Summary of participatory modeling workshops to understand ecological, social and economic dimensions of the U.S. Virgin Islands lobster fishery

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Summary of participatory modeling workshops to understand ecological, social and economic dimensions of the U.S. Virgin Islands lobster fishery

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1. Introduction

This working paper presents qualitative data from workshops with spiny lobster commercial fishers in the U.S. Virgin Islands. Workshops were designed to gather fisher perspectives and knowledge to better understand the local social-ecological dynamics driving the fishery. This approach was adapted from previous Southeast Fisheries Science Center research for SEDAR 74 Gulf of Mexico red snapper (Gervasi et al. 2022; Gervasi et al. 2023).

This research addresses the SEDAR 91 Caribbean spiny lobster data workshop term of reference #1, to ***"review available data inputs and provide tables and figures including, but not limited to: a) commercial and recreational catches and/or discards; b) length/age composition data; c) life history and ecological information; d) indices of abundance; and e) data through at least 2022."*** The specific data provided includes: socioeconomic system dynamics; local ecological knowledge of environmental, physical, and biological drivers; perceptions of abundance and population dynamic changes; and impacts of regulatory actions. This research also serves to inform term of reference #2, to ***"provide recommendations for future research in areas such as sampling, fishery monitoring, and stock assessment."*** This research is still in progress and findings summarized here are preliminary.

2. Methods

Fishers were consulted for this project via a combination of in-person and virtual workshops. Knowledgeable spiny lobster commercial fishers in St. Thomas- and St. Croix, USVI were identified via multiple "entry points" to ensure to the extent possible that a diversity of opinions were accessed. Contacts were recommended by the Caribbean Fisheries Management Council, NOAA Fisheries and individuals knowledgeable about the local industry. From these contacts, we attempted to balance individuals who have been regularly involved in the management process as well as those who have not.

Workshops were conducted in September and October of 2024 (Table 1). Fishers were asked a series of open-ended questions with the goal to address the following research questions:

- What are the main biological, environmental and socioeconomic factors that influence the USVI spiny lobster fishery and spiny lobster populations?
- What were the main technological and regulatory impacts that affected the USVI spiny lobster fishery?
- How do changes in the ecosystem affect businesses and communities?

The workshop agenda and questions were adapted from previous participatory modeling approaches used by the Southeast Fisheries Science Center (McPherson et al., 2022). The in-person workshops consisted of several components. We began with opening remarks outlining the objectives of the workshop, followed by participant introductions and a discussion of expectations. This was followed by an activity in which participants graphed and discussed their perceptions of changes in spiny lobster stock abundance and revenues over time. This activity served as a segue into a participatory conceptual modeling exercise, where participants identified

physical, biological, social, and economic factors perceived to affect lobster abundance and the interconnections between these factors.

As part of the modeling process, fishers described their perceptions of environmental change over time, how they make decisions regarding fishing effort, size preferences, discard practices, gear and technology usage, changes in fishing techniques, market dynamics, and profits. Once the model was complete, participants highlighted the most important factors in the system, identified the biggest risks to the fishery, and expressed their values regarding preferred management approaches. The workshop concluded with another graphing activity to capture perceptions of changes in critical factors over time, including trends in catchability, seasonality, shifts in gear usage, and other factors that could impact selectivity and catchability.

Virtual workshops were run in a similar manner, though due to logistical constraints we could not effectively carry out the graphing exercises. Instead, we elicited these patterns through verbal descriptions. The virtual workshop format also limited the participants' ability to view the conceptual model, as it was being built from the conversations. However, we were able to build the conceptual model using the Mental Modeler software and then display it electronically during the webinar; workshop facilitators then reviewed the model as it was displayed on the screen to ensure that participant perspectives were captured accurately.

Table 1. Summary of workshop dates, format, number of participants, and background of participants.

