A SURVEY ON WEATHER AND LOBSTER CATCHABILITY

Science 2020

Gulf Nova Scotia Fleet Planning Board
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Introduction and Project Background

The Gulf Nova Scotia Fleet Planning Board (GNSFPB) conducts annual lobster science projects to monitor the quality and recruitment levels throughout the Gulf of Nova Scotia. Given the public-health concerns around Covid-19, the GNSFPB was unable to conduct the typical sampling plan in 2020. Despite this setback, GNSFPB decided to use the unprecedented circumstances to conduct a thorough analysis of our historical data set, and to begin work on identifying trends and positive or negative pulses in the commercial fishery. A major factor in the fluctuation of catch rate throughout a fishing season, and over time, is weather and climate. This report, and associated phone survey, provides a baseline understanding of the impacts of weather (temperature, wind) on the lobster fishery throughout the Gulf of Nova Scotia.

The report will summarize the results of a harvester survey, which was created with the goal of gaining first-hand insight into how the behaviour and catchability of lobsters is directly affected by weather on a local and regional level within the Gulf. For this survey, a total of 15 lobster harvesters from various ports and subzones within the Gulf were interviewed to investigate trends and fluctuations between weather and the catchability of lobsters. The purpose of this report was to develop a resource informed by local harvesters, which would allow the GNSFPB to more accurately identify and monitor trends in our annual lobster data moving forward.

This report was also created in order to gain a better understanding of how lobster respond to changing weather conditions throughout the Gulf within the spring fishing season. Additionally, this archive of anticipated weather impacts will act as an educational tool for new or less experienced harvesters who are still learning about the relationships between landings and weather.

Survey Design

The sampling plan for the phone survey was designed to ensure that there was an even representation from all sub-zones throughout the Gulf of Nova Scotia. The diversity of fishing grounds of the harvesters surveyed will allow for specific information on the effect of weather on the catchability of lobsters to be collected from a regional and local standpoint. We recognize that the survey answers reflect the experiences of just one specific fish harvester and may not be a generalization of all conditions that are present in this area.

The participants selected for this survey were chosen in order to have an evenly distributed representation along the Gulf Nova Scotia coastline. Unfortunately, not all harvesters were able to participate in this survey, and therefore some areas may not specifically be represented in this report. The Gulf Nova Scotia Fleet Planning Board made efforts to interview harvesters that have participated in science work in the past. The participants and all results of the survey are anonymous, with responses labeled by fishing port instead of harvester name in order to protect the identity of the harvester.

The survey was designed to gather insight on key themes identified through a literature review of relevant academic literature and by discussion with Leonard LeBlanc, former fishermen. The completed survey was also reviewed by Stephanie Boudreau, a colleague at DFO with harvester survey experience.

The results are presented in a percentage format. It should be noted that not all answers will add up to a total of 100, as harvesters occasionally had more than one answer for each question or chose not to

answer. We recognize that the survey only sampled 1 perspective from each port, and therefore the results are subject to differences based on personal fishing backgrounds and practices. Some harvesters who fished in deeper waters may have different preferences for ideal water temperature and weather conditions in comparison to harvesters who fish in more shallow waters.

Survey Results

During the survey, the general fishing background of each harvester was recorded. This included information on the harvesters' fishing depth, the bottom structure of their fishing grounds, and whether their fishing grounds changed throughout the season. This was done in order to gain a greater understanding of the harvesters fishing conditions outside of weather influence, as well as identify any trends between the harvesters physical fishing conditions and the influence of weather on their landings.

Harbour	**Subzone**	**Site ID #**	**Fishing Depth at Beginning of Season**	**Fishing Depth at End of Season**	**Bottom Structure**	**Does Your Fishing Grounds Change Throughout Season**
Pugwash	26A3	1	6ft-59ft	6ft-59ft	Mainly rock, some broken bottom	No change other than some inside - outside
Wallace	26A3	2	20ft-60ft to start. Anywhere from 10ft-75ft	10ft-75ft	Mostly rock. Has fished bedrock/sand/gravel in the past	Yes. Start 20ft-45ft. As season progresses move deeper out to 75ft.
Pictou Island	26A1	3	5ft-80ft varies. Spread out for most of season	5ft-80ft varies. Spread out for most of season	30ft-35ft all rock. Some outside into mud	No
Baileys Brook	26A2	4	100ft-5ft	100ft-5ft	Mud/Rock/Sand	No
Arisaig	26A2	5	10ft-90ft	10ft-90ft	Rock/Gravel	No
Ballantynes Cove	26A2	6	80ft-20ft	80ft-20ft	Rock bottom	No
Cribbons Point	26A2	7	80ft-85ft	55ft-70ft	Mostly rock, with a few gravelly places	No
Bayfield	26A2	8	Varies from 35ft-80ft. Typically 45ft-75ft	Varies from 35ft-80ft. Typically 45ft-75ft	Rock/Gravel	Moves gear inwards as season progresses
Havre Boucher	26A2	9	10ft-85/90ft depends on year	10ft-85/90ft depends on year	Mostly gravel	No, usually constant
Aulds Cove	26B S	10	3 fathoms-15 fathoms	3 fathoms-15 fathoms	Rock/Gravel/Sand/ Mud	No
Little Judique	26B S	11	40ft-90ft	10ft-40ft	Rock/Sand or broken bottom	Start deep outside, move inside near end of season
Finlay Point	26B S	12	8 fathoms-18fathms	2 fathoms-10/12 fathoms	Rock/Sand	Deeper at start, may move closer if warm enough

