

Collective action governance and benefits distribution in the sturgeon value chain in Lâm Đồng province, Vietnam

Tram Anh T. Nguyen, Kim Anh T. Nguyen, Hao Cong Truong, Curtis M. Jolly



PII: S0044-8486(19)32234-3

DOI: <https://doi.org/10.1016/j.aquaculture.2019.734765>

Reference: AQUA 734765

To appear in: *aquaculture*

Received date: 27 August 2019

Revised date: 11 November 2019

Accepted date: 21 November 2019

Please cite this article as: T.A.T. Nguyen, K.A.T. Nguyen, H.C. Truong, et al., Collective action governance and benefits distribution in the sturgeon value chain in Lâm Đồng province, Vietnam, *aquaculture* (2018), <https://doi.org/10.1016/j.aquaculture.2019.734765>

This is a PDF file of an article that has undergone enhancements after acceptance, such as the addition of a cover page and metadata, and formatting for readability, but it is not yet the definitive version of record. This version will undergo additional copyediting, typesetting and review before it is published in its final form, but we are providing this version to give early visibility of the article. Please note that, during the production process, errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

Collective Action Governance and Benefits Distribution in the Sturgeon Value Chain in Lâm Đồng Province, Vietnam

Dr. Tram Anh T. Nguyen¹, Dr. Kim Anh T. Nguyen¹, Mr. Hao Cong Truong², Curtis M. Jolly^{3,*}

¹Tram Anh T. Nguyen is Senior Lecturer of Economics at the Faculty of Economics, Nha Trang University, Vietnam. ¹Kim Anh T. Nguyen is Associate Professor of Economics and Superior Lecturer at the Faculty of Economics, Nha Trang University, Vietnam; ²Hao Cong Truong is Lecturer of Finance, Technical and Economic College of Lâm Đồng, Vietnam; ³Curtis M. Jolly^{3,*} is Professor of Agricultural Economics at Auburn University, Alabama Agricultural Experiment Station, Alabama 36849.

*Curtis M. Jolly is corresponding author, cjolly@auburn.edu

Collective Action Governance of Value Chain of Sturgeon in Lâm Đồng Province, Vietnam**1. Introduction**

Major declines in natural sturgeon stocks due to overfishing and pollution over the past 30 years, plus high market demand for caviar, have raised questions on the sustainability of the fish and encouraged sturgeon farming out of its natural production range, mainly for the production of caviar (Bronzi and Rosenthal, 2014; Hunt, 2016). Observing the financial benefits of caviar production, Vietnam has persuaded investors to engage in sturgeon farming. The country has adopted an aggressive stance in promoting sturgeon farming and is now listed among the top ten global caviar producers (Bronzi and Rosenthal, 2014).

Vietnam invested in the development of the industry to assist in the diversification and sustainability of its aquaculture sector (Hunt, 2016). The government interest in sturgeon production was based on equitable and geographical distribution of income (Tuong, 2014). Therefore, the government of Vietnam permitted the importation of four species of sturgeon because of their ability to adapt to some of the country's coolest climatic areas found in ecological zones at high altitudes, (Maslyuk and Didenko, 2013). Scientists believe that Vietnam's high temperatures can help sturgeon to develop more rapidly, compared to other countries (Tuong, 2014). These species of sturgeon have been present in Vietnam since 2005 and have been experimentally raised in many places in Vietnam, such as Sa Pa (Lao Cai), Na Hang (Tuyen Quang), Thac Ba Reservoir (Yen Bai), Da Lat (Lâm Đồng), and Da Mi Lake (Binh Thuan), using cages, ponds, and flowing water. Sturgeon raised in these areas show a high level of adaptation.

The production of a female sturgeon in Vietnam takes about 6 to 8 years (Bronzi and Rosenthal, 2014). While producers wait for the high-priced caviar, they produce sturgeon flesh to defray some of their expenses. Though the production of sturgeon for flesh has increased

and many companies have attempted to produce this fish, the development of the sturgeon industry in Vietnam has not been commensurate with the natural potential of this country (The Fish Site, 2009). Many financiers who have attempted to invest in the industry have failed because of a lack of technical know-how to produce caviar, the hefty investment costs, a weak marketing chain, and a lack of network development. Added to the afore mentioned reasons for failure are that producers depend on their own experiences, and therefore, the quality of the sturgeon flesh is unstable, its price higher than it is in other countries in the region, and its economic efficiency is low. In addition, sturgeon from China have flooded Vietnam's market at a lower price than the "Dalat Sturgeon".

Vietnam has found a way to produce sturgeon flesh for a captive and unsaturated market, and therefore, the industry has had a good start (Ngan and Phong, 2016). However, there are few studies that examine the economics of sturgeon production and marketing in general and in Vietnam. In this study, we examine the sturgeon value chain in Lâm Đồng Province because of its production level and number of farms.

The aim of the paper is to conduct a supply and value chain analysis of sturgeon production and distribution for the Lâm Đồng sturgeon industry. The study will help domestic producers to differentiate their product and assist in developing a competitive advantage in the sturgeon market to ensure sustainability and market dominance in the future.

Objectives

The objectives of the study are to better understand and report on sturgeon industry profitability and efficiency in Lâm Đồng Province and to evaluate how industry participants are influenced by collaborative action association governance. More specifically, the study aims to identify the supply and value chains, and to do the following:

- 1) Determine the efficiency of sturgeon meat product movement along the supply chain.
- 2) Map the value chain for sturgeon in Lâm Đồng Province, describing the main stakeholders and the flow of product through the value chain.

- 3) Understand the costs and earnings profiles of the different activities performed by actors as they move the products along the value chain.
- 4) Evaluate how the concept of collaborative governance influences profitability, distribution of value added, and efficiency along the supply and value chains.
- 5) Identify the key constraints and problems impacting different actors in the value chain.

The paper is organized by giving a brief history of sturgeon production and marketing and then an in depth examination of the global value chain. The method follows the framework and value chain analysis. The results then generate and discuss findings of a survey, plus information from key informants and secondary data. A discussion follows and finally the concluding remarks.

2. History, introduction and production of sturgeon in Vietnam

Sturgeon and paddlefish are some of the oldest living vertebrates, with fossil records dating back more than 150 million years. Their skeletons are mostly cartilaginous. Most sturgeons are anadromous or semi-anadromous; that is, they live in oceanic or brackish waters, respectively, and then migrate to freshwater rivers for spawning (Mims et al. 2002). Some species, such as the lake and shovelnose sturgeons, are potamodromous and live in freshwater their entire lives. Sturgeon and paddlefish produce caviar, unfertilized processed eggs, which serve as a source of protein and a chief income earner to a number of producing countries (Bronzi, 2017). Production and exports have been declining globally due to, among other factors, habitat degradation and heavy market demand that lead to overexploitation, and illegal trade of caviar and the fish itself. Of the 27 species of sturgeon and paddlefish known, 85% are now on the brink of extinction (WWF, 2017).

Aquaculture production of sturgeon products started to increase in the early 2000s, though actual experimentation began as early as the 1940s to 1950s (Chebanov and Williot, 2018). A total of 2,329 commercial sturgeon farms were recorded globally by 2017. Of these farms, 54% were located in China, followed by Russia (24%), the Middle East (8%), the Far East (7%) and Europe (6%). Among the farming technologies, flow-through (FT) systems (36%) were most common, followed by recirculation aquaculture systems (RAS) (21%), cages (18%), mix FT/RAS (11%), and ponds (6%). In total the aquaculture sturgeon biomass production peaked at about 129,608 tons in the year 2015, and declined to 119,979 tons in 2016, and to 102,327 tons in 2017 (Bronzi et al., 2019). China contributed about 79,638 tons to the overall production in 2017, followed by Russia (6,800 tons), Armenia (6,000 tons), Iran (2,514 tons), and 52 other countries with less than 1,000 tons each. This production exceeded the wild caught fishery harvest during the 1970–1980s by more than four times. By 2016, production had reached 127,780 tons of sturgeon meat and caviar globally with 86% produced in China (Bronzi et al. 2019). Caviar production was estimated to reach 340 tons in 2016 and is forecast to reach approximately 550 tons by 2020, raising concerns that supply will exceed demand and hence, prices and profits will fall (Bronzi et al., 2017). Trade data showed that exported caviar (re-) exports (both sourced from the wild and aquaculture) declined from 229 tons in 2000 to 108 tons in 2015. Exports from aquaculture sources increased during the same period, and made up 95% of all trade by weight (Harris and Shiraishi, 2018).

The three highest ranked countries of origin and direct export during the period 2010–2015 were China, the USA and Italy. The top three individual exporting countries were Germany, France, The United Arab Emirates while the USA, Japan and France were the highest ranked importing countries. However, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) trade data indicate that the EU (28 EU Member States) was the largest importing market for caviar between 2010 and 2015 (WWF, 2018).

The increased demand for wild caught sturgeon and its short supply resulted in high prices and increased profits. Therefore, overfishing, poaching and illegal fishing pervaded the industry and the disappearance of certain species in particular regions became evident. To

avoid the disappearance of sturgeon species and to ensure that production and trade are sustainable, all species of sturgeon and paddlefish were listed on CITES since 1998 (Harris and Shiraishi, 2018).

The market enjoyed 15 years of high prices until supply outstripped demand due to overproduction from aquaculture and the acceptance of quality differences between wild source of caviar and that emanating from aquaculture production. In spite of the increased supply of caviar on the world market, prices stabilized because of an increase in world demand and trade due to development of new markets (Bronzi and Rosenthal, 2014). “Private customers and mass retailers” seem to be the most important customers at present, followed by “re-packers and airlines”. Consumers of the product consider quality, price and image and publicity as the three main product characteristics valued in their product choice (Bronzi et al. 2019).

Vietnam government and experts in search of economic alternatives to spur rural development and economic growth identified and encouraged the production of the high priced caviar and sturgeon. With assistance from Russian experts, the Fisheries Research Institute (RIA 1) imported sturgeon and began experimenting with breeding the species in May 2005. In 2006 Ca Tam Viet Nam founders and experts with the encouragement of the Ministry of Fisheries, Ministry of Science and Technology, Fisheries Association and many agencies and other organizations first conducted a research and study of “Survival and Raising Acipenseridae forms in Vietnam”.

In 2007, the Ha Quang Joint Stock Company cooperated with Russian experts to test the hatching and raising of Siberian, Russian, and Sterlet sturgeon at Tuyen Lam Lake (Dalat, Lâm Đồng), and succeeded. In November 2007, the company transferred all techniques to Vietnam Sturgeon Company Ltd in Da Lat. In 2008, Vietnam Sturgeon Company Ltd applied these techniques to raise Sterlet, Russian, Beluga, and Siberian sturgeon in the Da Mi Hydropower Reservoir (Binh Thuan Province) (Association for the Development of Coldwater Fish of Lâm Đồng, 2017). The water temperature in this lake averaged 30.5°C in July 2008. However, more than 20,000 Siberian, Russian, and Sterlet sturgeon survived, ate well, and gained weight at a

normal pace. The estimated output of sturgeon raised by Vietnam Sturgeon Company Ltd was about 300 tons in 2009 and expected to increase to 800-1,000 tons from 2010 onwards. Besides raising and exporting live sturgeon, the company also aimed to produce sturgeon caviar for export to countries such as Japan, America, and Russia in the next few years (Association for the Development of Coldwater Fish of Lâm Đồng, 2017).

The Phuong Bac Sturgeon Joint Stock Company located in (Thinh Hung, Yen Binh, Yen Bai) utilized cold spring water in 2009 to build a sturgeon hatchery in Thuong Bang La commune, Van Chan district (Yen Bai Province), and to commercially raise Siberian and Russian sturgeon in Thac Ba Reservoir. To date, this experimental model has produced tens of thousands of broodstock and sturgeon fingerlings and installed seven commercial cages (estimated value of each cage is 1.0 billion VND or USD 500,000; 1 USD = 22,000 VND). September 2009 served as an important juncture for the company to expand its operation in order to attain the expected commercial sturgeon production for 2010. At the same time, the company raised about 1,000 broodstock through a process of careful selection, and conducted studies on breeding that stimulated the expansion and development of the sturgeon industry in Yen Bai (Association for the Development of Coldwater Fish of Lâm Đồng, 2017). Other companies such as Giang Ly Company (Da Lat, Lâm Đồng), Thien Ha Company (Sa Pa, Lao Cai), and Chu Va Hydroelectric Power Company Limited also invested in raising sturgeon, but on a smaller scale.

Currently, sturgeon are raised in Vietnam using a variety of systems: they can be grown in tanks, ponds, ponds with flow-through streams originating from cold springs, and cages anchored in reservoirs. Since most sturgeon are kept at a temperature of 16-28°C, the fish grow 1.5-2.0 times faster than in temperate countries, the feed conversion ratio (FCR) is lower, and the raising time is shorter, so the labor cost is lower. These factors give sturgeon from Vietnam a competitive advantage in terms of price compared with sturgeon from temperate countries. By 2017, Vietnam had already moved to the 10th place in global sturgeon biomass production of countries producing more than 100 tons annually (Bronzi et al.2019).

