Consortium of International Agricultural Research Centres System Organization, 2020; Sumner et al., 2020), particularly in small-scale fisheries (SSF) aquaculture and capture fisheries (Bennett et al., 2020; Knight et al., 2020; Love et al., 2021). Though responses vary across areas, the Philippines' mitigating measures against COVID-19 were notably reflected in restrictions in the fishing operations (FAO, 2020; Immanuel, 2020) which led to the disruption and shutdown of numerous market chains that affected the supply chain of the LRFFT (Belton et al., 2021; Ferrer et al., 2021; Love et al., 2021; Sunny et al., 2021). On a regional scale, during the early periods of stricter community quarantines, municipal fisheries production nationwide declined by the highest percentage (7.02%) in the second quarter of 2020 (Ferrer et al., 2021). It posed disruptions not only to the local fishers but also to their families and other institutional networks (Mirasol, 2020; Hidayati et al., 2021). For instance, despite their counter-response to the inevitable impacts of COVID-19, LRFFT actors were compelled to continue fishing while overlooking the associated health risks and rising operational costs (Kaewnuratchadasorn et al., 2020).

Given the international nature of the LRFFT, the pandemic's disruptions have not been confined to the Philippines. Global studies have reported similar impacts on small-scale fisheries, especially in Southeast Asia, South Asia, and the Pacific Islands regions that, like the Philippines, are deeply involved in live fish export markets (Ferrer et al., 2021; Sunny et al., 2021; Zhang et al., 2021). For instance, export-focused fishers in Indonesia and Bangladesh faced comparable reductions in market access, increased transport costs, and health risks. These common patterns demonstrate how the COVID-19 crisis revealed structural vulnerabilities within transboundary seafood supply chains, especially those relying on live trade logistics and high-value reef fish commodities.

Policymakers around the world have been activating key policy levers to foster resiliency and restore both economic and social systems in the wake of the COVID-19 shocks (Organisation for Economic Co-operation and Development, 2020). To contribute to optimal resiliency, individuals or sectoral groups wield coping strategies (Nelson et al., 2007) that have been an

integral component of maintaining the well-being of the people and food security (e.g., Eriksson et al., 2020). And while the understanding of the implications of COVID-19 remains complex and incomplete from an individual's perspective, the government continues to respond to this crisis. For example, following the resolved decision of the COVID-19 Inter-Agency Task Force on Emerging Infectious Diseases (IATF-EID), the agency found out that fishers are crucial players and recommended that their activities must remain "unhampered" to ensure the continuity of domestic food security (Department of Health, 2020).

This study focuses on Palawan as one of the most important regions for LRFFT. Assuming that the government's coping mechanisms have been well structured and documented, this research investigates how these responses align with broader international concerns about building resilient fish trade systems in the face of global crises. Beyond the backdrop of the scientific community, the coping strategies, along with the trend analysis of the trade status of the *P. leopardus* before and after the COVID-19 pandemic, remain novel and viably important within the context of sustainable fish stock. Demonstrating the government's coping strategies will not only inform short-term responses but also enable the development of long-term strategy in a similar setting. This study aims to conduct a timely initial assessment of the trading parameters of *P. leopardus* in Palawan, evaluate the impacts of COVID-19 on its trade, and identify the governance attributes in the form of empirical evidence on how the Philippine government strategically manages these impacts.

MATERIALS AND METHODS

Description of the study area

Palawan is composed of 1,780 islands with 2,000 km of coastline located southwest of Manila, Philippines. Based on the jurisdiction of BFAR–Mindoro, Marinduque, Romblon, and Palawan (MIMAROPA), we established two distinct sub-areas, the southern Palawan (SP) and northern Palawan (NP). The former is composed of the municipalities of Balabac, Bataraza, Brookes Point, Rizal, Quezon, Roxas, and Puerto Princesa City (PPC), while the NP is comprised of San Vicente, Taytay, Culion, Coron, Busuanga, Cuyo, Magsaysay, and Agutaya (Fig. 1). Palawan has three major roll-on/roll-off (RoRo), which serve as gateways to trade; 11 non-RoRo-based seaports, one international airport, and three Principal-Class 2 airports (Philippine Ports Authority 2022).

Analytical framework

The fishery and aquatic products shipment datasets from 2018 to 2021 were sourced from BFAR–MIMAROPA under the Fisheries Inspection and Quarantine Service (FIQS). Of the total 8,498 records, only 8,440 complete datasets were used for the analysis. The trading parameters were assessed by examining the export volume and value in Palawan across four time periods: 2018 and 2019 (pre-pandemic years), 2020 (during the pandemic with stringent restrictions), and 2021 (during the pandemic with loosened restrictions). The trade vitalities were first analysed monthly. For the purpose of simplifying terms, the words "volume", "market value", and "value", denote the total exported amount. We also investigated two additional trading parameters including the type of shipment ("live", "fresh" or "fresh/live"), and the transhipment locations (ports of origin and destination).

A descriptive analysis was applied to assess the dynamics of disruptions within the trade and supply chain using the parameters stated earlier. The impact of COVID-19 on trade was investigated by comparing the volume and value in 2020 with the trade data from the same period in 2019 and 2021.

To interpret these trends meaningfully, this study adopts the food system resilience framework developed by Tendall et al. (2015) as its guiding analytical lens. This framework conceptualizes resilience as the capacity of a food system to absorb shocks, adapt to disturbances, and transform when necessary while continuing to deliver key functions such as food availability, access, and livelihoods. It provides a structured lens for understanding the disruptions caused by the COVID-19 pandemic and evaluating how the LRFFT, particularly the trade of *P. leopardus*, responded to these challenges. The resilience framework is operationalized through three key dimensions: absorptive capacity (the ability to withstand shocks while maintaining function), adaptive capacity (the ability to make incremental

 DOI: https://doi.org/10.59120/drj.v16i2.411

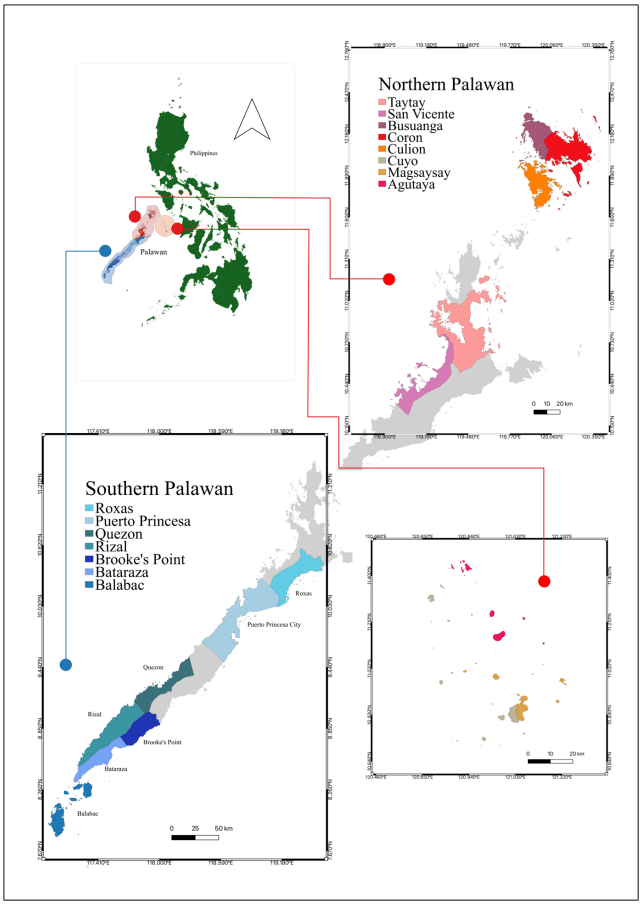

Figure 1. Study area detailing the different sub-areas in Southern Palawan and Northern Palawan based on BFAR–MIMAROPA's jurisdiction.

adjustments in response to changing conditions), and transformative capacity (the ability to fundamentally restructure to address long-term change) (Jeans et al., 2017; Tanner et al., 2017; Haider & Cleaver, 2023). These dimensions serve as interpretive tools in analysing the observed shifts in trading patterns, stakeholder coping strategies, and government responses within Palawan's LRFFT.