Inverness	26B S	13	6/7 fathoms-14 fathoms	Moves inwards to 3 fathoms in June	Rock	No
Margaree Harbour	26B N	14	Depends on spring. Ice coverage late - Deep, 10 to 20 fathoms. Ice gone early - Shallow, 5 to 12 fathoms.	Depends on season	Rock or gravel	No
Cheticamp	26B N	15	6 fathoms-8 fathoms	1 fathom-3 fathoms	Gravel/Rock. Mostly rock	Yes, follows the lobster

Figure 1. Sampling Locations ordered numerically. Listed with the general fishing background of harvester from each location.

Seasonal Change

During the survey, harvesters were asked a series of questions regarding the male/female ratio of their catches, and if that ratio varied throughout the season. They were also questioned on the occurrence of soft-shelled lobsters in their landings, and whether they noticed a change in when these soft-shelled lobsters were caught.

These questions about seasonal changes regarding male/female ratios and soft-shelled lobsters will provide insight into any regional differences in the conditions that trigger mating and moulting behaviour. This information will also be important to apply to future interpretation of annual Index and Blood Protein data.

Seasonal Change Survey Questions:

Do you see any changes in the male to female ratio throughout the season?

Of the 15 harvesters surveyed, 80% answered yes to this question, with 13% saying no, and 7% replying with somewhat. Roughly half (53%) of surveyed harvesters noted that there was an increase in females caught towards the end of the season. Some harvesters also observed a change in the distribution of size as well as sex throughout the season. One harvester from Margaree Harbour mentioned that sex distribution can be influenced by water depth, with higher rates of males being caught in deeper waters, and more females caught in warmer shallow waters. This fits with a trend suggested by several harvesters that more females are caught in warmer temperatures.

If you catch soft-shelled lobsters, when does that typically start to occur?

40% of harvesters reported that they did not catch soft-shelled lobsters, with 27% replying with yes, and an additional 33% reporting that they caught them sometimes but not very often. Overall, most harvesters said that they caught very minimal amounts of soft shells. 53% of all harvesters observed that soft shells are mostly caught towards the end of the fishing season.

Is the time that you have soft-shell lobsters in your catch changing?

Two thirds of harvesters (67%) reported no, they did not observe any change in the timing of soft shell lobsters in their catch. The remaining third (33%) responded with yes. Of those harvesters, some mentioned that the extension of the 2020 season due to Covid-19 circumstances may have pushed the season closer to the moulting time of lobsters, and because of this an increased number of soft shells have been seen in catches near the end of the season.

Weather Influence

During the survey, harvesters were asked if they considered weather to be an important determinant for their landings, and if they could also list any other determinants that would affect their catch. This acted as a precursor for the rest of the survey, which delved into greater detail of specific weather events such as temperature, wind, and ice coverage.

Weather Influence Introduction Survey Questions:

Do you consider weather to be an important determinant in your catch?

Of the 15 harvesters interviewed, all of them (100%) stated that they considered weather to be an important determinant in their catch. One harvester answered both yes and somewhat to this question as well. A harvester from Pictou Island explained that fishing in shallow water is heavily affected by weather.

When asked what other factors may play a determining role in the outcome of catches, spring tides were also listed as a factor that influenced the landings of harvesters. One harvester operating out of Cribbons Point claimed that the spring tides this year had caused a drop in catches by up to 20%-25%. Four harvesters responded that low pressure systems and thunderstorms had a negative influence on their landings.

Weather Influence – Wind

Harvesters were surveyed on the influence of wind on their landings, with consideration given towards both direction and strength, as well as the positive or negative outcomes of specific wind directions. Most harvesters listed more than one direction in their answers, and many identified specific speeds for certain areas that had a positive or negative affect.