2.1. Situation of sturgeon production in Vietnam and Lâm Đồng

According to FAO statistics (FAO, 2016), the production of sturgeon in Vietnam increased continuously from an output of only 120 tons per year in 2008 to 1,200 tons in 2013, at an average annual growth rate of 29.21%. From 2013 to 2014, the production of sturgeon declined sharply from 1,200 tons/year to 693 tons per year, with a decreased annual growth rate of 42.3% (Figure 1). During this period, many sturgeon businesses failed because of inadequate and inappropriate management models and lack of technical knowledge. Early producers were unable to compete with low-priced Chinese imports. From 2014 to 2016, sturgeon production increased again from 693 tons to 951 tons per year, at an average annual growth rate of 15.97% (Figure 1). Through the adoption of appropriate farming practices and new technology such as the flow-through system, sturgeon productivity has improved significantly in the last 5 years, from 7-10 kg/m³ in 2011 to 20-30 kg/m³ and 50 kg/m³ in 2016 (Figure 1).

The Research Institute for Aquaculture III has completed studies on raising sturgeon using a closed recirculation system. This system enhanced the yield to 61.67 kg/m³ with a survival rate of 95.7% and a growth rate of 8.46 g/day, compared to the cage-raising system (yield 33.72 kg/m³, survival rate 28.7%, growth rate 7.86 g/day). The widespread application of this technology on sturgeon farms will boost production and contribute to the establishment of the caviar industry in Vietnam (Lâm Đồng Department of Livestock Production, 2017).

[PLACE FIGURE 1 HERE]

2.2. Status of sturgeon rearing in Lâm Đồng

In Lâm Đồng, sturgeon are raised in cages on the reservoir (there are 185 cages on the reservoir at Ka La Lake, Di Linh District, belonging to Seaproduct Joint Stock Company, which is the enterprise using this form effectively), canvas-bottomed ponds, and composite tanks.

However, raising sturgeon in flowing streams is currently the most economically efficient system in Lâm Đồng. The flowing stream system helps to increase production rapidly and ensure product quality before sale.

The surface area used to raise sturgeon in 2017 was 50.86 ha (Figure 2). The average yield was 19.27 tons per ha, compared with 13.5 tons per ha in 2012. The yield of sturgeon raised in cages on Kala reservoir was 21 kg/m³ in 2017 compared to 8.5 kg/m³ in 2012. The average, production area growth rate of sturgeon in Lâm Đồng was 17.62% per year from 2012 to 2017.

Sturgeon raised in flowing streams through cement tanks accounted for 85% of total production, while the rest were raised in cages, reservoir and other systems. The production of sturgeon in Lâm Đồng in 2017 was three times higher than in 2012, although the number of enterprises investing in sturgeon decreased by one third. From 2012 to 2017, production of sturgeon increased steadily at an average growth rate of 26.29% per year.

[PLACE FIGURE 2 HERE]

3. Research method

3.1. Study area

Lâm Đồng Province is located in the Central Highlands (Tây Nguyên) region of Vietnam (Figure 3). Its capital is Da Lat. Lâm Đồng borders Khanh Hoa Province and Ninh Thuan Province to the east, Dong Nai Province to the southwest, Binh Thuan Province to the southeast, Dak Lak Province to the north, and Dak Nong Province to the northwest. Lâm Đồng is a mountainous province, and 70% of its area is covered in forest. In the northern region of the province, mountains such as Bidoup (2,287 m) and Lang Bian (2,167 m), can reach above 2,000 m in altitude.

[PLACE FIGURE 3 HERE]

Lâm Đồng Province has a tropical climate and experiences heavy monsoon rains. The weather is temperate and mild year-round, with average annual temperatures of 16°C- 23°C. The dry season is from December to March and the rainy season is from April to November. Annual rainfall ranges from 1,600-2,700 mm, but it is not evenly distributed in time and place; most days are sunny. The area receiving the southwest wind (Bao Loc City) has a high annual rainfall, amounting to 3,771 mm. Given the mild climate and the abundance of water, this province was chosen as an ideal area for the production of sturgeon.

3.2. Production conditions for sturgeon

The sturgeon is the oldest of freshwater fishes (Chebanov, 2011). Four species: Siberian, Beluga, Russian, and Sterlet were introduced in Vietnam 11 years ago. The Chinese sturgeon was also introduced, but its appeal was limited because of complaints about the taste and time to attain maturity (Hunt, 2016). All sturgeon species naturally inhabit temperate zones. The favorable temperature range is 10-20°C (Baensch et al., 1991). Water temperature during spawning ranges from 9-18°C (FAO, 2012). The absence of sturgeons from tropical rivers is probably related to their thermal requirements for maturation and early development, which generally need temperatures below 20°C (Bemis and Kynard, 1997). The species are migratory, but require low-salinity waters (5.43-14.34‰) and cannot survive extreme climatic conditions. Sturgeons are vulnerable to changing habitat conditions, but can live in aquaculture facilities designed to account for their natural habitat.

3.3. Study approach

Supply and value chain analyses in fisheries and aquaculture have a number of benefits, such as providing policy makers and fishing company management with a systematic tool that allows them to understand the processes in the industry (Russell and Haanoomanjae, 2012). To generate information for the production of this tool, these steps were followed:

- i. Review the national context and the market in which the supply and value chain operate.
- ii. Map and analyze the value chain using the benchmark of the nodes' performance against others and over time.
- iii. Assess critical challenges and factors.
- iv. Recommend ways to improve value chain performance and sustainability.
- v. Assess and evaluate the strengths and weaknesses and the costs and benefits of each link in the value chain.

The researchers collected quantitative data for each link in the value chain through structured questionnaires used to interview the key players in the sector. Primary data were collected from the seven (G7 sturgeon) firms that are responsible for 85% of sturgeon production in Lâm Đồng province. Data were also collected from one sturgeon collector in Ho Chi Minh City, two collectors in Da Lat, two retailers and supermarkets, and two restaurants and hotels in Dam Rong District, Lạc Duong District, Da Lat City, and Tan Binh District, Ho Chi Minh City, from December 2017 to July 2018. The sample size and the province selected are large enough to draw conclusions about the sturgeon flesh production industry, since many of the other firms concentrate mainly on caviar production. The G7 firms are responsible for 85% of all sturgeon produced in Lâm Đồng Province, and the province is responsible for about 55% of all sturgeon produced in Vietnam.

Secondary data were sourced from local departments such as the Agricultural and Rural Development Department and the Lâm Đồng Sub-Department of Livestock, Veterinary, and Aquatic Production, and from the Association for the Development of Coldwater Fish of Lâm Đồng for the periods 2007 to 2018 (MARD, 2015; General Statistics Office of Vietnam, 2013). We also benefited from research information and results published in reports and magazines in Vietnam.

The data collected from primary and secondary sources were entered in an Excel spreadsheet to develop simple enterprise budgets for each of the major actors operating in the sturgeon market. We also performed descriptive statistics for the important variables where needed (Cong, 2018).

4.0 Framework: Value Chain Analysis

Sustainability is at the core of every value chain activity. The fishery and aquaculture value chain includes value-adding activities involved in the conversion of inputs into outputs to deliver goods to the final users or consumers (Porter, 1985; Porter, 1990; Kotni, 2016). The term *value chain* describes a model of how firms purchase raw material inputs (feed, equipment, captures, and culture fisheries) and add value to them through production and marketing processes and functions until they arrive at the consumer's table (Kaplinsky, 2004; De Silva, 2011). Organization of the value chain should facilitate links for the formation of a solid base to attain competitive advantage (Pathania-Jain, 2001). The functions of each link in the chain involve sourcing inputs, producing goods or services, and then distributing/selling products to the next link in the chain. Lynch (2003) combined the functional aspects of the chain with its organizational activities. The author said that the value chain entails the linkage of two areas that lead to the assessment of the contribution of each part to the overall added value.

Value chain analysis (VCA) is a mapping activity that allows a firm to identify all marketing transactions and support activities that add value to its final product and analyze these activities in terms of contribution to net benefits (Kaplinsky and Morris, 2001; Hellin and Meijer, 2006). These marketing activities result in increased efficiency flow and profits to the actors working along the value chain (De Silva, 2011). VCA also serves as a diagnostic tool that helps firms to sort out their activities and substitute less costly inputs for ones that are more expensive in the efficient transfer of goods from producers to consumers (Taylor, 2005).

Fisheries VCA involves the evaluation of all activities required to efficiently transfer products (whole fish, fillets, fish steaks, fish nuggets, and processed fish) to the final consumers (Chidoko et al., 2014; Christensen et al., 2011). VCA is necessary to capture the essence of the structure of markets, their relationships, actor participation, their conduct and performance, and the critical constraints that limit the proper functioning of the market (Macfadyen et al., 2012).

VCA focuses on examining the actors, structures, and dynamics of value chains, particularly the typologies of various actors and the activities, linkages, and relations between them (Bowig et al., 2010). To date, VCA studies in the fisheries industry have centered on areas with more developed aquaculture value chains and a long history of production. Value chain analyses are rare in the early stages of production of a species and are seldom included as part of the pilot economic and financial analyses (Lim, 2016). In some cases, supply chain analysis is preferred at the implementation stages of a project. In VCA and market studies of fishery and aquaculture products, marketing costs and marketing margins are important measurable variables (Nowsad, 2016), whereas supply chain analysis emphasizes technical and economic efficiency.

The relationship between value and supply chains has been discussed in several studies (Barney, 1997; Lazzarini, et. al., 2001, Sweeney, 2009). Supply chains are sets of downstream activities representing consecutive stages of value creation (Sweeney, 2009). The supply chain comprises the flow of all information, products, materials, and funds between the different stages of creating and selling a product. In supply chains, production is focused on efficient logistics using upstream and downstream businesses aimed mostly at pushing products to market. Supply chains are primarily focused on costs and reducing the time taken to present the product at the point of sale (Hackshaw, 2016). Every step in the process, including producing a good or service, manufacturing it, transporting it to a place of sale, and selling it, encompasses a company's supply chain (Tarver, 2018). Steps in the supply chain, such as inbound logistics, production, and outbound logistics, offer many direct opportunities to add value to the fish for customers/consumers.

In contrast to the supply chain, the value chain is a sequence of upstream activities that add value to a product, from primary production through processing and marketing, up to the final sale to the consumer (Nick, 2014). Value chain activities are seen as the strategic evolution in the process of meeting consumer demand, as the market participants seek to achieve product differentiation and gain competitive advantage through value adding or value creation initiatives at each node in the product supply chain. The value starts from the consumer in the form of a demand for the product (Feller et al., 2006).

Value chain analysis explains the relationships among the actors and the regulatory agencies as they organize a range of activities to move the good from primary production to end consumers, distribute profits, and control resources and environmental sustainability (Gereffi, 1995; Gereffi and Korzeniewicz, 1994; Gereffi et al., 2005; Raikes, 2011; Ribot, 2002). The approach can be characterized as “a tool for understanding who benefits from natural resources, the rules and regulations that enforce control of those patterns of behavior and how the distribution of benefits might be changed” (Ribot, 1998). Those agents that “drive” or direct the vertical coordination of the chain assume greater power, and attempt to control and regulate the mechanisms that increase sales and reduce costs, increasing net profits and ensuring efficient movement of the product to final consumers (Daviron and Gibbon, 2002). These more powerful agents may adopt a “command and control” approach to execute their function for the good of the group. The important aspect of this arrangement is determining who is in charge of access to supply chain processes and the contractual, functional, and relational linkages in existence. Social and hierarchical relations definitely influence the supply and value chains and exercise power over market access, value addition distribution, and profit margin (Ribot, 1998; Gereffi and Korzeniewicz, 1994). According to Ketchen and Guinipero (2004), as stated in Carbone (2017), “the supply chain belongs to the vast category of hybrid institutions or complex business forms organized to perform tasks that neither the market nor the firm can achieve under specified conditions.”

Gereffi et al. (2005) developed a typology that describes the governance of relationships, or the rules and behaviors of primary actors along the supply and value chains.

The authors defined five types of value chain power relationships or governance that range from market to hierarchy, including modular, relational, and captive (Gereffi et al. 2005; Ponte and Sturgeon, 2014). Market-based governance means that no single supply chain actor has control over the other supply chain actors. Bijman et al. (2011) believed that coordination may be essential because of the mutual dependencies (or interdependencies) between different activities and diverse transactions in the value chain. The coordination may not necessarily require internal execution, but various institutional governance mechanisms may come into play based on the complexity of the business activities, the nature of the actors, and the social, political, economic, and environmental settings in which the related businesses operate. Ouchi (1980) distinguished three principal governance mechanisms: market, bureaucracy, and clan. Grandori and Furnmari (2008) named four: market, hierarchy, community, and democracy. Ménard (2004) took the concept of hybrid forms of governance a step further: building on Williamson's (1991) hybrid forms between market and hierarchies. Ménard (2004) called the hybrids "a collection of weirdos" to express their heterogeneity. Saarelainen and Sievers (2012) believed that these hybrids may include cooperatives and collective action organizations.