Workshop location	Dates	Format	Number of participants	Gear breakdown
St. Thomas	Sept 17, 2024	In-person	6	Trap fishers
St. Croix	Sept 19, 2024	Virtual	1	Trap & dive fisher
St. Croix	Sept 20, 2024	In-person	11	Trap and dive fishers, university researcher, and former government official
St. Croix	Oct 8, 2024	Virtual	3	Diver fishers and former government official

3. Results

3.1 Environmental Drivers

A variety of environmental factors were identified as influencing lobster dynamics (Table 2). Many of these factors were thought to influence the distribution or movement of lobster. Other factors influenced lobster abundance directly or indirectly. Environmental drivers also impacted other aspects of the fishery, such as the catchability or habitat impacts, which then indirectly were perceived to influence lobster dynamics. Workshop participants also differentiated between the wider Caribbean lobster stock and the local subpopulation that was the target of their fishing operations, and they described how particular environmental factors impacted the immigration or emigration of lobster with respect to the larger Caribbean-wide stock.

Table 2. The various environmental drivers mentioned in the workshops, areas in which these drivers were mentioned, and the particular impacts that were perceived.

Driver	Island	Impacts of driver
Ocean temperatures	All	Ocean temperatures were thought to impact distribution, growth, behavior, and disease susceptibility in lobster. High ocean temperatures were associated with pushing lobster into deeper waters, and it is perceived that catchability increases in winter due to higher availability of lobster closer to shore with cooler temperatures.
Hurricanes	All	Hurricanes are viewed as both damaging and beneficial for the ecosystem. When strong hurricanes directly hit the islands the habitat and lobster caves are damaged, but strong surges can "clean" reefs by removing loose material and algae. Hurricanes cause sedimentation and can alter bottom structures, destroying some habitats while creating new ones, which changes the distribution of lobster. Major storms, such as Maria and Hugo, cause significant damage to fishing gear and boats, impacting the fishery. However, these storms do not generally impact the lobster population significantly and it is perceived to recover quickly following the storms.
Water quality	All	Occasional influxes of freshwater (possibly from the Orinoco River) can change water color and affect visibility, impacting diving operations due to reduced visibility. Pollution and sedimentation all contribute to contaminated nearshore waters and this affects lobster distribution as the lobster move to less polluted areas. The main drivers of poor water quality mentioned were coastal development, runoff, sewage, and derelict vessels, all of which were of concern.
Currents	All	Particular current patterns, which can be seasonal in nature, are associated with lobster movement and distribution. In St. Croix, currents can shift very rapidly, which influences fishing strategies (e.g., how traps are set and how dives are planned). These currents can also affect larval distributions; favorable currents can transport larvae to suitable habitat while unfavorable currents can lead to poor recruitment. Strong currents around St. Croix help retain fish and lobster larvae in the area, supporting local populations. As one participant described: "All current stays and swings around so the fish actually stay here."
Seasons	All	Seasonal changes in temperature, daylight, and food availability are perceived to affect lobster behavior, growth, and reproduction. Fishers adapt their strategies based on these patterns.
Cold fronts	St. Thomas	Changes in barometric pressure associated with cold fronts were perceived to cause lobster movement and changes in behavior.

Ocean acidification	St. Croix	Increasing ocean acidification was thought to impact shell formation in lobster, particularly in the early life stages.
Climate change	St. Croix	Climate change was linked to rising ocean temperatures, ocean acidification, and changes in current patterns, all of which are thought to impact lobster populations.

3.2 Biological drivers

As with the case of environmental drivers, multiple biological drivers were identified by workshop participants that were thought to influence lobster abundance directly (e.g. through mortality) or indirectly (through movement or immigration).

Table 3. The various biological drivers mentioned in the workshops, areas in which these drivers were mentioned, and the particular impacts that were perceived.