Harbour	Subzone	Site ID #	Positive Wind Directions	Positive Wind Speeds	Negative Wind Directions	Negative Wind Speeds
Pugwash	26A3	1	SW	Strong	E	Strong
Wallace	26A3	2	NW	20 knots and above	E	20 knots and above
Pictou Island	26A1	3	W/SW/SE/NW	Moderate	E/NE	20 knots
Baileys Brook	26A2	4	NW	n/a	NE	5 knots and above
Arisaig	26A2	5	W/NW/SW	n/a	E/NE/S	n/a
Ballantynes Cove	26A2	6	S/SW/W	n/a	E/NE/SE	Strong
Cribbons Point	26A2	7	N/NW/W	15-20 knots for deeper water	E/SE	20 knots and above
Bayfield	26A2	8	SW for shallow. N/NW/W for deep.	n/a	E	n/a
Havre Boucher	26A2	9	N/S/SW	20 knots and below	NE	15 knots and above
Aulds Cove	26B S	10	W/NW/N/SW	20–25 knots	S/SE	Strong
Little Judique	26B S	11	S/SW	15 knots and below	E/NE	NE any strength. Strong E winds
Finlay Point	26B S	12	W/SW	10-15 knots	E/NE	15 knots and above
Inverness	26B S	13	S/SW	Any strength	E/NE	Any strength
Margaree Harbour	26B N	14	S/SW	13-22 knots	E/NE	n/a
Cheticamp	26B N	15	SW	Light	N/NE	Over 20 knots

Figure 2. Sampling Locations ordered numerically. Listed with the reported positive and negative wind directions for each site in addition to surveyed speeds. “n/a” indicates that the harvester did not indicate a specific speed.

Some variation may occur for the direction and speeds of certain sites. Harvesters that participated in this survey may prefer specific wind speeds and directions that may not represent the overall preferences of harvesters from that sampling location. Part of this variation can be attributed to the fishing grounds and personal preferences of the surveyed fish harvester, as they identified speeds and directions that had an influence on their catch from personal accounts. This means that a harvester

fishing outside in deeper water may have identified different positive and negative wind variables than a harvester fishing inside at shallower depths at the same sampling location.

Wind Influence Survey Questions:

What winds can you identify that cause an increase in your catch? Considering both direction and strength?

Regarding directions that offered a positive influence on catches, the majority of fish harvesters (80%) listed Southwest winds as beneficial. 33% listed South winds as positive, and one fisherman noted that Southeast was occasionally helpful. Roughly half (47%) of harvesters responded that West winds caused an increase in their catches, in addition to 47% of harvesters favouring Northwest winds, and 27% favouring North winds. No harvesters listed Northeast or East as beneficial. Overall, winds with a westerly direction (Northwest, West, Southwest) were highlighted by harvesters as directions beneficial to their catch. Preferred wind strength tended to vary across sites, but as one harvester described "West is the best".

What winds can you identify that cause a decrease in your catch? Considering both direction and strength?

Of the 15 harvesters that participated in the survey, 73% identified East winds as having a negative impact on their catches. Northeast was also commonly listed, with 67% of harvesters reporting that wind from a Northeast direction also caused a decrease. A few harvesters (20%) noted that winds from the Southeast had a negative impact as well, in addition to 13% listing South, and 7% listing North winds as a negative influence.

An overall trend can be observed, with winds of an easterly direction (East, Northeast, Southeast) being most commonly identified by harvesters as having negative impacts on their landings. Several harvesters also identified low pressure systems and thunderstorms in conjunction with easterly winds as a cause for drops in catch. One harvester who fishes out of Arisaig described how the timing of certain winds had an impact on catch. South winds early in the season in that area is said to peel off the warm top layer of water. Cold water then comes in underneath and drops the bottom temperature, resulting in a decrease in catch. This phenomenon may be caused by the Ekman Flow dynamic, which is described in detail in the Discussion section below. Some harvesters indicated a specific wind speed at which the impacts are felt.

Responses to these questions were categorized and formatted into a visual map depicting winds of both positive and negative influence on a local and regional level throughout the Gulf of St. Lawrence. This visual aid can be used as a guide for new or less experienced harvesters who are not yet familiar with how wind direction acts as a determinant for their landings.