The intermediate form of hybrid governance encompasses both market and hierarchical governance. Hence collective action is placed under the hybrid form of governance mechanism (Table 1) for this study. Collective action organizations are voluntary associations of businesspeople who cooperate to pursue common interests of members. Because of high transaction and investment costs, small holders without the capital to enter business may resort to collective action groups to enable all farmers to participate in sturgeon investment. These business associations or collective action groups support members in developing their production and business activities, protect their interests, and represent them. Activities can include lobbying, information gathering, creating market protection mechanisms, providing business services, and market research. In order for smallholders to participate in collective action activities, they need resources which determine whether an individual participates or not and to what extent the individual participates (Mutonyi, 2016). Such action organizations can be linked to a value chain both vertically (buyer-seller relationships) and horizontally (inter-

firm coordination, linkages to service providers and policy makers) (Saarelainen and Sievers, 2012).

Vertical integration works in unison with horizontal integration to stimulate business growth linkages (Neven and Reardon, 2002). Zuurbier et al., (1996) contended that horizontal integration can elicit vertical cooperation, and this is why vertical integration usually follows horizontal integration (Neven and Reardon, 2002). Horizontal activities include grouping together to increase small producers' bargaining power and therefore, strengthening their position in the value chain (Bijman and Hanisch, 2012). Important vertical activities by cooperatives and business associations can include providing information about market requirements and supporting their members in complying with them.

The nature of the sturgeon product under study, its stage in the product life cycle, and the years required for its production (Maslyuk and Odenko, 2013) force us to adapt the types of governance mechanisms proposed by Bijman et al. (2011). We have substituted collaborative action organizations for community governance in the model proposed by Grandori and Furnmari (2008) (Table 1). We do not accept this typology as the ultimate classification, but rather a proposed modification for a diversified approach to model the solution to the problem at hand. We also integrate the stages and conditions of production and marketing and the various channels of the supply chain to show how the type of governance influences the value added and profit distribution throughout the marketing chain. Since sturgeon production is in the early stages of the industry life cycle, a group of producers have put together an association to assist with governance of the value chain.

[PLACE TABLE 1 HERE]

5. Results and discussions

5.1. Supply and value chain

The main actors involved in the sturgeon supply and value chains in Lâm Đồng Province include the collective action association (already described), input providers, sturgeon farmers, local sturgeon collectors, and other collectors, wholesalers, retailers, hoteliers, restaurants, and consumers.

5.1.1. Governance along the value chain

Decree 98 of 2018 regulates all associations for the production and sale of agricultural products in Vietnam. Under the new regulation, parties assuming the prime responsibility for creating associations receive state budget support up to VND 500 million or USD13, 836 to secure consultancy services for the formation of an association, the study of the establishment of an association project, design contracts and development plans for production, trading, and marketing. An association project also receives state support equal to 30% of the investment funds for equipment and construction of infrastructure facilities, which must not exceed VND 10 billion (USD 495.00)(Vietnam Law and Legal Forum Official Gazette, 2018). The associations may include joint venture companies. In the case of the association under study, it is under the supervision of the Ministry of Agriculture and Rural Development and the People's Committee of Lâm Đồng Province.

On July 7, 2017, the Association for the Development of Coldwater Fish of Lâm Đồng was formed by a group of sturgeon-producing companies in Lâm Đồng Province. The association, which is classed as a “collective action association,” approved a draft MoU with seven voluntary members (G7) to implement principles related to the production and consumption of cold-water fish. A five-member committee heads the association, including a chairperson, two vice-chairs, and two other members. A three-member supervisory board handles the activities of the association. Under the signed agreement, members must agree to these stipulations:

- Production enterprises can only sell to Truong Toan Limited Liability Company, which plays the role of the central body for purchasing sturgeon in the local market and Ho Chi Minh City.

- Member enterprises operate under the supervision of the association in establishing mechanisms for price agreements, production planning, and consumption of sturgeon.
- Members operate under the supervision of the association in establishing a price negotiation mechanism.
- Members must tag the fish marketed to establish a brand of sturgeon produced in the Lâm Đồng Province.
- Members commit to pay a membership fee of 500 million VND (22,728.00USD) per year and fines will be deducted from the fees until the fee reaches a minimum of 300,000,000 VND or 13,636 USD; then the fund must be replenished with more contribution.
- The association will levy fines of between 50 million and 300 million VND (USD 2,273 and 13,636) for violations of its code of behavior.
- For example:
 - i. The late submission or no submission of a production and distribution plan to the association results in a fine of 50 million VND (USD 2,273.00);
 - ii. Failure to comply with production and distribution plan generates a fine of 50 million VND (USD 2,273.00);
 - iii. Failure to acquire seeds from companies not listed or not sanctioned by the association results in a fine of 3000 million VND (USD 13,636.00).
 - iv. The use of banded substances results in a fine of 300 million VND (USD 13,636.00);
 - v. The purchase or sale of foreign sturgeon in violation of association rules will bring a fine 300 million VND (USD 13,636.00);
 - vi. Selling fish to an organization not designated by the association without a credible explanation results in a fine of 300 million VND (USD13, 636.00).

The administration of fines depends on the detection and agreement of 50% of the voting membership.

5.1.2. Collective action association

The collective action association seeks to control market participants' behaviors to ensure market success. Members must sign and adhere to a contract in which there is a membership fee. The signed contract is the binding legal document for fulfilling the obligations of the parties, protecting the legitimate rights and interests among the input suppliers, the farming enterprises, and collecting and purchasing businesses according to the terms of the contract.

The group's stringent regulations on production, marketing, and environmental regulation set the tone for the industry and control its structure and profitability. Its decisions and direction are in line with the mandates of the national and local ministries of agriculture, the local people's committee, and the research institute to ensure that the sturgeon industry grows sustainably. Its high registration fee, regulation enforcement on selling requirements, market linkages, command and control mechanism and relational/market interconnections influence market participants' profits and value addition. The association uses a horizontal integration process to bring producers together for joint action, and vertical integration plus a system of command and control to regulate and enforce codes of conduct for actors operating along the supply and value chains.

The association is relatively new but it is in the process of developing detailed regulations to monitor the behavior of operators at various stages of the value chain and to solicit commitments from suppliers of broodstock, feed, chemicals, and equipment for market participants. According to the survey, out of the seven members producing sturgeon in Lâm Đồng, three units sold sturgeon only to Truong Toan Co., Ltd., the designated intermediary for the association, and four members sold their sturgeon mainly to Truong Toan Co., Ltd., plus traders and consumers in the province. The association attempted to exert control along the supply and value chains in order to affect supply, quality, standards, and distributional benefits along the chains. However, producers experienced climatic disaster in 2018 and were permitted to sell to other collectors without a penalty.

5.1.3. Input providers

Input providers include broodstock providers, fingerling suppliers, chemical suppliers, and equipment businesses. Farmers were free to purchase some inputs with or without contract or regulatory supervision from the Association for the Development of Coldwater Fish of Lâm Đồng for the period 2007-2018. According to the survey, there are three enterprises supplying breeding stock: Da Phu Limited Company, Ngoc Mai Trang Limited Company, and Khanh Van Limited Company. There are four enterprises producing their own broodstock: Dai Duong Spring Co., Ltd.; Viet Duc Trading Co., Ltd.; Phi Huynh Limited Company; and Truong Toan Limited Company. The association has identified only two of the companies, Viet Duc Trading Co., Ltd. and Phi Huynh Limited Company as the companies from which producers must source seeds or breeding stock. Truong Toan and Dai Duong Spring Co., Ltd. use all its own breeding stock for raising sturgeon. The producing companies must use 100% Siberian sturgeon seeds. The results also show that 100% of the sturgeon enterprises surveyed signed contracts to buy breeding stocks from the two selected companies.

Three feed companies sell two types of imported feed from Russia for fingerlings 50 g and under, and for fish above 50 g. The feed companies provide credit to producers, and also transport the feed to their farms. The survey indicates that these are the enterprises that supplied feed to producers: Pomboy-Skretting Long An Company, UNI President Vietnam-Binh Duong, and Raisio (Finland) (Cong, 2018). These companies were recognized by the association as legitimate suppliers of feeds. The survey suggests the existence of a relational/market linkage between enterprises and also 100% of the sturgeon-producing enterprises selected the alternative of signing contracts to buy feed from these feed suppliers. There are a number of suppliers of chemicals and equipment providing inputs to producers.

5.1.4. Sturgeon producing companies

The farmers are mainly joint-stock or single-owned companies. They purchase fingerlings, feed, and other inputs from known business entities. The sturgeon producers have market/relational linkages with the input providers. However, the relationship that exists between the farmers, collectors, and wholesalers/retailers is regulated by the Association for the Development of Coldwater Fish of Lâm Đồng, based on operational instruments of consent, joint decisions, regulations, and punishments, or a command and control system. This group seeks to ensure the smooth operation of the value chain through democratic representation and consensus.

The area for raising sturgeon occupied 47 hectares in 2017. The average yield in 2017 reached 19.27 tons/ha compared with 13.5 tons/ha in 2012, the productivity of sturgeon raised on the Kala reservoir was 21 kg/m³ in 2017 compared with 8.5 kg/m³ in 2012. Although the number of enterprises investing in raising sturgeon fell by one third, the production of sturgeon was up 3.0 times compared to the production in 2012 (in 2012, the production of sturgeon was 305 tons). Production totals for commercial sturgeon from the G7 enterprises in 2015, 2016, and 2017 were 547, 687.5, and 826 tons respectively (Association for the Development of Coldwater Fish of Lam Dong, 2017).

The flow diagram in Figure 4 shows the relational linkages among the various market participants. After 10-12 months, a sturgeon reaches 2 kg and goes through one of the supply chain participants dictated by the association or is sold at the pond bank. Commercial sturgeon producers may also supply fish directly to the collectors along the value chain if the designated collector is unable to purchase the product at a given time.

5.1.5. Production costs and returns

The average production cost of sturgeon for the period 2015-2017 was 119,968 VND/kg (USD 4.74/kg), but the average sale price for the same period was 151,667 VND/kg (USD 6.89/kg), generating marginal returns of 44,774 VND/kg (USD 2.04/kg) (Table 2). Feed cost made up the largest component, 56.25% of total cost, while fingerlings made up 21.51%, and

cleaning costs made up 2.16%. The marginal profit per kg is comparable to, if not greater than, that of any other aquaculture species produced in Vietnam today.

[PLACE TABLE 2 HERE]

5.1.6. Sturgeon collectors

Truong Toan Limited Company is selected as the sole distributor of Lâm Đồng Association and is required to abide by the regulations of the Association. According to the rules of the association:

- i. Producers must stop or reduce feeding 72 hours before harvest.
- ii. The changes in weight due to excess water at harvest must be considered and a weight loss deducted at the time of sale at a rate of 0.5% of the initial weight.
- iii. Truong Toan Limited Company must accept responsibility for the source, origin and quality of the product.
- iv. The market price must be agreed upon by the buyer and seller. The failure to purchase sturgeon within a given time results in a fine and the seller can then decide to sell to an outside buyer.
- v. Branding is controlled by the association and adhered to by the collector. All fish must be tagged on the fin with a plastic label with the brand name of Da Lat sturgeon.
- vi. Truong Toan Limited Company is responsible for the distribution of the branded product, until it reaches the consumer's plate.

According to the survey, 75.79% of the sturgeon raised by members of the association during the study period was channeled through the Truong Toan Limited Liability Company to the wholesale market to retailers, of which 98.19% went to retailers and supermarkets in Saigon via supply channel 3, and 1.81% went to hotels and restaurants. Figure 4 shows that 22.4% of sturgeon was directed to local collectors, of which 70% went to local restaurants and 30% to retailers and then to consumers. Farmers were able to sell 1.82% to consumers at the pond bank.

The survey results show that the farming, buying, and selling of sturgeon in Lâm Đồng Province flow through three different channels. The first (channel 1) involves direct sales of 1.81% at the pond banks. Channel 2 is composed of sub-channels 2.1 and 2.2, where 22.4% of total production is sold locally in Lâm Đồng. Sub-channel 2.1 goes through local collectors to retailers/supermarkets to consumers/customers. In sub-channel 2.2, the product passes through local collectors to restaurants/hotels to consumers/customers. Channel 3 is made up of sub-channels 3.1 and 3.2, which deliver 75.7% of total production to customers/consumers. In sub-channel 3.1, the product moves from the farm to Truong Toan Limited Liability Company or private collectors to wholesale to retailers/supermarkets, and then to customers/consumers in Saigon. In sub-channel 3.2, the product moves from the farm to Truong Toan Limited Liability Company to collectors, then through wholesale markets to restaurants and hotels to customers/consumers in Saigon (Table 3).