Driver	Island	Impacts of driver
Habitat changes	All	Habitat degradation is perceived to reduce the total amount of suitable lobster habitat and impact both population distribution and abundance. It was noted that coral bleaching reduces lobster habitat and that there is lower catch in bleached areas. Causes of coral reef habitat degradation mentioned include tourism activities (e.g. jet skis) that can damage shallow water habitats, as well as sunscreen chemicals.
Sargassum blooms	All	Large influxes of sargassum seaweed are perceived to negatively impact coastal areas, particularly mangroves, and potentially affect juvenile lobsters. Sargassum also affects fishing operations by clogging boat motors.
Fish populations	All	There is the perception that lionfish are having a significant impact on lobster by competing with them for habitat and space. Other species of fish are natural predators of lobster and influence their population size and distributions.
“Slimy” algae	St. Croix	A new species of algae described as “slimy” is covering large areas of the seafloor and is perceived to impact lobster distributions as fewer lobsters are found in these areas.
Disease	St. Croix	There are various diseases affecting lobster health; these were perceived to be linked to population declines and also reduced marketability of catch.

3.3 Socio-Economic Drivers

Market Dynamics

The U.S. Virgin Islands' lobster fishery began in the 1960s and 1970s, driven by growing tourism demand. Prior to this period, lobsters were often used as bait or given away to supplement other fish sales. As hotels and restaurants started requesting lobster, a new fishery developed. This shift laid the groundwork for the current market-driven approach that characterizes the local fisheries.

Workshop participants in the U.S. Virgin Islands emphasize the "market-based" nature of their fisheries, particularly the lobster fishery. Market-based fishing implies that local catch volumes are closely aligned with local demand patterns. Fishers adjust their harvesting activity based on prevailing market conditions, allowing for self-regulation of fishing activities. For example, if the market is oversupplied with lobsters, fishers may take a break, reduce their focus on lobsters, or shift to alternative species.

The spiny lobster fishery exemplifies market-based fishing partly because of the detrimental impacts of freezing on taste and quality. The strong consumer preference for fresh over frozen lobster necessitates that fishers adapt their fishing strategies and pricing in response to market demand. Conversely, species such as queen conch and reef fish afford fishers greater flexibility in managing their catches, inventory, and pricing because they can be frozen without significant loss of quality. However, the potential for cold storage in the islands is constrained by several factors, notably frequent power outages.

Insights from workshops conducted in St. Thomas and St. Croix illustrate fishers' responses to prevailing market conditions:

- One St. Thomian participant explained, "*If sales are bad, we have to cut back. We have no choice. If the lobsters aren't selling, I focus on what is."*
- Another participant from St. Thomas added, "*If we don't have the sales to move these lobsters, it doesn't make sense to catch them. You only make money if you're selling; you don't make any money if you just have to hold onto it. Catching it is only half the battle.*"
- A participant from St. Croix highlighted the necessity of targeting: "*Si hay demanda de langosta, tú te mueves para la langosta; si hay demanda de carrucho, te mueves para el carrucho; si hay demanda de cotorro, te mueves para el cotorro. El que no sepa hacer eso no vive aquí como un pescador.*" ["If there's demand for lobster, you move to lobster; if there's demand for conch, you move to conch; if there's demand for parrotfish, you move to parrotfish. Whoever doesn't know how to do that doesn't live here as a fisherman."]
- This Crucian participant further elaborated, "*A mí no me gusta vender. Yo tengo la clientela para el carrucho, que el carrucho es el 100% de mi target species. Cuando el carrucho es tranca, yo tengo que evolucionar alrededor de los clientes de langosta y de pescado. Si hay días que no tenemos nada vendido, nosotros nos quedamos en la casa.*" ["I don't like selling. I have the clientele for the conch, and the conch is 100% of my target species. When things get tight, I have to evolve around the lobster and fish customers. If there are days when we don't have anything sold, we stay at home."]

Lobster Demand

Lobster demand in the U.S. Virgin Islands is mainly driven by tourism and local consumption.

Tourist Demand

Tourist demand peaks from November to April, coinciding with the influx of visitors from the continental U.S. and other regions seeking to escape colder climates. This period significantly boosts demand from hotels and restaurants, which are major buyers (see, Table 4). Demand fluctuates with tourist arrivals, reaching its lowest point during the hurricane season (July-September) when many tourists depart and restaurants close. In October, demand begins to recover as restaurants reopen and tourist numbers increase. Workshop participants from St. Thomas highlighted that their most productive lobster fishing occurs towards the end of the slow season, underscoring the close alignment between supply and the prevailing demand.