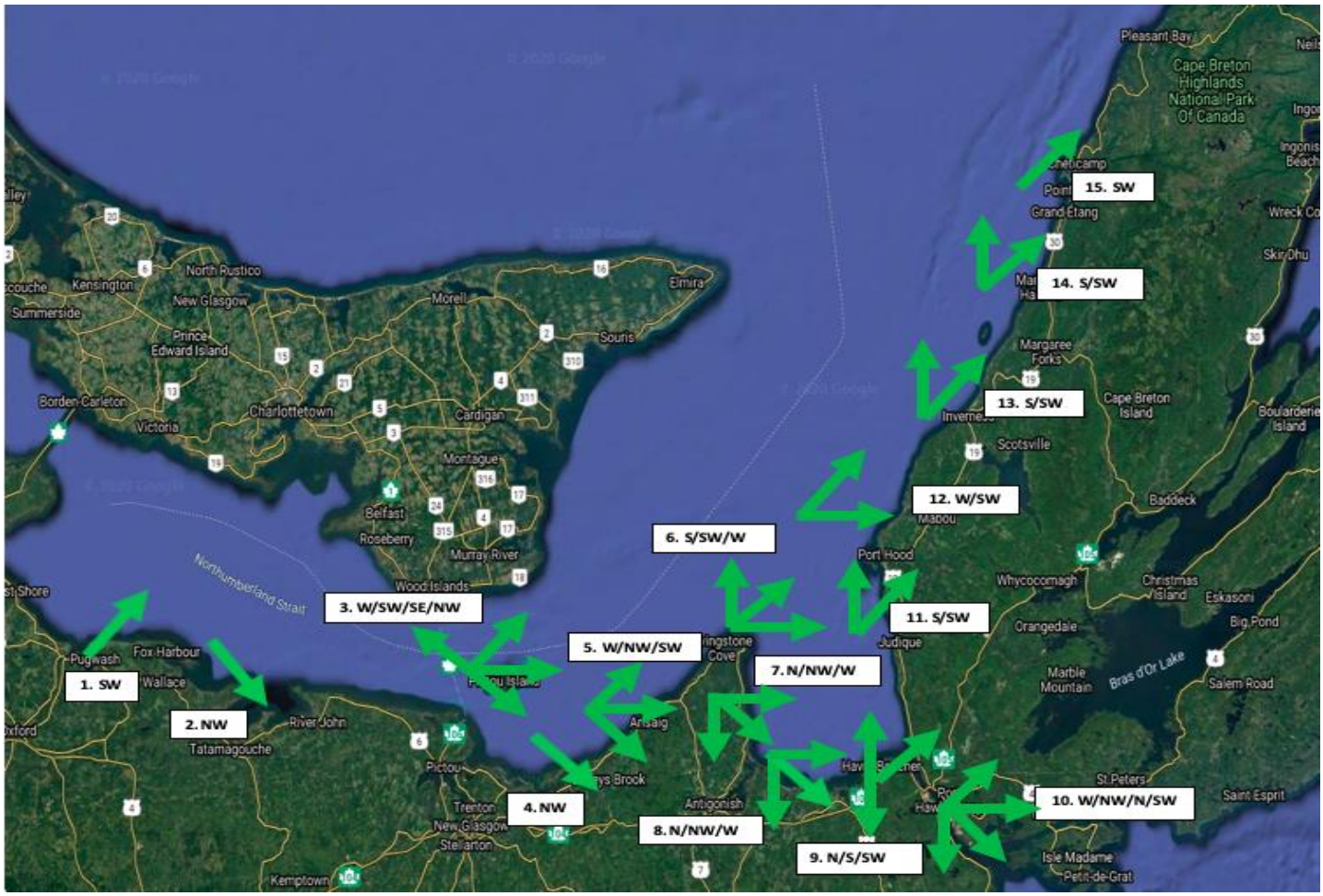

Figure 3. Wind directions with a positive influence on catch at specific sampling locations throughout the Gulf. Sites are numbered according to the list in Figure 1. Arrows represent direction of the wind origin.