[PLACE FIGURE 4 HERE]

Collectors are either from the local area or from Truong Toan Limited Liability Company outside the province; they purchase sturgeon from the farms and guarantee that it reaches consumers in the shortest possible time to ensure product safety. The survey results show that producers often contact collectors directly to negotiate the price if they want to sell small quantities at the pond bank. Enterprises wishing to sell large quantities contact local collectors or those from outside the province to transport the product to the wholesale markets located in Binh Dien and Tan Binh in Saigon. In the Ho Chi Minh City market, collectors purchase fish from farmers or from Truong Toan Limited Liability Company and sell to retailers, restaurants, and supermarkets in Ho Chi Minh City and neighboring provinces. According to collectors surveyed in the province (channel 2), 30% of the sturgeon was sold to retailers and 70% was sold to restaurants/hotels by collectors.

The survey results show that the link between producing enterprises and sturgeon collectors is based strictly on their commitment to the Association for the Development of Coldwater Fish of Lâm Đồng and its command and control hierarchal governance. Producers communicate with collectors through advanced booking by telephone. This linkage between

farming enterprises and sturgeon collectors is a verbal commitment, but regulatory information is based on the association's stipulations. The linkage between other agents outside the Association for the Development of Coldwater Fish of Lâm Đồng agreement is based on mutual trust achieved through negotiation and verbal arrangement. Among them, Ca Tam Suoi Dai Duong Company sells directly to consumers.

[PLACE TABLE 3 HERE]

5.1.7. Transportation logistics

Climatic and weather conditions affect sturgeon immediately after harvest. The sturgeon will die and the quality of meat will deteriorate rapidly if left unattended after harvest (Cong, 2018). Therefore, sturgeon collectors must have specialized trucks with oxygen tanks to transport the sturgeon alive to the marketplace. The shorter the transportation time, the higher is the sturgeon quality. Sturgeon farms lower the pond water levels and wait for collectors to buy the fish. The purchasing time is often 0.4-0.6 hours. The time for transportation to the Binh Dien wholesale market is 10-12 hours, and then transportation to retailers, supermarkets, restaurants, and hotels takes around 1-3 hours.

5.1.8. Market information

Marketing agents often exchange and share information about the price, quantity, and quality of commercial sturgeon. According to the interview responses from producer enterprises, 100% indicated that they sourced market information from collectors, 85.7% received information from media and relatives/friends, 71.4% obtained information from other buying and selling intermediaries, and 14.3% received information from other sources.

5.2. Analysis of cost and marginal profit of each agent

The marginal cost and profit for each agent in the Lâm Đồng sturgeon value chain are clearly shown in Table 4. We notice in Table 4 that the average cost of production has decreased in the past 3 years. In 2015, it was 119,968 VND/kg (USD 5.45/kg). In 2016, it decreased by 15.9% compared to 2015. In 2017, it only went down by 1% compared to 2016. The costs of fingerlings and feed account for more than 50% of the production costs; the cost of fingerlings in 2016 was 31% lower than in 2015, and in 2017 3.4% lower than in 2016. Feed costs in 2016 were 12.6% lower compared to 2015, but in 2017 were 1.7% higher than in 2016.

The farm price of sturgeon is the major component of traders' costs and has the greatest impact on the net income of intermediary aquaculture businesses. The price of sturgeon in 2015 was about 160,000 VND/kg (USD 7.27/kg), and the average profit earned by the businesses was about 40,032 VND/kg (USD 1.71/kg), equivalent to 25.02% of the total cost. Due to the increasing production of sturgeon in Lâm Đồng in recent years and the competition of sturgeon imports, the price of sturgeon decreased in 2016 by 3.1% and in 2017 by 9.7%. However, due to the decrease in cost of fingerlings and feed (which account for a large proportion of total expenses), the marginal profit of businesses increased by 35.2% in 2016 before 2017's decrease of 25.9%.

For sturgeon collectors, labor accounted for a large proportion of their total cost (about 39%). Because of the decrease in the price of sturgeon, their marginal profit also changed slightly during the three selected years of study, increasing by 1.2% in 2016 compared to 2015, then remaining the same in 2017.

[PLACE TABLE 4 HERE]

The purchase price decreased significantly and the offer price decreased slightly for collectors inside and outside the province during the years of the survey, and hence, their marginal profit increased. Marginal profit in 2016 increased by 9% compared to 2015, while in 2017 it rose by 8.2% in contrast to 2016. For retailers and supermarkets, increase in total cost was due mainly to storage space and labor costs, which varied around 20,000 VND/kg (USD

0.91). Marginal profit in 2016 declined by 20.7% compared with 2015, and in 2017, it increased by 17.4% compared with 2016. For restaurants and hotels, due to the relationship between the offer price and purchase price, the marginal profit did not change significantly decreasing at a rate of 0.9% per year over the years of the survey.

5.2.1. Value-added structure and marginal profit rate in the value chain analysis

Table 5 describes the profit and value-added structure of Lâm Đồng sturgeon. Farmers generated the highest proportion of value added, accounting for 44.98% in 2017, but over the three years studied, the structure shows downward and upward trends. On the other hand, because of the decrease in the cost of fingerlings and feed over the years of study and the effective management of production costs, marginal profits in 2015, 2016, and 2017 were quite high: 33.4%, 53.7%, and 40.2%, respectively.

[PLACE TABLE 5 HERE]

5.2.2. Analysis of economic efficiency of the sturgeon value chain

From the total value added for the channel 1, the farming businesses acquired 100% of benefit. Similarly, from the total profit of the channel, the farming businesses received 100% of benefit. However, participants exchanged only 15 tons at the pond banks (Table 6). Table 5 and Figure 5 illustrate the distribution of value added and profit among agents in the value chain on average of 1 kg of product. For all channels, the value added varied from 17.44%-100% and the profits for the various actors ranged from 22.47%-100%. The table suggests that the shorter the channel, and if the product does not end up at hotels and restaurants, the larger is the farmers

benefit in terms of profit and value added. The farmers' benefit, value added and profit, as seen in channels 2.1 and 3.1, figure 5 are fairly large, but diminished considerable when hoteliers and restaurants are the final consumers. The collectors' relative shares are the largest if the product ends up in the hands of the retailers as seen in channel 2.1 and 3.1. When the end consumers are the hotels and restaurants the farmers and collectors' relative shares are the lowest possible.

[PLACE FIGURE 5 HERE]

It is clear that the distribution of benefits across the entire sturgeon value chain is not commensurate with the market and investment risks of aquaculture businesses. According to the survey, the investment required for sturgeon fishery infrastructure is high, ranging from 7 billion to 15 billion VND per hectare (USD 318,182 to 631,818 per ha) depending on farm location. Further, aquaculture production businesses associated to the association are the first agents to create products and value added in the chain, and bear both market and climate risks. The level of risk in sturgeon production and marketing does not encourage businesses to adopt new technologies such as 90-95% reusable water aquaculture systems or closed recirculation systems with a water reuse level of 50-60%.

[PLACE TABLE 6 HERE]

5.2.3. Product quality of sturgeon value chain

The results indicate that consumers trust and appreciate the quality of sturgeon from Da Lat. They indicated that the sturgeon produced in the province had a better flavor than imported sturgeon. The quality of the sturgeon is highly dependent on the quality of the feed. Thus, consumers' ability to distinguish the taste of Da Lat sturgeon from that of imported sturgeon from other countries and areas of Vietnam is important, and producers can use this information to improve their competitive advantage. Producers with an increasing relational/market connection with feed producers can impress upon them the need to control

the feed quality. Though a market incentive might be attractive, the feed cost makes up about 56% of total costs, and any increase in costs might lower levels of profit.

6. Discussions

Sturgeon production in Lâm Đồng Province is in the early production stages, but contributes about 55% of the total national output. The levels of investment for the production of this species are high and financed by equity capital and loan of companies or joint stock ventures. Seven of the 12 companies in the province formed an association to control the production, marketing, and distribution of sturgeon products. These companies supply about 85% of all sturgeon produced in Lâm Đồng Province. The group functions as a collective action association (MARD, 2015), with a board of directors and a supervisory committee. The organization was able to solicit national as well as local government support for its establishment (Vietnam Law and Legal Forum Official Gazette, 2018), but requires a membership fee that is substantially large for a single producer. The association has assumed leadership of the sturgeon supply and value chains and attempted to establish regulatory mechanisms to ensure the efficient movement of quality product to final consumers over a sustainable period (Daviron and Gibbon, 2002). It is unknown whether the association was formed to access government funding as a group or strictly to warrant a competitive position in the global sturgeon market.

Whatever the objectives of the association, its efforts toward regulation to minimize the use of certain banned chemicals in the production system, prevent pollution and contaminants, and minimize ecological disturbances are precautionary measures that encourage the sustainable growth of the industry. The association has taken early steps to assure that the industry is heading in the right direction. The association engages in lobbying, information gathering, creating of market protection mechanisms, providing business services, and market research on behalf of members (Saarelainen and Sievers, 2012). However, not all the laws and regulations influencing the interconnections among the actors in the marketplace are strong, and not all the investors participate in the association.

The association used a form of horizontal integration to organize members to act and solicit assistance, and used a form of vertical integration to develop linkages along the value chain to ensure the supply of a quality and differentiated product to consumers. As Neven and Reardon (2002) suggested, horizontal integration precedes vertical integration. Although the association is working through a supervisory body, one noticeable stipulation is that members must sell to Truong Toan Limited Liability Company. The study revealed that the association is using a form of command and control to direct sales to a company with monopsony power, likely for the purpose of guaranteeing product quality at a low cost and encouraging market expansion through product branding. According to Ribot (1998) and Gereffi et al. (1994), social and hierarchical relations guide efficient product flow through the supply and value chains and exert power on market access, value addition distribution, and profit margin. The association's agreement to sell quality product to only one collector and endeavor to establish a recognizable brand may be an attempt at assuming a dominant position in the sturgeon marketplace. The purpose of tagging the fish using a chip is to establish a differentiated product and a brand preference.

The supply chain for sturgeon in Lam Đồng Province consists of three main channels that are involved in the transfer of the product to consumers. Based on the results from the study, the product flows efficiently through the chain. Most of the products move along the channels with little friction, but value addition distribution and profit margins are unrelated to levels of investment and risk. Producers' margins and value additions are reasonable, but low in comparison to the investment risks they bear. Restaurants and hotels, on the other hand, receive high margins of profit and value added, and the levels of investment per kg of sturgeon for the restaurants and hotels are relatively high when compared to those of producers or collectors. The total investment of the hotels and restaurants may only be a small fraction of the investment of producers (Hunt, 2016) and collectors, and this is why the returns do not seem commensurate with the levels of risk.

The association influences the industry, first by forcing members to sell to only one outlet, although it is unclear how this action influences value addition and profit margins.

Second, the value addition and profit margins to the producer are the smallest when the product passes through channels 2.2 and 3.2, and the highest when the product goes through channel 1. Perhaps producers should behave as free riders and seek alternative means of selling their product through channel 1, where they receive the highest profit margins and value addition, but this all depends on the ability of consumers to access the pond bank to purchase the product. The volume of product sold through channel 1, where the profit margins and value addition for producers are 100%, depends on market constraints and the price elasticities of demand. Sale at the pond bank does not allow for branding as “Đà Lạt sturgeon”, since the fish may not be tagged, and problems of product traceability may result. However, the total traded is small and direct and this may not be a major concern to actors.

The research results show that the Association for the Development of Coldwater Fish of Lâm Đồng directs the transfer of sturgeon products from the farm to their final consumers. This is considered a collective action association that seeks to horizontally bring firms together and vertically integrate the firms to establish a dominant and sustainable position in the sturgeon market. The other parts of the chain include farming enterprises, sturgeon collectors, retailers, supermarkets, restaurants, and hotels. These agents have various market, relational, and hierarchical interconnections that affect market participants’ behavior, market structure, and industry promotion. The type of organization is more or less a hybrid amalgamation in which there is centralization in sale and free market and relational linkages (Ketchen and Guinipero, 2004; Carbone, 2017). The hybrid structure, though not easily operational, lowers costs and increases profits (Rangavittal and Sohn, 2008). However, the association is still slow at decentralization, total vertical integration, and the formation and enforcement of regulations to guide market participants’ behaviors along the value chain. There is still a need to include all firms and collectors to work under the aegis of the association. So far, there has been little attempt at developing monitoring, risk- and benefit-sharing mechanisms.

Sturgeon farming enterprises have not exploited and optimally used their potential water resources in the production of sturgeon. The demand for sturgeon far exceeds the supply, and the industry is still growing (Ngan and Phong, 2016). The level of technology applied

is still low, which has affected the output and the quality of the product the consumers receive. According to the result of the survey, the seven aquaculture businesses studied have not applied the GAP standard model in production. However, with the growth of the industry and further development of the value chain, it is hoped that a combination of supply and value chain analysis that shows the successful operation of a collective action association will encourage all firms to participate in the value chain under the umbrella of the association.