The government's coping mechanisms were evaluated using official data from BFAR, grey literature, and publicly available online sources. This analysis was explicitly framed within the resilience model to identify which coping measures reflected absorptive, adaptive, or transformative capacities. Rather than merely describing trade dynamics, the study situates these shifts within a systemic understanding of resilience, emphasizing how institutional responses, policy decisions, and market behaviours contribute to the LRFFT system's capacity to recover from, and adjust to, pandemic-induced disruptions (Marchand et al., 2016; Béné, 2020).

RESULTS

Trade dynamics of *Plectropomus leopardus* in Palawan

All the sub-areas were involved in the trade during 2018–2021. In Southern Palawan, Balabac had one trade record in 2018 and two records for Bataraza and Brooke's Point in 2018 and 2019, respectively. Rizal and Roxas had data available in 2021; however, the former maintained consistent records throughout the year (Table 1). In NP, Busuanga and Culion had one trade record in 2019, while Agutaya, Coron, Cuyo, and Magsaysay hadtwo trade records in 2018 and 2019. Interestingly, San Vicente was the only area in Northern Palawan with trade records for 2021 (Table 1).

In Southern Palawan, PPC emerged as the top exporter of *P. leopardus* with the highest volume production of 447,394 kg (Php 189,365,400) in 2019. Even during 2018, PPC remained the top exporter with at least a 53.44% increase in volume

(39.61%) the following year. This was higher than the volume generated by Rizal in the same year, with a difference of 199,934 kg. However, the more notable disparity lies in the monetary value, amounting to Php 5,493,793. Of the three major exporters in SP in 2020, PPC fell behind in the third spot (590 kg and Php 290,000) during the second quarter. Within this period, Quezon came out as the top exporter (55,616 kg and Php 44,729,580), followed by Rizal (2,472 kg and Php 3,508,400) (Table 1).

An approximately 84.13% decrease in volume has been recorded in Roxas from 2019 to 2020, and it further decreased by 64.27% between 2020 and 2021. Consistently, most export trading activities with significantly high production volumes occurred during the second and third quarters of each year.

Table 1. Trading exports of *Plectropomus leopardus* from Southern Palawan to major markets between 2018 and 2021. (Units: Export volume in kilogram; Export value in Philippine Peso. All Php to USD conversions were calculated using the average exchange rate for the year 2020, the primary year of analysis (1 USD = 49.62 Php), based on data from the Bangko Sentral ng Pilipinas).

Municipality/ City	Year	Jan-Mar		Apr-Jun		Jul-Sept		Oct-Dec		Total	
		Volume	Value	Volume	Value	Volume	Value	Volume	Value	Volume	Value
Balabac	2018	-	-	-	-	-	-				
Bataraza	2019	265	405,000	50	20,000	-	-		36,260	47	36,260
	2018	-	-	6,249	1,418,000	837	705,500	47	-	315	425,000
Brooke's	2019	-	-	974	385,513	180	25,000	-	2,113,650	12,472	4,237,150
Point								5,386	1,026,448	3,125	1,436,961
	2018	-	-	-	-	-	-	1,972			
Puerto	2020	-	-	590	290,000	-	-		1,015,608	658	1,015,608
Princesa								658	-	590	290,000
	2019	59,468	24,944,700	117,506	50,438,800	172,424	74,324,300	-			
	2018	5,804	6,090,200	15,336	10,204,460	73,223	39,421,300		39,657,600	447,394	189,365,400
Quezon	2020	7,082	8,782,600	7,000	2,384,000	22,110	11,546,580	97,816	58,643,300	208,272	114,359,260
	2019	11,097	16,617,500	20,310	28,341,900	23,804	29,385,836	113,909	22,016,400	55,616	44,729,580
	2018	700	1,047,200	-	-	-	-	19,424	16,073,500	64,571	90,418,736
Rizal	2021	1,310	1,200,000	16,278	5,330,000	5,194	5,550,000	9,360	170,035	466	1,217,235
	2020	2,472	3,508,400	-	-	-	-	116	6,750,000	29,737	18,830,000
	2019	18,787	46,424,272	16,682	15,767,044	15,997	23,793,980	6,955	-	2,472	3,508,400
	2018	18,923	26,191,050	19,739	27,350,612	17,498	21,349,005	-	13,033,380	60,089	99,020,676
Roxas	2021	-	-	-	-	573	650,000	8,622	33,974,800	80,338	108,865,467
	2020	3,736	3,851,000	882	1,120,000	3,312	1,805,000	24,178	1,170,000	1,589	1,820,000
	2019	6,300	10,352,250	4,888	8,675,280	3,975	4,902,400	1,015	1000,000	4,447	3,136,000
	2018	21,545	14,916350	12,456	7,108,800	-	-	60	14,141,670	28,029	38,071,600
								12,865	3,490,000	35,758	25,387,050

In NP, Coron supplied the highest market value to the provincial economy with at least Php 305,060,207 in 2019 alone (Table 2). Cuyo followed the lead, with a volume of about 70,109 kg in 2018 (Php 36,089,426), but not until 2020, which subsequently yielded no trade records. Interestingly, even during the pre-pandemic period, there was already a 43.16% decrease in the volume in Cuyo. A similar decreasing pattern was observed between the two pre-COVID-19 periods in Agutaya, and a gradual to sudden reduction was noted in San Vicente and Taytay.

Of the eight trading sub-areas in NP, Agutaya, Coron, Cuyo, Magsaysay, and San Vicente experienced no subsequent trades within the first two quarters of 2018. Similarly, Agutaya, Busuanga, Culion, Magsaysay, and Taytay had no trade data during the first half of 2019. The largest volume production in NP was recorded during the third quarter of 2019 in Coron, reaching a peak of 94,923 kg. This production, which costs Php 117,777,050, was 328.74% higher than the combined total value generated by the rest of the municipalities in NP in the third quarter of 2019 (php 35,826,870). Unfortunately, Coron was dropped from the list of top exporters in 2020, noting that San Vicente and Taytay continued the trading operations. Eventually, these two sub-areas stopped exportation in the last quarter of 2020, leaving no export operations in NP during the implementation of mobility restrictions amidst COVID-19. San Vicente and Taytay suffered reductions of 91.61% and 0.14% in volume from 2019 to 2020. Between 2020 and 2021, the volume production in San Vicente further went down by 25.13%.

DOI: https://doi.org/10.59120/drj.v16i2.411

Table 2. Trading exports of *Plectropomus leopardus* from Northern Palawan to major markets between 2018 and 2021. (Units: Export volume in kilogram; Export value in Philippine Peso. All Php to USD conversions were calculated using the average exchange rate for the year 2020, the primary year of analysis (1 USD = 49.62 Php), based on data from the Bangko Sentral ng Pilipinas).