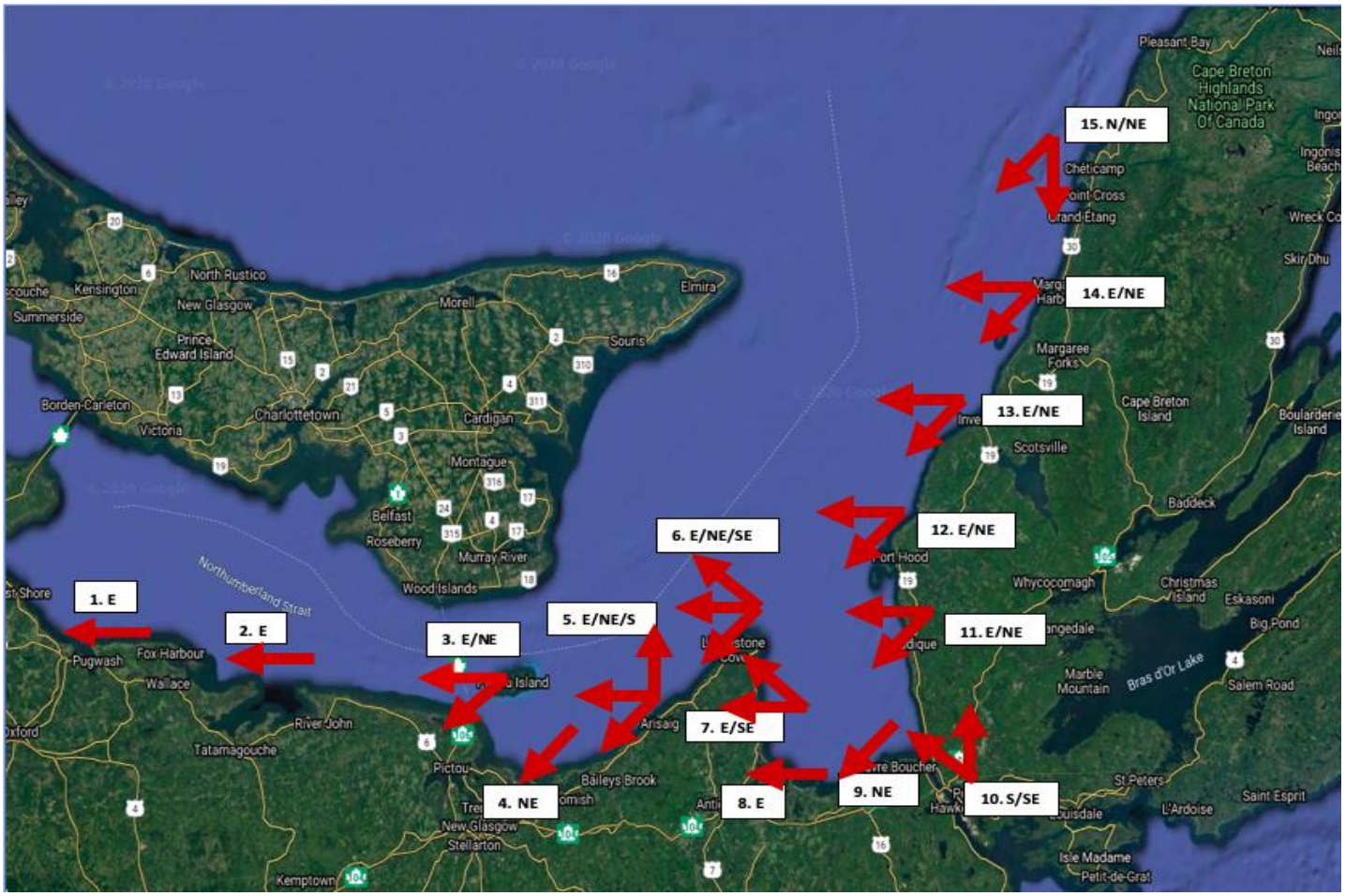

Figure 4. Wind directions with a negative influence on catch at specific sampling locations throughout the Gulf. Sites are numbered according to the list in Figure 1. Arrows represent direction of the wind origin

Temperature

Temperature is an important determinant in the catch rate of lobster. Bottom temperature of water can directly influence lobster activity, as well as life cycles pertaining to moulting and mating. Warmer bottom temperatures increase lobster activity, and subsequently increase catch rate, as lobsters are more likely to move around to forage and are caught in traps. Lobsters move slower in cold water. They are less active and typically less likely to move around and encounter a trap.

This survey interviewed harvesters in order to examine how temperature fluctuations affected their catches on a local and regional level throughout the Gulf. Explanations were given describing if landings were impacted by temperature change, and how lobsters in that region responded to varying temperature fluctuations.

Temperature Influence Survey Questions:

Do temperature fluctuations affect your catch?

Of the 15 harvesters that participated in this survey, all of them (100%) answered yes. One harvester answered both yes and somewhat. Overall there was a general consensus among harvesters that temperature fluctuations acted as a determinant for their catches.

If yes, how do temperature fluctuations affect your catch?

Answers to this question were varied, with 27% of harvesters reporting that temperature fluctuations have a positive impact on their catches, and 40% of harvesters declaring that temperature fluctuations had a negative impact that dropped their catch. 33% of harvesters answered that it could cause both a positive or negative impact, depending on the type of fluctuation. Fluctuations that caused the temperature to increase was commonly reported to increase catches, while negative temperature fluctuations caused catches to drop.