7. Conclusion

The sturgeon industry is highly profitable and encouraging to outside investors, but the level of investment required is high and out of the reach of many single investors. The governments of Vietnam and Lâm Đồng Province encourage investment in sturgeon production to diversify the fisheries sector and promote equitable income distribution. There are 12 sturgeon enterprises producing fish products in Lâm Đồng Province, of which seven have integrated for the sustainable development of the industry. These seven firms are responsible for a large share of the sturgeon produced in Lâm Đồng Province and Vietnam as a whole. Their association positively influences profitability and value added distribution, but also affects market structure and market participants' behavior.

The future of the industry looks promising; it will likely attain the objective of sector diversification and equitable income distribution. The association advises enterprises to invest in the construction of new farms or to renovate old farms by applying semi-circulation and closed-circulation technology in order to limit water shortages in the dry season, which reduce the productivity of stream sturgeon-raising enterprises.

The study showed that this form of hybrid governance is appropriate for a small number of large firms requiring huge investment layouts. The study result is one of the first showing that a collective action association organized in the early stages of industry growth may influence the distribution of resources and their sustainable use to guarantee market conduct of actors that generate substantial value addition and profits for stakeholders.

It is necessary to have a long-term solution to create a competitive position for the sturgeon value chain and to establish links between agents in the chain, particularly the link between production and consumption through relational governance to combine the accrual of benefits from the supply chain and the value chain. The linkage mechanism should enhance the discipline and supervision of the association through economic contracts among all agents in the chain and members of G7. However, for solid governance, the actors should demonstrate their ability to develop suitable linkages to stimulate the supply of sufficient quantity and quality of sturgeon products through the application of VietGAP and GlobalGAP practices.

7.1. Limitations of the study

The study was conducted using a limited sample size, but one almost as large as the population of actors along the supply and value chains. The study is a one-time exercise with no other studies for comparison of costs, returns, and efficiency. However, the contribution of this study is significant and it will serve as a guide for future studies.

8.0 Acknowledgement

The authors would like to thank the ClimeFish Project financed by The European Union's Horizon 2020 research and innovation programme under grant agreement No. 677039 and the NORHED Project (QZA-0485, SRV-13/0010) for their support in the preparation of this paper.

9.0 References

- Association for the Development of Coldwater Fish of Lâm Đồng, 2017. Document of the Congress of the Association for the Development of Coldwater Fish of Lâm Đồng in 3rd period, Lâm Đồng.
- Baensch, H.A., R. Riehl, 1991. Aquarien atlas, Bd. 3, Verlag für Natur-und Heimtierkunde, Germany.
- Barney, J. B. .997. Gaining and Sustaining Competitive Advantage, Addison-Wesley, Reading.
- Bemis, W.E., B. Kynard, 1997. Sturgeon Rivers: An introduction to scipenseriform biogeography and life history, Environ. Biol. Fish. 48: 167-183.
- Bijman, J., M. Hanisch, 2012. Support for farmers' cooperatives: Developing a typology of cooperatives and producer organizations in the EU, Wageningen UR, <https://www.wur.nl/en/Publication-details.htm?publicationId=publication-way-343337323431>.
- Bijman, J., R. Muradian, A. Cechin, 2011. Agricultural cooperatives and value chain coordination, in: A.H. Helmsing, S. Vellema (Eds.), Value Chains, Social Inclusion and Economic Development: Contrasting Theories and Realities, Routledge, New York.
- Bolwig, S. S., A. Ponte, A. du Toit, L. Riisgaard, N. Halberg, N. 2010. Integrating poverty and environmental concerns into value-chain analysis: a conceptual framework, Dev. Policy Rev. 28, no. 2 173-194. <http://dx.doi.org/10.1111/j.1467-7679.2010.00480.x>
- Bronzi, P., M. Chebanov, J. T. Michaels, Q. Wei, H. Rosenthal, J. Gessner, 2019. Sturgeon meat and caviar production: Global update 2017; J. Appl. Ichthyol.; February 28; <https://doi.org/10.1111/jai.13870>
- Bronzi, P., 2017. Results of the questionnaire. Presentation at the 8th International Symposium on Sturgeon. Vienna, Austria. (Vienna, 10th to 16th September, 2017; Proceedings under preparation) November.

- Bronzi, P., J. Gessner,, H. Rosenthal, 2017. An update to 2016 of sturgeon and caviar global scenario. Presentation at the 8th International Symposium on Sturgeon. Vienna, Austria. (Vienna, 10th to 16th September, 2017; Proceedings under preparation).
- Bronzi, P., H. Rosenthal, 2014 Present and future sturgeon and caviar production and marketing: A global market overview, J. Appl. Ichthyol. 30 :1536–1546.
- Carbone, A., 2017. Food supply chains: coordination governance and other shaping forces, Agr. Food Econ. 5, no. 3 <https://doi.org/10.1186/s40100-017-0071-3>
- Chebanov, M., P. Williot; 1989. An assessment of the characteristics of world production of Siberian sturgeon destined to human consumption. Chapter 8 in book: The Siberian Sturgeon (*Acipenser baerii*, Brandt, 1869) Volume 2 – Farming by Williot, P. & M.
- Chebanov, M.S., E.V. Galich, 2011. Sturgeon hatchery manual, FAO Fisheries and Aquaculture Technical Paper no. 558, FAO, Ankara.
- Chebanov. M.S. 2018. State Center for Sturgeon Gene Pool Conservation “Kubanbioresursi” Kuban State University, Krasnodar, Russia; ISBN 978-3-319-61674-2; <https://doi.org/10.1007/978-3-319-61676-6>
- Chidoko, C., S.C., Sakuhuni, S. Mufandaedza, 2014. The structure-conduct-performance paradigm in the beer industry in Zimbabwe, Global Journal of Advanced Research 2, no. 4: 735-741.
- Cong, H., 2018. Analysis of sturgeon value chain in Lam Đồng Province, Thesis submitted in partial fulfilment for the Degree of Master in Economics, Nha Trang University, Nha Trang, Vietnam.
- Christensen, V., J., A. Steenbeek, P. Failler. 2011, Combined ecosystem and value chain modeling approach for evaluating societal costs and benefits of fishing, Ecol. Model. 222: 857-864.

- Daviron, B., P. Gibbon, 2002. Global commodity chains and African export agriculture, *J. Agrar. Change*, 2, no. 2:137-161.
- De Silva, D.A.M. 2011. Value chain of fish and fishery products: Origin, functions and application in developed and developing country markets, Food and Agriculture Organization.
- Feller, A., D. Shunk, T. Callarman, 2011. Value chains versus supply chains, BP. Trends, <http://www.bptrends.com>,
- Food and Agriculture Organization of the United Nations (FAO), 2016. Fishery and aquaculture statistics, <http://www.fao.org/fishery/statistics/software/fisostatj/en>,
- Food and Agriculture Organization of the United Nations, (FAO), 2012. The State of World Fisheries and Aquaculture. <http://www.fao.org>.
- General Statistics Office of Vietnam, 2013. Statistical data, http://www.gso.gov.vn/default_en.aspx?tabid=491 (accessed 5 December 2014).
- Gereffi, G. 1995. Global Production Systems and Third World Development, Cambridge University Press, Cambridge.
- Gereffi, G., M. Korzeniewicz, 1994. Commodity Chains and Global Capitalism, Praeger Publishers.
- Gereffi, G., J. Humphrey, T. Sturgeon, 2005. The governance of global value chains, *Rev. Int. Politi. Econ.* 12, no. 1: 78-104.
- Grandori, A., S. Furnari, 2008. A chemistry organization: combinatory analysis and design, *Organ. Stud*, 29, no. 3: 459-485.
- Hackshaw, L., 2016. Evaluating and developing a market-driven value chain that provides high quality fresh fish products for the local market in Antigua and Barbuda, United Nations University Fisheries Training Programme, Iceland [finalproject], <http://www.unuftp.is/static/fellows/document/lar15prf.pdf>.

- Harris, L., H. Shiraishi,. 2018. Understanding the global caviar market; Results of a rapid assessment of trade in surgeon caviar. TRAFFIC and WWF Joint Report; ISBN no: 978-1-85850-436-0
- Hellin, J. M. Meijer, 2006. Guidelines for value chain analysis. ftp://ftp.fao.org/es/esa/lisfame/guidel_ValueChain.pdf.
- Hunt, 2016. L. Waiter, is this caviar Beluga, Seruga or Vietnamese? <https://bluenotes.anz.com/posts/2016/09/waiter-is-this-caviar-beluga-sevruga-or-vietnamese>, (Accessed 28 January 2019).
- Kaplinsky, R., 2004. Spreading the gains from globalisation: what can be learned from value-chain analysis, *Problems of Economic Transition* 47, no. 2: 74-1153.
- Kaplinsky, R., M. A. Morris, 2001. Handbook for Value Chain Research, International Development Research Center, Ottawa, Canada.
- Ketchen Jr., D. J., L. C. Guinipero, 2004. The intersection of strategic management and supply chain management, *Ind. Mark. Manag.* 33, no. 1 51–56.
- Kotni, V.V.D.P., 2016. Value chain management in marine fisheries: A case study of Andhra Pradesh, *Int. J. Manag. Val. Suppl. Chains* 7, no. 2: 9-19.
- Lâm Đồng Department of Livestock Production, Veterinary and Aquaculture, 2017. Report on the development of cold water fish in Lâm Đồng in 2017, Lâm Đồng,
- Lâm Đồng Portal, <http://www.lamdong.gov.vn/EN-US/HOME/ABOUT/Pages/Geography.aspx>
- Lazzarini, S. C., F. R. Chaddad, M. L. Cook, M.L. 2001. Integrating supply chain and Network Analysis: The study of net chains, *Journal of Chain and Network Science* 1: 7-22.
- Lim, G., 2016. Value chain upgrading: Evidence from the Singaporean aquaculture industry, *Mar. Policy* 63: 191-197. <http://dx.doi.org/10.1016/j.marpol.2015.03.016>
- Lynch, R. 2003. Corporate Strategy, third ed., Prentice Hall Financial Times,

- Macfadyen, G. A. M. Nasr-Alla, D. Al-Kenawy, et al., 2012. Value-chain analysis—An assessment methodology to estimate Egyptian aquaculture sector performance, *Aquaculture* 362-363, no. 28: 18-27.
- Maslyuk, I. A. Didenko, 2013. Environmental assessment report: Import of Russian, Siberian, Beluga and hybrid between Russian sturgeon and Siberian sturgeon to Australia: Supporting information for application to amend the list of specimens suitable for live import into Australia, Kyiv, Ukraine.
- Ménard, C., 2004. The economics of hybrid organizations, *Journal of Institutional and Theoretical Economics*; 160: 345–376. <http://www.jstor.org/stable/10.2307/40752467> (Accessed 22 November 2011).
- Mims, S., A Lazur, W. L. Shelton, B. Gomelsky, F. Chapman, 2002. Production of sturgeon: Species Profile; Southern Regional Aquaculture Center; SRAC Publication No. 7200.
- Ministry of Agriculture and Rural Development (MARD), 2015. Decision approving the development plan of cold water fish by 2020, 2030 vision, No: 3195 / QD-BNN-TCTS, Hanoi.
- Mutonyi, S., 2016. Value chain dynamics and impact of collective action on smallholder livelihood improvement in Kenya, Thesis submitted in partial fulfilment of the requirements of a public PhD degree at the Faculty of Science, University of Copenhagen (UCPH) and the School of Agricultural, Food and Biosystems Engineering, Technical University of Madrid.
- Neven, D., T., T. Reardon, 2002. Modal choice in international alliances between producers of horticultural products, in: J.H. Trienekens and S.W.F. Omta (Eds.), *Paradoxes in Food Chains and Network (Proceedings of the Fifth International Conference on Chain and Network Management in Agribusiness and the Food Industry)*, Wageningen Academic Publishers.

- Ngan, D.A.K., H. T. Phong, H. T. 2016. Supply chain design for agriculture product in Vietnam: A case study of sturgeon in Kon Tum Province. <http://apiems2016.conf.tw/site/userdata/1087/papers/0349.pdf>,
- Nick, W., 2014. Management and marketing of Bangladesh's freshwater fisheries, in: A.K.M.A. Nowsad, M. K. Saha (Eds.), *Proceedings of the National Workshop on Fish for the Future*, Hortex Foundation.
- Nowsad, A.K.M.A., 2016. Supply and value chain of fish in super-shop outlets in Dhaka City, BAU Department of Fisheries Technology.
- Ouchi, W.G., 1980. Markets, bureaucracies and clans, *Admin Sci Quart*; 25, no. 1: 129-134.
- Pathania-Jain, G., 2001. Global parents, local partners: A value-chain analysis of collaborative strategies of media firms in India, *J Med. Econ* 14, no. 3: 169-187.
- Ponte, S., T. Sturgeon, 2014. Explaining governance in global value chains: a modular theory-building effort, *Rev. Int. Polit. Econ.* 21, no. 1: 195–223.
- Porter, M.E., 1990. *The Competitive Advantage of Nations*, The Free Press, New York,
- Porter, M.E., 1985. *Competitive Advantage: Creating and Sustaining Superior Performance*, The Free Press, New York,
- Raikes, P., M. F. Jense, S. Ponte., 2011. Global commodity chain analysis and the French filière approach: Comparison and critique, *Econ Soc* 29, no. 3: 390-417.
- Rangavittal, G., T..Sohn, 2008. The impact and dynamics of centralization in supply chain decision-making, Thesis submitted in partial fulfillment of the requirements for the Degree of Master Engineering in Logistics, MIT, Massachusetts.
- Ribot, J., 2002. Theorizing access: Forest profits along Senegal's charcoal commodity chain, *Dev Change* 29: 307-341.