Local Demand

Local seafood demand in St. Thomas and St. Croix remains steady year-round, with occasional peaks during festivals, religious observances (e.g., Lent), holidays (e.g., 4th of July), and special occasions such as graduations (see, Table 5). However, workshop participants in St. Croix noted a stronger local preference for parrotfish, doctor fish, and 'olde' wife (queen triggerfish). The period from late August to early September sees the lowest local seafood demand, including lobster, as regular customers allocate most of their income to back-to-school expenses. This period also coincides with peak hurricane season, resulting in the lowest tourist numbers.

Workshop participants from St. Thomas emphasized that local demand is their "bread and butter" due to the regularity of local seafood purchases, contrasting with the seasonal nature of tourist demand. Restaurants account for the majority of lobster purchases, with the remainder bought by regular clients for personal consumption. These restaurants serve both locals and visitors. A workshop participant in St. Thomas highlighted the importance of restaurants and local clients, particularly during the low tourist season, stating, "*If they don't carry us, we struggle.*" He further noted that if restaurants did not purchase fish during the low season, fishers would drop them as customers.

Table 4. Seasonal Demand in the U.S. Virgin Islands as reported by workshop participants.

Month	Lobster Demand	Notes
January	High	Tourist high season
February	High	Tourist high season
March	High	Tourist high season
April	Medium	Lent (reef-fish); Tourist shoulder season
May	Medium	Tourist shoulder season
June	Medium	Tourist shoulder season
July	Medium	Tourist low season
August	Low	Tourist low season; Back to school

September	Low	Tourist low season
October	Medium	Tourist shoulder season
November	High	Tourist shoulder season
December	High	Tourist high season

Table 5. Main local festivals and religious observances affecting seafood demand in the U.S. Virgin Islands.

Island	Event Name	Date	Description
St. Thomas	Lobster Fest	November	A festive event featuring a variety of lobster dishes, live music, and a lively atmosphere.
	St. Thomas Carnival	April	One of the Caribbean's largest celebrations, with parades, music, and cultural activities.
	Taste of St. Thomas	April	A culinary event displaying local chefs and restaurants, many showcasing seafood dishes.
	Mango Melee	July	A celebration of mango season with cooking competitions, tastings, and family-friendly activities
St. John	St. John Celebration	End of June - early July	A carnival remembering Independence Day and the end of slavery with parades and fireworks.
St. Croix	Crucian Christmas Festival	December - January	A month-long celebration with parades, music, and cultural events, including seafood.
	Mardi Croix	February	A unique Mardi Gras party with parades, live music, and local food.
	Agrifest	February	An agricultural and food fair exhibiting local produce and seafood.
	Taste of St. Croix	April	A food festival and competition presenting local chefs and seafood dishes.
All	Local Elections	November	Elections bring people together (every 2 years, most recent election in USVI is on Nov. 5, 2024)
	Christmas and New Year's	December	Festivities include church services, boat parades, and fireworks, with increased seafood consumption.

	Lent (Fridays)	February - April	Many Christians abstain from meat and consume seafood on Fridays during Lent.
	Easter Celebrations	April	Church services and community gatherings, often featuring seafood dishes.

Pricing and Sales

Pricing

Fishers from the U.S. Virgin Islands sell directly to restaurants, hotels, and individual customers. Some prefer to take pre-orders rather than selling at traditional fish markets because it allows them to control their pricing and inventory more efficiently.

Although workshop participants from both St. Thomas and St. Croix reported that lobster prices generally remain stable throughout the year, fishers do adjust them based on market conditions to remain competitive. Participants from St. Thomas noted that if they need to move product, they might lower prices and reduce their fishing effort. They emphasized that price reductions affect the entire market, compelling other fishers to adjust their prices as well, which can undermine market stability. One St. Thomian participant explained, "*Sometimes you just gotta bite the bullet and cut back a couple dollars per pound, a dollar per pound and make it work.*" Another participant from St. Thomas mentioned that if the product wasn't selling, he would cut back on fishing and lower prices, though he preferred not to do this often due to the potential domino effect on the market. Another St. Thomian participant noted that if sales are slow, it is more beneficial to reduce fishing activity rather than lower prices. Workshop participants from both islands also noted that locals are generally more price-sensitive than tourists are.