Many of the harvesters that answered either positive or both gave a specific temperature range or ceiling that would cause the catches to increase. Several harvesters indicated that positive temperature fluctuations of around 2-6 degrees Celsius will have a positive influence on landings. Many harvesters emphasized that warming of the water to a certain degree gradually had a positive impact, but too large of a temperature change or a sudden fluctuation would cause catches to drop regardless if the temperature was increasing or decreasing.

If the temperature fluctuation was too large or too sudden, harvesters described lobsters as “going into a shock”. Catches would drop for a day or two until lobsters adjusted to the sudden temperature change. 33% of harvesters noted that there was a time delay for the lobsters to adjust and the catches to recover after a temperature fluctuation. Several harvesters gave specific temperature ranges that would cause the lobsters to go into a shock. One participant out of Pictou Island reported that a drop in temperature by 2, 3, or 4 Degrees Celsius would reduce fishing for a day or two. They noted that drops in temperature by that degree would cause a decrease in catch by up to 200-300 pounds.

Some variation in answers may exist for certain sites. Harvesters that participated in this survey may prefer temperature ranges and fluctuations that may not represent the overall preferences of harvesters from that sampling location. Part of this variation can be attributed to the fishing grounds and personal preferences of the surveyed fish harvester, as they identified how temperature fluctuations had an influence on their catch from personal accounts. This means that a harvester fishing outside in deeper water may be impacted by temperature fluctuations differently than a harvester fishing inside at shallower depths in the same sampling location.

Ice Coverage

This survey examines the potential impacts winter ice coverage may have on the Gulf lobster fishery through firsthand accounts from harvesters. Survey participants were interviewed on the level of winter ice coverage, as well as the timing of the annual ice-breakup.

Ice Coverage Influence Survey Questions:

Does the level of winter ice coverage affect your landings?

When asked this question, 73% of the surveyed harvesters responded that the level of winter ice coverage did influence their landings. 27% answered that the level of ice coverage affected their landings somewhat. Only one harvester said no, they did not see any connection between winter ice coverage and their landings.

Roughly half (47%) of the harvesters stated that they found the level of winter ice coverage to have a positive effect on their landings. One harvester from Aulds Cove described how the winter ice acted as a stabilizer for water temperature, protecting the water from winds. The ice helped prevent drastic temperature fluctuations that would have otherwise negatively affected the catch. A harvester who operates out of Cribbons Point noted that ice was beneficial for their fishing as a personal preference; due to their fishing grounds being in deep water and thus having better fishing when the water is cold and rough in early May. Their personal preference of ice staying later for colder water being beneficial to deep fishing may not be representative of the preferences of all harvesters from Cribbons Point. Several harvesters who participated in this survey and fish at deeper depths acknowledged winter ice staying late as a positive for them as well. The harvester from Pictou Island described the water being colder if the ice left early. They identified that catches at the start of the season seem to be better if the ice stays later.

Some harvesters (27%) said that the level of winter ice coverage can have both a positive or negative effect on their landings depending on the year and the timing of the annual ice break-up. Harvesters had preferences for the timing of the annual ice break-up depending on their fishing depth. Only one harvester operating out of Arisaig stated that the level of winter ice coverage had a negative effect on their landings. They noted that if the ice stays in late the water is too cold. However, they also mentioned there has been less ice coverage in recent years. Overall the effect of winter ice coverage and the influence it may hold over a harvester's landings is directly connected to their fishing grounds and depth.

Does the timing of the annual ice break-up affect your landings?

Two-thirds (67%) of harvesters responded yes, the timing of the annual ice break-up affects their landings and their season. 20% said somewhat, explaining that the timing of the ice break-up does affect landings, but they are unsure of the extent of its influence. 20% of harvesters replied no, they don't believe the timing of the annual ice break-up has any correlation with their landings, other than occasionally delaying the season start date.

The answers regarding the impact the timing has on landings is varied. 20% of harvesters interviewed say it has a positive impact, 20% say it has a negative impact. 33% of harvesters declare it can have both

positive and negative impacts depending on the situation. Several harvesters mentioned the timing of the annual ice break-up affecting the placement of the lobsters during the fishing season. Harvesters who fish in deeper water mentioned ice staying late as being beneficial, as the colder water keeps the lobsters deep where they fish. Many harvesters described their ideal ice break-up time for the most productive season and highest fishing weeks. From the responses gathered, a trend can be seen identifying the annual ice-break up being an important determinant for the timing of the lobster fishing season throughout the Gulf.

Many harvesters (53%) mentioned that the timing of the annual ice break-up may delay the start of their season and have a negative effect on their landings. A few harvesters also mentioned that they have seen less ice in recent years in their areas. The influence the timing of annual ice break-up has on the timing of the season and distribution of the lobsters seems to vary between different sampling locations. Some harvesters describe the ice leaving early causes the lobsters to move to shallower waters, while others claim it keeps them at deeper depths. Overall, it seems many harvesters agree that the break-up of winter ice coverage does have some influence on lobster distribution, the timing of the season, and the timing of the peak fishing weeks.