- Russell, D, S., Haanoomanjae, 2012. Manual on value chain analysis and promotion. Regional training on value chain analysis, Project ref. N° SA-4.1-B20, Pescares Italia SRL,
- Saarelainen, E., M. Sievers, 2012. The role of cooperatives and business associations in value chain development, ILO Value Chain Development Briefing Paper 2, https://www.ilo.org/employment/Whatwedo/Publications/WCMS_182602/lang--en/index.htm,
- Sweeney, E., 2009. Supply chain management and the value chain: Supply chain perspectives, Journal of the National Institute for Transport and Logistics 10, no. 2:13-15.
- Tarver, E., 2018. What is the difference between a value chain and a supply chain? Investopedia, <https://www.investopedia.com/ask/answers/043015/what-difference-between-value-chain-and-supply-chain.asp>,
- Taylor, D.H., 2005. Supply chain analysis: An approach to value chain improvement in agri-food chains, Int. J. Phys. Distrib. Log. 35 : 744-761.
- The Fish Site, 2009. Potential for sturgeon farming in Viet Nam., <https://thefishsite.com/articles/potential-for-sturgeon-farming-in-viet-nam>, (Accessed 28 January 2019).
- Tuong, T., 2014. Sturgeon able to benefit Vietnam, Vietnam Investment Review. <https://www.vietnam.vn/sturgeon-able-to-benefit-vietnam-27898.html>, 2014 (Accessed 28 January 2019),
- Vietnam Law and Legal Forum Official Gazette, .2018. 82-84.
- Williamson, O.E. 1991. Comparative economic organizations: the analysis of discrete structural alternatives, Admin. Sci. Quart. 36: 269-296.
- WWF, .2017. *WWF Network Sturgeon Strategy*. <https://danube-sturgeons.org/wp-content/uploads/2017/10/WWF-Global-Sturgeon-Strategy-2017.pdf>

Zuurbier, P. J. P., J. H. Trienekens, G. W. Ziggers, 1996. Verticale Samenwerking, Kluwer Bedrijfsinformatie, Deventer.

Journal Pre-proof

Declaration of interests

☒ The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

☐ The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

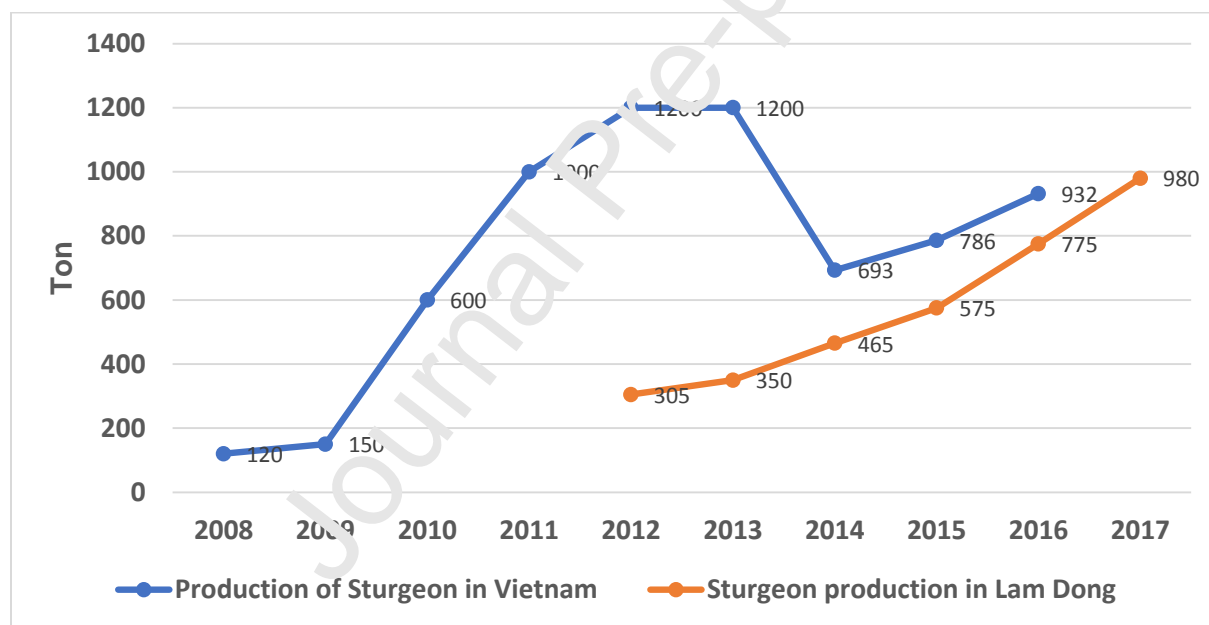


Figure 1. Production of Sturgeon in Vietnam from 2008 to 2016 and Lam Dong sturgeon production from 2012 to 2017

Source: FAO (2016) and Lâm Đồng Sub Department of Livestock, Veterinary & Aquatic Production, 2017

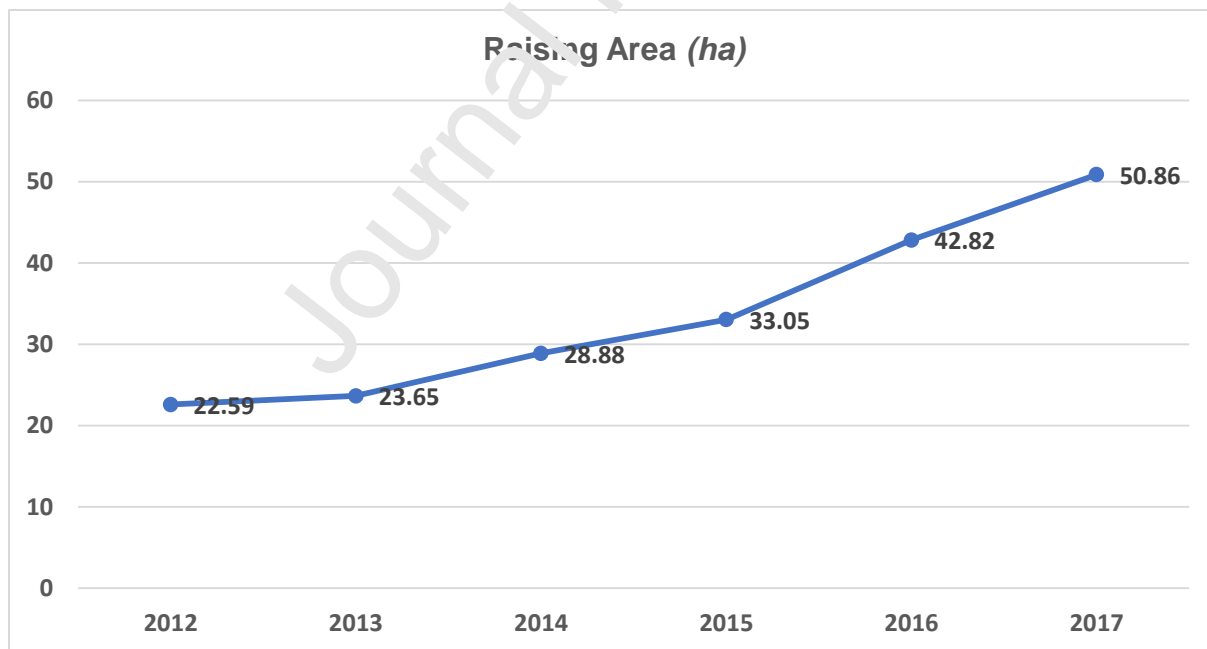


Figure 2. Raising area for sturgeon in Lam Dong from 2012 to 2017

Source: *Lâm Đồng- Sub Department of Livestock, Veterinary & Aquatic Production, 2017*