Municipality/ City	Year	Jan-Mar		Apr-Jun		Jul-Sept		Oct-Dec		Total	
		Volume	Value	Volume	Value	Volume	Value	Volume	Value	Volume	Value
Agutaya	2019	-	-	-	-	-	-	40	3,500	40	3,500
	2018	-	-	-	-	200	50,000	481	406,500	681	456,500
Busuanga	2019	-	-	-	-	4,900	6,500,000	-	-	4,900	6,500,000
Coron	2019	63,534	92,821,000	61,408	94,462,157	94,923	117,777,050	-	-	219,865	305,060,207
	2018	-	-	-	-	100	12,300	-	-	100	12,300
Culion	2019	-	-	-	-	1,765	1,953,000	-	-	1,765	1,953,000
Cuyo	2019	-	-	63,572	14,652,900	36,243	14,679,700	2,511	9,136,000	39,851	38,468,600
	2018	-	-	-	-	23,984	20,246,920	46,125	15,842,506	70,109	36,089,426
Magsaysay	2019	-	-	-	-	960	508,000	171	214,000	1,131	722,000
	2018	-	-	-	-	825	678,000	508	572,500	971	770,500
San Vicente	2021	-	-	-	-	979	820,000	176	174,900	1,155	994,900
	2020	475	330,800	340	212,500	627	590,000	-	-	1,442	1,133,300
	2019	-	-	808	965,000	6,641	4,433,270	9,748	9,372,810	17,198	14,771,080
	2018	-	-	-	-	-	-	9,908	9,621,101	9,908	9,621,101
Taytay	2020	2,200	400,000	2,190	1,391,000	1,841	428,000	-	-	6,231	2,219,000
	2019	-	-	-	-	3,680	2,850,500	2,560	7,066,000	6,240	9,916,500
	2018	2,730	415,000	3,260	573,000	2,400	320,000	1,097	1,430,000	9,487	2,738,000

In Figure 2, PPC emerged as the leading exporter in Palawan, with a combined total of at least 656,256 kg from 2018 to 2021. Although Coron ranked as the second major exporter, supplying approximately 33.52% less than PPC, this small island municipality excelled in export value, surpassing the city's total market price by at least 0.35%. Following the leads of PPC and Coron, the SP further integrated the two top exporters, ranked by export volume and value. Quezon and Rizal continued to dominate the market, contributing more than Php 100 million to the fishery sector. Roxas was largely unaffected by COVID-19 restrictions and secured the fifth position (70,243 kg and Php 68,542,750).

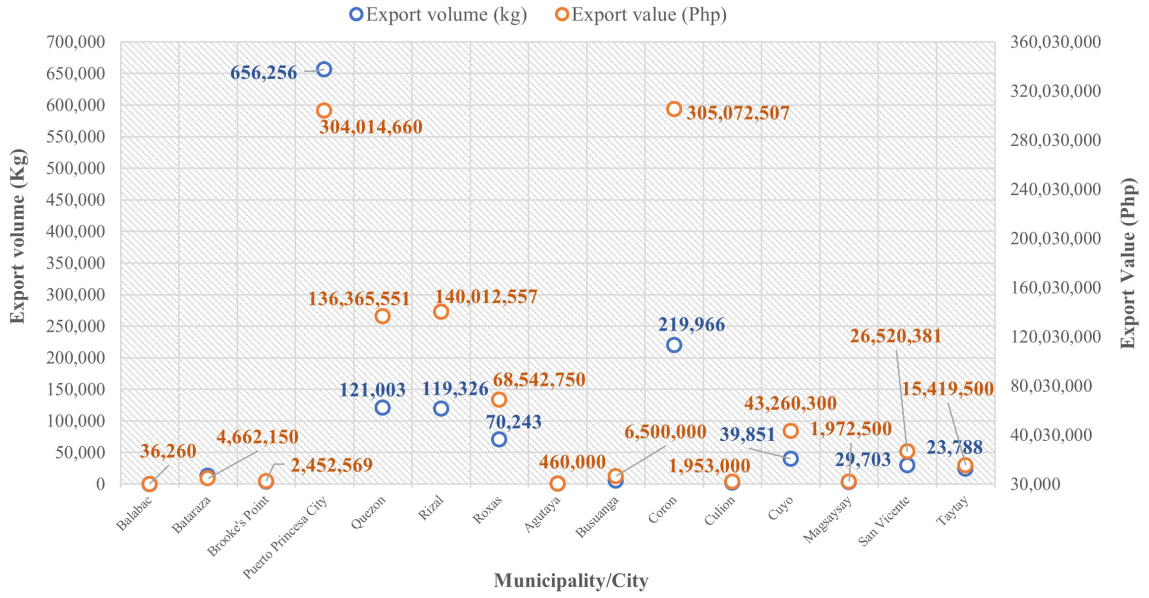

Figure 2. Export volume and value trends of *Plectropomus leopardus* from different municipalities in Palawan from 2018 to 2021.

Rizal topped the list of having the highest volume production of live *P. leopardus* from 2018 to 2021. Its equivalent market value (Php 224,710,171) has an absolute difference of 66.74 % from Quezon between 2018 and 2020 (Table 3). Puerto Princesa landed the sixth spot, having only an overall volume for the live commodity at 433 kg (Php 164,000) between 2018 and 2020. However, PPC eventually turned out to be the top exporter of fresh *P. leopardus* in the same periods, toppling others with a value of Php 303,850,660 (652,096 kg).

Table 3. Trading exports of *Plectropomus leopardus* in Palawan between 2018 and 2021 concerning the commodity's shipment status. (Units: Export volume in kilogram; Export value in Philippine Peso. All php to USD conversions were calculated using the average exchange rate for the year 2020, the primary year.

Municipality/ City		Jan-Mar		Apr-Jun		Jul-Sept		Oct-Dec		Total
	Year	Volume	Value	Volume	Value	Volume	Value	Volume	Value	
Balabac	2018	47	36,260	-	-	-	-	47	36,260	
Bataraza	2019	125	287,000	190	138,000	-	-	315	425,000	
	2018	3,596	1,801,700	8,876	2,435,450	-	-	12,472	4,237,150	
Brooke's Point	2019	870	940,810	2,256	496,151	-	-	3,126	1,436,961	
	2018	629	986,908	29	28,700	-	-	658	1,015,608	
Puerto Princesa	2020	-	-	590	290,000	-	-	590	290,000	
	2019	-	-	447,394	189,365,400	-	-	447,394	189,365,400	
	2018	433	164,000	204,112	114,195,260	-	-	208,272	114,359,260	
Quezon	2020	9,756	21,715,400	45,860	23,014,180	-	-	55,616	38,475,580	
	2019	62,443	89,333,636	2,128	1,085,100	-	-	64,571	90,418,736	
	2018	816	1,217,235	-	-	-	-	816	1,217,235	
Rizal	2021	27,724	16,500,000	2,013	2,330,000	-	-	29,737	18,830,000	
	2020	2,367	3,494,000	105	14,400	-	-	2,472	3,508,400	
	2019	56,938	98,562,306	3,151	458,370	-	-	60,089	99,020,676	
	2018	74,026	106,153,865	6,468	3,165,000	-	-	80,494	109,318,865	
Roxas	2021	1,589	1,820,000	-	-	-	-	1,589	1,820,000	
	2020	4,782	5,045,000	3,208	1,831,000	-	-	7,990	6,876,000	
	2019	27,509	37,938,830	520	132,770	-	-	28,029	38,071,600	
	2018	32,240	24,481,050	3,938	1,034,100	-	-	36,178	25,515,150	
Agutaya	2019	-	-	40	3,500	-	-	40	3,500	
	2018	221	350,000	460	106,500	-	-	681	456,500	
Busuanga	2019	4,852	6,455,000	-	-	48	45,000	4,900	6,500,000	
Coron	2019	216,863	301,279,207	-	-	3,003	3,781,000	219,866	305,060,207	
	2018	-	-	100	12,300	-	-	100	12,300	
Culion	2019	1,765	1,953,000	-	-	-	-	1,765	1,953,000	
Cuyo	2019	14,977	24,025,000	102,327	18,020,100	-	-	117,304	42,045,100	
	2018	16,701	25,976,020	53,408	10,070,406	-	-	70,109	36,089,426	
Magsaysay	2019	998	672,000	133	50,000	-	-	1,131	722,000	
	2018	793	1,127,000	540	123,500	-	-	1,333	1,250,500	
San Vicente	2021	1,155	994,900	-	-	-	-	1,155	994,900	
	2020	833	730,800	609	402,500	-	-	1,442	1,133,300	
	2019	16,280	14,605,910	918	165,170	-	-	17,198	14,771,080	
	2018	9,909	9,621,101	-	-	-	-	9,909	9,621,101	
Taytay	2020	3,940	1,840,000	2,291	379,000	-	-	6,231	2,219,000	
	2019	4,780	9,155,000	3,290	1,307,500	-	-	8,070	10,462,500	
	2018	1,000	1,213,000	8,087	1,125,000	-	-	9,087	2,338,000	
Southern Palawan	2021	29,313	18,320,000	2,013	2,330,000	-	-	85,353	20,650,000	
	2020	16,905	30,254,400	49,763	25,149,580	-	-	66,668	49,149,980	
	2019	147,760	226,775,582	455,449	2,172,391	-	-	155,815	228,947,973	
	2018	111,787	134,841,081	223,423	120,858,510	-	-	338,937	255,695,528	
Northern Palawan	2021	1,155	994,900	-	-	-	-	1,155	994,900	
	2020	4,773	2,570,800	2,900	718,500	-	-	7,673	3,352,300	
	2019	260,515	358,145,117	106,708	19,546,270	3,051	3,826,000	370,274	381,487,387	
	2018	28,624	38,287,121	62,595	11,437,706	-	-	91,219	49,767,827	