Discussion

Wind

Data and personal accounts collected from the wind portion of this survey were formatted into visual representations of positive and negative wind directions. Figures 3 and 4 depict winds of both positive and negative influence throughout the Gulf of St. Lawrence. Having a visual diagram of wind direction also allows for the examination of how Ekman Flow affects the lobster fishery within the Gulf. According to Drinkwater and Tremblay (2006), in the northern hemisphere, water is pushed to the right of the wind, perpendicular to the direction of wind flow. When a wind of a specific direction blows past a coastline, water can either be pushed towards or away from the shore; causing a downwelling or upwelling of water. This movement of water is a key factor in the determination of bottom temperature.

Downwelling of water occurs when wind blowing past a coastline pushes water towards the shore, forcing the sun-warmed surface water down to greater depths and raising the bottom temperature of the water. Therefore, a westerly wind blowing past a north-facing shoreline will push the warm upper layers of water towards the shore, causing a downwelling and raising the bottom temperatures in that area. Upwelling occurs when wind blowing past a coastline pushes water away from the shore, resulting in an upwelling of cold water from depth to replace the water being pushed away from shore (Drinkwater, Tremblay, 2006). This upwelling of cold water also causes the bottom temperature of the water to decrease. For example, an easterly wind blowing past a north-facing shoreline would force the warm upper layer of water away from the shore, causing an upwelling.

Wind-induced upwelling or downwelling can change bottom temperature and therefore influence CPUE, as lobster activity and catchability is affected by bottom temperature (Drinkwater, Tremblay, 2006). Downwelling of water is typically beneficial towards lobster landings, as the increase in bottom temperature results in an increase in lobster activity and subsequently catchability (Drinkwater, Tremblay, 2006). The wind maps in this report act as a visual guide to the different wind directions in relation to the shape of the shoreline within the Gulf (Figures 3 and 4). Additionally, it offers insight into how fishing within the Gulf of St. Lawrence is influenced by Ekman Flow on a local and regional level.

Trends can be identified from the data collected in this survey that are consistent with a classical Ekman response. The positive and negative wind map both display trends of wind direction that correspond with the coastline of the sampling location. These trends of direction coincide with Ekman upwelling and downwelling on the coastline of that fishing port. The positive responses to the survey highlighted winds of a westerly origin (Northwest, West, Southwest), which would be on par with downwelling on the coastline of the Gulf. Downwelling would raise the bottom temperature and thus benefit catches. The negative wind directions also showed trends, with winds of easterly origin (Northeast, East, Southeast) being most commonly identified as having a negative influence on catches. This wind direction corresponds with an upwelling, which would cause the bottom temperature to decrease and thus negatively impact catches.

Temperature

Wind direction acts as a determinant for lobster landings through its influence on temperature variability by upwelling and downwelling. Temperature, specifically the bottom temperature of the water, has a direct impact on lobster catchability (Tremblay, Drinkwater, 2006). During this survey, all harvesters identified temperature fluctuations as a determinant for their catch. This is because lobster behaviour is closely linked to water temperature. Studies have shown that lobster activities such as walking rate is dependent on temperature, with higher activity occurring at warmer temperatures. Lobsters are more likely to move and search for food in warmer water temperatures compared to cold. Increased activity also leads to increased possibility of lobsters encountering traps, raising CPUE and catchability (Paloheimo, 1963).

Temperature also influences biological processes of lobsters, such as the moulting and mating cycles. Lobsters typically moult after the end of the spring fishing season within the Gulf of St. Lawrence, but lobsters may begin preparing to moult during the fishing season depending on the temperature. If warmer water temperatures are experienced during the spring season, lobster may prepare to moult earlier. These cycles affect lobster catchability as well, as lobsters preparing to moult or mate are less likely to forage for food and are thus less likely to be caught (Tremblay, Drinkwater, 2006).

Even though lobster activity, and thus catchability, increases with warming temperatures, there is a simultaneous decrease in catchability at the time that lobsters are preparing to moult – which partially negates the benefits from increased water temperature (Tremblay, Drinkwater, 2006). Of the harvesters that participated in this survey, opinions were varied on the influence temperature fluctuations had on their catches. A common theme observed among the survey results was that an increase in temperature caused an increase in catches; whereas a decrease in temperature led to a drop in catch. These observations also align with the process of upwelling and downwelling and how they affect bottom temperature and lobster catchability.