Size Preferences

Participants from St. Thomas also noted that while customers often request specific sizes of lobsters ("*some like bigger, some like smaller*"), they provide "*what the sea gives them*." They do not charge different prices for different lobster sizes; instead, they charge by the pound. They also reported that only undersized lobsters are discarded. One St. Thomian participant summarized the situation regarding restaurant purchases: "*We can't, you know, we can make lobster smaller, but where you'd buy a whole lobster tail, they'll probably sell you half a lobster tail because it's a three-pound lobster versus when you bought a whole lobster tail, it's a pound and a half. So they're gonna work with it or make different dishes with those bigger lobsters*." Participants from St. Croix noted that while most buyers purchase lobsters by weight, some clients specifically request larger lobsters (2-3 pounds). However, the general practice is to sell lobsters at a consistent price per pound, regardless of size.

Factors Affecting Supply and Demand

Workshop participants from both St. Thomas and St. Croix identified several significant factors influencing the supply and demand of seafood, particularly lobster. Table 6 provides a concise overview of the primary issues discussed during the workshops.

Table 6. Key factors affecting lobster supply and demand in the U.S. Virgin Islands as reported by workshop participants.

Issue	Island	Impact on Supply/ Demand	Description
Lobster Migration	All	Supply	Seasonal movement affects catch rates. Lobsters prefer cooler waters (Nov-Jan) and move to deeper waters in summer.
Rising Costs	All	Supply	Increasing prices for materials (e.g., wire for traps) and fuel impacts profitability. Wire costs nearly doubled in recent years.
Regulatory Changes	All	Supply	Limited entry programs, gear restrictions, and carapace length regulations affect market dynamics. Trap reduction program only mentioned in St. Croix.
Technological Advancements	All	Supply	Improvements in trap design, vessel size, and navigation equipment have increased efficiency. Potential use of rebreathers for diving (though not common due to cost).
Local Economic Conditions	All	Demand	Declining local population and per capita income have reduced local seafood demand. USVI's inflation-adjusted per capita personal income fell 14% from 2010 to 2020. Population decreased by 17% in St. Thomas and 19% in St. Croix during the same period.
Seasonal Tourism	All	Demand	Tourist demand peaks from November to April, creating significant fluctuations in demand. Hotels and restaurants are major buyers during this period.
Local Events	All	Demand	Festivals, religious observances (e.g., Lent), holidays (e.g., 4th of July), and special occasions (e.g., graduations) drive higher consumption of lobster.
COVID-19 Pandemic	All	Mostly demand since most fishers were essential workers	Initially decreased tourism and restaurant demand. Later, stimulus checks boosted local demand and visitor spending. Increased prices of certain food items like meat, benefiting local fish demand.

Power Outages	All	Both	Frequent outages affect sales, storage capabilities, and overall market stability. Restaurants and customers hesitate to buy large quantities due to spoilage risk. Impacts fishers' ability to store catch and maintain ice machines.
Hurricanes (e.g., Maria and Irma in 2017)	All	Both	Caused major disruptions and damage to local infrastructure. Initially reduced tourism but increased demand from rebuilding workers. Some residents displaced. Long-term impact on hotel availability, especially in St. Croix.
Market Access	St. Thomas, St. John	Demand	Closure of traditional markets like Fort Milner has impacted sales and customer relationships.
Imports	St. Thomas, St. John	Demand	Occasional imports from British Virgin Islands affect the local market, forcing some local fishers to slow sales for a few weeks.
Poaching	St. Croix	Supply	Illegal fishing activities, particularly by new entrants without proper licenses to dive and trap, impact the market.
Conch Closure	St. Croix	Supply	During conch season, lobster often becomes a bycatch species for many fishers, after that they become target species.
Declining Number of Fishers	St. Croix	Supply	Fewer licensed fishers due to high costs, limited managerial skills, alternative employment opportunities, and relocation after hurricanes.
Trap Poaching	St. Croix	Supply	Divers reportedly stealing lobsters from traps, impacting supply for trap fishers.
Off-island Sales	St. Croix	Demand	Some fishers have sold to other jurisdictions like St. Thomas and Puerto Rico, though some sales (e.g., to Vieques) appeared to have ceased. However, there were mixed reports on this issue.