DOI: https://doi.org/10.59120/drj.v16i2.411

In NP, Coron was the top exporter of the live commodity but only after the pandemic began. Coron's total market value in 2019 was 134.07% higher than the market value generated by Rizal within four inclusive years. Cuyo followed Coron with a market value of approximately Php 50,001,020, and Coron had a market value of approximately Php 50,001,020 (Table 3). The price of fresh commodities was comparatively lower than that of live ones. In Cuyo for example, despite having higher volume productions of fresh commodity in 2018 and 2019 (53,408 kg and 102,327 kg) against the live *P. leopardus* (16,701 kg and 14,977 kg), the equivalent values of fresh products were lower (Php 10,070,406 and Php 18,020,100) than the live products (Php 25,976,020 and Php 24,025,000).

As much as 97.22 % of the overall production of the commodity in SP was transported to the National Capital Region (NCR). This accounts for about 289,619 kg (Php 224,878,425). Meanwhile, in NP, a large portion of exported products in 2018 was reported withouta specified destination, accounting for approximately 64.86% of the total volume for that year (see Supplementary Information Table 1).

A qualitative inquiry on the impacts of COVID-19

Following the conceptual framework of food resilience, we identified three specific phases where the impacts of COVID-19 across different periods became the primary factor influencing the mobility, transport accessibility, and trade of *P. leopardus*.

Phase 1 refers to the period (January to December 2019) as the pre-pandemic time when LRFFTs were normally undisrupted. Phase 2 refers to the period (January to December 2020) when the Philippine government initially convened to monitor the viral outbreak in China until the implementation of the most stringent measures. Furthermore, the first case of local transmission of COVID-19 was confirmed, leading to the implementation of travel restrictions in the NCR on 13 March 2020 and in MIMAROPA by 17 March 2020. Following the National Action Plan of the IATF-EID, the community quarantine was extended until 30 April 2020, which further caused disruptions to the trade of *P. leopardus* (Amit et al., 2021). By August 2020, the most stringent implementation of community quarantines was adopted in anticipation of the second wave of the COVID-19 outbreak (Ocampo and Yamagishi, 2020; Vallejo and Ong, 2020). In December 2020, the massive government procurement of vaccines continued. Phase 3 (January to December 2021) refers to the continuation of the rapid mobilisation of immunisation against COVID-19 to attain herd immunity. Lockdowns were slowly lifted, and more lenient community quarantines were implemented (Baclig, 2021). In December 2021, the country began to slowly adopt the possibility of transitioning to the endemic phase (Mendoza, 2022).

The outbreak of COVID-19 caused numerous disruptions in the LRFFT, particularly in the export of *P. leopardus* from Palawan. Following the initial outbreak in the first quarter of 2020, NCR, Region IV-A, and PPC were placed under enhanced community quarantines (ECQ) indiscriminately. The ECQ resulted in the suspension of face-to-face school classes, the prohibition of mass gatherings, the restructuring of government offices, the closure of many businesses except those crucial for food security, and restrictions on mass transportation (Hapal, 2021).

Similar to the Philippines, China, as one of the major importers of *P. leopardus* from Palawan, also suppressed the demand and supply chain in the market since gatherings were prevented, especially during the Spring. Festival holiday from January 25 to February 1, 2020 (Shen et al., 2022) has prohibited the operations of wholesale and retail markets for raw meat, fish, and other live animals (Zhang et al., 2021). Globally, a drastic shift in consumer demand for restaurant services occurred as COVID-19 picked up the pace (Open Table, 2022). The cessation of the exportation of *P. leopardus* significantly dropped during 2019–2020 (see Supplementary Information Table 1).

Transport operations play a crucial role in the supply chain during the pandemic, but not all the modes of transport services received equal repercussions (Arab Trade Union Confederation, 2020). Bulk shipments, for example, have not seen any major disruptions, especially if they are essential to the food supply (Schmindhuber and Qiao, 2020). However, since the price of air freight soared high during the pandemic, this sector has

been severely disrupted, causing a 26% drop compared to during the same period last year (United Nations Children's Fund, 2021). Problems arise further for perishable fishery products because of inter-country government quarantine regulations. In China, the government required a 14-day quarantine period for the clearance of goods, thus, delaying the movement in the supply chain (Gosh et al., 2022). This posed a serious concern, especially for live commodities, as it increases the chance of spoilage and/or storage expenses.

During COVID-19 pandemic, many businesses faced complete shutdowns at the onset of social distancing restrictions and this significantly affected the fishers and the supply chain (Love et al., 2021; Belton et al., 2021). Export-oriented SSFs have faced a vast reduction in demand (Orlowski, 2020a). In the Philippines, slashed prices due to reduced demand from local restaurants have drastically reduced fishing activity (Ocampo and Yamagishi, 2020; Mendoza, 2022). In addition, COVID-19 has disrupted the fish market supply due to the fragmented operation by the financiers and middlemen, which resulted in lesser or limited lending for the fishers as they also struggled to dispose of fish catches due to the consequences of punitive travel restrictions (Ruddle, 2011).