Many harvesters also mentioned that gradual temperature fluctuations were better for catch. They noted that sudden large fluctuations in temperature caused catches to drop as lobsters entered a “shock”. After a sudden temperature fluctuation, catches were reported to drop for a period of a couple days until the lobsters adjusted. The acclimation and walking speeds of lobster in connection to temperature has been studied previously. McLeese and Wilder (1958) conducted an experiment that tested lobsters at their acclimated temperatures as well as temperatures they were not acclimated to in order to create an Index of Lobster Activity.

Ice Coverage

There is little academic or government reporting on the relationship between seasonal ice coverage and fishing success throughout the Southern Gulf of St. Lawrence, so the comments by harvesters are anecdotal and cannot be verified by literature. In summary, a majority of harvesters (70%) believe that the level of winter ice coverage does influence their seasonal landings. A smaller portion (26%) think that the level of ice only somewhat affects landings. Only one harvester said that the level of ice coverage doesn't affect landings.

There appears to be a consensus that higher ice coverage has a positive affect on seasonal landings. Harvesters theorize that the ice cover acts as insulation and will stabilize the water temperature by protecting it from wind-induced temperature fluctuations.

The break-up and melting of the ice-cover plays a role in the distribution of lobster during the first few weeks of the fishery. It appears that the preference for early or late departure of ice depends directly on fishing location and depth, as some of the responses were contradictory. One harvester from Cribbons Point mentioned that they fish in deeper water, and therefore prefer an early departure of ice because it keeps the water colder longer (keeping the lobsters at a deeper depth). While another harvester from Margaree Harbour indicated that an early departure of ice will bring lobsters closer to the shore.

It is evident that seasonal ice coverage does have some influence over lobster landings, especially during the first few weeks of the fishery. The ice indirectly affects landings by influencing water temperature. The information in the section above (Temperature) may explain some of the interactions between ice coverage and landings.

Conclusion

This report aimed to investigate the harvester perspective on the role that weather plays with regards to short term changes in lobster landings within the Gulf of St. Lawrence. The report summarizes the results of a survey, which collected first-hand accounts of the impact that temperature, wind and other climactic conditions have on lobster catches. The results provide the GNSFPB with a resource that is informed by local opinions that will help to identify and monitor trends in future lobster science data from annual sampling in the Gulf. We recognize that the information collected through the survey is a brief glimpse into the individual experience of a few harvesters and is also dependent on factors such as fishing depth, proximity to shore, and general level of experience.

Wind was identified to play a significant role on lobster landings. The majority of harvesters identified that winds of a westerly direction (Northwest, West, Southwest) have a positive influence on their catch. Harvesters noted that winds of an easterly direction (Northeast, East, Southeast) cause a decrease in their catch. These results correspond with the theory of Ekman Response where wind-induced upwelling or downwelling can change the bottom temperature, thus influencing lobster activity and catchability (Drinkwater, 2006). For example, an easterly wind on a north-facing shoreline would cause an upwelling that is not beneficial to lobster activity and would cause a brief decrease in CPUE. Figures 3 and 4 provide a visual summary of the relationship between wind direction and catchability, generally westerly winds are positive and easterly winds are negative.

Ice coverage and the timing of the annual ice break-up is another mechanism that influences the water temperature, especially in the first few weeks of the season. The timing of the ice break-up is said to determine the physical distribution of lobster in the beginning of the season. For harvesters who fish at a deeper depth, the annual ice cover may allow for 'peak production' in the first several weeks of the season. Several harvesters did note that they have seen less ice in recent years compared to historical averages.

Water temperature is closely tied to changes in lobster landings, as it influences lobster behaviour and the timing of important biological processes such as moulting and mating. There was a clear consensus that temperature fluctuations affect lobster catches in the short-term. Harvesters explained that fluctuations that result in a warmer bottom temperature will have a positive influence on catches; while fluctuations to a cooler temperature will cause catches to drop. Lobsters become less active in colder water, and spend less time and energy walking and searching for food or mates. The majority of harvesters that identified temperature fluctuations as potentially having a positive influence noted that the temperature increase had to be gradual. Sudden temperature fluctuations, regardless of increase or decrease in temperature, would send lobster into a shock.

The GNSFPB should apply the knowledge gained in this survey to all future annual reporting of the Index and Blood Protein reports. It would be worthwhile to conduct statistical analysis using the data from the seasonal temperature probes in the Gulf, alongside the Index data. Again, we recognize that the experiences recorded in this report are those of individual fish harvesters. If there is an opportunity to conduct a similar survey in the future, it would be useful to clarify some of the questions to eliminate inconsistencies in the format of the answers and to increase the number of participants to improve representation.

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