Journal Pre-proof

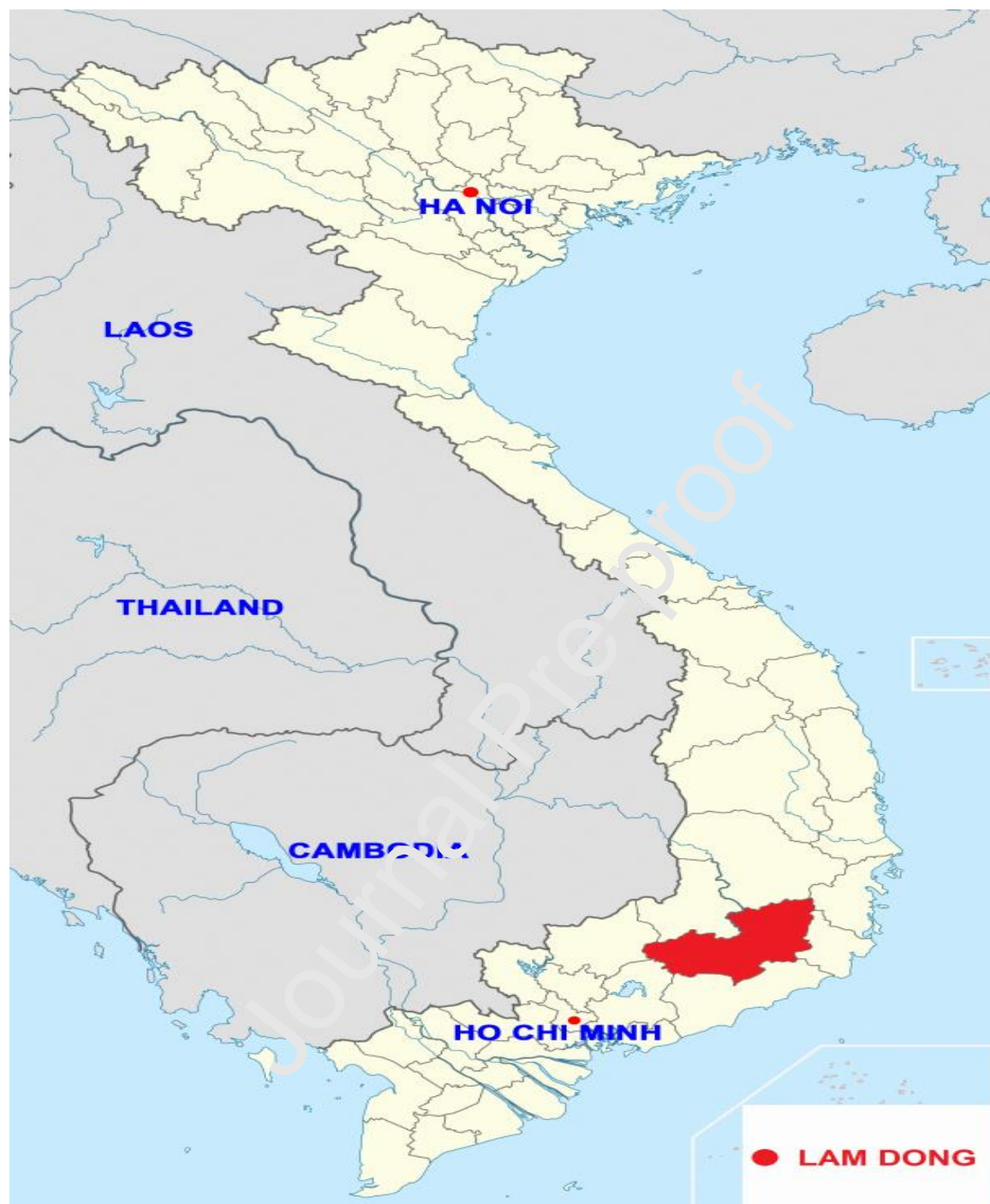


Figure 3. Map of Vietnam showing location (Red) Lâm Đồng Province

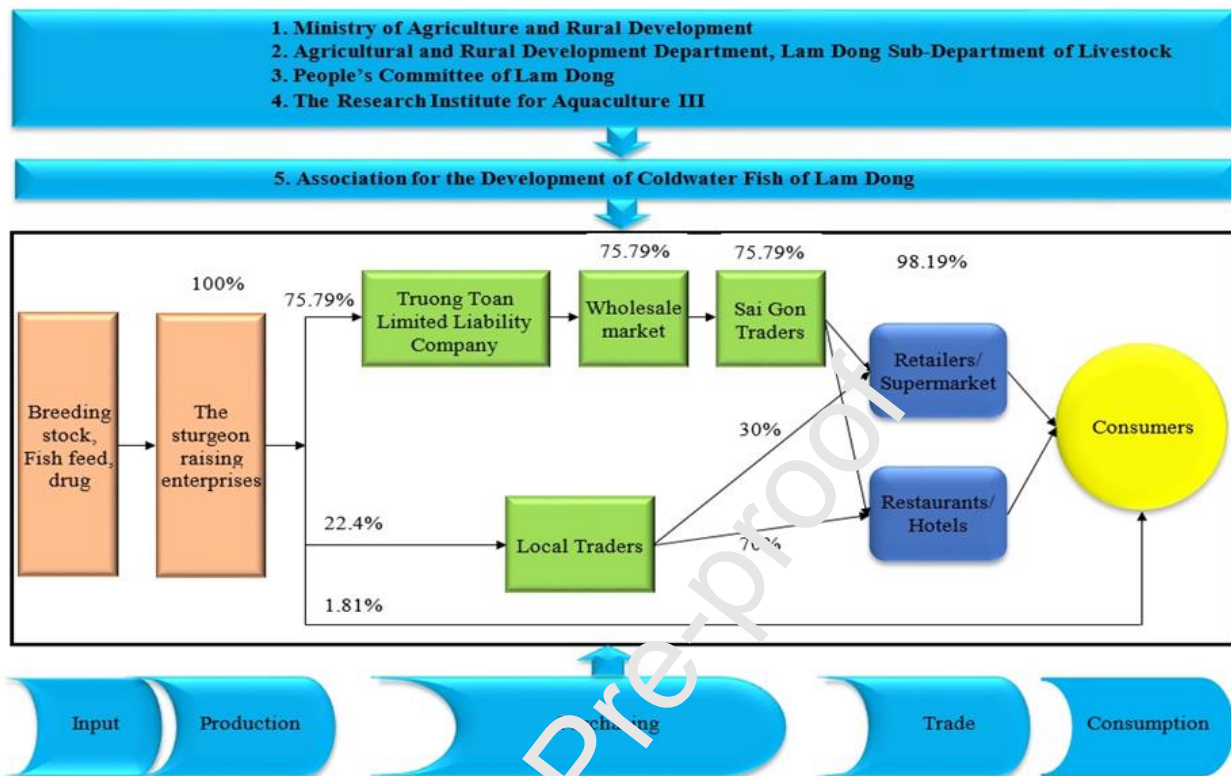


Figure 4. Sturgeon value chain model in Lâm Đồng

Source: Author's collection and synthesis

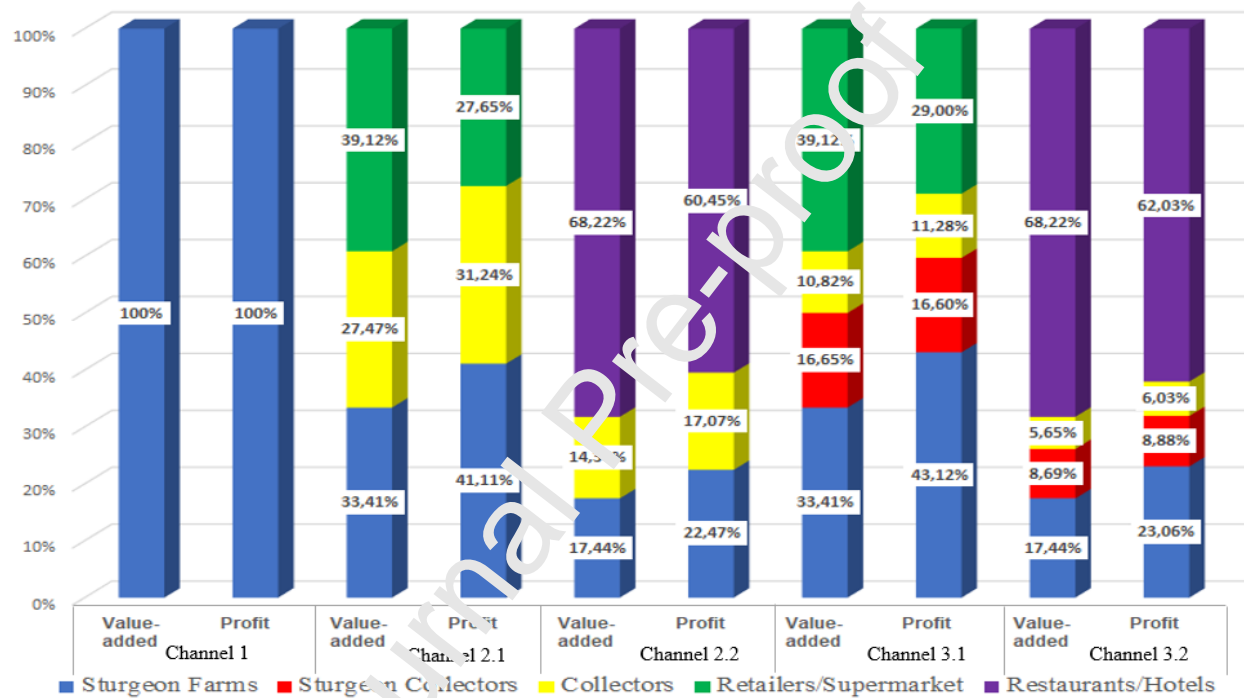


Figure 5. Distribution of value added and profit of the sturgeon value chain in 2017
Source: Author's collection and synthesis

Table 1. Four types of proposed governance

Attributes	Market	Hierarchy	Relational	Collective Action Association
Main coordination instruments	Reciprocity, strong incentives	Command and control	Social arrangement, congruence and agreement	Consensus, joint decision, hierarchal
Way of operation	Price	Rules	Agreements	Volunteerism, rules, penalties, and performance evaluation
Cost of operations (Administrative costs)	Low	High	Low	Low
Flexibility	High	Intermediate	High	Intermediate
Capacity to solve horizontal coordination problems	Low	Intermediate	Low	Intermediate
Capacity to solve vertical coordination problem	Low	High	Low	Intermediate

Table 2. Costs and marginal profits of stakeholders in the sturgeon value chain

Items	Amount (USD/kg)			Average	Compare (%Δ)*	
	2015	2016	2017		2016/2015	2017/2016
1. Sturgeon Farms						
Sale price	7.27	7.04	6.36	6.89	-3.1	-9.7
Fingerling cost	1.29	0.90	0.87	1.02	-31.0	-3.4
Feed cost	2.89	2.53	2.57	2.66	-12.6	1.7
The cost for cleaning the pond	0.12	0.10	0.09	0.10	-12.0	-15.1
Cost of treating the fish (for disease)	0.02	0.03	0.03	0.03	10.6	11.6
Labor cost	0.49	0.41	0.39	0.43	-16.8	-3.3
Cost of energy	0.06	0.05	0.05	0.05	-11.7	3.0
Other costs	0.03	0.03	0.06	0.04	5.2	121.8
Total variable costs	4.90	4.04	4.07	4.33	-17.5	0.6
Income above variable costs	2.36	3.00	2.34	2.57	27.1	-22.0
Depreciation	0.54	0.54	0.47	0.52	-0.6	-12.8
Total cost	5.45	4.58	4.53	4.74	-15.9	-1.0
Marginal profit	1.82	2.46	1.82	2.03	35.2	-25.9

Source: Author's collection and synthesis

** Calculations made based on VND currency.*

Table 3. Channel and product flow from farmers to customers/consumers

Channels and product flows	Percentage of product flow
<ul style="list-style-type: none"> • Channel 1: <ul style="list-style-type: none"> ➤ Sale at pond bank (Sturgeon Farms→Consumers) 	Accounting for 1.81% of total production of sturgeon in Lâm Đồng
<ul style="list-style-type: none"> • Channel 2: <ul style="list-style-type: none"> ➤ Channel 2.1 (Sturgeon Farms→Local Collectors→Retailers/Supermarket→Consumers) ➤ Channel 2.2 (Sturgeon Farms→Local Collectors→Restaurants/Hotels→Consumers) 	Accounting for 22.4% of total production of sturgeon in Lâm Đồng
<ul style="list-style-type: none"> • Channel 3: <ul style="list-style-type: none"> ➤ Channel 3.1 (Sturgeon Farms→Sturgeon Collectors→Wholesale Market→Sai Gon Collectors→Retailers/Supermarket→Consumers) ➤ Channel 3.2 (Sturgeon Farms→Sturgeon Collectors→Wholesale Market→Sai Gon Collectors→Restaurants/Hotels→Consumers) 	Accounting for 75.79% of total production of sturgeon in Lâm Đồng

Source: Author's collection and synthesis

Table 4. Costs and marginal profit of stakeholders in the sturgeon value chain

Items	Amount (USD)			Compare (%)*	
	2015	2016	2017	2016/2015	2017/2016
1. Sturgeon Farms					
Total cost	5.45	4.58	4.53	-15.9	-1.0
Fingerling cost	1.29	0.90	0.87	-31.0	-3.4
Feed cost	2.59	2.53	2.57	-12.6	1.7
The cost for cleaning the pond	0.12	0.10	0.09	-12.0	-15.1
Cost of treating the fish (for disease)	0.02	0.03	0.03	10.6	11.6
Labor cost	0.49	0.41	0.39	-16.8	-3.3
Depreciation	0.06	0.05	0.05	-0.6	-12.8
Cost of energy	0.03	0.03	0.06	-11.7	3.0
Other costs	1.29	0.90	0.87	5.2	121.8
Sale price	7.27	7.04	6.36	-3.1	-9.7
Marginal profit	1.82	2.46	1.82	35.2	-25.9
2. Sturgeon Collectors					
Collecting price	7.27	7.04	6.36	-3.1	-9.7
Total additional cost	0.19	0.21	0.21	6.9	-0.1

Items	Amount (USD)			Compare (%Δ)*	
	2015	2016	2017	2016/2015	2017/2016
Labor cost	0.10	0.09	0.08	-7.1	-9.0
Cost of preserving fish	0.02	0.02	0.01	-15.7	-8.9
Transportation costs	0.04	0.04	0.04	-10.7	25.0
Depreciation	0.01	0.01	0.01	6.2	3.2
Fees and charges	0.03	0.06	0.06	95.7	0.4
Other costs	49	39	32	-20.4	-17.9
Sale price	8.18	7.95	7.27	-2.8	-8.6
Marginal profit	1.10	1.12	1.12	1.2	0.0
3. Collectors					
Purchase price	8.18	7.95	7.27	-2.8	-8.6
Additional cost	0.10	0.10	0.11	9.5	8.7
Sale price	8.68	8.50	7.86	-2.1	-7.5
Marginal profit	0.40	0.44	0.48	9.0	8.2
4. Retailers/Supermarkets					
Purchase price	8.68	8.50	7.86	-2.1	-7.5
Additional cost	0.91	0.91	0.91	0.0	0.0
Sale price	10.91	10.45	10.00	-4.2	-4.3
Marginal profit	1.32	1.04	1.23	-20.7	17.4
5. Restaurants/Hotels					
Purchase price	8.68	8.50	7.86	-2.1	-7.5
Additional cost	2.23	2.23	2.23	0.0	0.0
Sale price	15.91	15.68	15.00	-1.4	-4.3
Marginal profit	5.00	4.95	4.91	-0.9	-0.9

Source: Author's collection and synthesis

* Calculations made based on VND currency.

Table 5. Distribution of added value and profit margins in the Lam Dong sturgeon value chain in 2015-2017

Year	Items	Sturgeon Farms	Sturgeon Collectors	Collectors	Retailers/ Supermarkets	Restaurants/ Hotels
2015	Purchase price/Sale price	7.27 8.18 8.68				
	Total cost (USD)	5.45	7.46	8.27	9.59	10.91
	- Additional cost (USD)		0.19	0.10	0.91	2.23
	Marginal profit	1.82	1.10	.40	1.32	5.00
	Marginal profit/Total cost %	33.4	14.8	4.9	13.7	45.8
	Marginal profit/Additional cost %		570.1	423.8	145.0	224.5
	Value-added distribution %	50.0	18.5	7.4	12.0	12.1
2016	Purchase price/Sale price	7.04 7.95 8.50				

Year	Items	Sturgeon Farms	Sturgeon Collectors	Collectors	Retailers/ Supermarkets	Restaurants/ Hotels
	Total cost (USD)	4.58	7.25	8.05	9.41	10.73
	- Additional cost (USD)		0.21	0.10	0.91	2.23
	Marginal profit	2.46	1.12	0.44	1.04	4.95
	Marginal profit/Total cost %	53.7	15.4	5.5	11.1	46.2
	Marginal profit/Additional cost %		539.9	421.7	115.0	222.4
	Value-added distribution %	42.7	24.9	7.5	12.6	12.3
2017	Purchase price/Sale price	6.56 7.27 7.86				
	Total cost (USD)	4.53	6.57	7.39	8.77	10.09
	- Additional cost (USD)		0.21	0.11	0.91	2.23
	Marginal profit (USD)	1.82	1.12	0.48	1.23	4.90
	Marginal profit/Total cost %	40.2	17.0	6.5	14.0	48.6
	Marginal profit/Additional cost %		540.2	420.0	135.0	220.4
	Value-added distribution %	44.8	20.13	8.09	13.74	13.06