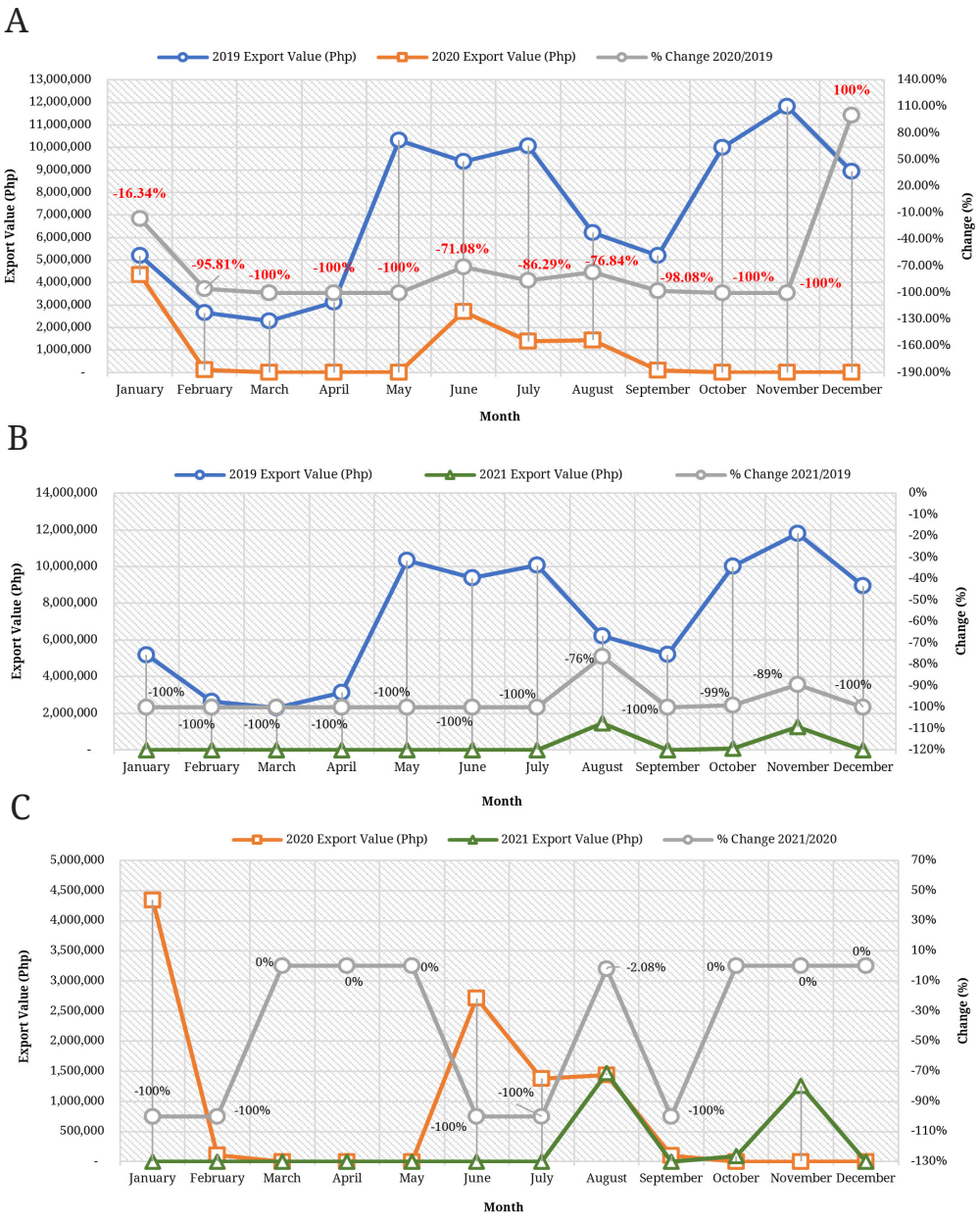

Figure 3. Comparison of export value trend of *Plectropomus leopardus* in southern Palawan: 2020 and 2019 (A), 2021 and 2019 (B), and 2021 and 2020 (C).

 DOI: https://doi.org/10.59120/drj.v16i2.411

Although the government directed the need to exempt fishing operations from restrictions, confusion and miscommunication occurred during the early months of implementation. As a result, SSFs were apprehended for violating the quarantine protocols (Mirasol, 2020) and the failure of the Local Government Units (LGUs) to follow the government in a free-flow system of fishing amid COVID-19 (Biong, 2020; Ocampo and Yamagishi, 2020). In NP, the percentage of change in the total value before and during the pandemic was more pronounced than in SP (Figure 3).

Owing to the initial yet sudden effects of COVID-19 on the economy during the first quarter of 2020, it further went down by 16.5% by the end of the second quarter, mainly as a result of stringent restrictions such as lockdown measures (dela Cruz and Morales, 2020; Atienza, 2022; National Economic and Development Authority, 2022). Dela Cruz and Morales (2020) have further stressed that it is during this period that the Philippines experienced the first economic recession in 29 years.

Fishers involved in the trade of *P. leopardus* are just a few of the many households challenged by the pandemic in terms of food security. The closure of the LRFFT in Palawan in the first quarter of 2020 not only caused the discontinuation

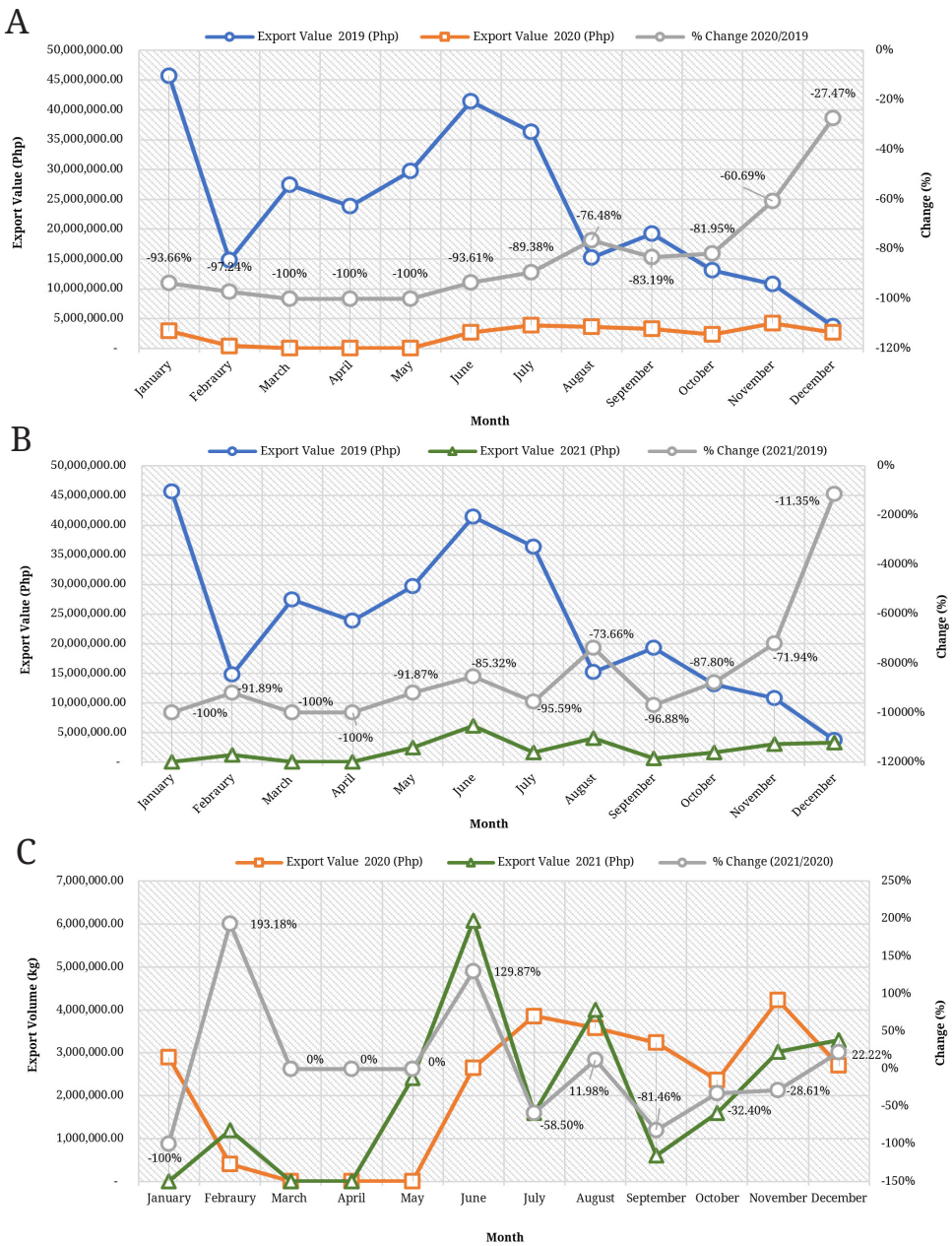

Figure 4. Comparison of export value trend of *Plectropomus leopardus* in southern Palawan: 2020 and 2019 (A); 2021 and 2019 (B); and 2021 and 2020 (C).