Technological Advancements

Understanding technological advancements in fisheries is necessary for accurate stock assessments. Tables 7 and 8 highlight key changes discussed during the workshops. Generally, advancements stemmed from four main areas: a) improvements in trap construction (materials and designs), b) changes in vessel and engine sizes, c) updates in fishing practices and equipment (e.g., trap pullers, buoys), and d) enhancements in navigation and safety (e.g., GPS, fish and depth finders, cell phones, weather apps).

To fully grasp these changes over time, it is crucial to incorporate additional sources of information, such as peer-reviewed and gray literature (e.g., Kojis' commercial fishers censuses), and to conduct further research. It is also important to recognize that placing these changes on a timeline can be challenging due to the presence of both early and late adopters. A broader analysis that includes these elements will help create a more detailed timeline of the ongoing transformations in the fisheries sector.

Table 7. Timeline of key technological advancements as recalled by workshop participants in St. Thomas.

Approximate Date	Technology Adopted	Notes
Early to mid-1900's	Initially, ("grandparents time") traps were made out of vine, the rope out of palm tree, and the buoy out of lumber, later traps were made of bush berry wood and chicken wire.	Improved durability of traps
1970s-1980s	Small open wooden boats, some used oars and others had small engines (5 HP). 14-16 foot, considered large Fishers fished 25-28 traps in a set hauled by hand. Traps were individually buoyed because they were pulled by hand.	Limited fishing capacity, fishers got wet As profits increased, fishers could purchase larger engines 35 HP. Wooden boats required more maintenance (needed to keep them wet so they would not leak). Customers would help bring the boat ashore.
1980s	Introduction of manual pullers Transition from chicken wire to stronger materials for traps (plastic/vinyl coated wire, a few had frames made of reinforced steel instead of wood with a zinc anode added to prevent electrolysis) Square traps become more popular Boats became larger (18-25 foot)	Transition to better materials, traps lasted longer Easier to haul traps, but still labor-intensive. Participants stated that trap numbers remained the same after introduction of trap because were participating in other fisheries such as line fishing. Some trappers were pulling 2 sets of traps every week (i.e., go out every 3 days). They also stated that they did not change fishing grounds (i.e., did not venture offshore) Improve ability to set traps and find fish

	Engines became more reliable, but not necessarily fuel efficient (18-55 HP). The cost of a 5-gallon fuel can was $2.50. Boats move away from wooden hulls towards plywood covered with fiberglass and fiberglass hulls. Introduction of fish and depth finders	
Late 1980s-1990s	Introduction of gas-powered pullers Hydraulic pullers only used by 3 or 4 large boats Size of boats increased (20-40 foot), mostly fiberglass	Further reduced physical labor in hauling traps
1990s-2000s	Larger, enclosed boats Hydraulic pullers became more popular	Increased comfort, safety, and fishing capacity Significantly reduced physical labor, increased efficiency
2000s-Present	Introduction of GPS (early 2000's) Four stroke engines became more prevalent in 2010's.	GPS improved ability to locate and return to fishing spots since they did not rely on landmarks to find sites. Pot retrieval become very efficient. GPS helped fishers venture out to other places they did not know they existed (same at the same depth, some deeper). Four stroke engines improved fuel efficiency and were quieter but were harder to maintain ("Four-stroke engines are more expensive because you maintain them differently. Whereas a two stroke you just make sure you put oil in it when you're filling up the gas and you're good to go.")