Source: Author's collection and synthesis

Table 6. Quantities and prices the sturgeon were sold in 2017

Items	Sturgeon Farms (USD)	Sturgeon Collectors (USD)	Collectors (USD)	Retailers/ Supermarkets (USD)	Restaurants/ Hotels (USD)	Total (USD)
Channel 1 (Sturgeon Farms→Consumers)						
Sale price (USD) (9.09					9.09

Table 6. Quantities and prices the sturgeon were sold in 2017

Items	Sturgeon Farms (USD)	Sturgeon Collectors (USD)	Collectors (USD)	Retailers/ Supermarkets (USD)	Restaurants/ Hotels (USD)	Total (USD)
Input cost	4.53					4.53
Additional cost	0					0
Value-added	4.55					4.55
<i>Percentage</i>	<i>100</i>					<i>100</i>
Net value added (Profit)	4.55					4.55
<i>Percentage</i>	<i>100</i>					<i>100</i>
Channel 2						
Channel 2.1 (Sturgeon Farms→Local Collectors→Retailers/Supermarket→Consumers)						
Sale price	6.36		7.86	10.00		24.22
Input cost	4.54		6.36	7.86		18.76
Additional cost	0		0.11	0.91		1.02
Value-added	1.82		1.50	2.14		5.46
<i>Percentage</i>	<i>33.41</i>		<i>27.47</i>	<i>39.12</i>		<i>100.00</i>
Net value added (Profit)	1.82		1.39	1.23		4.44
<i>Percentage</i>	<i>41.11</i>		<i>31.24</i>	<i>27.65</i>		<i>100.00</i>
Channel 2.2 (Sturgeon Farms→Local Collectors→ Restaurants/Hotels→Consumers)						
Sale price	6.36		7.86		15.00	29.23
Input cost	4.54		6.36		7.86	18.77
Incremental cost	0		0.11		2.23	2.34
Value-added	1.82		1.50		7.13	10.46
<i>Percentage</i>	<i>17.44</i>		<i>14.34</i>		<i>68.22</i>	<i>100.00</i>

Table 6. Quantities and prices the sturgeon were sold in 2017

Items	Sturgeon Farms (USD)	Sturgeon Collectors (USD)	Collectors (USD)	Retailers/ Supermarkets (USD)	Restaurants/ Hotels (USD)	Total (USD)
Net value added (Profit)	1.82		1.39		4.91	8.12
Percentage	22.47		17.07		60.45	100.00
Channel 3						
Channel 3.1 (Sturgeon Farms→Sturgeon Collectors→Wholesale Market→Sai Gon Collectors→Retailers/Supermarket→Consumers)						
Sale price	6.36	7.27	7.86	10.00		31.50
Input cost	4.54	6.36	7.27	7.86		26.04
Additional cost	0	0.21	0.11	0.91		1.23
Value-added	1.92	0.91	0.59	2.13		5.46
Percentage	33.41	15.65	10.82	39.12		100.00
Net value added (Profit)	1.82	0.70	0.48	1.23		4.23
Percentage	43.12	16.60	11.28	29.00		100.00
Channel 3.2 (Sturgeon Farms→Sturgeon Collectors→Wholesale Market→Sai Gon Collectors→Restaurants/Hotels→Consumers)						
Sale price	6.36	7.27	7.86		15.00	36.50
Input cost	4.53	6.36	7.27		7.86	26.03
Additional cost	0	0.21	0.11		2.23	2.55
Value-added	1.82	0.91	0.59		7.14	10.46
Percentage	17.44	8.69	5.65		68.22	100.00
Net value added (Profit)	1.82	0.70	0.48		4.91	7.91
Percentage	23.06	8.88	6.03		62.03	100.00

Source: Author's collection and synthesis

Table 6. Quantities and prices the sturgeon were sold in 2017

Items	Sturgeon Farms	Sturgeon Collectors	Collectors	Retailers/ Supermarkets	Restaurants/ Hotels
Channel 1 (Sturgeon Farms→Consumers)					
Sale quantities (<i>tons</i>)	15.0				
Sale price (<i>USD/kg</i>)	9.91				
Channel 2					
Channel 2.1 (Sturgeon Farms→Local Collectors→Retailers/Supermarket→Consumers)					
Sale quantities (<i>tons</i>)	55.5		55.5	55.5	
Sale price (<i>USD /kg</i>)	6.36		7.86	10.00	
Channel 2.2 (Sturgeon Farms→Local Collectors→ Restaurants/Hotels→Consumers)					
Sale quantities (<i>tons</i>)	129.5		129.5		129.5
Sale price (<i>USD /kg</i>)	6.36		7.86		15.00
Channel 3					
Channel 3.1 (Sturgeon Farms →Sturgeon Collectors→Wholesale Market→Sai Gon Collectors→Retailers/Supermarket→Consumers)					
Sale quantities (<i>tons</i>)	187.8	187.8	187.8	187.8	
Sale price (<i>USD /kg</i>)	6.36	7.23	7.86	10.00	
Channel 3.2 (Sturgeon Farms→Sturgeon Collectors→Wholesale Market→Sai Gon Collectors→Restaurants/Hotels→Consumers)					
Sale quantities (<i>tons</i>)	438.2	438.2	438.2		438.2
Sale price (<i>USD /kg</i>)	6.36	7.23	7.86		15.00

Journal Pre-proof

Highlights

- Collective action association use horizontal and vertical integration for organizing producers
- The association used cautionary measures to increase competitive advantage and sustainability
- Employment of hierarchical governance and monopsony power to organize value chain actors
- Sturgeon production for flesh is profitable and generates uneven value addition distribution
- The industry is yet to exhaust its production potential but profits are encouraging to investors

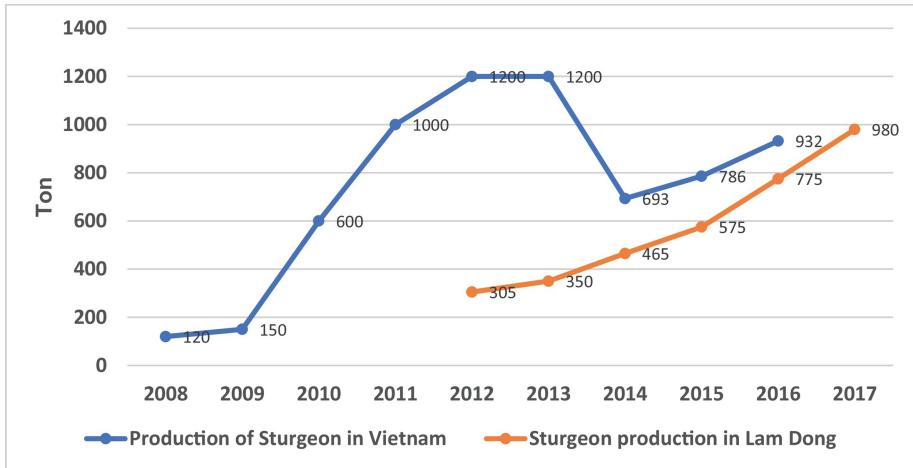


Figure 1

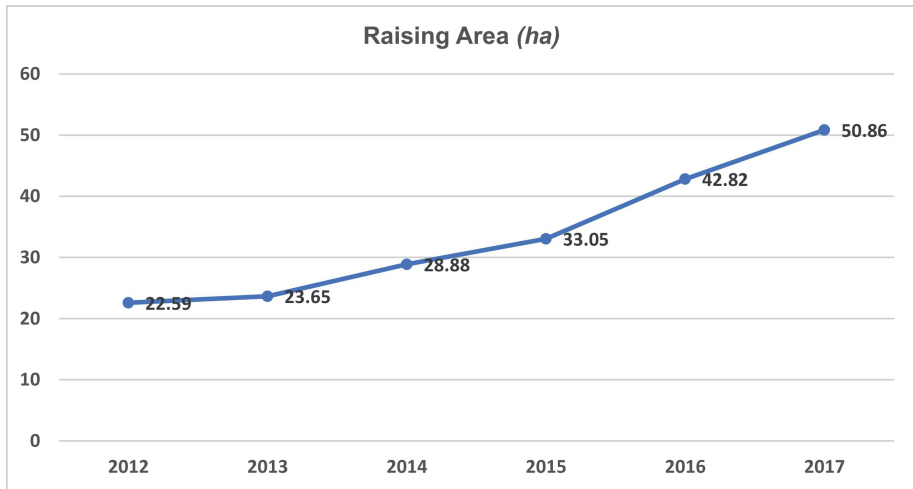


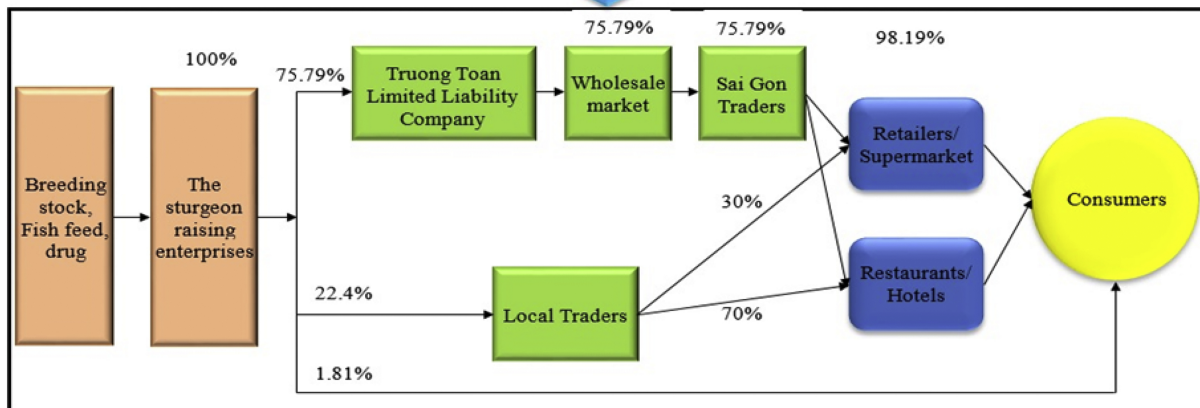
Figure 2



Figure 3

1. Ministry of Agriculture and Rural Development
2. Agricultural and Rural Development Department, Lam Dong Sub-Department of Livestock
3. People's Committee of Lam Dong
4. The Research Institute for Aquaculture III

5. Association for the Development of Coldwater Fish of Lam Dong



Input

Production

Purchasing

Trade

Consumption

Figure 4

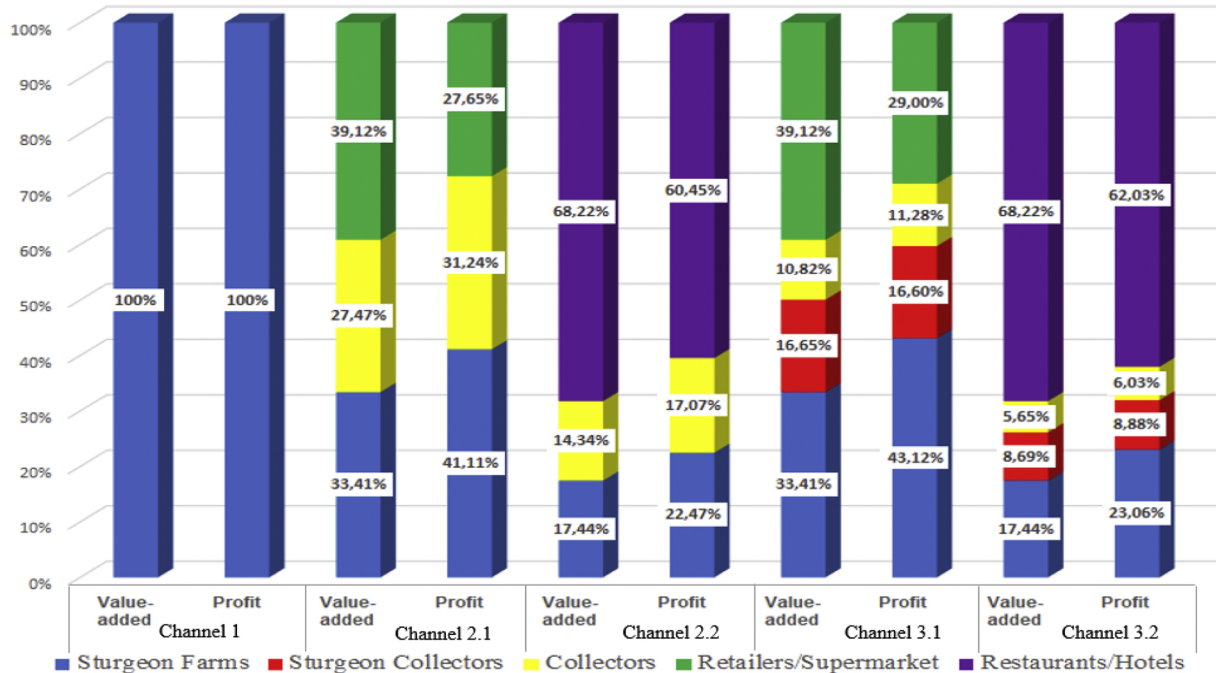


Figure 5