of income for business operators but also for those who were directly or indirectly involved in this business enterprise. Their challenges and experiences with food insecurity were at least depicted in a global context, serving as a small representation of the Filipino families who have been severely impacted by the pandemic (Atienza, 2022). Some of the fishers engaged in LRFFT were trapped in a system of patronage and debt (Macusi et al., 2022). Even in instances where fishing is deemed an essential service, social distancing measures have precluded many SSFs from fishing due to vessel size or trading in close quarters in local markets (Orlowski, 2020b; Zhang et al., 2021). Such incidents are evident in the significant reduction of exports in both SP and NP, particularly in the first and second quarters of 2020 (Figure 4).

Regardless of export quality, even if they were fresh/frozen, top importers of frozen seafood outside the Philippines, such as China, have seen traces of COVID-19 transmission in the commodities, which caused further substantial damage in the fish trade network (Zhang et al., 2021).

Coping strategies of the government

In general, the government's response to COVID-19 has been described by many as one of the longest in the world. Until recently, the government has continued to implement coping strategies to address the challenges posed by disruptions in trade and the supply chain. Some of these coping strategies lasted for a shorter time while others have had a long and more profound impact on the supply chain. On 24 March 2020, the Republic Act 11469 ("Bayanihan to Heal as One Act") was enacted to provide emergency subsidy funds to 18 million low-income households through the Social Amelioration Program (SAP). In this scenario, the LGUs utilized their existing 5% calamity funds to support the regulatory implementation of business and consumer practices, especially within the marginalised informal sector where thousands of local traders of *P. leopardus* are coming from (DOH, 2020).

Continuous movement of aquatic products

The demand for luxury seafood in international markets significantly declined, which caused the collapse of many other fisheries and business sectors, such as China's LRFFT (Zhang et al., 2021). This was an indicator of massive changes that unfolded in SSF and coastal fishing communities in Palawan. In response, most of the local fish traders shifted to an alternative source of income or at least targeted different fish species. Although the movement of these aquatic products in the supply chain remains challenging due to the pandemic, the government strategically adopted the "food lane project" of the Department of Agriculture (DA) in 2018. The accreditation of agriculture and fishery suppliers, including the vehicle operators of these products, was given preferential incentives, such as exemption from the truck ban, ease of passage through checkpoints, and designation of food lane routes across different regions. This strategy allowed the resumption of activities and services while maintaining necessary precautionary measures (DA, 2020a).

Another DA's program ("Seafood Kadiwa ni Ani at Kita on Wheels") linked the SSFs and consumers in an attempt to bring fresh fish products to the communities (Datu, 2020). Specifically, the LGUs collaborated with the SSFs in distributing food packs to ECQ-affected areas, promoting the local consumption of export products that had been lost in the market. The challenges brought by the pandemic created a new business paradigm, through online marketing platforms, for wider promotion and easier distribution of the food supplies (DA, 2020a).

Food security monitoring and price-stabilization

Amidst the pandemic, the DA maintained its strong collaboration across all its bureaus and attached agencies to objectively enhance food productivity, supply availability, accessibility, and price stability. In these initiatives, the monitoring of COVID-19-related government policies and programs, under the Philippine Council for Agriculture and Fisheries (PCAF) and the Agricultural and Fishery Councils (AFCs), was regularly employed to ensure the continuity of transparent processes. Furthermore, the validation and monitoring of projects and activities were streamlined through the PCAF's programme to ensure that the food prices of basic commodities in the market align with the government-prescribed suggested retail price (SRP) (PCAF,

 DOI: https://doi.org/10.59120/drj.v16i2.411

2020). In turn, based on the DA's supervision and LGUs' support and facilitation, the suppliers of fishery products were urged to keep the price below 20% of the SRP in a timely manner. A Price Act-based freeze scheme was imposed automatically nationwide for 60 days (starting in March 2020) and was further extended in the following months (DA, 2020b). Moreover, the AFCs also monitored the implementation of the SAP for SSFs nationwide. Under which, the AFCs further facilitated the management and monitoring of the "Ahon Lahat, Pagkaing Sapat (ALPAS) Kontra sa COVID-19" to guarantee the sufficiency of food supplies and the continuity of good agri-fishery practices, technologies, and services across the fishery sectors (DA, 2020c; PCAF, 2020).

Conditional assistance to affected households

As mentioned earlier, the government procurement programs in different LGUs created a leeway to boost the sales of marginalized fishers. And based on RA 11469, the other fiscal package provisions target the vulnerable groups (e.g., senior citizens, low-income households, displaced workers, and affected small businesses). Specifically, the government assistance to SSFs during the pandemic includes: (1) loan provision based on the Php 2.8 billion Survival and Recovery Aid Program amounting at Php 25,000 allowable cash support for every affected household without recurring an interest rate (Mirasol, 2020); (2) Php 2,000-worth of subsidy relief and additional food and cash vouchers worth Php 3,000 under the Cash and Food Subsidy for Marginal Farmers and Fisherfolk Program; (3) provisions of livelihood assistance in forms of supplying fishing gears and boats under the Special Area for Agricultural Development Program and Php 29.1 million production inputs under the ALPAS (Tecson, 2020); and (4) the provision of marine floating fish cages for aquaculture development under the Targeted Actions to Reduce Poverty and Generate Economic Transformation program (DA, 2020c).

DISCUSSION

There are notable variations between the volume and the associated market price, as not all exported commodities were traded as "live". For example, the combined total volume in the second and third quarters of 2020 in Quezon (29,110 kg) only accounts for about Php 13,930,580. Although the combined total volume in the first and fourth quarters of the same year (26,506 kg) was lower than in the other consolidated quarters, its associated market price was 121.09% higher than the previous record. We also found similar patterns in volume production against its market value in PPC, Rizal, Bataraza, Roxas, and Brooke's Point. Annually, we have observed a similar trend across different areas, where high-volume production does not always translate to higher market value. For example, despite a 14.90% difference in volume between 2019 and 2020 in Quezon, we found a 61.67% difference in value (see Table 1). This further suggests the dynamics of the price range of the commodity within a particular season of a year, which may have been influenced by several factors such as the availability of the demand and the pandemic (e.g., Fabinyi and Dalabajan, 2011; Sadovy et al., 2003).