2000s-Present	Improved trap construction (steel frames, 2-inch mesh wire hex) Some started using pneumatic tools and nail guns to build traps	More durable traps, lasting longer and requiring less frequent replacement Pneumatic tools made easier and more efficient to build wire traps (e.g., cut wire)
2010s-Present	Improved software for "old" pieces of technology (GPS, fish and depth finders, etc.) Weather apps (WINDY, NOAA, Weather Passage, Guru, etc.)	Improved software evolved slowly over time, now can tell e.g. type of bottom (sand vs reef) Allow to plan your (weekly) fishing schedule more efficiently ("instead or praying). Weather reporting (before listen to radio on the morning, now simply check your phone whenever)

Table 8. Timeline of key technological advancements as recalled by workshop participants in St. Croix.

Approximate Date	Technology Adopted	Notes
1960's to 1980's	Transition from chicken wire to more durable materials like coated wire and rebar for traps	Increased durability and longevity of traps. Reduced maintenance costs and frequency of trap replacement. Improved catch rates due to better trap designs and materials.
1970s to 1980s	Trap Puller	Reduced physical strain by mechanizing hauling process, increased efficiency, smaller crew requirements, reduced operational costs Allowed fishing in deeper waters up to 300 feet
Early 1990s	Global Positioning System (GPS) Depth and Fish Finder	Improved navigation, location tracking, and safety, especially in poor weather conditions and at night. Improved efficiency in locating fishing spots, gear (e.g., traps) and retrieving lost equipment, reduced operational costs Enhanced ability to fish at greater depths and areas without losing traps due to drop-off, increasing catch potential

		Enhanced location of fishing grounds, better habitat understanding
2000's-Present	Mobile Communication Devices	Improved communication, enhanced safety, streamlined logistics
2010-Present	Weather Buoys & Apps	Improved safety, navigation, and trip planning by providing better weather forecasts

3.4 Impact of Regulatory Actions

Understanding fishers' perceptions of lobster fishery regulations is important for accurate stock assessments. However, the limited detail in current comments makes it difficult to draw definitive conclusions about policy outcomes. To track regulatory changes over time, it is important to integrate a variety of information sources, including peer-reviewed literature, gray literature (e.g., Caribbean Fishery Management Council Plans and Amendments, Kojis et al.'s commercial fisher censuses and other historical timelines such as those by Rios and Agar from previous SEDARs).

The discussion on regulatory changes highlighted the benefits of carapace length regulations, implemented several decades ago. Most participants in St. Thomas and St. Croix viewed these regulations positively, crediting them for the healthy state of the lobster fishery. One participant from St. Croix reported observing berried lobsters below the legal size, which he argued allowed them to spawn two or three times before reaching harvesting size.

Participants from both islands perceived the moratorium on new fishing licenses as a positive measure to prevent overfishing. They noted that the moratorium helped maintain viability for existing fishers, even though some license holders are not actively fishing. Participants in St. Croix observed that when the moratorium was lifted in 2021, many new entrants began diving and trapping illegally for lobster and conch. The lifting of the moratorium only allows new entrants to use hook and line, which has limited earning potential compared to diving and trapping. Notably, the Fish Trap Reduction Program was mentioned in St. Croix but not in St. Thomas.

4. Conclusions

We used participatory modeling methods to better understand the biological, social and economic components of the USVI lobster fishery. This work sought to increase fishing community engagement and buy-in to the stock assessment process, and integrate local knowledge and perspectives into the stock assessment process. This effort addresses several recommendations from the Caribbean Strategic Planning process workgroup "Socio-economic Data Needs and Implementation into US Caribbean Fisheries Stock Assessment" including: 1) using a systematic approach to guide the consideration of ecosystem and socio-economic factors in stock assessment and fisheries management, 2) using the SEDAR process as a pathway for incorporating socio-economic data into decision-making, 3) conducting conceptual modeling and collection of qualitative data in preparation for assessment, and 4) establishing mechanisms for data collection that addresses ecosystem-based fisheries management and engages stakeholders. Specifically, the local knowledge and stakeholder perspectives documented here can be used to better understand the behavior of fishing fleets and markets, assist with interpretation of trends, and identify changes in selectivity, catchability or other parameters, for which various assumptions must be defined and justified within the stock assessment model.

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The scientific results and conclusions, as well as any views or opinions expressed herein, are those of the authors and do not necessarily reflect those of NOAA or the Department of Commerce.

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