In terms of variations between volume production and value in NP, we found that the market price also varies depending on the specific time of year. For example, in Cuyo a nearly identical total amount of traded commodities has been paid for on two separate occasions, with a volume difference of at least 27,329 kg between the second and third quarters of 2019. Our assessments also revealed that market value varies across different municipalities. In the second quarter of 2019, Coron and Cuyo exported 61,408 kg and supplied 63,572 kg, respectively. However, in terms of its equivalent value, Coron generated as much as 644.66% (Php 94,462,157) more than Cuyo (Php 14,652,900). We also found differences in market price based on the two different years particularly before and during the pandemic. During the last quarter of 2019, Magsaysay exported 171 kg with an equivalent market price of Php 214,000. However, in the same quarter in 2021, San Vicente supplied a slightly higher volume (176 kg) yet only generated Php 174,900.

From 2018 to 2021, SP exported higher volume of live commodity (646,773 kg) than NP (470,317 kg). These also account for a slightly higher market price valued at Php 554,443,481 compared with the north (Php 435,602,414) (Table 3). Interestingly, in both jurisdictions, the

highest volume production of either live or fresh commodities was recorded in 2019. However, a notable number of fresh commodities were recorded in 2020 in Quezon. By comparison, such small volume production with significantly high export value seems accounted to the availability of the commodity in the supply chain since Quezon remained the top exporter of *P. leopardus* in 2020 in SP. From 2020 to 2021, the volume production of the live commodity in NP decreased by 75.80 %, but increased in SP by 73.40 %. In both jurisdictions, the value of the live commodity decreased by 61.30% and 39.45%.

The LRFFT's core component, "live fish", depicts the relative production of exported live *P. leopardus* compared to the fresh commodity in Palawan, as many people preferred this over fresh or frozen options. For instance, Chinese consumers are more particular about the texture, colour, and size of LRFF. Maintaining such standards is crucial, as globally, Chinese consumers, particularly those from Hong Kong, mainland China, and Taiwan, remain the top importers and re-exporters of the LRFF from Southeast Asia (Sadovy et al., 2003). In terms of volume and market price (Table 3), *P. leopardus* dominates the local and international markets among other LRFF exported from Palawan. It is undoubtedly because Chinese consumers favour red-coloured fish more than others, as they consider it auspicious (Sadovy et al., 2003). The differences in the characteristics of the LRFF have resulted in the dynamic spread of prices in the market. It is also the reason why the exported live *P. leopardus* in Palawan, although showing less volume production compared with the exported fresh product, had considerably higher generated market value than the latter (Table 3). At a retail price in China, the LRFF have fetched from the Philippines at Php 600 (USD 12) per kilogram, which could reach Php 9,000 (USD 180) per kilogram (Sadovy et al., 2003; Michael Fabinyi & Dalabajan, 2011), which is considerably more than the price of similar LRFF. In Taytay for example, the Worldwide Fund for Nature (2011) reported that due to quick financial gain, the majority of fishers were engaged in LRFFT. Salao et al. (2013) further claimed that on average, a household in Taytay earned at least Php 382,940 (approximately USD 9,300) per year for LRFFT. In 2020, the amount of live export commodities reached a very low to zero production level compared to previous years. In Taytay, San Vicente, Roxas, Rizal, Quezon, and PPC, the dwindling production of exported live *P. leopardus* persisted in persisted the failure to compensate for the loss in the economy (Table 3). These disruptions were caused by the discontinuation of commodity exports in international markets due to COVID-19. Particularly, beginning the first quarter of 2020, China urged the public to suppress gatherings, specifically during the Spring Festival holiday when major primary consumption of LRFF regularly takes place (Peng et al., 2020; Shen et al., 2022).. This was followed by an embargo on consuming "wild" animals (Zhang et al., 2021) and the forcible closure of wholesale and retail markets for raw meat and fish products (Yang et al., 2020). Such circumstances justified the chain of effects despite the complex nature of the trade in the market. Since the products did not reach the international market in 2020, we assumed that the Philippine government procured the traded commodities during this period to support local traders and maintain the flow of fishery products in the local supply chain.

In 2015, Palawan was known as the centre of LRFFT in the Philippines, with an export market value of at least USD 40 million (Yan, 2015). Since its inception in the 1980s, the LRFFT in the province has still soundly dominated the market until the pandemic. The entire success and potential of the LRFFT in the province are owed to its geographical location. However, although Palawan is known to have a significantly extensive coverage of coral reef assemblages in the country, the rising trend of targeting spawning areas and the unsustainable collection of juvenile reef fishes, including the *P. leopardus*, has almost destroyed Palawan's LRFFT (Yan, 2015). Similar to other areas in neighbouring countries of Southeast Asia, WWF Malaysia reported a declining trend in the LRFF stocks within the last 10 years (Daw et al., 2002). Although we cannot see this decreasing trend using the data we used, indeed, we do not exclude the possibility that the dynamic changes in the trade of *P. leopardus* for this study are somehow not just due to the consequences of the COVID-19 but might also due to overexploitation and destructive fishing methods as few of the predefined problems since the 1990s (Pomeroy et al., 2008).

 DOI: https://doi.org/10.59120/drj.v16i2.411

These challenges mirror regional trends in grouper aquaculture that have been documented in Asia. For instance, Ybañez and Gonzales (2023) identified persistent limitations in broodstock quality, hatchery availability, feed access, and disease control, as well as the impact of capture-based aquaculture practices and declining wild stocks. Although the Philippines maintains a leading role in LRFFT, the systemic vulnerabilities seen in Palawan are part of a wider regional pattern, exacerbating sustainability concerns. The fact that 67% of cultured species are still classified as "least concern" under conservation assessments (Ybañez and Gonzales, 2023) offers short-term reassurance, but the presence of vulnerable and data-deficient species signals long-term ecological risk if current extraction and aquaculture practices persist without reform.

Furthermore, we also consider that the trade dynamics in *P. leopardus* in Palawan could also be attributed to the seasonality trend. Our findings showed that, beginning in the second quarter of each year, the volume production for *P. leopardus* peaked at its highest level until the end of the third quarter, before it deviated from the trend in the last and first quarters. Gonzales et al. (2020) reported a similar pattern of trend in the fish landing's catch per unit effort (CPUE) in Taytay during the northeast monsoon (October–March), which has lower CPUE than the second and third quarters. On some occasions, we found no records of exportation in four sub-areas in SP and five municipalities in NP during the first quarter of the pronounced years (Table 1). Daw et al. (2002) claimed that in the Malaysian region of Kudat, the high-volume production of exported *P. leopardus* occurring between June and November. Interestingly, fishers from this area derived two main possible explanations for why this inclusive period had better productivity. Accordingly, the reasons are weather favourability and fish aggregations, which happened between May and July (Daw et al., 2002).

It is therefore important to distinguish between regular seasonality trends and pandemic-induced disruptions. While annual patterns suggest that peak productivity generally occurs during the second and third quarters, coinciding with spawning periods and favorable weather, our data showed unusually sharp declines in volume and value during these same months in 2020. This timing aligns directly with the enforcement of COVID-19 restrictions on mobility and export logistics. As such, these declines cannot be fully explained by seasonal variation alone and instead point to the significant impact of government-imposed lockdowns, market closures, and trade suspensions during the height of the pandemic.

Palla (2011) has further suggested that ripe gonads among the species were prevalent between June and July and November and January. His findings propose the spawning period, which became one of the bases of the Provincial Ordinance No. 941 of 2005 in Palawan, in implementing the regulatory mandates that promote sustainable LRFFT and instituting live reef fishing closed seasons during May–June and November–December annually (Johannes and Ogburn, 1999). However, in succeeding years after its implementation, many fishers discouraged the regulation of the LRFFT since it affected their food security (Fabinyi, 2010). Furthermore, although we were expected to observe a contrasting result in the volume production between May and June for this study, within the established closed-season period, we considered three possible explanations. First, the existing problems of weak monitoring, where the policy implementations and regulations are mostly virtually absent in extreme municipalities of Palawan (Michael Fabinyi and Dalabajan, 2011). Second, the problems in fish caging highlight poor accreditation and monitoring. For example, among the 174 fish-cagers in Taytay, the WWF noted that only two had accreditation from the Palawan Council for Sustainable Development, while 65 had municipal permits. This type of problem poses uncertainties in the validity of the data since the LRFF catch does not go through the standard recording systems (Matillano et al., 2008). Third, the legal framework for LRFFT lacks a seamless implementation between laws and different levels of jurisdiction. For example, the Fisheries Code of 1998 prohibits exporting LRFF except for hatched produce in accredited hatcheries (RA 8550). In contrast, this prohibition is inapplicable due to the lack of administrative order from BFAR (Dalabajan, 2005).

Weaknesses in species-level data collection and identification further exacerbate these regulatory gaps. Similar to issues observed in

Palawan, Razi et al. (2023) found that across many Indonesian fish landing sites, groupers are not identified by their scientific names but are generically recorded as "kerapu." In addition to weak caging regulations, the absence of precise species-level identification methods further complicates monitoring and conservation of LRFFT species. For example, a recent barcoding study from Simeulue and Banyak Islands in Aceh, Indonesia, generated a COI sequence library for 20 grouper species from 70 specimens across 16 landing sites (Fadli et al., 2025). They found that the genus Epinephelus dominated landings (54%), while Plectropomus, a primary species in Palawan's LRFFT, comprised 13%. Notably, their molecular approach revealed subtle interspecific differences with an average genetic distance of 0.51% at the species level, underscoring the complexity of grouper identification in multispecies fisheries. This kind of database is crucial in places like Palawan, where groupers are often generically labelled or misidentified in records, obscuring species-specific exploitation trends and undermining conservation and trade regulations. The absence of such genetic monitoring in Palawan represents a missed opportunity to safeguard the ecological sustainability and economic traceability of the LRFFT.

Regardless of the different environmental factors that may have influenced the fish stocks of the species in the wild, a phenomenon like COVID-19 is both inevitable and unpredictable. Based on observations of trade activities in Palawan and an in-depth exploratory investigation of disruptions and coping strategies, we found that the government itself is the primary driver of recovery and resilience in the industry. Such a government's initial and immediate response to the crisis following the outbreak is a vital component of strong governance that every actor within the LRFFT is depending upon. For example, while the government initially ignored the importance of local fishers as vital to food security during the early period of the pandemic, the local IATF-EID's immediate response by recognising them as "food frontliners" helped mitigate the impact of COVID-19 in the supply chain. Additionally, from the most lenient to the most stringent restrictions, the government's complex coordinated actions created a platform to implement the different strategic programs and mechanisms to facilitate recovery and resiliency (DA, 2020c).

In the process, the government's experience also demonstrates how various stakeholders mitigate risk by adapting to new challenges and opportunities in the demand for fish supply, as well as developing new types of markets (e.g., e-commerce) that are beneficial for exports. We found that uncertainty in international markets put the whole industry in jeopardy, making the LRFF products reduce demand in some target markets, leading to a shortage of supply within the domestic arena. However, one of the drawbacks of the government's responses to COVID-19 is the prolonged implementation of regulatory restrictions and quarantine measures. This prompted the government to exhaust its available resources to mitigate or alleviate the economic and social impacts on the people. The SAP, for example, which came in the mid-late of the year, implies a weak systematic program and has been long overdue by the SSF sector (Ferrer et al., 2021).

While rooted in the Palawan context, the findings of this study have broader applicability to other SSF across Southeast Asia. Countries such as Indonesia, Malaysia, and Vietnam also reliant on the live reef food fish trade faced similar COVID-19-related disruptions. The Philippine experience, particularly its decentralized procurement, adaptive mobility policies for fishers, and formal recognition of fisheries as essential, provides transferable strategies for resilience planning. These lessons are especially relevant for trade-dependent fisheries in the Coral Triangle, where socio-ecological vulnerabilities persist (Ferrer et al., 2021).

CONCLUSIONS

The economic importance of the trade of *P. leopardus* has been widely acknowledged through the years but was tested when COVID-19 came. Its impacts not just challenged the government but also the local fishers and traders. New policies were formulated and the government stoutly faced numerous problems and challenges despite many uncertainties and criticism. However, while the risks associated with COVID-19 remain uncertain, this research found that the cooperation and collaborative efforts of

the government, along with all economic sectors and the people, are key to important coping mechanisms that achieve stable food security and resilience. The Philippine government's response to these disruptions and challenges is perhaps one of the most important perspectives in this research. Despite the negative implications of COVID-19 for the economy in general, as well as for the fish stock, people, and trade of *P. leopardus* in Palawan, this pandemic has brought opportunities for improvement.

While community quarantine restrictions stopped the fishers from going out into the sea, it is worth noting that the problem of destructive fishing remained unsolved. The pandemic reminded us of the importance of continuing the fight against the exploitation of illegal fishing methods. Furthermore, we also found that strengthening self-reliance as a nation is crucial to achieving greater resiliency and adaptive capacity should any disaster occur again. The trade exportation of *P. leopardus* in the province is primarily driven by foreign markets, however, in such events when the international markets collapse, the domestic markets must drive local demand and improve productivity, quality, and safety standards. This means diversifying the products and creating more local networks to keep the trade active and sustained.

Although part of the government's interventions was the SAP, we found that this intervention is unsustainable. For instance, the opportunity to adopt a multi-stakeholder investment scheme could help stabilize the trade by encouraging different stakeholders to invest in services to local traders or growers of *P. leopardus* From this perspective, the government could enhance research and development, extension, marketing, and credit and insurance policies to support fishers by fostering partnerships with private stakeholders, thereby accelerating recovery and increasing resilience. We emphasised here the crucial aspect of introducing social protection for all, especially the marginalised and vulnerable producers and local traders of *P. leopardus*, to ensure that their products, livelihood assets, mutual savings, and health are insured.

Ultimately, this pandemic paved the way to enhance social capital by promoting the formulation and professionalization of different societal associations. Furthermore, this phenomenon challenged the fragility of collaboration among the various stakeholders. Thus, creating suitable linkages, market access, networks, and alliances may tend to generate new innovative ideas and become more capable and resilient in handling market risks in the future.

ACKNOWLEDGMENT

This research received funding from the Global Challenges Research Fund (GCRF), United Kingdom Research and Innovation (UKRI), under grant agreement NE/P021107/1. The authors also acknowledge the valuable contribution of BFAR MIMAROPA, through the Fisheries Inspection and Quarantine Services (FIQS), for the provision of data.

FUNDING SOURCE

This research has received funding from the Global Challenges Research Fund (GCRF), United Kingdom Research and Innovation (UKRI) under grant agreement NE/P021107/1.

CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest related to the conduct, authorship, or publication of this research.

AUTHOR CONTRIBUTIONS

Conceptualization: C. B. C.; Methodology: C. B. C.; Validation: C. B. C., E. H. A., and L. A. C.; Analysis: C. B. C.; Data curation: C. B. C., Z. A. D.; Resources: E. H. A.; Writing-original draft preparation: C. B. C.; Writing-review and editing: C. B. C., R. E. S., K. G. M., A. Z. C., L. A., H. P. P., and L. A. C.; Visualization: C. B. C.; Supervision: L. A. C.; Funding acquisition: L. A. C.

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